

Atlantic States Marine Fisheries Commission

**DRAFT AMENDMENT 3 to the
Interstate Fishery Management Plan
For SHAD AND RIVER HERRING
For Public Comment
(American Shad Management)**



ASMFC Vision Statement:

Healthy, self-sustaining populations for all Atlantic coast fish species or successful restoration well in progress by the year 2015.

Approved for Public Comment August 2009

Draft Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring

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Atlantic States Marine Fisheries Commission
Shad and River Herring Plan Development Team

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This Draft Amendment was developed through the concerted and dedicated efforts of several individuals, groups and agencies. Guidance was provided by the Atlantic States Marine Fisheries Commission's Shad and River Herring Management Board, chaired by Paul Diodati (Massachusetts Division of Marine Fisheries (2008-2009)). Technical assistance was provided by the Shad and River Herring Technical Committee (chaired by Robert Sadzinski (2008-2009)), the American Shad Stock Assessment Subcommittee (chaired by Andy Kahnle (2004-2007)), and the Shad and River Herring Advisory Panel (chaired by Patricia Jackson (2008) and Byron Young (2009)).

Special assistance was provided by the following people: Robert Beal (ASMFC), Toni Kerns (ASMFC), Jessie Thomas (ASMFC) and Kathryn Hattala (NY DEC). The Plan Development Team is also grateful to the many individuals who made contributions to the preparation of this Amendment. These include the professional and technical staff of the various state and federal agencies involved in the Atlantic States Marine Fisheries Commission who provided the editorial comments and suggestions to the Team. In addition, the Atlantic States Marine Fisheries Commission extends its gratitude to the numerous dedicated conservationists, commercial fishermen, and anglers who have written letters and attended public hearings to express their opinions and ideas about American shad management.

PUBLIC COMMENT PROCESS AND PROPOSED TIME LINE

The public is encouraged to submit comments regarding this document during the public comment period. Comments will be accepted until **5:00 p.m. (EST) on October 22, 2009**. Regardless of when they were sent, comments received after that time will not be included in the official record. The Shad and River Herring Management Board will use public comment on this Draft Amendment to develop the final Amendment 3 to the Shad and River Herring Fishery Management Plan.

You may submit public comment in one or more of the following ways:

1. Attend public hearings held in your state or jurisdiction
2. Refer comments to your state's member on the Shad and River Herring Management Board or Advisory Panel, if applicable
3. Mail, fax, or email written comments to the following address:
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If you have any questions please call Kate Taylor at (202) 289-6400.

PUBLIC COMMENT INPUT

This Commission is seeking public comment on all sections of the draft Amendment, but specifically is interested in public comment on the following regulatory and monitoring programs, as well as the timeline for implementation:

PROPOSED MONITORING PROGRAM SPECIFICATIONS (Page 17)

States and jurisdictions will be required to conduct annual fisheries independent and dependent monitoring. Fisheries independent monitoring includes juvenile abundance, adult stock structure and abundance, and stocking success. Fisheries dependent monitoring includes monitoring of American shad commercial and recreational fisheries.

PROPOSED COMMERCIAL FISHERIES MANAGEMENT MEASURES (Page 31)

Options considered for regulation include the following:

- Option 1 – Status Quo
- Option 2 – Reduce harvest in existing directed shad fisheries.
- Option 3 – Close fisheries with exceptions for those with sustainable fisheries.
- Option 4 – Close directed fisheries on mixed stocks.
- Option 5 – Coastwide moratorium on all American shad harvest.

PROPOSED RECREATIONAL FISHERIES MANAGEMENT MEASURES (Page 32)

Options considered for recreational regulation include the following:

- Option 1 – Status Quo
- Option 2 – Reduce harvest in existing recreational shad fisheries.
- Option 3 – Recreational license/permit for American shad fisheries.
- Option 4 – Close fisheries with exceptions for systems with a sustainable fishery.
- Option 5 – Allow catch and release recreational fisheries only.
- Option 6 – Moratorium on American shad recreational fisheries

PROPOSED TIMELINE FOR IMPLEMENTATION

The Shad and River Herring Management Board is considering the following implementation deadlines *once Amendment 3 is approved*:

- Option 1 – 3 months
- Option 2 – 6 months
- Option 3 – 12 months
- Option 4 – January 1st of the following year

TENTATIVE TIMELINE FOR AMENDMENT 3 COMPLETION

	May 2008	June 2008	July 2008	Aug 2008	Jan 2009	Feb 2009	Mar 2009	Apr 2009	Aug 2009	Sept 2009	Oct 2009	Nov 2009	Dec 2009	Jan 2009
Approval of Draft PID by Management Board	X													
Public review and comment on PID	X	X	X											
Board review of public comment; Board direction on what to include in Draft Amendment 3				X										
Preparation of Draft Amendment 3					X	X	X	X						
Review and approval of Draft Amendment 3 by Management Board									X					
Public review and comment on Draft Amendment 3									X	X	X	X		
Board review of public comment on Draft Amendment 3												X		
Preparation of Final Amendment 3													X	
Review and approval of the final Amendment 3 by the Board, Policy Board and Commission														X

EXECUTIVE SUMMARY

INTRODUCTION: The Commission is currently developing Amendment 3 to its Interstate Fishery Management Plan (or FMP) for Shad and River Herring under the authority of the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA 1993). Amendment 3 will address management measures only for American shad. Management measures for alewife and blueback herring (collectively river herring) are contained in Amendment 2. Shad and river herring management authority lies with the coastal states and is coordinated through the Commission.

Responsibility for compatible management action in the Exclusive Economic Zone (EEZ) from 3-200 miles from shore lies with the Secretary of Commerce through the ACFCMA in the absence of a federal fishery management plan.

STATEMENT OF THE PROBLEM: In 2007, the American Shad Stock Assessment Subcommittee (SASC) completed an American shad stock assessment report, which was accepted by the Peer Review Panel (PRP) and the Shad and River Herring Management Board in August 2007 (ASMFC 2007). The 2007 American shad stock assessment found that stocks were at all-time lows and did not appear to be recovering to acceptable levels. It identified the primary causes for the continued stock declines as a combination of excessive total mortality, habitat loss and degradation, and migration and habitat access impediments. Although improvement has been seen in a few stocks, many remain severely depressed compared to their historic levels.

Anadromous fish species, such as American shad, are unlike almost all other fish species that are cooperatively managed under ASMFC. Most other ASMFC species are exclusively oceanic and all of their habitat and life cycle needs can be satisfied in the marine environment (although some may utilize coastal shore or estuarine habitat for part of their life). Anadromous fish, as a result of their freshwater and estuarine spawning and nursery requirements, must come into close contact with human populations, and are therefore vulnerable to the many threats and potential sources of injury and mortality associated with human activity in and around rivers and estuaries.

This document identifies specific issues on which the Commission is seeking public comment:

- American shad monitoring requirements;
- Bycatch monitoring requirements;
- Commercial fisheries management measures; and
- Recreational fisheries management measures
- Habitat recommendations
- Implementation Plans

IMPLEMENTATION BENEFITS: Implementation of Amendment 3 and consequent restoration of American shad stocks will produce significant ecological, cultural and economic benefits. Ecologically, American shad and other alosines played important ecological roles in freshwater, estuarine and marine environments during their life cycles. Cultural benefits will arise in part from the revitalization of traditional fisheries and the numerous shad festivals historically held along the east coast each spring during the spawning run. Cultural benefits to Native American tribes will arise through restoration of their traditional fisheries and fishing rights.

DESCRIPTION OF THE RESOURCE AND MANAGEMENT UNIT: The American shad is the largest North American member of the shad and herring family, and historically occurred in all major rivers from Maine through the east coast of Florida. The management units for American shad under this

Fishery Management Plan Amendment include all migratory American shad stocks of the Atlantic coast of the United States.

LIFE HISTORY AND HABITAT REQUIREMENTS: American shad are a migratory anadromous fish that spend most of their life at sea along the Atlantic coast and enter freshwater as adults in the spring to spawn. Most young emigrate from their natal rivers during their first year of life. American shad stocks are river-specific; that is, each major tributary along the Atlantic coast appears to have a discrete spawning stock. Habitats used by American shad include adult spawning sites in coastal tributaries and larval and juvenile nursery areas in the freshwater portions of the rivers and their associated bays and estuaries.

GOALS AND OBJECTIVES:

Goal: Protect, enhance, and restore Atlantic coast migratory stocks and critical habitat of American shad in order to achieve levels of spawning stock biomass that are sustainable, can produce a harvestable surplus, and are robust enough to withstand unforeseen threats.

Objectives:

- Maximize the number of juvenile recruits emigrating from freshwater stock complexes.
- Restore and maintain spawning stock biomass and age structure to achieve maximum juvenile recruitment.
- Manage for an optimum yield harvest level that will not compromise Objectives 1 and 2.
- Maximize cost effectiveness to the local, state, and federal governments, and the ASMFC associated with achieving Objectives 1 through 3.

Strategies to Achieve Objectives:

- Quantify and effectively manage sources of bycatch mortality where possible.
- Quantify and effectively manage sources of predation where possible and appropriate.
- Restore and maintain access to historical spawning and nursery habitat (i.e., dam removal and fishway installation).
- Maintain total mortality (Z) of American shad stocks at or below stock assessment benchmarks.
- Ensure that adequate monitoring techniques are implemented to measure migratory success (i.e., upstream and downstream fish passage at barriers).
- Ensure that stock monitoring data are collected and that they are adequate to characterize stock status and stock response to management actions (i.e., develop a sampling program that provides an annual measurable output for spawning stock and juvenile production status)
- Achieve river specific restoration targets for American shad populations as specified in the recent shad assessment or in existing stock specific restoration plans.
- Ensure that the production of hatchery fish is used effectively during restoration efforts.
- Maximize cost effectiveness of data collection to minimize costs to states and jurisdictions through coordinated monitoring, flexibility in monitoring methods, and early vetting of monitoring and management plans.
- Identify interactions between other Commission species management plans (positive or negative) and the objectives stated above.

SUSTAINABLE FISHERY DEFINITION: This document proposes the adoption of a sustainable fisheries definition which is consistent with current coastwide management of river herring (alewife and blueback herring) as described in Amendment 2 to the Shad and River Herring FMP. Amendment 2 defines a sustainable fishery as “those that demonstrate their stock could support a commercial and/or recreational fishery that will not diminish the future stock reproduction and recruitment.”

OVERFISHING DEFINITION: Amendment 1 to the American shad and River Herring Fishery Management Plan (ASMFC 1999) refined the definition of overfishing for American shad stocks to be an *instantaneous rate of fishing mortality* rate (F) from directed fisheries that was at or above a benchmark of F_{30} . The most recent stock assessment (ASMFC 2007) concluded that the Amendment 1 definition of overfishing was no longer valid for American shad stocks since they are subjected to several sources of human-induced mortality that includes: directed fishing (F), fish passage mortality at dams, river pollution, and bycatch and discard in indirect fisheries activity. As an interim solution, the recent ASMFC stock assessment (ASMFC 2007) combined all human-induced rates into a single overall human induced rate called H. Since the components of human-induced mortality (directed fishing, dam-induced, pollution, and bycatch) are difficult or impossible to quantify, ASMFC (2007) did not attempt to develop a benchmark for the combined H that was analogous to F_{30} for directed fishing alone. Instead, ASMFC (2007) developed benchmark values for *total instantaneous mortality* or Z_{30} (see Table 1). Under this new definition, American shad stocks are affected by a combined human-induced instantaneous mortality rate (H) and by natural mortality (M). Therefore, the total instantaneous mortality (Z) equals H plus M. Overfishing is defined as fishing a given stock at a rate which exceeds the specified Z_{30} .

MONITORING PROGRAM SPECIFICATIONS: The collection of adequate fish stock and fishery monitoring data is necessary to achieve the goal and objectives of the American Shad management program. A well designed monitoring program provides measurable outputs that can be used to judge the effectiveness of current management efforts in achieving the desired outcome. This amendment recommends that states increase coordination of data collection on American shad among states with shared water bodies, as well as between freshwater and marine sections of agencies. All data should be provided to ASMFC.

This amendment proposes modification to some of the monitoring requirements specified in Addendum 1 to Amendment 1 of the Shad and River Herring Fishery Management Plan. All other monitoring requirements will remain compliance criteria. States and jurisdictions will be required to conduct annual fisheries independent and dependent monitoring. Fisheries independent monitoring includes juvenile abundance, adult stock structure and abundance, and stocking success. Fisheries dependent monitoring includes monitoring of American shad commercial and recreational fisheries. States and jurisdictions may apply to the Management Board for *de minimus* status. Monitoring will be conducted using methods proposed by the state or jurisdiction and subject to Technical Committee review and Board approval.

States and jurisdictions may propose to the Management Board alternative monitoring if they develop a stock specific definition of a sustainable fishery or stock recovery targets and the proposed alternative monitoring measures progress to the definition or targets.

BYCATCH MONITORING AND REDUCTION: States and jurisdictions will be required to annually monitor bycatch and discard of American shad in fisheries that operate in state waters of rivers and estuaries. Ocean bycatch and discard, however, are coastwide problems that affect shad stocks in all coastal states. Therefore, this amendment recommends that ocean bycatch and discards be monitored cooperatively by coastal states through the Commission, in cooperation with Fishery Management Councils and NOAA Fisheries.

PROPOSED REGULATORY PROGRAM: The management program enacted by this amendment may include any one strategy or combination of strategies listed below. Based on the public comment received as the result of reviewing this draft and recommendations from the Shad and River Herring Technical Committee and Shad and River Herring Advisory Panel, the Shad and River Herring Management Board will devise broad guidelines for a management program to be adopted via this amendment. The details of implementation are not included because details are to be proposed by the states in response to Management Board guidelines and will be subject to Management Board approval.

COMMERCIAL FISHERIES MANAGEMENT MEASURES: Mandatory reporting on catch and effort in active commercial fisheries for all alosines (American shad, hickory shad, and river herring) is required as per Section 3. Options considered for regulation include the following:

- Option 1: Status Quo
- Option 2: Reduce harvest in existing directed shad fisheries.
- Option 3: Close fisheries with exceptions for those with sustainable fisheries.
- Option 4: Close directed fisheries on mixed stocks.
- Option 5: Coastwide moratorium on all American shad harvest.

RECREATIONAL FISHERIES MANAGEMENT MEASURES: All states and jurisdictions are required to monitor and report recreational catch and harvest of American shad, and to maintain appropriate regulations for limiting the harvest. Options considered for recreational regulation include the following:

- Option 1: Status Quo
- Option 2: Reduce harvest in existing recreational shad fisheries.
- Option 3: Recreational license/permit for American shad fisheries.
- Option 4: Close fisheries with exceptions for systems with a sustainable fishery.
- Option 5: Allow catch and release recreational fisheries only.
- Option 6: Moratorium on American shad recreational fisheries

HABITAT CONSERVATION AND RESTORATION: American shad stocks along the Atlantic coast are greatly diminished compared to historic levels of the 1880's and early 1900's when landings were near 50 million pounds per year. Much of this reduction has been related to spawning and nursery habitat degradation or blocked access to habitat, resulting from human activity (e.g.; human population increase; sewage and storm water runoff; industrialization; dam construction; increased erosion, sedimentation and nutrient enrichment associated with agricultural practices; and losses of riparian forests and wetland buffers associated with resource extraction and land development). Protection, restoration and enhancement of American shad habitat, including spawning, nursery, rearing, production, and migration areas, are critical objectives necessary for preventing further declines in American shad abundance, and restoring healthy, self-sustaining, robust, and productive American shad stocks to levels that will support the desired ecological, social, and economic functions and values of a restored Atlantic coast American shad population.

THREATS TO AMERICAN SHAD HABITAT: Threats to American shad habitats include the following: barriers to migration; water withdrawals; toxic and thermal wastewater discharge; channelization, dredging and instream construction; inappropriate land uses; atmospheric deposition; climate change; competition and predation by invasive and managed species; fisheries activities; and instream flow regulation.

RECOMMENDATIONS FOR HABITAT RESTORATION, ENHANCEMENT, USE AND PROTECTION: Detailed recommendations are provided to states and jurisdictions for avoiding, reducing or mitigating the impact of the following threats on American shad habitats: dams and other obstructions and water quality and contamination. Additional detailed recommendations are provided for habitat protection and restoration; state permitting programs; and American shad stock restoration and management of stocking programs. While this amendment proposes the development of habitat restoration and protection programs, implementation of these programs is not required.

IMPLEMENTATION PLANS: In order to be successful in achieving the stated goal of Amendment 3, states are required to develop Implementation Plans. Implementation Plans will consist of two parts: 1. Review and update of the fishing/recovery plans required under Amendment 1 for the stocks within their jurisdiction; and 2. Habitat plans. The two components may be combined into a single Implementation Plan. Separate Implementation Plans shall be developed for those systems listed in Tables 2 and 3 and which are under the state's authority. For states which share a river or estuary, states should include those monitoring programs conducted or planned by the state, applicable state regulations, and habitat and habitat threats applicable to state waters. In shared water bodies where there is a management cooperative, the cooperative or a member state or jurisdiction can be appointed to write the Implementation Plan. States are encouraged to develop plans for any additional systems, as feasible. In some cases, the requirements of this section may be largely met by existing basinwide diadromous fish restoration plans prepared by the federal and state agencies to address the requirements of the Federal Energy Regulatory Commission hydropower licensing requirements.

FISHING/RECOVERY PLAN UPDATES: The updated Fishing/Recovery Plan must include a description of existing and planned monitoring and existing and planned regulatory measures. It may also include a definition of sustainability, development of benchmark goals (if different from or in addition to those identified in 2007 Stock Assessment), and a proposed timeframe to achieve stated objectives. Monitoring sections of the fishing/recovery plan updates should address the state specific monitoring requirements specified in Tables 2 and 3. If states cannot conduct required monitoring, the plan update should identify required monitoring that cannot be done and reasons why it cannot be conducted. It is the intention of this amendment to discuss such problems with state implementation prior to plan adoption so that the Commission can work with the state to obtain secure funding or to develop an alternative. The amendment contains a detailed framework for the Fishing/Recovery Plan updates (see Section 6.1).

If a state or jurisdiction chooses to develop a definition of sustainability or stock restoration goals as part of its Fishing/Recovery Plan, it may propose for Management Board review an alternative monitoring plan that measure stock status relative to the definition or goal.

HABITAT PLANS: The Habitat Plans should include a summary of current and historical spawning and nursery habitat, threats to those habitats, and habitat restoration programs. States and jurisdictions may focus on those threats to habitats within their boundaries that are deemed most significant. A recommended framework for the Habitat Plans is included in the amendment (see Section 6.2). Many of the recommended assessments may have already been conducted by the states as part of their Wildlife Action Plans or Comprehensive Wildlife Conservation Plans.

AMENDMENT REVISIONS: Once the American shad Management Board approves a management program, states and jurisdictions are required to obtain approval from the Management Board prior to changing their management program in any way that might alter a compliance measure. Changes to management programs that affect measures other than compliance measures must be reported to the Management Board but may be implemented without prior approval.

ADAPTIVE MANAGEMENT: It is important to note that this amendment provides the Management Board with the ability to re-evaluate and modify the management program very rapidly in response to stock conditions or public input.

COMPLIANCE: Full implementation of the provisions in this amendment is necessary for the management program to be equitable, efficient and effective. States (to include states as well as the District of Columbia and Potomac River Fisheries Commission) are expected to implement these measures faithfully under state laws.

MANDATORY COMPLIANCE ELEMENTS FOR STATES: A state or jurisdiction will be determined out of compliance with the provision of this fishery management plan according to the terms of Section 7 of the ISFMP Charter if:

- It's Implementation Plans and annual compliance reports have not been approved by the Shad and River Herring Management Board; or
- It fails to meet any scheduled action required by Section 9.2, or any addendum prepared under adaptive management (Section 7.2); or
- It has failed to implement a change to its program, when determined necessary by the Shad and River Herring Management Board; or
- It makes a change to its monitoring programs required under Section 3 or its regulations required under Section 4 without prior approval of the Shad and River Herring Management Board.

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1. INTRODUCTION

The Atlantic States Marine Fisheries Commission (Commission) was formed by the 15 Atlantic coast states in 1942 in recognition that fish do not adhere to political boundaries. The Commission serves as a deliberative body, coordinating the conservation and management of the states shared near shore fishery resources (marine, shell, and anadromous) for sustainable use. The Commission focuses on responsible stewardship of marine fisheries resources. It serves as a forum for the states to collectively address fisheries issues under the premise that as a group, using a cooperative approach, they can achieve more than they could as individuals. The Commission does not promote a particular state, jurisdiction, or a stakeholder sector.

The Commission's mission is to promote the better utilization of the marine, shell, and anadromous fishery resources of the Atlantic seaboard through the development of a joint program for the promotion and protection of such resources, and by the prevention of physical waste of the fisheries from any cause.

The vision statement of the Commission is: Healthy, self-sustaining populations for all Atlantic coast fish species or successful restoration well in progress by the year 2015.

The Commission is currently developing Amendment 3 to its Interstate Fishery Management Plan for Shad and River Herring (ACMFC 1985, 1999, 2000, and 2002), or FMP, under the authority of the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA 1993). Shad and river herring management authority lies with the coastal states and is coordinated through the Commission. Responsibility for compatible management action in the Exclusive Economic Zone (EEZ) from 3-200 miles from shore lies with the Secretary of Commerce through ACFCMA in the absence of a federal fishery management plan. Further, each federal Fishery Management Council "...shall comment on and make recommendations to the Secretary and any Federal or State agency concerning any such activity that, in the view of the Council, is likely to substantially affect the habitat, including essential fish habitat, of an anadromous fishery resource under its authority" (from Magnuson-Stevens Fishery Conservation and Management Act, Section 305, P.L. 104-297, (b) FISH HABITAT (3)(B)).

PLEASE NOTE: While the FMP is the management document for American shad (*Alosa sapidissima*), hickory shad (*Alosa mediocris*), blueback herring (*Alosa aestivalis*), and alewife (*Alosa pseudoharengus*), **the required provisions of Amendment 3 pertain only to American shad.** The adoption of this amendment would not alter the monitoring requirements or fishery management measures for alewife, blueback herring or hickory shad.

1.1 BACKGROUND INFORMATION

1.1.1 Historical Fishery and Management

Historically, American shad, hickory shad, alewife, and blueback herring (collectively termed alosines) were an extremely important fishery resource and supported very large commercial fisheries along the Atlantic coast of both the United States and Canada. Coastwide landings of American shad at the turn of the century were approximately 50 million pounds. However, by

1980, they decreased dramatically to 3.8 million pounds. Total landings of river herring (alewife and blueback herring) varied from 40-65 million pounds from 1950-1970, then declined steadily thereafter to less than 12 million pounds by 1980. These dramatic declines in commercial landings were perceived as an indication that a coordinated management action would be required to restore alosine stocks to their former levels of abundance. Therefore, in 1981, the members of the Atlantic States Marine Fisheries Commission recommended the preparation of a cooperative Interstate Fishery Management Plan (FMP) for American Shad and River Harrings. The initial FMP was completed in 1985 and recommended management measures that focused primarily on regulating exploitation and enhancing stock restoration efforts. At the time the FMP was completed, the implementation of its recommendations was at the discretion of the individual states, because the Commission did not have direct regulatory authority over individual state fisheries.

A supplement to the FMP was approved by the Commission in 1988. This document included reports prepared by the Shad and River Herring Stock Assessment Subcommittee and summaries of material presented at a 1987 Anadromous Alosine Research Workshop. The 1988 supplement also changed management recommendations and research priorities based on new research findings.

In spite of the efforts to develop and implement the FMP and supplements, alosines stocks continued to decline (Figure 1) and, in 1994, the Plan Review Team and the Management Board determined that the original FMP was no longer adequate for protecting or restoring the remaining shad and river herring stocks. They concluded that the declines may have been the result of overharvest by in-river and ocean-intercept fisheries; excessive striped bass predation (Savoy and Crecco 1995); biotic and abiotic environmental changes; and loss of essential spawning and nursery habitat due to water quality degradation and blockages of spawning reaches by dams and other impediments.

A second coastwide assessment was completed 1998 and Amendment 1 to the FMP was adopted in April 1999. The amendment was revised by addendums in 2000 and 2002. Amendment 1 and the addendums focused on maintaining directed fishing mortality below set benchmarks. These directives have defined ASMFC shad management through the present.

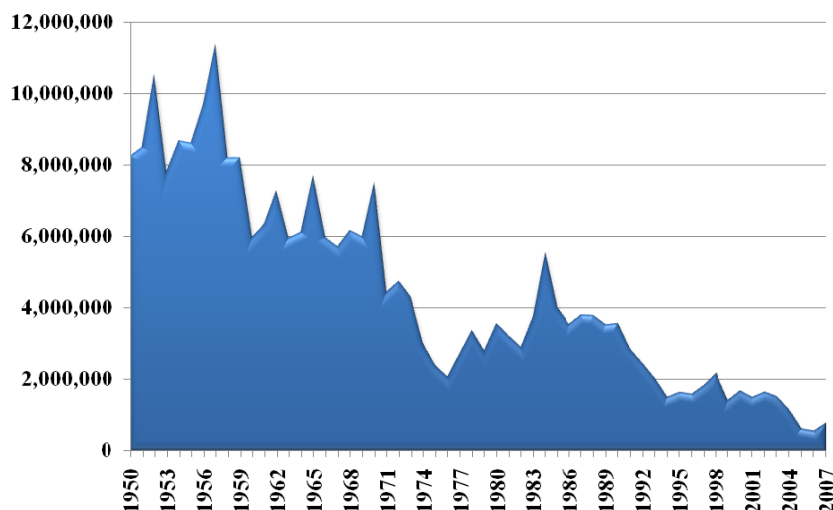


Figure 1. Total (in-river and ocean) commercial landings (pounds) of American shad for the U.S. Atlantic coast, 1950-2008 (Source: NMFS, Fisheries Statistics Division, Silver Spring, MD, pers. comm.).

1.1.2 Statement of the Problem

In 2007, the American Shad Stock Assessment Subcommittee (SASC) completed an American shad stock assessment report, which was accepted by the Peer Review Panel (PRP) and the Shad and River Herring Management Board in August 2007 (ASMFC 2007). The 2007 American shad stock assessment found that stocks were at all-time lows and did not appear to be recovering to acceptable levels. It identified the primary causes for the continued stock declines as a combination of excessive total mortality, habitat loss and degradation, and migration and habitat access impediments. Although improvement has been seen in a few stocks, many remain severely depressed compared to their historic levels.

Given these findings, the PRP recommended that current restoration actions need to be reviewed and new directives need to be developed and implemented. The SASC and PRP recommendations included actions to reduce fishing mortality, improve fish passage at mitigation barriers, reduce dam passage mortality and delay, increase larval stocking, and implement habitat restoration actions.

Anadromous fish species, such as American shad, are unlike almost all other fish species that are cooperatively managed under ASMFC. Most other ASMFC species are exclusively oceanic and all of their habitat and life cycle needs can be satisfied in the marine environment (although some may utilize coastal shore or estuarine habitat for part of their life). It has long been assumed that human impact on the ocean environment has been non-existent or minimal. It has also been assumed that the only major human-induced impact on oceanic fish species was from recreational and commercial fishing that resulted in direct mortality. However, anadromous fish, as a result of their freshwater and estuarine spawning and nursery requirements, must come into direct contact with human populations; therefore, they are vulnerable to the many sources of mortality associated with human activity in and around rivers and estuaries.

Extensive populations of anadromous fish species historically existed along the Atlantic coast prior to the Industrial Era. Since that time, non-fishery human-induced threats may have had a significant impact on anadromous fish stocks. Moreover it is likely that American shad stocks and the resulting Atlantic coast population may not reach its full potential until these other threats are adequately addressed.

This document identifies specific issues on which the Commission is seeking public comment:

1. American shad monitoring requirements (Section 3.1 and 3.2);
2. Bycatch monitoring requirements (Section 3.3);
3. Commercial fisheries management measures (Section 4.1); and
4. Recreational fisheries management measures (Section 4.2)
5. Habitat recommendations (Section 5.0)
6. Implementation Plans (Section 6.0)

1.1.3 Benefits of Implementation

1.1.3.1. Social and Economic Benefits

Restoring, enhancing and maintaining the stability and productivity of the Atlantic coast population of American shad will enhance the economic and social benefits for the Commission member states and the nation as a whole. The economic values associated with these benefits would include direct use values (e.g., consumptive use values related to commercial and recreational fishing, and non-consumptive use values such as observing spawning runs), indirect-use values (e.g., contribution to the forage of many other economically important species such as striped bass, and enrichment of freshwater system productivity through transfer of marine derived nutrients), and non-use values (i.e., existence and option values) for current and future generations. For example, an option value might be the value someone places on the potential of future generations having the option of harvesting American shad, which would then be a consumptive use value. The indirect-use values are mainly contributed through the ecological benefits attributed to American shad, which in turn provide ecosystem functions that enhance their numerous direct and non-use economic value.

Although the indirect-use and non-use economic values can be difficult to quantify in dollar terms, it is readily apparent that American shad have supported valuable commercial fisheries along the entire Atlantic coast. However, these fisheries have declined dramatically in recent years. The nominal ex-vessel unit price, which is the price received by the harvesters not adjusted for inflation, for American shad ranged from \$0.325 to \$1.022 per pound and averaged \$0.534 per pound for the years 1980 through 2007. The nominal total (aggregate) ex-vessel value of the U.S. Atlantic coast American shad harvest has ranged from a high of over \$2 million in 1984 to a low of about \$540,000 in 2006, after the ocean-intercept fishery closure was implemented in all Atlantic coastal states, and it averaged \$1.1 million for the years 1980 to 2007. Additionally, the market price paid by the final consumer can be 3 to 10 times or more than the ex-vessel price, yielding an increased economic benefit (i.e., direct use value) well above the price paid to the vessel owner/operator. See Appendix A for a discussion of methodology.

Recreational fisheries for American shad are often poorly documented, if at all. The National Marine Fisheries Service operates the Marine Recreational Fisheries Statistics Survey (MRFSS) to obtain information on recreational fisheries for marine species. MRFSS does not adequately capture information on anadromous fisheries, including those for American shad because the current survey design focuses on active fishing sites along coastal and estuarine areas rather than inland non-tidal waters where most recreational fishing for American shad occurs. However, the seasonal economic impact of shad recreational fisheries may be substantial. A 1986 study of shad anglers fishing on the Delaware River indicated that they collectively spent about \$1.6 million during a nine week angling season (PFBC 2008), equivalent to approximately \$3 million in 2007. Moreover, the aggregate willingness to pay (economic value) for these shad anglers was estimated to be about \$3.2 million or an equivalent \$6 million in 2007 (PFBC 2008). Similar recreational fisheries exist in many rivers along the Atlantic coast and each would likely contribute an equivalent economic value.

1.1.3.2. Ecological Benefits

American shad play an important ecological role in freshwater, estuarine, and marine environments during its anadromous life cycle. They influence food chains by preying on some species and serving as prey for others, throughout all life stages (Facey et al. 1986, MacKenzie et al. 1985, Weiss-Glanz et al. 1986). During earlier periods of high abundance, American shad also played a significant role in ecosystem nutrient and energy cycling. This was most apparent in South Atlantic coastal river systems, where the percentage of repeat spawning is low and many of the fish die shortly after spawning, thus transferring nutrients and energy derived from the marine system into the freshwater interior rivers. Durbin et al. (1979) conducted a study of the effects of post spawning alewife on freshwater ecosystems. It was suggested that the potential influence of alosine migration on the nutrient and energetic dynamics of Atlantic coast ecosystems is equivalent to effects documented for similar systems in the Pacific Northwest for salmon rivers. Garman (1992) studied the fate and potential significance of post spawning anadromous fish carcasses in the James River, Virginia. He hypothesized that, before recent declines in abundance, the annual input of marine-derived biomass via alosine migrations was an important episodic source of energy and nutrients for the non-tidal James River.

As prey, American shad are important for other species that are themselves important commercially, recreationally and ecologically. American eels prey on American shad eggs, larvae and juveniles in freshwater, and striped bass consume juveniles (Facey et al. 1986, Mansueti and Kolb 1953, Walburg and Nichols 1967). Savoy and Crecco (1995) also suggest a direct linkage between increased striped bass predation and the dramatic drop in American shad and blueback herring abundance in the Connecticut River. Predation on juvenile American shad by other large predators (e.g. weakfish, bluefish) is also perhaps a minor factor that could be delaying the recovery of American shad stocks in the Chesapeake Bay (Klauda et al. 1991). Once in the ocean, as a schooling species with no dorsal or opercula spines, American shad are undoubtedly preyed upon by many species including sharks, tunas, king mackerel, seals, and porpoises (Melvin et al. 1985, Weiss-Glanz et al. 1986). American shad are also a seasonally important prey species for a number of riparian fish, birds, and wildlife species, with the adult spawning American shad arriving in the early spring when other prey may be scarce and the nesting/breeding season is just beginning for many wildlife predators.

1.1.3.3. Cultural Benefits

American shad were and are of cultural significance to Native Americans, European colonists and contemporary Americans who reside near and/or fish in rivers which supported or continue to support spawning runs (Brandywine Conservancy 2005, Day 2006, Groth 1996, McPhee 2002). American shad spawning runs in the spring were an essential element of Native American nutrition. One example is the run in the Penobscot River, Maine, which has been home to the Penobscot Indian Nation for more than 10,000 years. Historic findings of Penobscot fish nets, baskets and spears indicate the sustenance and subsistence significance of fish to the tribe (Day 2006). As noted in Day (2006, page 29), "Federally recognized rights to sustenance fishing rights today remain relatively meaningless for lack of sea-run fish and because resident fish are contaminated." The same statements regarding the historic significance of the runs and

the current meaninglessness of their rights could well be applied to every other Native American tribe along the entire east coast from Maine through Florida.

The cultural significance of American shad and other anadromous species is reflected in the traditions that took root which reflected the significance of sea-run fish in people's lives (Day 2006). The first-caught salmon of the season from the Penobscot was sent to the President of the United States; families passed fishing traditions through the generations; and fishing clubs for salmon and shad sprang up along the river. The names of the fish are still etched on the inland landscape—for instance, Shad Pond on the Penobscot, where shad can no longer migrate due to downstream dams (Day 2006).

The State of Connecticut General Assembly designated American shad as its State Fish in 2003, the only state to select the species. It was selected because it 1) was a native Connecticut fish; 2) had great historical significance in that it provided food for Native Americans and colonists; 3) it was and is of great commercial value to the state; and 4) because the hardiness of this migratory fish reflects the true Connecticut spirit as reflected in the state's motto: "Qui Transtulit Sustinet" (*He who transplanted still sustains*).

Many communities celebrated and still celebrate the arrival of American (and also hickory) shad by holding festivals to mark the occasion. See Appendix B for a list of current and historic festivals held along the Atlantic coast. These festivals are held during the spring of the year to coincide with the American shad spawning run, and generally entail fishing for, and consumption of, American shad, along with a variety of other activities including running events, arts and crafts shows, music, and many other activities designed to promote social interactions among residents, attract tourists, and benefit the local economy.

Many of the cultural values associated with runs of American shad and other species provide significant incentives for restoration of the runs (Day 2006), as well as for the bolstering of states' economies. Additional benefits include restoration of meaning for Native American and other fishing rights; educational potential of fish bypasses; perpetuation and/or reestablishment of local festivals which are of economic benefit to the residents; and reinvigorating the traditions of fishing for sea-run fish on many east coast rivers.

The most comprehensive account of the role which American shad has played in the culture of North America since colonization by Europeans is that by John McPhee (McPhee 2002). In *The Founding Fish*, McPhee's research documents the relevance of American shad in seventeenth and eighteenth-century America. He documents George Washington's prowess as a commercial shad fisherman (in 1771, Washington caught 7,760 American shad) and the role of the species in the lives of Henry David Thoreau and John Wilkes Booth. It is clear from his work that American shad have played a significant and largely continuous role in the lives of Americans since European colonization.

1.2 DESCRIPTION OF THE RESOURCE

A comprehensive description of the Atlantic coast stocks of American shad can be found in the 1985 Interstate Fishery Management Plan for Shad and River Herring and in the 2007 American

shad stock assessment (ASMFC 2007). This section provides the basic information necessary to understand how anadromous American shad relate to their essential habitats and the significance of the commercial and recreational fisheries to the economy and culture of the Atlantic coast.

1.2.1 American Shad Life History

American shad are an anadromous fish that spend most of their life at sea along the Atlantic coast and enter freshwater as adults in the spring to spawn. American shad stocks are river-specific; that is, each major tributary along the Atlantic coast appears to have a discrete spawning stock. This is because American shad have been documented to have a high fidelity to return, in the spring, to their natal tributary to spawn. Young-of-year fish often migrate downstream to estuaries over the summer. In the fall or subsequent spring, juveniles emigrate from freshwater and estuarine nursery areas and join a mixed-stock, sub-adult coastal migratory population. After four to six years individuals become sexually mature and migrate to their natal rivers during the spring spawning period that may vary by latitude (see Appendix C for a full description of the American shad life history and habitat requirements). The 2007 American shad stock assessment report identified 86 separate tributaries or potential individual stocks. Of the 86 tributaries identified, only 31 were deemed to have adequate data for a tributary specific stock assessment.

1.2.2 American Shad Stock Assessment Summary

ASMFC, 1988

The first stock assessment was conducted in 1988 (ASMFC 1988) and focused on American shad stocks in 12 Atlantic coast rivers. The Shepherd stock-recruitment model was used to estimate maximum sustainable yield (MSY) and maximum sustainable fishing rate (F_{msy}). They found that MSY was positively correlated to drainage area and that highest F_{msy} occurred in the central part of the species range.

ASMFC, 1998

The second coastwide stock assessment conducted by the ASMFC was completed in 1998 (ASMFC 1998). Generally, assessments were conducted on a river-specific basis, but some grouping of river systems occurred (e.g., Maine rivers were examined collectively, Upper Bay Maryland, Albemarle Sound, and Waccamaw and Pee Dee rivers).

A Thompson-Bell yield-per-recruit (YPR) model was used to derive the overfishing definition (F_{30}) for some shad stocks where possible. F_{30} is that level of fishing mortality that theoretically results in a female spawning stock biomass that is 30% of that possible when only natural mortality acts on the stock. This level of fishing mortality has been shown to be sustainable in other species with similar life history parameters. The assessment examined catch and harvest data, exploitation rates, fish-lift counts, current and historic coastal (F_c) and in-river (F_r) fishing mortality rates, and other indicators of stock status for American shad from selected stocks or

river systems located from Maine to the Altamaha River, Georgia, with special attention on recent (1992 to 1996) stock dynamics.

The 1998 assessment concluded that there was evidence of recent (1992-1996) and persistent stock declines in the Hudson and York Rivers and of recent stock increases in the Pawcatuck and Connecticut Rivers. The assessment concluded that the drop in commercial landings in the Edisto River was largely due to a reduction in fishing effort and did not reflect stock abundance. In addition, the assessment reported that there was no evidence of recent stock declines for the Merrimack River, Delaware River, upper Chesapeake Bay tributaries, Rappahannock River, James River, Santee River, and the Altamaha River. Stock declines inferred from declining trends from river-specific commercial landings were evident for the Neuse River, Pamlico River, Cape Fear River, Waccamaw-Pee Dee River, Savannah River, Albemarle Sound tributaries, and rivers in the state of Maine.

Where estimation of recent F rates (1992-1996) was possible, all estimates of total F ($F_c + F_r$) were below F_{30} , suggesting that these stocks were not overfished. At that time, the assessment also concluded that there was no evidence that the ocean-intercept fishery had an adverse impact on American shad abundance along the Atlantic coast and that there was no evidence of recent (1990-1996) recruitment failure for Maine rivers, Pawcatuck River, Connecticut River, Hudson River, Delaware River, Upper Chesapeake Bay tributaries, Altamaha River and Virginia rivers.

ASMFC, 2007

A coastwide American shad stock assessment was completed and accepted by the Management Board in August 2007. The 2007 stock assessment found that American shad stocks were at all-time lows and did not appear to be recovering. Recent declines of American shad were reported for Maine, New Hampshire, Rhode Island, and Georgia stocks, and for the Hudson (NY), Susquehanna (PA), James (VA), and Edisto (SC) rivers. Low and stable stock abundance was indicated for stocks in Massachusetts, Connecticut, Delaware, a tributary to the upper Chesapeake Bay, the Rappahannock River (VA), and some South Carolina and Florida stocks. Stocks in the Potomac and York Rivers (VA) have shown some signs of recovery in recent years. Data limitations and conflicting data precluded conclusions about status or trends of many of the stocks in North and South Carolina.

The 2007 stock assessment report identified primary causes for stock decline as a combination of overfishing, pollution, and habitat loss due to dam construction. In recent years, coastwide harvests have been 500-900 metric tons (1 – 2 million pounds), nearly two orders of magnitude lower than in the late 19th century. Given these findings, the Peer Review Panel recommended that current restoration actions need to be reviewed and new measures need to be identified and applied. The Peer Review Panel suggested considering a reduction of fishing mortality, enhancement of dam passage and mitigation of dam-related fish mortality, stocking, and habitat restoration.

1.3 HABITAT REQUIREMENTS

American shad utilize coastal tributaries and the associated bays and estuaries for spawning and larval and juvenile nursery habitat. In addition, migratory sub-adult and adult American shad utilize near shore ocean habitats. These habitats are distributed along the Atlantic coast from the Bay of Fundy, Canada to Florida. Use of these habitats by migratory American shad may increase or diminish as the size of the population changes, habitat quality deteriorates, or habitat access is impaired. For an in-depth description of American shad Habitat Requirements see Appendix C.

As noted in section 1.2.1 the migratory nature of anadromous American shad exposes them to numerous human-induced threats that can result in direct or indirect mortality and reduced juvenile and adult spawning stock recruitment which impact stock status. Some of the most important human-induced threats, from a management perspective, are those leading to freshwater or ocean pollution, habitat degradation or migratory impairment. Individual and cumulative negative impacts to American shad habitat results in reduced stock health, leading to a declining Atlantic coast population. The causes of many human-induced threats are often under some form of regulatory management already, which could be used as a means to avoid, minimize, or reduce the impact of the habitat threats associated with human activities.

1.4 DESCRIPTION OF THE FISHERIES

American shad historically supported important commercial and recreational fisheries along the entire Atlantic coast; however, these fisheries have declined dramatically in recent years. Two types of fisheries exploit spring spawning migrations of American shad: in-river and ocean-intercept. In-river fisheries only exploit the stock native to that system, whereas ocean-intercept fisheries exploit mixed stocks of different river origins. There are some estuarine fisheries (e.g., Delaware Bay, Winyah Bay) that also exploit mixed stocks.

Catch statistics for both ocean and in-river American shad fisheries on the Atlantic coast are compiled by the National Marine Fisheries Service (NMFS) and state agencies for both commercial and recreational fisheries; however, there are data gaps in these records. It is important to note that harvest from fishers operating in-river, or from fisheries that are not federally licensed, might not be reported to NMFS. In addition, bycatch in non-directed fisheries is poorly documented. Information provided below is based on state reports (e.g. annual Compliance Reports) and data available from NMFS.

1.4.1 Commercial Fishery

Since the early 1800s, the American shad supported major commercial fisheries along the Atlantic coast and was one of the most valuable food fish of the U.S. Atlantic coast before World War II (Rulifson et al. 1982). However, American shad, alewives, blueback herring, and other anadromous species were already declining in southern New England by 1870 (Bowen 1970; Moring 1986). Primary causes were impassable dams located on major New England Rivers as well as heavy pollution near towns and mills. For example, the first dam on the Connecticut River was constructed in 1798 at Turners Falls, Massachusetts, which was a 16-foot high

structure impassable to all migrating fishes. The estimated U.S. Atlantic coast catch in 1896 was 50 million pounds, but it declined to approximately 10 million pounds per year between 1930 and 1960 (Weiss-Glanz *et al.* 1986) and to about 2 million by 1976.

Historically, aggregated commercial landings (coastal ocean and in-river) of American shad have shown major long-term declines, but coastal ocean landings of American shad did increase more than four-fold after 1978. In 1980, coastal ocean landings equaled approximately 623,000 pounds. By 1989, this number had peaked to 2.1 million pounds, and in 1996 landings were 1.1 million pounds. Ocean harvest contributed about 11 % of total Atlantic coast landings in 1978; this contribution increased yearly to approximately 67% by 1996 as ocean landings increased and in-river landings declined.

The closure of the ocean-intercept fishery in 2005 lowered the coastwide total landings of American shad. Based upon landings data provided in ASMFC Compliance Reports from individual states and jurisdictions, 2007 coastwide landings totaled 824,730 pounds (ASMFC, 2008). Combined landings from North Carolina and South Carolina accounted for 64% of the commercial harvest in 2007. Connecticut, Delaware, New York, New Jersey, and Georgia accounted for 35% of the commercial harvest in 2007. Maine, New Hampshire, Massachusetts, Rhode Island, Pennsylvania, Maryland, the District of Columbia, and Florida reported no directed shad harvest in their state. Shad bycatch landings from ocean waters in 2007 were reported at 4,562 pounds, or about 0.55% of the coastwide commercial harvest. However, it is important to note that only three states—Maine, Massachusetts, and New Jersey – reported landings of ocean bycatch.

A preliminary analysis of recent ex-vessel value trends for the commercial American shad fishery can be found in Appendix A. The analysis suggests that in times of generally declining commercial shad landings, market “signals” may have encouraged harvesters to perceive an ex-vessel market segment with the potential of offsetting declining harvest quantities with substantially higher ex-vessel prices. In other words, American shad harvesters in past decades may have continued to fish in response to continued market demand capable of supporting profitable ex-vessel revenues even though catch quantities declined, (i.e., a relatively inelastic own ex-vessel price situation). For open access fisheries, such relatively inelastic demand along with other factors has been implicated in the depletion of various fishery stocks (e.g., Brandt 1999).

1.4.2 Recreational Fishery

Data on recreational fisheries for American shad are limited or are non-existent. The National Marine Fisheries Service operates the Marine Recreational Fisheries Statistics Survey (MRFSS) to obtain information on recreational fisheries for marine species. MRFSS does not adequately capture information on anadromous fisheries, including those for American shad because the current survey design focuses on active fishing sites along coastal and estuarine areas rather than inland non-tidal waters where most recreational fishing for American shad occurs. Error associated with data on harvest, catch, and effort is often high.

Although data on coastwide recreational fishing catch and effort for American shad are limited, it is readily apparent that substantial shad sport fisheries occur on the Connecticut (CT and MA), the Hudson (NY), the Delaware (NY, PA and NJ), the Susquehanna (MD), the Santee and Cooper (SC), the Savannah (GA), and the St. Johns (FL) Rivers. Limited shad recreational fisheries occur on several other rivers in Massachusetts, Virginia, North Carolina, South Carolina, and Georgia. In 2007, recreational creel limits ranged from zero to 10 fish per day, with the exception of the Santee River (SC), which is permitted to have a 20 fish per day creel limit due to the approval of a conservation equivalency plan in 2000. It is estimated that tens of thousands of shad are caught by hook and line from large Atlantic coast rivers each year by recreational anglers. However, the actual harvest (i.e. catch and removal) may amount to only about 20-40% of total catch due to the prevalence of catch-and-release angling practices.

1.4.3 Tribal Fisheries

There are known tribal fisheries for American shad fisheries (see Section 1.1.3.3), but the extent of effort and harvest is undocumented.

1.4.4 Non-Consumptive Factors

People interested in conservation and wildlife have been known to actively engage in observation of American shad migration during the annual spawning migration as they pass through constricted natural corridors and fish passage facilities. In some regions, this non-consumptive use of the American shad resource is an important part of public education, local heritage, ecotourism, and outdoor recreation. Real-time video of spring spawning migrations of alosines are available via online webcams for both the fishway at Boshers' Dam on the James River and Fairmount Dam on the Schuylkill River (available at: <http://www.dgif.virginia.gov/fishing/shadcam/index.asp?pop=3> and <http://fairmountwaterworks.com/sony/fishpop.php>, respectively). In addition, volunteer involvement in non-consumptive cooperative fishery projects has included activities related to American shad, including the "Shad-In-Schools" educational program and angler group larval shad hatcheries.

Some local governments also sponsor springtime shad festivals and/or related events that include non-fishing activities. According to the American Rivers organization (2008), shad fishing and related tourism along the Susquehanna River generate approximately \$30 million annually in economic impacts and "...the estimated values of a restored shad run in Maryland range from \$42 million to \$178 million."

1.4.5 Interactions with Other Fisheries, Species and Other Uses

For an in-depth description of American shad bycatch, interactions with protected species and interactions with other invasive or managed species see Appendix E.

1.4.5.1 Bycatch

Catch of American shad that occurs in fisheries directed at other species is referred to as bycatch. Bycatch also refers to illegal or unmarketable fish caught in directed fisheries. Estimates of bycatch are difficult to obtain since few studies have focused specifically on that issue. Bycatch losses contribute to the total mortality of American shad, and are important to consider in the current and future management of these fisheries.

Reported shad bycatch landings from ocean waters in 2007 decreased from 2006 levels and were 4,562 pounds, or about 0.55% of the coastwide commercial harvest. It is important to note that only three states—Maine, Massachusetts, and New Jersey—reported landings of ocean bycatch that were used in the calculation of the above statistics. There are concerns that the amount of bycatch that is actually occurring may be much higher than what is reported.

1.4.5.2 Interaction with Protected Species

The management of the American shad populations has the potential to intersect with the management and restoration efforts of a number of protected species. The resulting interactions can potentially have negative impacts for both American shad and the protected species. The protected species can place competitive and predatory pressures on American shad and vice versa. The protected species can also be impacted by regulated fishery activities directed at American shad. The potential for these interactions should be considered during the development of future American shad fishery management plans and actions. Also, the resource agencies responsible for management and restoration of protected species need to be made aware of the potential impacts of their plans and activities on American shad management and restoration efforts.

1.4.5.3 Interaction with Invasive and Other Managed Species

The management of the American shad population has the potential to intersect with the management of a number of invasive (e.g., snakehead fish), and managed species (e.g., commercial and recreational, freshwater and ocean). The resulting interactions are similar to those for protected species and require the same considerations.

2. PROPOSED AMENDMENT 3 GOALS AND OBJECTIVES

Goal: Protect, enhance, and restore Atlantic coast migratory stocks and critical habitat of American shad in order to achieve levels of spawning stock biomass that are sustainable, can produce a harvestable surplus, and are robust enough to withstand unforeseen threats.

Objectives:

- Maximize the number of juvenile recruits emigrating from freshwater stock complexes.
- Restore and maintain spawning stock biomass and age structure to achieve maximum juvenile recruitment.

- Manage for an optimum yield harvest level that will not compromise Objectives 1 and 2.
- Maximize cost effectiveness to the local, state, and federal governments, and the ASMFC associated with achieving Objectives 1 through 3.

Strategies to Achieve Objectives:

- Quantify and effectively manage sources of bycatch mortality where possible.
- Quantify and effectively manage sources of predation where possible and appropriate.
- Restore and maintain access to historical spawning and nursery habitat (i.e., dam removal and fishway installation).
- Maintain total mortality (Z) of American shad stocks at or below stock assessment benchmarks (Table 1).
- Ensure that adequate monitoring techniques are implemented to measure migratory success (i.e., upstream and downstream fish passage at barriers).
- Ensure that stock monitoring data are collected and that they are adequate to characterize stock status and stock response to management actions (i.e., develop a sampling program that provides an annual measurable output for spawning stock and juvenile production status)
- Achieve river specific restoration targets for American shad populations as specified in the recent shad assessment (Table 1) or in stock specific restoration plans.
- Ensure that the production of hatchery fish is used effectively during restoration efforts.
- Maximize cost effectiveness of data collection to minimize costs to states and jurisdictions through coordinated monitoring, flexibility in monitoring methods, and early vetting of monitoring and management plans.
- Identify interactions between other Commission species management plans (positive or negative) and the objectives stated above.

The Commission (2007) developed benchmark mortality rates and restoration targets (abundance) for some individual American shad stocks and for aggregate American shad stocks in selected regions. This amendment adopts all of these benchmarks (Table 1). Benchmark mortality rates are not targets, but are rates that should not be exceeded. Restoration targets for abundance indices are targets that should be reached before directed fishing can be initiated.

2.1 MANAGEMENT UNIT

The management units for American shad under this Fishery Management Plan Amendment include all migratory American shad stocks of the Atlantic coast of the United States.

Recommendations on management for migratory American shad in the Exclusive Economic Zone (3-200 nautical miles offshore) can be found in Section 4.10

Table 1. Benchmark mortality rates and restoration targets developed by ASMFC (2007)

Region / River	Mortality		Restoration Targets ^c
	Z (instantaneous)	A (%) ^a	
New England	Z ₃₀ = 0.98	A ₃₀ = 0.62	
Hudson River, NY	Z ₃₀ = 0.73	A ₃₀ = 0.51	
York River, VA	Z ₃₀ = 0.85, Native American fishery F ₃₀ = 0.27	A ₃₀ = 0.57	Gill net monitoring index catch rate ^b = 17.44
Albemarle Sound, NC	Z ₃₀ = 1.01	A ₃₀ = 0.63	
Potomac River			Pound net landings = 31.1 lbs/net-day
James River, VA			Gill net monitoring index catch rate ^b = 6.4
Rappahannock River, VA			Gill net monitoring index catch rate ^b = 1.45
St. John's River, FL			Recreational angling CPUE > 1.0 fish/hour

^a Total mortality defined as the percent of fish present at the start of the year that die from all causes.

^b Calculated as area under the curve

^c States and river basin cooperatives may have stock specific recovery targets that are used, but not included in this amendment.

2.2 DEFINITION OF SUSTAINABLE FISHERY

This document proposes the adoption of a sustainable fisheries definition which is consistent with current coastwide management of river herring (alewife and blueback herring) as described in Amendment 2 to the Shad and River Herring FMP. Amendment 2 defines a sustainable fishery as “those that demonstrate their stock could support a commercial and/or recreational fishery that will not diminish the future stock reproduction and recruitment.”

2.3 DEFINITION OF OVERFISHING

The classic definition of overfishing considers overfishing to occur whenever a fish stock is subjected to a level of fishing mortality that jeopardizes the capacity of that stock to produce a maximum yield on a continuing basis. Benchmark fishing mortality is the estimated mortality rate at and above which overfishing occurs.

Amendment 1 to the American shad & River Herring FMP (ASMFC 1999) refined the definition of overfishing for American shad stocks to be an instantaneous rate of fishing mortality rate (F) from directed fisheries that was at or above a benchmark of F₃₀. This benchmark was defined as the *level of directed fishing mortality* that theoretically resulted in a female spawning stock biomass that was 30 % of that in an unfished, “virgin” stock that only experienced natural mortality. Female spawning stock biomass is the total weight of females in all age classes in the spawning population. This definition ignored man-induced mortality from other sources.

The basis for this definition was the assumption that American shad stocks were only affected by F from directed fishing and by instantaneous natural mortality (M) and the total instantaneous mortality (Z), was equal to M plus F. Thus, an unfished stock that only experienced natural mortality would contain the maximum potential female spawning stock biomass. Any fishing on the stock would reduce this biomass to less than maximum. At some point, as the rate of fishing increased, the female spawning stock biomass would be reduced until it contained 30% of the maximum female biomass. The fishing rate that resulted in 30% of the maximum female spawning stock biomass was defined as F_{30} . This overfishing definition was not to be utilized as a target for fisheries to achieve, nor was it believed to be suitable for rebuilding depleted stocks, but was developed to serve as a benchmark that should not be exceeded in any given year. Amendment 1 assumed that fishing rates at or below F_{30} would be sustainable because such rates were documented to be sustainable in other stocks with similar population parameters to American shad. The amendment focused on the female component of the spawning stock because female abundance was considered to be the population factor that most limited reproduction and subsequent recruitment.

2.3.1 Proposed Overfishing Definition

The most recent stock assessment (ASMFC 2007) concluded that the Amendment 1 definition of overfishing that focused only on directed fishing mortality (F) was no longer valid for American shad stocks because shad are affected by several sources of human-induced mortality. These include: directed fishing (F), fish passage mortality at dams, mortality from pollution, and bycatch and discard mortality in indirect fisheries activity. All of these sources of mortality can be substantial, can be controlled, and should therefore be considered when setting a benchmark mortality rate. Ignoring or neglecting human-induced mortality factors except for directed fishing jeopardizes achievement of the goals of the Shad and River Herring Fisheries Management Plan.

As an interim solution, the recent ASMFC stock assessment (ASMFC 2007) combined all human-induced rates into a single overall human induced rate called H. Since the components of human-induced mortality (e.g., directed fishing, dam-induced, pollution, and bycatch) are difficult or impossible to quantify, ASMFC (2007) did not attempt to develop a benchmark for the combined H that was analogous to F_{30} for directed fishing alone. Instead, ASMFC (2007) developed benchmark values for total instantaneous mortality or Z_{30} (Table 1). These benchmark values were defined as the *level of total instantaneous mortality (Z)* that resulted in a female spawning stock biomass that was 30% of the total female spawning stock biomass in a stock that experienced only natural mortality ($Z=M$). Z can be measured in fish stocks by a variety of methods.

This document proposes adoption of the Z_{30} benchmark proposed by ASMFC (2007). American shad stocks are affected by a combined human-induced instantaneous mortality rate (H) and by natural mortality (M). Therefore, the total instantaneous mortality (Z) equals H plus M. A stock that experienced only natural mortality, with no human-induced mortality, would contain the maximum potential female spawning stock biomass. As human-induced mortality increases, female spawning stock biomass would decrease. At some point of increased human-induced mortality and thus total mortality, the stock would contain a female spawning stock biomass that

was 30% of the maximum. The rate of total mortality that resulted in a female spawning stock biomass that was 30% of the maximum is the Z_{30} . For example, in New England stocks of American shad, a Z that equals 0.98 reduces female spawning stock biomass to 30% of that present when only natural mortality acts on the stocks, assuming a natural mortality (M) of 0.38.

The ASMFC (2007) approach broadened the classic definition of “over-fishing” from one that focused on directed fishing to one that encompassed all human-induced sources of mortality. Under this new definition, a stock would be “overfished” if the stock exhibited a total instantaneous mortality rate at or above Z_{30} . Moreover, if a stock was judged to be overfished, all sources of mortality would have to be reduced until total instantaneous mortality dropped below the Z_{30} benchmark. The priority here would be to reduce mortality from inadequate passage at dams and bycatch since these losses are avoidable and do not benefit society. Reducing mortality from directed fishing without reducing mortality from other man-induced causes is not encouraged because it transfers fish production from a beneficial use to nonbeneficial uses. Excessive mortality (i.e., at or above Z_{30}) on a stock with no directed fishery would be a warning that bycatch, dam passage mortality, or some other form of human-induced mortality should be addressed. Directed fishing could continue without reduction of stocks where total mortality was below Z_{30} .

American shad stocks of the Atlantic coast exhibit a range of life history attributes because shad stocks spawn in rivers with different morphologic characteristics over a broad latitudinal range. Differences in parameters such as age at maturity, weight at age, and frequency of repeat spawning affect how a stock responds to increased mortality and thus different stocks often have different values of Z_{30} . ASMFC (2007) provided Z_{30} estimates for stocks or aggregate stocks in regions with adequate data. However, many stocks remained without such benchmarks because needed data were lacking or non-existent.

American shad populations may contain multiple year classes in their spawning stocks. Annual total mortality can affect all of these year classes, with older year classes experiencing higher cumulative mortality. Consequently, the spawning stock biomass lost from human-induced factors may be greater than one would intuitively expect from an annual measured rate of mortality.

2.3.2 Future Overfishing Definition Refinement

Under this amendment, as resources become available, the TC and the SASC will define a more robust benchmark mortality rate definition for American shad stocks. The new definition should embrace the approach proposed by ASMFC (2007) and it should include, or address all sources of human-induced mortality (e.g., directed fishing, bycatch and discards, and losses from dams and other water development projects). These can be combined in a single human-induced rate or partitioned into separate human-induced rates as needed. They should NOT be added to natural mortality when calculating new benchmarks. Changes to the overfishing definition based on this work will be implemented through future addendums. Further, the TC and SASC should also develop target or rebuilding rates to allow population numbers to grow. These rebuilding targets would require developing a new lower mortality threshold that would increase spawning stock biomass.

3. PROPOSED MONITORING PROGRAM SPECIFICATIONS

The collection of adequate fish stock and fishery monitoring data is necessary to achieve the goal and objectives of the American Shad management program. A well designed monitoring program provides measurable outputs that can be used to judge the effectiveness of current management efforts in achieving the desired outcome. This amendment proposes modification to some of the monitoring requirements specified in Addendum 1 to Amendment 1 of the Shad and River Herring Fishery Management Plan. All other monitoring requirements will remain compliance criteria.

States and jurisdiction specific requirements are listed in Tables 2 and 3 of this amendment (modifications to Addendum 1 and additions under this amendment are noted in bold). One modification of note involves states and jurisdictions which share a river or an estuary. Under this amendment, such states and jurisdictions are considered to be equally responsible for monitoring of the system. States and jurisdictions that share a resource, but do not conduct a commercial fishery, will be exempt from monitoring the commercial fishery. States and jurisdictions which share a river or estuary may elect which state or jurisdiction will conduct specific monitoring programs for the shared water body. In shared water bodies where there is some sort of management cooperative, such as the Delaware River Basin Fish and Wildlife Management Cooperative, the cooperative may be designated as the responsible party and should report results. States and jurisdictions will supply the Commission with copies of cooperative or interstate agreements when such agreements relieve from or assign states and jurisdictions the responsibility for monitoring activities. A single report summarizing monitoring results from a shared water body is preferred, but not required. Additionally, a second modification proposed under Amendment 3 is the removal of the recreational monitoring requirement from the Nanticoke River, DE (Table 3) due to the closure of this fishery.

States and jurisdictions may propose to the Management Board alternative monitoring if they develop a stock specific definition of a sustainable fishery or stock recovery targets and the proposed alternative monitoring measures progress toward the definition or targets (See Section 6). This amendment recognizes that sustainable fisheries may operate on stocks that are at lower than maximum abundance. However, such fisheries must not jeopardize long term stock persistence or the achievement of any stock recovery targets. Definitions of sustainable fisheries and restoration targets can be index-based or model-based (See Table 1 for examples). Changes to sustainable fisheries definitions, stock recovery targets, and monitoring programs may be submitted for review and approval by the Management Board at any time (See Sections 6 and 7).

In many states, both the freshwater and the marine sections of state resource agencies collect data on American shad. Often, only those collected by the marine section are provided to ASMFC. This amendment recommends that states and jurisdictions increase coordination of data collection on American shad between freshwater and marine sections of the agency, and that all data be provided to ASMFC through the annual compliance report.

Under this amendment, states and jurisdictions will review existing monitoring programs and submit implementation plans for existing and planned monitoring as per Section 6.1. The Shad and River Herring Management Board and Technical Committee will review proposed monitoring programs (See Section 9) to determine if they meet the requirements of Section 3. States and jurisdictions may also submit proposals to change their required monitoring programs as per Section 7.1 of this document. The Technical Committee will review such proposals and prepare recommendations and technical advice for the Management Board. The Management Board will determine final approval for changes to required management programs (See Section 7.1).

Proposed monitoring requirements of Amendment 3 and program specific modifications are summarized in the following sections. Results of state monitoring will be reported annually to the Commission as per Section 9.3. One important change in Amendment 3 is that, in addition to a written report, all states and jurisdictions will be required to add annual monitoring data to Excel spreadsheets used in the recent ASMFC (2007) stock assessment. The ASMFC, in cooperation with the TC, will provide states with a template for the spreadsheets. Annual data updates on spreadsheets will be considered part of the compliance reports and will be due at the same time as the written annual compliance reports, unless otherwise determined by the Management Board. This change facilitates annual assessment of stock condition and the development of future benchmark assessments. Excel spreadsheet submittals have proven effective and helpful in other ASMFC species management plans.

The Commission has attempted to minimize such costs in this amendment through coordinated monitoring where possible, flexibility in monitoring methods, and early vetting of monitoring and funding issues through the submission of implementation plans (Section 6). Submission of implementation plans to the Management Board will facilitate discussion of state problems and allow the Commission to work with the states to explore opportunities to secure funding or develop alternatives.

3.1 PROPOSED FISHERY-INDEPENDENT MONITORING

States and jurisdictions that are currently required to conduct fisheries independent monitoring will still be required to continue such sampling, unless otherwise noted. This amendment proposes additional annual monitoring for those systems listed in Table 2.

3.1.1 Juvenile Abundance Indices

Annual juvenile recruitment (i.e., appearance of young-of-year or Age-0 fish in the ecosystem) of American shad is measured to assess annual production, to predict future year-class strength, to provide a warning of recruitment failure or major habitat change, and to measure contribution of hatchery-released larvae. Juvenile recruitment is measured by sampling age zero juvenile fish abundance in or downriver of nursery habitat.

All annual juvenile abundance indices, or JAIs, shall be reported as a geometric mean as described by ASMFC (1992) and Crecco (1992), or area under the curve (AUC) as described by ASMFC (2007). Confidence intervals should be provided for geometric means. ASMFC will

provide jurisdictions and states with a method to calculate confidence intervals on geometric means. Use of the geometric mean reduces the probability of a single value unduly influencing management action and is most appropriate for sampling that occurs within the nursery area. AUC is most useful when juvenile sampling occurs downriver of nursery areas and fish are sampled during emigration. Abundance of juveniles that emigrate is a function of average daily emigration and days of emigration. A simple geometric mean of catch rates would reflect only the average daily emigration, but not the number of days of such emigration. The AUC approach accounts for both the number of days that juveniles emigrate as well as the daily catch or catch rate and thus is a better measure of annual juvenile out migration when sampling is conducted downstream of the nursery area.

The sampling protocol (stations, sampling intensity and gear type) should be consistent over time for the period the index is to be calculated. Juvenile abundance indices can be biased if fish older than age zero are included. Since age-1 juvenile fish occasionally intermingle with age-zero fish in nursery areas, it is important that sampling programs include a protocol to correctly identify these fish so that they can be eliminated from the catch data prior to summary. Approaches to identifying older fish include length measurements and age estimates from scales or otoliths.

For new sampling programs, states and jurisdictions will document the details of the sampling design and proposed data summary approach. The Technical Committee shall review any such submittal and either recommend to the Management Board that it accept or reject the new sampling program. If the recommendation is to reject the new sampling program, the Technical Committee will provide a written explanation to the Management Board.

Validation is not required for any particular JAI survey, but it is encouraged. A long time series of data and consistent inter-annual at-sea mortality rates are needed for successful validation, which makes validation of American shad juvenile indices difficult. Validation will not be a criterion for accepting or rejecting any given JAI survey.

3.1.1.1 *Juvenile Abundance Index Surveys*

States that are currently required to conduct a JAI survey, as specified in Addendum 1 to Amendment 1, will still be required to continue such sampling, unless otherwise noted. States that do not currently conduct juvenile abundance monitoring will develop a program to implement such monitoring as designated in Table 2. The Management Board may require juvenile abundance surveys for newly reestablished American shad runs.

3.1.1.2 *Definition of Juvenile Recruitment Failure*

The criteria for judging juvenile recruitment failure should provide for an early warning of emerging problems in production of young from a given stock. The current definition of juvenile recruitment failure in Amendment 1 (three consecutive JAI values that are lower than 90% of all other values in the river specific data set) is considered inadequate in that it would only flag extreme problems. This amendment proposes a new definition of juvenile recruitment failure, where failure occurs when three consecutive JAI values are lower than 75% of all other values in

the stock specific data series. This definition is identical to that in Section 3.1.1 of Amendment 6 to the Interstate Fishery Management Plan for Atlantic Striped Bass.

3.1.1.3 *Evaluation of Juvenile Abundance Indices*

The Technical Committee will annually examine trends in all required juvenile abundance indices. If any JAI shows juvenile recruitment failure, then appropriate action shall be recommended to the Management Board.

3.1.2 **Adult Stock Characteristics and Abundance**

Annual data on characteristics and abundance of adult spawning stocks are needed to determine efficacy of management approaches. Coupled with juvenile abundance indices and mortality estimates, they clarify population dynamics and progress toward management goals.

States that are currently required to conduct adult spawning or population monitoring, as specified in Addendum 1 to Amendment 1, will still be required to continue such sampling, unless otherwise noted. States and jurisdictions that do not currently conduct such monitoring will implement adult spawning or population monitoring in rivers under their management authority as designated in Table 2.

States and jurisdictions may employ a variety of survey techniques to monitor their American shad spawning populations. The objective is to obtain an annual measure of either absolute (population size estimate) or relative abundance. Measures may include mark-recapture studies, enumeration at fish passage facilities, catch-per-unit-effort (CPUE) by appropriate sample gear, or other indices of abundance. As part of spawning stock surveys, states will take representative samples of adults to determine size, sex and age composition and repeat spawning (for states north of South Carolina) of fish in each stock they are monitoring. When possible, states and jurisdictions north of South Carolina will calculate mortality and survival estimates for each stock.

The recent stock assessment identified several populations where additional fishery independent stock monitoring was warranted (See Table 2). On fishways where passage is measured, passage efficiency will be reported when possible. In cases where passage efficiency is not known, passage numbers cannot be used as indices of stock abundance, because the percent of the population that is passed is unknown and is likely to vary annually. In these cases, it is recommended that states either determine passage efficiencies or develop stock abundance indices downriver of the first barrier.

3.1.2.1. Evaluation of Adult stock characteristics and abundance

The Technical Committee will annually review adult stock characteristics and abundance relative to benchmarks and targets listed in Table 1 or the objectives in state specific fishing/recovery plans and recommend appropriate management actions to the Board if and where appropriate.

3.1.3 Stocking and Hatchery Evaluation

Many Commission jurisdictions augment existing populations or re-introduce populations using fish culture or fish transfer programs. Techniques most frequently used include culture and stocking of larvae or juveniles, and stocking of pre-spawned adults that have been netted or trapped from nearby or distant waters. A detailed summary of current approaches is available through the Commission.

States and jurisdictions with active hatchery programs for American shad will be required to mark all stocked larval and juvenile fish for identification of hatchery products. River and year specific marks are recommended for determining age and year class when fish return as adults. If river and year specific marks are not logistically possible for all stocking programs coastwide, then priorities should be developed through the interstate process. States and jurisdictions with active hatchery programs for American will be required to annually report the number and life stage of stocked fish and estimates of hatchery contribution (percent wild versus hatchery) in the juvenile or adult population. These states or jurisdictions must submit proposals for evaluation under Section 6.0 and annual results as per Section 9.3. Any state wishing to initiate stocking programs for American shad must present a program description including marking and evaluation approach for Commission review. States should work in cooperation with appropriate federal or regional programs to ensure that marking schemes are coordinated with other states to prevent conflicts in operations.

3.2 PROPOSED FISHERY-DEPENDENT MONITORING

States that are currently required to conduct fishery-dependent monitoring will still be required to continue such programs, unless otherwise noted. This amendment proposes additional annual fisheries dependent monitoring for those systems listed in Table 3. Monitoring requirements may be fulfilled by data collected by the Atlantic Coastal Cooperative Statistics Program (ACCSP) where appropriate. States and jurisdictions may petition the Management Board for *de minimis* status, which exempts them from fishery dependent monitoring requirements (See section 7.1.3).

3.2.1 Commercial Fishery-Dependent Surveys

States and jurisdictions will be required to annually monitor the American shad commercial fisheries operating within their state by methods developed by the state or jurisdiction and subject to TC review and Board approval. The survey approach should be appropriate to the fisheries monitored and should provide estimates of total catch (numbers or weight and water

body), total landings (if different than total catch, numbers or weight, and water body), total effort in the fisheries, and length, weight, age, sex, and repeat spawning composition (for states north of South Carolina) from a subsample of the catch. These data will be reported annually. This requirement may be fulfilled by the commercial component of the ACCSP.

3.2.2 Recreational Fishery Surveys Required

The current, every five year, creel survey will be replaced with annual monitoring and reporting of catch, landings, and effort in the recreational fishery through a method developed by the state or jurisdiction and subject to Board review and approval. Techniques used to gather these data may include, but are not limited to, creel surveys, angler logs, surveys of license/permit holders, MRFSS or Marine Recreational Information Program (MRIP) (where appropriate), and reporting requirements for obtaining/maintaining a license or permit. Note that the MRFSS does not survey fisheries above head of tide in coastal rivers where most recreational shad fisheries occur. The future MRIP program may address these deficiencies.

Table 2.

SUMMARY OF MANDATORY FISHERY-INDEPENDENT MONITORING PROGRAMS FOR AMERICAN SHAD.

STATE / JURISDICTION	SYSTEM	SAMPLING PROGRAM (Bolded sections are proposed under Amendment 3, cooperative efforts apply to all monitoring programs unless specified)
Maine	Androscoggin & Saco Rivers	<ul style="list-style-type: none"> • Annual spawning stock survey to include passage counts, CPUE, or some other abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • Hatchery Evaluation
	Merrymeeting Bay & tributary rivers	<ul style="list-style-type: none"> • JAI: Juvenile abundance survey (GM)
New Hampshire	Exeter River	<ul style="list-style-type: none"> • Annual spawning stock survey to include passage counts, CPUE, or some other abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM) • Hatchery Evaluation
	Merrimack River	<ul style="list-style-type: none"> • Annual spawning stock survey to include passage counts, CPUE, or some other abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • JAI: Juvenile abundance survey (GM) • Calculation of mortality and/or survival estimates where possible (Cooperative effort between New Hampshire, Massachusetts, and the USFWS)
Massachusetts	Merrimack River	<ul style="list-style-type: none"> • Annual spawning stock survey to include passage counts, CPUE, or some other abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • JAI: Juvenile abundance survey (GM) • Calculation of mortality and/or survival estimates where possible (Cooperative effort between New Hampshire and Massachusetts, and the USFWS)
	Connecticut River	<ul style="list-style-type: none"> • Annual spawning stock survey to include passage counts, CPUE, or some other abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • JAI: Juvenile abundance survey • Calculation of mortality and/or survival estimates where possible (Cooperative effort between Massachusetts and Connecticut)
Rhode Island	Pawcatuck River	<ul style="list-style-type: none"> • Annual spawning stock survey to include passage counts, CPUE, or some other abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM)
Connecticut	Connecticut River	<ul style="list-style-type: none"> • Annual spawning stock survey to include passage counts, CPUE, or some other abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM) • (Cooperative effort between Massachusetts and Connecticut)

STATE / JURISDICTION	SYSTEM	SAMPLING PROGRAM (Bolded sections are proposed under Amendment 3, cooperative efforts apply to all monitoring programs unless specified)
New York	Hudson River	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM)
	Delaware River	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM) <p>(Cooperative effort among New Jersey, New York, Pennsylvania, and Delaware)</p>
New Jersey	Delaware River	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM) <p>(Cooperative effort among New Jersey, New York, Pennsylvania, and Delaware)</p>
Pennsylvania	Delaware River	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM) <p>(Cooperative effort among New Jersey, New York, Pennsylvania, and Delaware)</p>
	Susquehanna River	<ul style="list-style-type: none"> • Annual spawning stock survey to include passage counts, CPUE, or some other abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM) • Hatchery Evaluation <p>(Cooperative effort between Pennsylvania and Maryland)</p>
	Lehigh River	<ul style="list-style-type: none"> • Annual spawning stock survey to include passage counts, CPUE, or some other abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • Hatchery Evaluation
Delaware	Delaware River	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM) <p>(Cooperative effort among New Jersey, New York, Pennsylvania, and Delaware)</p>
	Nanticoke River	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM) • Hatchery Evaluation <p>(Cooperative effort between Delaware and Maryland)</p>

STATE / JURISDICTION	SYSTEM	SAMPLING PROGRAM (Bolded sections are proposed under Amendment 3, cooperative efforts apply to all monitoring programs unless specified)
Maryland	Upper Chesapeake Bay / Susquehanna River	<ul style="list-style-type: none"> • Annual spawning stock survey to include passage counts, CPUE, or some other abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM) • Hatchery Evaluation <p>(Susquehanna River monitoring is a cooperative effort between Pennsylvania and Maryland)</p>
	Nanticoke River	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM) <p>(Cooperative effort between Delaware and Maryland)</p>
	Potomac River	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM) • Hatchery Evaluation <p>(Cooperative effort among Maryland, District of Columbia, Potomac River Fisheries Commission, and Virginia)</p>
District of Columbia	Potomac River	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM) • Hatchery Evaluation <p>(Cooperative effort among Maryland, District of Columbia, Potomac River Fisheries Commission, and Virginia)</p>
Potomac River Fisheries Commission	Potomac River	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM) • Hatchery Evaluation <p>(Cooperative effort among Maryland, District of Columbia, Potomac River Fisheries Commission, and Virginia)</p>
Virginia	Potomac River	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM) • Hatchery Evaluation <p>(Cooperative effort among Maryland, District of Columbia, Potomac River Fisheries Commission, and Virginia)</p>
	James, York, and Rappahannock Rivers	<ul style="list-style-type: none"> • Annual spawning stock survey to include passage counts, CPUE, or some other abundance index and representative subsamples that describe size, age, and sex composition of the spawning stock • Calculation of mortality and/or survival estimates where possible • JAI: Juvenile abundance survey (GM) • Hatchery Evaluation
North Carolina	Albemarle Sound and its tributaries, Tar-Pamlico, Neuse, and Cape Fear Rivers	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of the spawning stock • Calculation of mortality and/or survival estimates where possible • Hatchery Evaluation • Juvenile Abundance Index (Albemarle Sound only)

STATE / JURISDICTION	SYSTEM	SAMPLING PROGRAM (Bolded sections are proposed under Amendment 3, cooperative efforts apply to all monitoring programs unless specified)
South Carolina	Santee-Cooper system, Edisto River, Winyah Bay and tributaries (Waccamaw and Pee Dee Rivers)*	<ul style="list-style-type: none"> • Annual spawning stock survey to include passage counts, a relative abundance index, and/or population estimates and representative subsamples that describe size, age, and sex composition of the spawning stock * State may elect to sample these systems on a rotational basis (i.e., one system evaluated per year) • JAI: Juvenile abundance survey (GM)
	Savannah River	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of the spawning stock • JAI: Juvenile abundance survey (GM) (Cooperative effort between South Carolina and Georgia)
Georgia	Altamaha and Ogeechee Rivers	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index or population estimates and representative subsamples that describe size, age, and sex composition of the spawning stock • JAI: Juvenile abundance survey (GM)
	Savannah River	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of the spawning stock • JAI: Juvenile abundance survey (GM) (Cooperative effort between South Carolina and Georgia)
Florida	St. Johns River	<ul style="list-style-type: none"> • Annual spawning stock survey to include an abundance index and representative subsamples that describe size, age, and sex composition of the spawning stock • JAI: Juvenile abundance survey (GM)

Table 3

SUMMARY OF MANDATORY FISHERY-DEPENDENT MONITORING PROGRAMS FOR AMERICAN SHAD

STATE / JURISDICTION	SYSTEM	SAMPLING PROGRAM (Bolded sections are proposed under Amendment 3)
ASMFC	Atlantic Ocean (State and Federal waters) – cooperative effort with ALL coastal states and the NOAA Fisheries.	• Coordinate cooperative inter-state effort of ALL coastal states for mandatory reporting or at sea monitoring of bycatch (numbers or weight) and effort from commercial fisheries; subsamples shall indicate size, age, and sex composition of catch.
All states and jurisdictions	Rivers and estuaries	Mandatory reporting of bycatch (numbers and weight) and effort from commercial fisheries; subsamples shall indicate size, age, and sex composition of catch.
Maine	In-river	• Monitor recreational landings, catch, and effort
New Hampshire	In-river	• Monitor recreational landings, catch, and effort.
Massachusetts	Merrimack River	• Monitor recreational landings, catch, and effort.
	Connecticut River	• Monitor recreational landings, catch, and effort. (Cooperative effort between Massachusetts and Connecticut)
Connecticut	Connecticut River	• Mandatory reporting of landings (numbers and weight), catch (numbers and weight), and effort from commercial fisheries; subsamples shall indicate size, age, and sex composition of catch. • Monitor recreational landings, catch, and effort. (Cooperative effort between Massachusetts and Connecticut)
Rhode Island	Pawcatuck River	• Monitor recreational landings, catch and effort.
New York	Hudson River	• Mandatory reporting of landings (numbers and weight), catch (numbers and weight), and effort from commercial fisheries; subsamples shall indicate size, age, and sex composition of catch. • Monitor recreational landings, catch, and effort.
	Delaware River	• Monitor recreational landings, catch, and effort. (Cooperative effort among New Jersey, New York, Pennsylvania, and Delaware)
New Jersey	Delaware River and Bay	• Mandatory reporting of landings (numbers and weight), catch (numbers and weight), and effort from commercial fisheries; subsamples shall indicate size, age, and sex composition of catch. • Monitor recreational landings, catch, and effort. (Cooperative effort among New Jersey, New York, Pennsylvania, and Delaware)
Delaware	Delaware River and Bay	• Mandatory reporting of landings (numbers and weight), catch (numbers and weight), and effort from commercial fisheries; subsamples shall indicate size, age, and sex composition of catch. • Monitor recreational landings, catch, and effort. (Cooperative effort among New Jersey, New York, Pennsylvania, and Delaware)
	Nanticoke River	• None required. Fishery closed.
Pennsylvania	Delaware River	• Monitor recreational landings, catch, and effort. (Cooperative effort among New Jersey, New York, Pennsylvania, and Delaware)
Maryland	Susquehanna River	• Monitor recreational landings, catch, and effort.
	Potomac River	• Monitor recreational landings, catch, and effort. (Cooperative effort among Maryland, District of Columbia, the Potomac River Fisheries Commission, and Virginia)
District of Columbia	Potomac River	• Monitor recreational landings, catch, and effort. (Cooperative effort among Maryland, District of Columbia, the Potomac River Fisheries Commission, and Virginia)

STATE / JURISDICTION	SYSTEM	SAMPLING PROGRAM (Bolded sections are proposed under Amendment 3)
Potomac River Fisheries Commission	Potomac River	<ul style="list-style-type: none"> • Mandatory reporting of landings (numbers and weight), catch (numbers and weight), and effort from commercial fisheries; subsamples shall indicate size, age, and sex composition of catch. • Monitor recreational landings, catch, and effort. (Cooperative effort among Maryland, District of Columbia, the Potomac River Fisheries Commission, and Virginia)
Virginia	York, Rapahhanock, and James Rivers	<ul style="list-style-type: none"> • Monitor recreational landings, catch, and effort where appropriate
	Potomac River	<ul style="list-style-type: none"> • Monitor recreational landing, catch, and effort (Cooperative effort among Maryland, District of Columbia, the Potomac River Fisheries Commission, and Virginia)
North Carolina	Albemarle Sound and its tributaries, Tar-Pamlico, Neuse, and Cape Fear Rivers	<ul style="list-style-type: none"> • Mandatory reporting of landings (numbers and weight), catch (numbers and weight), and effort from commercial fisheries; subsamples shall indicate size, age, and sex composition of catch. • Monitor recreational landings, catch, and effort where appropriate
South Carolina	Edisto River, Santee River, Winyah Bay and its tributaries (Waccamaw and Pee Dee Rivers)	<ul style="list-style-type: none"> • Mandatory reporting of landings (numbers and weight), catch (numbers and weight), and effort from commercial fisheries; subsamples shall indicate size, age, and sex composition of catch. • Monitor recreational landings, catch, and effort where appropriate. • * South Carolina may elect to sample these systems on a rotational basis (i.e., one system evaluated per year)
	Savannah River	<ul style="list-style-type: none"> • Mandatory reporting of landings (numbers and weight), catch (numbers and weight), and effort from commercial fisheries; subsamples shall indicate size, age, and sex composition of catch. • Monitor recreational landings, catch, and effort (Cooperative effort between South Carolina and Georgia)
Georgia	Altamaha and Ogeechee Rivers	<ul style="list-style-type: none"> • Mandatory reporting of landings (numbers and weight), catch (numbers and weight), and effort from commercial fisheries; subsamples shall indicate size, age, and sex composition of catch. • Monitor recreational landing, catch, and effort where appropriate.
	Savannah River	<ul style="list-style-type: none"> • Mandatory reporting of landings (numbers and weight), catch (numbers and weight) and effort from commercial fisheries; subsamples shall indicate size, age, and sex composition of catch. • Monitor recreational landings, catch, and effort (Cooperative effort between South Carolina and Georgia)
Florida	St. Johns River	<ul style="list-style-type: none"> • Monitor recreational landings, catch and effort.

3.3 BYCATCH MONITORING AND REDUCTION

Bycatch and discard of American shad in commercial fisheries may be an important factor inhibiting the recovery of this species and this issue is given special emphasis in Amendment 3. States and jurisdictions will be required to annually monitor bycatch and discard of American shad in fisheries that operate in state waters of rivers and estuaries.

Ocean bycatch and discard are coastwide problems that affect shad stocks in all coastal states. Therefore, this amendment recommends that ocean bycatch and discards be monitored cooperatively by coastal states through the ASMFC, in cooperation with Fishery Management Councils and NOAA Fisheries. Observer coverage in ocean fisheries must be increased, and portside coverage expanded to provide statistically valid estimates of bycatch and discard losses. The planned bycatch module of the Atlantic Coastal Cooperative Statistics Program may be the best approach to this monitoring requirement when it becomes available.

It is known that many Atlantic coastal American shad stocks migrate to the Gulf of Maine and the Bay of Fundy in summer to feed. In Canadian waters, they are taken in directed fisheries and as bycatch. Size of losses to these sources is not known. This amendment recommends that the Commission work with the Department of Fisheries and Oceans Canada to obtain information on American shad losses in the Bay of Fundy and on potential actions that could reduce bycatch.

Responsibility for reporting ocean bycatch should be decided by the Management Board and be based on future arrangements developed to cooperatively monitor ocean fisheries.

Responsibility for reporting results of bycatch in river and estuarine fisheries remains with the states and jurisdictions. These results will be reported to the Commission annually as per Section 9.3. This amendment recommends that the Shad and River Herring Management Board coordinate American shad bycatch monitoring with other Commission species management boards to improve collection efficiency and coverage of bycatch data.

In documented cases of high American shad bycatch, the involved jurisdiction(s) shall recommend approaches to reduce such bycatch to the Management Board for review. Options may include gear restrictions and time/area closures.

3.4 SUMMARY OF MONITORING PROGRAMS

3.4.1 Biological Information

States and jurisdictions are mandated to implement the fishery-independent and dependent monitoring programs identified for American shad (Tables 2, 3, 4). States and jurisdictions may propose to the Board an alternative monitoring program if designed to measure progress toward restoration objectives or response to a defined sustainable fishery (Section 6). Whenever practical, state harvest and effort reporting requirements will coincide with current and future mandates of the ACCSP. Data needs not covered by the ACCSP will still be covered by annual reports submitted in conjunction with Amendment 3.

3.4.2 Social and Economic Information

Consumptive use (e.g. fishing activities before closures) and non-consumptive use (e.g. ecotourism activities) surveys focusing on social and economic data should be conducted periodically in a manner consistent with the intent of the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA) and the ACCSP Implementation Plan.

Table 4. Summary of monitoring requirements for American shad. **(Bolded sections are proposed under Amendment 3)**

Fishery-Independent	Juvenile Abundance Index
	Annual spawning stock survey and representative sampling for biological data
	Calculation of mortality/survival estimates (when available)
	Hatchery evaluation (hatchery vs. wild)--when in place
	Fishway counts; report inefficiencies (when available)
Fishery-Dependent	Mandatory reporting of landings (numbers and weight) , catch (numbers, weight) and effort. <ul style="list-style-type: none"> • Sub-samples shall characterize size, age, spawning marks, sex, and species composition of catch (when available)
	Commercial
	Monitor recreational by water body of landings , catch and effort: <ul style="list-style-type: none"> • Creel surveys, or • Survey license/permit holders, or • MRFSS/MRIP, or • Reporting requirements for obtaining/maintaining license or permit, or • Angler logbooks, or • Other
	Recreational
	Require monitoring and reporting of harvest, bycatch and discards of American shad in all fisheries <ul style="list-style-type: none"> • Bycatch in rivers and estuaries to be monitored and reported by states • Bycatch in at sea and near shore ocean fisheries to be monitored and reported by cooperative interstate and Federal arrangements determined by the Board
Bycatch	
Increase observer coverage and employ portside monitoring	
Coordinate with other FMPs	
Annual Summary Report	Annual data summaries to be added to Excel spreadsheets used by ASMFC (2007)

4. PROPOSED REGULATORY PROGRAM

The management program enacted by this amendment may include any one strategy or combination of strategies listed below. Based on the public comment received as the result of reviewing this draft and recommendations from the Shad and River Herring Technical Committee and Shad and River Herring Advisory Panel, the Shad and River Herring Management Board will devise broad guidelines for a management program to be adopted via this amendment. The details of implementation are not included because details are to be proposed by the states in response to Management Board guidelines and will be subject to Management Board approval. It is important to note that this amendment provides the Management Board with the ability to re-evaluate and modify the management program very rapidly in response to stock conditions or public input. Please see Section 7.2 for the mechanisms available for adaptive management.

4.1 COMMERCIAL FISHERIES MANAGEMENT MEASURES

Mandatory reporting on catch, landings, and effort in active commercial fisheries for all alosines (American shad, hickory shad, and river herring) is required as per Section 3.

Whenever practical, state catch, harvest and effort reporting requirements will coincide with current and future mandates of the Atlantic Coastal Cooperative Statistics Survey (ACCSP). Data needs not covered by the ACCSP will still be covered by annual reports submitted in conjunction with the Amendment.

Option 1: Status Quo

This option would allow individual states and jurisdictions to maintain the rights to manage all American shad commercial fisheries in state waters as outlined in Amendment 1. Currently, all states and jurisdictions are allowed to maintain the commercial coastal and in-river fishing regulations that were in place as of April 1999 with the exception that they must maintain the closure of the directed ocean fishery that was initiated in April 1999 and fully implemented on 1 January 2005. States may institute more conservative regulations.

Option 2: Reduce Harvest

This option would require individual states and jurisdictions to reduce harvest from directed American shad fisheries. Each state may recommend approaches to reduce harvest, including but not limited to, gear and season restrictions, area closures, commercial trip limits and limited access. Harvest reduction is most appropriate for shad stocks exhibiting high or increasing total mortality and declining abundance.

Option 3: Close Fisheries with Exceptions for Systems with Sustainable Fisheries

Under this option states and jurisdictions must close all commercial fisheries for American shad. Exceptions can be made on a system-by-system basis. In order to maintain a commercial American shad fishery, states and jurisdictions would have to demonstrate that their American shad stock could support a commercial fishery. Data to substantiate these claims may include repeat spawning ratio, spawning stock biomass, total mortality rates, juvenile abundance levels, fish passage counts, and hatchery contribution to stocks. States must petition the Management Board for a fishery in the state fishing and recovery plan (Section 6). The Management Board will have the authority to permit an American shad commercial fishery on any system under its jurisdiction.

Option 4: Close Directed Fisheries on Mixed Stocks

Under this option states and jurisdictions would be required to close all fisheries directed at the harvest of American shad where the harvest includes individuals from more than one stock. Exceptions could be made for mixed stock fisheries where states could demonstrate that such fishing activity does not harm harvested stocks. Data to substantiate these claims may include repeat spawning ratio, spawning stock biomass, total mortality rates, juvenile abundance levels, fish passage counts, and hatchery contribution to stocks.

Option 5: Coastwide Moratorium on American Shad Harvest

Under this option, states and jurisdictions would be required to implement regulations prohibiting the commercial harvest, possession and landing of American shad within their jurisdiction.

Shad and River Herring Advisory Panel Recommendation: The Shad and River Herring Advisory Panel endorses both *Option 3 (Close Fisheries with Exceptions for Systems with a Sustainable Fishery)* and *Option 4 (Close Directed Fisheries on Mixed Stocks)*.

4.2 RECREATIONAL FISHERIES MANAGEMENT MEASURES

Option 1: Status quo

This option would allow individual states and jurisdictions to maintain the rights to manage all American shad recreational fisheries in state waters as outlined in Amendment I. Currently, all states and jurisdictions are allowed to maintain the recreational fishing regulations that were in place as of April 1999 or they may institute more conservative regulations. Currently, all jurisdictions shall not exceed an aggregate 10 fish daily creel limit in recreational fisheries for American shad or hickory shad, with the exception of the redirection canal in the Santee-Cooper system where an aggregate 20 fish daily creel limit is in place.

Option 2: Reduce Harvest

Under this option, states and jurisdictions would be required to develop regulations that would reduce the harvest American shad. Method of reduction should be recommended by individual states or jurisdictions, and include but are not limited to gear restrictions, coastwide creel limits, or area / seasonal closures. It is highly recommended that states eliminate lethal recreational methods such as bowfishing, gillnetting and tournaments.

Option 3: Recreational License/Permit

Under this option states and jurisdictions would be required to institute licensing or permitting requirements for the recreational harvest of American shad from state waters. The license or permit should include a reporting requirement for information such as catch, harvest numbers, and effort or allow the jurisdiction to survey the licensed/permitted fishermen for recreational catch and effort information. Recreational fishermen could be licensed or permitted through existing state programs, through the federal registry, or through the creation of a specific anadromous or alosine recreational license/permit.

Option 4: Close fisheries with exceptions for systems with a sustainable fishery

Under this option, states and jurisdictions must close all recreational fisheries for American shad. Exceptions could be made on a system-by-system basis. In order to maintain a recreational shad fishery states and jurisdictions would have to demonstrate that their stocks could support a recreational fishery. Data to substantiate these claims may include repeat spawning ratio, spawning stock biomass, total mortality rates, juvenile abundance levels, fish passage counts,

and hatchery contribution to stocks. States must petition the Management Board for a fishery in the state fishing and recovery plan (Section 6). The Management Board will have the authority to permit an American shad recreational fishery on any system under its jurisdiction.

Option 5: Allow catch and release recreational fisheries only

Under this option, states and jurisdictions would be allowed to have a catch and release recreational fishery. Current data available suggests that the mortality rate of American shad in a catch and release fishery is low, although more research is needed to understand the long-term mortality rates.

Option 6: Moratorium on American shad

Under this option states and jurisdictions would be required to implement regulations prohibiting the recreational harvest, possession and landing of American shad within their jurisdiction.

Shad and River Herring Advisory Panel Recommendation: The Shad and River Herring Advisory Panel endorses *Option 4 (Close Fisheries with Exceptions for Systems with a Sustainable Fishery)*. For all other systems the Advisory Panel endorses *Option 5 (Allow Catch and Release Only)*.

5. HABITAT CONSERVATION AND RESTORATION

American shad stocks along the Atlantic coast are greatly diminished compared to historic levels of the 1880's and early 1900's when landings were near 50 million pounds per year. Much of this reduction has been related to spawning and nursery habitat degradation, or blocked access to habitat, resulting from human activity (e.g.; human population increase; sewage and storm water runoff; industrialization; dam construction; increased erosion, sedimentation and nutrient enrichment associated with agricultural practices; and losses of riparian forests and wetland buffers associated with resource extraction and land development).

Protection, restoration and enhancement of American shad habitat, including spawning, nursery, rearing, production, and migration areas, are critical objectives necessary for preventing further declines in American shad abundance, and restoring healthy, self-sustaining, robust, and productive American shad stocks to levels that will support the desired ecological, social, and economic functions and values of a restored Atlantic coast American shad population. For more detailed information on Alosine habitat, please refer to Appendix C.

5.1 American shad Habitat

Freshwater Spawning, Egg Development and Larval Rearing Habitat

American shad spawning, egg development, and larval nursery habitat is geographically located in the freshwater portions of Atlantic coast rivers, and their associated tributaries and estuary (river complex). Each of these freshwater aquatic features is under exclusive jurisdiction of the

state, states, or jurisdictions within which they are contained. Collectively, these associated freshwater aquatic features spatially define the primary juvenile production unit of a defined American shad stock.

The quality and quantity of habitat within a river complex has a direct bearing upon the juvenile recruitment capacity of the associated stock and ultimately its potential contribution to the Atlantic coast population.

Estuarine Juvenile Rearing and Migration Corridors

The importance of estuaries to American shad as juvenile rearing habitat is not yet fully understood, however evidence suggests that estuaries are important to many American shad stocks. Estuaries are also often important migratory corridors for both spawning adult and emigrating juvenile American shad. Some potential threats in the estuarine environment include degraded juvenile habitat resulting from human-induced impacts, mortality from fisheries, and impediments to migration.

Coastal Production and Migration Corridors

The Atlantic coast ocean environment provides critical migration corridors and production habitat for sub-adult and adult American shad. Potential threats to coastal American shad habitat include: marine acidification; pharmaceutical disposal, wastewater discharge, pesticide contamination; invasive species; niche displacement; and global climate change.

5.2 Potential Threats to American shad Habitat

Barriers to migration – There has likely been considerable loss of production from historic American shad spawning and rearing habitat due to human activities that block access to habitat and/or impact safe, timely and effective fish migration in rivers along the Atlantic coast of the United States.

Water withdrawals - Large volume water withdrawals (e.g., drinking water, pumped-storage hydroelectric projects, irrigation, and snow-making, cooling), especially at pumped-storage facilities, can drastically alter local instream flow characteristics (e.g., reverse river flow). Withdrawals may also alter other physical characteristics of the river channel, including stream width, depth, current velocity, substrate and temperature. This can cause delayed movement past the facility, or impingement or entrainment at intakes causing mortality or injury.

Toxic and thermal wastewater discharge - Industrial and municipal discharges often contain toxic chemicals, such as heavy metals and various organic chemicals (e.g., insecticides, solvents, herbicides) that are harmful to aquatic life. Many contaminants have been identified as having deleterious effects on fish, particularly reproductive impairment. Chemicals and heavy metals can be assimilated through the food chain, producing sub-lethal effects such as behavioral and reproductive abnormalities, fin erosion, epidermal lesions, blood anemia, altered immune

response, and egg mortality. Thermal discharges can block or impede migration, interfere with egg/larval development, and reduce water quality.

Channelization, dredging, and instream construction - Channelization has the potential to cause significant environmental impacts including bank erosion, elevated water velocity, reduced habitat diversity, increased drainage, and poor water quality. Dredging and disposal of spoils along the shoreline can also create spoil banks, which block access to sloughs, pools, adjacent vegetated areas, and backwater swamps. Dredging may also release contaminants resulting in bioaccumulation, direct toxicity to aquatic organisms, or reduced dissolved oxygen levels. Dredge spoil banks are often unsuitable habitat for fishes. Instream construction may harm habitat, disrupt migration, or result in direct or delayed mortality (e.g., underwater blasting).

Land use - The effects of land use and land cover on water quality, stream morphology, and flow regimes are numerous, and may be one of the most important factors determining quantity and quality of aquatic habitats. Studies have shown that land use influences dissolved oxygen, sedimentation and turbidity, water temperature, pH, nutrients, and flow regime.

Atmospheric deposition - Atmospheric deposition occurs when pollutants are transferred from the air to the earth's surface. Such deposition is a significant source of pollutants to many water bodies. Pollutants can get from the air into the water through rain and snow, falling particles, and absorption of the gaseous form of the pollutants into the water. Atmospheric deposition that causes low pH and elevated aluminum (acid rain) can contribute to water chemistry changes that result in direct or indirect mortality of young-of-year fish.

Climate change - As climate changes occur, modification of habitat is expected to occur in many aquatic environments. Such modifications could result in changes in large-scale distribution patterns for fish species, and consequent changes in the thermal niche space available. The linkage between fish production and thermal niche space is confounded when the habitat is made unsuitable by a low dissolved oxygen concentration. Annual events that seem related to the seasonal cycle of water temperature might increase in frequency. Temperature plays a dominant role in keying the actual spawning events. Survival of eggs and larvae is often dependant upon the relative timing of egg deposition and environmental vagaries within the spawning period. Predicted temperature changes could be accompanied by rising sea levels with attendant flooding of spawning habitats in estuaries and wetland nursery areas. Rising sea level requires consideration of many coastal processes, including: tidal ranges, storm surges, intrusion of groundwater and surface water, sedimentary processes, and the response by the plant communities of coastal ecosystems to changes in these processes. Resultant impacts are likely to be highly site-specific and to include changes both in temperature and dissolved oxygen structure and other physiographic features.

Competition and predation by invasive and managed species – Several aquatic and terrestrial species pose a potential threat to various life stages of American shad through direct or indirect competition, or predation. The presence and abundance of these species are often the result of human-induced activity (i.e., accidental or intentional introduction, level of population control or management, and propagation).

Fisheries Activities - Some fishing gear or practice may have unacceptable negative impacts on American shad habitat or migration (e.g., habitat damage, bycatch mortality).

Instream Flow Regulation - In rivers with flow regulation (e.g., storage and peaking hydroelectric power generation dams), and consumptive water withdrawals (e.g., irrigation, domestic water supply, industrial use) habitat quality and quantity, fish passage, and water for American shad may be impacted.

5.3 Habitat Utilization

States are encouraged to utilize existing production capacity of historic, but currently inaccessible freshwater spawning and larval rearing habitat through a process of trap and transport of excess spawning stock, or planting of aquaculture produced fry and fingerlings. This will help to both increase juvenile recruitment for the stock, and will develop a stock component imprinted to upstream habitat that can take advantage of it once access is restored through barrier removal or installation of fish passage.

5.4 Fisheries Practices

The use of any fishing gear or practice that is documented to have unacceptable negative impacts on American shad habitat or migration (e.g., habitat damage, bycatch mortality) should be prohibited within the area of that habitat or corridor, as determined by the appropriate jurisdiction(s).

5.5 Habitat Restoration, Enhancement, Utilization, and Protection Recommendations

Dams and Other Obstructions

General Fish Passage

- 1) States should work in concert with the United States Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) to identify hydropower dams that pose significant impediment to diadromous fish migration, and target them for appropriate recommendations during Federal Energy Regulatory Commission (FERC) relicensing.
- 2) States should identify and prioritize barriers in need of fish passage based on clear ecological criteria (e.g., amount and quality of habitat upstream of barrier, size, and status of affected populations). These prioritizations could apply to a single species, but are likely to be more useful when all diadromous species are evaluated together.
- 3) A focused, coordinated, well supported effort among federal, state, and associated interests should be undertaken to address the issue of fish passage development and efficiency. The effort should attempt to develop new technologies and approaches to

- improve passage efficiency with the premise that existing technology is insufficient to achieve restoration and management goals for several Atlantic coast river systems.
- 4) Where obstruction removal is not feasible, install appropriate passage facilities, including fish lifts, fish locks, fishways, navigation locks, or notches (low-head dams and culverts).
 - 5) At sites with passage facilities, evaluate the effectiveness of upstream and downstream passage; when passage is inadequate, facilities should be improved.
 - 6) Facilities for monitoring the effectiveness of the fish passage devices should be incorporated into the design where possible.
 - 7) When designing and constructing fish passage systems, the behavioral response of each species of interest to appropriate site-specific physical factors should be considered.
 - 8) If possible, protection from predation should be provided at the entrance, exit, and throughout the passage.
 - 9) The passage facility should be designed to work under all conditions of head and tail water levels that prevail during periods of migration.
 - 10) Passages are vulnerable to damage by high flows and waterborne debris. Techniques for preventing damage include robust construction, siting facilities where they are least exposed to adverse conditions, and removing the facilities in the winter.
 - 11) Passage facilities should be designed specifically for passing alosines at optimum efficiency.

Upstream Fish Passage

- 1) American shad must be able to locate and enter the passage facility with little effort and without stress.
- 2) Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.
- 3) Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Downstream Fish Passage

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

Other Dam Issues

- 1) Where practicable, remove obstructions to upstream and downstream migration. in lieu of fishway construction
- 2) Locate water intakes where impingement/entrainment rates are likely to be lowest, employ intake screens or deterrent devices to prevent egg and larval mortality, and alter water intake velocities to reduce mortalities.

- 3) To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
- 4) Natural river discharge should be taken into account when instream flow alterations are being made to a river because it plays a role in the migration patterns of diadromous fish.
- 5) Ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account instream flow needs for American shad migration, spawning, and nursery use, and minimize deviation from natural flow regimes.
- 6) When considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations to enhance river habitat.

Water Quality and Contamination

- 1) Maintain water quality and suitable habitat for all life stages of diadromous species in all rivers with populations of American shad
- 2) Reduce non-point and point sources of pollution in American shad habitat areas.
- 3) Implement best management practices (BMPs) along rivers and streams, restore wetlands, and utilize stream buffers to control non-point source pollution.
- 4) Implement erosion control measures and BMPs in agricultural, suburban, and urban areas to reduce sediment input, toxic materials, and nutrients and organics into streams.
- 5) Upgrade wastewater treatment plants and remove biological and organic nutrients from wastewater.
- 6) Reduce the amount of thermal effluent into rivers and require a thermal zone of passage for fish migration and movement.
- 7) Provide management options regarding water withdrawal and land use to minimize the impacts of climate change on temperature and flow regimes.
- 8) Discharge earlier in the year to reduce impacts to migrating fish.
- 9) Conduct studies to determine the effects of dredging on diadromous habitat and migration; appropriate best management practices, including environmental windows, should be considered whenever navigation dredging or dredged material disposal operations would occur in a given waterway occupied by diadromous species.
- 10) Introduction of new categories of contaminants should be prevented.

Habitat Protection and Restoration

- 1) States should identify, characterize, and quantify existing spawning and nursery habitat within its jurisdiction.
- 2) When states have identified habitat protection or restoration as a need, state marine fisheries agencies should coordinate with other agencies to ensure that habitat

- restoration plans are developed, and funding is actively sought for plan implementation and monitoring.
- 3) Any activity resulting in elimination of essential habitat (e.g., dredging, filling) should be avoided.
 - 4) States should map substrate for freshwater tidal portions of rivers to determine suitable diadromous fish habitat, and that habitat should be protected and restored as needed.
 - 5) States should notify, in writing, the appropriate federal and state regulatory agencies of the locations of habitats used by diadromous species. Regulatory agencies should be advised of the types of threats to diadromous fish populations, and recommended measures that should be employed to avoid, minimize, or mitigate any threat to current habitat quantity or quality from an activity regulated by that agency.
 - 6) Each state encompassing diadromous fish spawning rivers and/or producer areas should develop water use and flow regime guidelines protective of diadromous spawning and nursery areas.
 - 7) States should identify and quantify potential shad and river herring spawning and nursery habitat not presently utilized, including a list of areas that would support such habitat if water quality and access were improved or created, and analyze the cost of recovery within those areas. States may wish to identify areas targeted for restoration as essential habitat.
 - 8) Resource management agencies in each state should evaluate their respective state water quality standards and criteria to ensure that those standards and criteria account for the special needs of alosines. Primary emphasis should be on locations where sensitive egg and larval stages are found.
 - 9) ASMFC should designate important shad and river herring spawning and nursery habitat as Habitat Areas of Particular Concern (HAPCs).
 - 10) States should endeavor to ensure that proposed water diversions or withdrawals from river tributaries would not reduce or eliminate American shad habitat.

Permitting

- 1) States should develop policies for limiting development projects seasonally or spatially in spawning and nursery areas; define and codify minimum riparian buffers and other restrictions where necessary.
- 2) Projects involving water withdrawal (e.g., power plants, irrigation, water supply projects) should be scrutinized to ensure that adverse impacts resulting from impingement, entrainment, and/or modifications of flow and salinity regimes due to water removal will not adversely impact diadromous fish stocks.
- 3) Each state should establish seasonal windows of compatibility for activities known or suspected to adversely affect freshwater American shad life stages and their habitats (e.g., dredging, filling, aquatic construction), and notify the appropriate state and federal regulatory agencies of the recommended windows.
- 4) State fishery regulatory agencies should develop protocols and schedules for providing input on Federal permits and licenses required by the Clean Water Act, Federal Power Act, and other appropriate vehicles, to ensure that diadromous fish habitats are protected.
- 5) All state and federal agencies responsible for reviewing impact statements for projects that may alter anadromous alosine spawning and nursery areas should ensure that those

projects will have no impact or only minimal impact on those stocks. Of special concern are natal rivers of newly established stocks or stocks considered depressed or severely depressed.

Stock Restoration and Management

- 1) When populations have been extirpated from their habitat, states should coordinate alosine stocking programs, to restore habitat production including:
 - a. Reintroduction to the historic spawning area
 - b. Expansion of existing stock restoration programs, and
 - c. Initiation of new strategies to enhance depressed stocks.
- 2) When releasing hatchery-reared larvae into river systems for purposes of restoring stocks, states should synchronize the release with periods of natural prey abundance to minimize mortality and maximize nutritional condition states should determine functional response of predators on larval shad at restoration sites to ascertain appropriate stocking level so that predation is accounted for, and juvenile out-migration goals are met. Also, determine if night stocking will reduce mortality.
- 3) All stocked larvae and juveniles should be marked. Marking should allow identification of stocked fish by stocked river, age, and year class at the juvenile stage and when fish return to spawn as adults.

Other

- 1) States should promote cooperative interstate research, monitoring, and law enforcement. Establish criteria, standards, and procedures for plan implementation as well as determination of state compliance with management plan provisions.
- 2) Diadromous fish may be vulnerable to mortality in hydrokinetic power generation facilities, and such projects should be designed and monitored to eliminate, or minimize, fish mortality.

River-Specific Habitat Recommendations

River-specific habitat recommendations for American shad can be found in:

Atlantic States Marine Fisheries Commission. 2007. American shad stock assessment report for peer review, volumes II and III. Atlantic States Marine Fisheries Commission Stock Assessment Report No. 07-01 (Supplement), Washington, D.C.

6.0 IMPLEMENTATION PLANS

In order to be successful in achieving the stated goal of Amendment 3, states are required to develop Implementation Plans. Implementation Plans will consist of two parts: 1. Review and

update of the Fishing/Recovery Plans required under Amendment 1 for the stocks within their jurisdiction; and 2. Habitat Plans. For existing state and jurisdiction shad plan requirements see Amendment 1: *Section 4.5 Adaptive Management, Subsection 4.5.1.1 Procedural Steps – Item E; Section 5.1 Mandatory Compliance Items for States - Subsection 5.1.2 Compliance Schedule;* and *Table 11* Format for state fishing and recovery plans. The updated Fishing/Recovery Plan must include a description of existing and planned monitoring and existing and planned regulatory measures. It may also include, where required, a definition of sustainability, development of benchmark goals (if different from or in addition to those identified in 2007 Stock Assessment), and a proposed timeframe to achieve stated objectives. The habitat plans are new and should include a summary of current and historical spawning and nursery habitat, threats to those habitats, and habitat restoration programs.

Monitoring sections of the Fishing/Recovery Plan updates should address the state specific monitoring requirements specified in Tables 2 and 3. If states cannot conduct required monitoring, the plan update should identify required monitoring that cannot be done and reasons why it cannot be conducted. It is the intention of this amendment to discuss identified implementation problems with the state or jurisdiction prior to plan adoption so that the Commission can work with the state or jurisdiction to explore the opportunity to secure adequate funding resources for implementation, or to develop an acceptable alternative that can be implemented with available resources.

If the state or jurisdiction chooses to develop a definition of sustainability and stock restoration goals (See Option 3 of Section 4.1 and Option 4 of Section 4.2), it may propose to the Management Board an alternate monitoring plan that measures stock status relative to the definition or goal. If approved by the board, this monitoring program will replace that specified in Tables 2 and 3.

Separate Implementation Plans shall be developed for those systems listed in Tables 2 and 3 and which are under the state or jurisdiction's authority. For states and jurisdictions which share a river or estuary, states should include those monitoring programs conducted or planned by the state, applicable state regulations, and habitat and habitat threats applicable to state waters. In shared water bodies where there is some sort of management cooperative, the cooperative or a member state or jurisdiction can be appointed to write the Implementation Plan. States are encouraged to develop plans for any additional systems, as feasible.

This amendment proposes to adopt the below frameworks for the updated Fishing/Recovery Plans and the Habitat Plans. Under this amendment the Technical Committee shall review each plan to ensure that the minimal technical specifications of Amendment 3 are met by the states and jurisdictions. The Management Board should determine an appropriate timeline for completion, adoption and periodic review of plans. The PDT proposes that states and jurisdictions should have one year, from the time of Amendment adoption, to complete the Fishing/Recovery Plans and three years from the time of Amendment adoption to develop the Habitat Plans. Submission of these plans to the Management Board is a required action under Amendment 3. These plans are one time submissions under this amendment. They do not replace the annual state compliance reports discussed in Section 8.

It is understood that the review and update will take considerable time and resources on the part of the states, the federal agencies, and the Commission and, its staff to fully develop and implement. It will require leadership and facilitation from the Commission and its staff. It will also require the technical expertise and input from the Plan Review Team, Plan Development Team, and Technical Committee. The federal agencies are strongly encouraged to lend their support and provide assistance in the form of facilitation, planning, technology, and training services.

All plans are to be regularly reviewed, assessed and updated as needed on five-year basis by the state or jurisdiction that prepared them, with a summary report of the review provided to the Board.

6.1 Updated Framework for the Fishing/Recovery Plans

The Plan Development Team proposes the following framework for the updated Fishing/Recovery Plans. The Management Board should task the Technical Committee to review, modify as needed, and approve this framework.

- 1) **Sustainable Fishery Alternative (If proposed)**
 - a. Request for fisheries
 - b. Definition of sustainability
 - c. Benchmark goals and objectives or restoration goals/targets.
 - d. Proposed time frame for achievement

- 2) **Stock Monitoring Programs** – Describe the monitoring currently used, or planned, to assess status and characteristics of the spawning stock and of progress toward goals. See requirements of Tables 2 and 3. States and jurisdictions should indicate any required monitoring that cannot be conducted (See Section 6.0).
 - a. Fishery Independent
 - i. Juvenile abundance indices
 - ii. Adult stock monitoring
 1. Relative or absolute abundance
 2. Age, size, sex composition
 3. Total mortality (where possible)
 4. Upriver and downriver passage efficiencies (where possible)
 - iii. Hatchery evaluation
 1. Proportion of hatchery fish present in juvenile or adult populations
 - b. Fishery Dependent
 - i. Commercial Fishery
 1. Total catch, landings, and effort
 2. Age, size, and sex composition of harvested fish
 - ii. Recreational fishery
 1. Total catch, landings, and effort or catch per unit effort from a subsample
 - iii. Bycatch and discards

- 3) **Fishery Management Program** – Summarize fisheries regulatory program developed in response to fishery management options (Sections 4.1 and 4.2) selected by the Management Board.
 - a. Commercial fishery
 - b. Recreational fishery
 - c. Bycatch and discards

6.2. Habitat Plans

The Plan Development Team proposes the following framework for the Habitat Plan. The Management Board should task the Technical Committee to review, modify as needed, and approve this framework. This outline is designed to be an inclusive framework for organizing information on habitat, and threats to that habitat. As such, it is likely that data may not yet be available for some items. In those cases, states and jurisdiction should indicate data status (e.g., not available, being collected, being analyzed, under review).

- 1) **Habitat Assessment** – Assess the habitat (historic and currently available) and impediments to full utilization of the habitat.
 - a. Spawning Habitat
 - i. Amount of historical in-river and estuarine spawning habitat (e.g., river kilometers, water surface area (hectares)).
 - ii. Amount of currently accessible in-river and estuarine spawning habitat (i.e., habitat accessible to adult fish during the upstream spawning migration).
 - b. Rearing Habitat
 - i. Amount of historical in-river and estuarine young-of-year rearing habitat (e.g., river kilometers, water surface area (hectares)).
 - ii. Amount of currently utilized in-river and estuarine young-of-year rearing habitat (i.e., habitat available to larval stage and young-of-year fish through natural spawning or artificial stocking of hatchery reared juvenile fish).
- 2) **Threats Assessment** – Inventory and assess the critical threats to habitat quality, quantity, access, and utilization (see - *Appendix C* for a detailed habitat description). For those threats deemed by the state or jurisdiction to be of critical importance to restoration or management an American shad stock, the state or jurisdiction should develop a threats assessment for inclusion in the Habitat Plan. Examples of potential threats to habitat quality, quantity, and access for American shad stocks include:
 - a. Barriers to migration inventory and assessment
 - i. Inventory of dams, as feasible, that impact migration and utilization of historic stock (river) specific habitat. Attribute data for each dam should be captured in an electronic database (e.g., spreadsheet) and include: name of dam, purpose of the dam, owner, height, width, length, impoundment size, water storage capacity, location (i.e., river name, state, town, distance from river mouth, geo-reference coordinates), fish passage facilities and measures implemented (i.e., fish passage type, capacity, effectiveness, and

- operational measure such as directed spill to facilitate downstream passage), and information source (e.g., state dam inventory).
- ii. Inventory of other human-induced physical structures (e.g., stream crossing/culverts), as feasible, that impact migration and utilization of historic habitat (data on each structural impediment should include: type, source, and location).
 - iii. Inventory of altered water quality (e.g., low oxygen zones) and quantity (e.g., regulated minimum flows that impact migration corridors and/or migration cues), as feasible, impediments that impact migration and utilization of historic habitat (data on each water quality and quantity impediment should include: type, source, location, and extent).
 - iv. Assess barriers to migration in the watershed and characterize potential impact on American shad migration and utilization of historic habitat.
- b. Water withdrawals inventory and assessment
 - i. Inventory of water withdrawals (both permitted and known unpermitted), as feasible, that impact or have the potential to impact (e.g., fish entrainment and impingement, instream habitat alteration, and/or alteration of instream flow) migration and utilization of historic habitat.
 - ii. Assess water withdrawals in the watershed and characterize potential impact on American shad migration and utilization of historic habitat.
 - c. Toxic and thermal discharge inventory and assessment
 - i. Inventory of toxic and thermal discharge of water, where applicable, that impact or have the potential to impact (e.g., create a barrier, lethal concentration, and/or reduce fitness) migration and utilization of historic habitat.
 - ii. Assess toxic and thermal discharge in the watershed and characterize potential impact on American shad migration and utilization of historic habitat.
 - d. Channelization and dredging inventory and assessment
 - i. Inventory of channelization and dredging projects, as feasible, that impact or have the potential to impact (e.g., create a barrier, degrade substrate, and/or reduce water quality) migration and utilization of historic habitat.
 - ii. Assess stream channelization and dredging in the watershed and characterize potential impact on American shad migration and utilization of historic habitat.
 - e. Land use inventory and assessment
 - i. Inventory of land use in the watershed that impact or have the potential to impact (e.g., alter run-off regimes, degrade riparian habitat, increase siltation, reduce water quality and/or diminish riparian buffers) migration and utilization of historic habitat.
 - ii. Assess land use in the watershed and characterize potential impact on American shad migration and utilization of historic habitat.
 - f. Atmospheric deposition assessment
 - i. Assess atmospheric deposition in the watershed and characterize potential impact on American shad migration and utilization of historic habitat.
 - g. Climate change assessment

- i. Assess potential climate change impacts in the watershed and characterize their impact on American shad migration and utilization of historic habitat.
 - h. Competition and predation by invasive and managed species assessment
 - i. Assess competition and predation by invasive and managed species in the watershed and characterize potential impact on American shad migration and utilization of historic habitat.
- 3) **Habitat Restoration Program** – For threats deemed to be of critical importance to the restoration and management of American shad stocks within its jurisdiction, each state or jurisdiction should develop a program of actions to improve, enhance and/or restore habitat quality and quantity, habitat access, habitat utilization and migration pathways. These programs may include plans to take direct corrective actions within the state or jurisdictions’ authority, or to consult with agencies that have management authority over the threat, inform them of the impacts the threat is having on American shad stocks, and recommend potential alternatives or corrective actions to alleviate that threat. Section 5.5 Habitat Restoration, Enhancement, Utilization, and Protection Recommendations should be consulted for potential actions that could be included in the Habitat Restoration Program. While this amendment proposes the development of such programs, the implementation of these programs is not required. Programs could include:
- a. Barrier removal and fish passage program – Develop a program to eliminate, minimize, or mitigate impacts from barriers identified in 2 (a) above.
 - b. Hatchery product supplementation program – Consider the stocking of hatchery reared larvae or juveniles to spawning or rearing habitat that is underutilized due to migration barriers or to new habitat following barrier removal.
 - c. Water quality improvement program - A program should be developed to address identified impacts of poor water quality to spawning success and juvenile recruitment in 2 (b) and (c) above.
 - d. Habitat improvement program - A program should be developed to address identified impacts to habitat in 2 (d) and (e) above and to protect quality habitat.
 - e. Project permit/licensing review program for water withdrawals, toxic and thermal discharge, channelization and dredging, and land use and development, that includes development of recommendations and conditions to avoid, minimize, or mitigate associated impacts to American shad migration and utilization of historic habitat - A program should be developed to identify, review, assess, and comment or condition permitted/licensed development projects that could impact aquatic habitat or restoration efforts
 - f. Programs to avoid, minimize, or mitigate associated impacts to American shad migration and utilization of historic habitat from atmospheric deposition and climate change – Atmospheric deposition and climate change may impact restoration efforts and will need to be addressed through cooperative engagement with the public and regulatory bodies that can influence positive change, or eliminate/diminish the identified impacts. It is recommended that a program be

developed to engage in the public debate and/or regulatory actions in order to attain full consideration of impacts of atmospheric deposition and climate change on American shad habitat and restoration efforts. It is also recommended that the ASMFC should consider developing a plan to engage as a unified body in the atmospheric deposition and climate change debate, and formulate a position statement on future action by regulatory agencies that address the identified impacts.

7. AMENDMENT REVISIONS

7.1 Future Changes to Management Regimes

Once the Shad and River Herring Management Board approves a management program (monitoring, regulatory and habitat), states and jurisdictions are required to obtain approval from the Management Board prior to changing their management program in any way that might alter a compliance measure. Changes to management programs that affect measures other than compliance measures must be reported to the Management Board but may be implemented without prior approval. States and jurisdictions submitting alternative proposals must demonstrate that the proposed management program will not contribute to excessive mortality of the resource or inhibit restoration of the resource. The Management Board can approve an alternative management program proposed by a state or jurisdiction if the state or jurisdiction can show to the Management Board's satisfaction that the alternative proposal will have the same conservation value as the measure contained in this amendment or any addenda prepared under Adaptive Management (Section 7.2). All changes in state and jurisdictional plans must be submitted in writing to the Management Board and the Commission either as part of the annual FMP Review process or with the annual compliance report.

7.1.1 General Procedures

A state may submit a proposal to the Commission for a change to its regulatory program or any mandatory compliance measure under this amendment, including a proposal for *de minimis* status. Such changes shall be submitted to the Chair of the Plan Review Team, who shall then distribute the proposal to the Management Board, Plan Review Team. The Plan Review Team may request additional guidance from the Technical Committee, Stock Assessment Subcommittee and Advisory Panel, as necessary. The Plan Review Team is responsible for gathering the comments, if requested, from the Technical Committee, Stock Assessment Subcommittee and Advisory Panel, and presenting the comments to the Management Board in a timely fashion.

The Shad and River Herring Management Board can approve an alternative management program proposed by a state or jurisdiction if the state or jurisdiction can show to the Management Board's satisfaction that the alternative proposal will have the same conservation value as the measure contained in this amendment or any addenda prepared under Adaptive Management (Section 7.2).

7.1.2 Management Program Equivalency

The Shad and River Herring Technical Committee, under the direction of the Plan Review Team, will review any alternative management program proposals and provide the Management Board its evaluation of the adequacy of the proposals.

7.1.3 *De Minimis* Fishery Guidelines

The Commission's Interstate Fisheries Management Program Charter defines *de minimis* as "a situation in which, under the existing condition of the stock and scope of the fishery, conservation and enforcement actions taken by an individual state would be expected to contribute insignificantly to a coastwide conservation program required by a Fishery Management Plan or amendment" (ASMFC 2003).

[Once the specific management programs are adopted, the requirements for de minimis and the management program elements (i.e. commercial and recreational monitoring) that states and jurisdictions are exempt from will be determined by the Management Board.]

States and jurisdictions may petition the Shad and River Herring Management Board at any time for *de minimis* status if their fishery falls below the threshold level determined by the Board. Once *de minimis* status is granted, designated states and jurisdictions must submit annual compliance reports to the Management Board and request *de minimis* status on an annual basis.

7.2 ADAPTIVE MANAGEMENT

The Shad and River Herring Management Board may vary the requirements specified in this amendment as part of adaptive management in order to conserve American shad resources. Specifically, the Management Board may change state and jurisdiction requirements under Sections 3 and 4 (see Section 7.1.2). Such changes will be instituted to be effective on January 1 or the first fishing day of the following year, but may be put in place at an alternative time when deemed necessary by the Management Board.

7.2.1 General Procedures

The Shad and River Herring Plan Review Team will monitor the status of the fishery and the resource and report on that status to the Management Board annually or when directed to do so by the Management Board. The Plan Review Team will consult with the Technical Committee, Stock Assessment Subcommittee and Advisory Panel, as necessary, when making such a review and report. The report may contain recommendations for proposed adaptive management revisions to the amendment.

The Management Board will review the Plan Review Team report and may consult further with the Technical Committee, Stock Assessment Subcommittee or the Advisory Panel. The Management Board can direct the Plan Development Team to prepare an addendum to make

changes that it deems necessary. The addendum shall contain a schedule for the states and jurisdictions to implement its provisions.

The Plan Development Team will prepare a draft addendum as directed by the Management Board and, upon approval from the Board, shall distribute it for review and comment to all states and jurisdictions with declared interest in the fishery. A public hearing will be held in any state or jurisdiction that requests one. After a 30-day review period, the Plan Development Team will summarize the comments and present them to the Management Board.

After considering the comments, the Management Board will direct the Plan Development Team on what to include in the final addendum. The Management Board shall review the final version of the addendum. The Management Board shall then consider whether to adopt or revise and then adopt the addendum.

Upon the adoption of an addendum to implement adaptive management, states and jurisdictions shall prepare plans, when necessary, to implement the addendum and submit those plans to the Management Board for approval, following the schedule contained in the addendum.

7.2.2 Measures Subject to Change

The following measures are subject to change under adaptive management upon approval by the Management Board:

- (1) Habitat considerations;
- (2) Overfishing definition;
- (3) Rebuilding targets and schedules;
- (4) Fishery-independent monitoring requirements;
- (5) Fishery-dependent monitoring requirements;
- (6) Bycatch monitoring and reduction requirements;
- (7) Reporting requirements;
- (8) Effort controls;
- (9) Area closures;
- (10) Gear restrictions or limitations;
- (11) Catch controls;
- (12) Fishing year and/or seasons;
- (13) Possession limits;
- (14) Quotas;
- (15) Bycatch limits and reporting;
- (16) Observer requirements;
- (17) Closures;
- (18) Regulatory measures for the recreational fishery;
- (19) Recommendations to the Secretaries for complementary actions in federal jurisdictions;
- (20) *De minimis* specifications;
- (21) Compliance report due dates; and
- (22) Any other management measures currently included in the Shad and River Herring Interstate Fishery Management Plan.

7.3 EMERGENCY PROCEDURES

The Shad and River Herring Management Board may authorize or require emergency action that is not covered by, or is an exception or change to, any provision in Amendment 3. Procedures for implementation of emergency action are addressed in the Commission's Interstate Fisheries Management Program Charter, Section Six (c)(10) (ASMFC 2003).

8. MANAGEMENT INSTITUTIONS

The management institutions for shad and River herring shall be subject to the provisions of the ISFMP Charter (ASMFC 2003). The following are not intended to replace any or all of the provisions of the ISFMP Charter. All committee roles and responsibilities are included in detail in the ISFMP Charter and are only summarized here.

8.1 The Commission and the ISFMP Policy Board

The Atlantic States Marine Fisheries Commission and the ISFMP Policy Board are generally responsible for the oversight and management of the Commission's fisheries management activities. The Commission must approve all fishery management plans and amendments, including this Amendment 3, and must also make final determinations concerning state compliance or non-compliance. The ISFMP Policy Board reviews any non-compliance recommendations from the various management boards and sections and, if it concurs, forwards them on to the Commission for action.

8.2 Shad and River Herring Management Board

The Shad and River Herring Management Board is established by the Commission's ISFMP Policy Board and is generally responsible for carrying out all activities under this amendment. It establishes and oversees the activities of the Plan Review Team, Plan Development Team, Technical Committee and Stock Assessment Subcommittee, and requests the establishment of the Commission's Shad and River Herring Advisory Panel. Among other things, the Management Board makes changes to the management program under adaptive management and approves the state and jurisdictional programs implementing the amendment and alternative state programs under Sections 6 and 7. The Management Board reviews the status of state and jurisdiction compliance with the FMP at least annually and, if it determines that a state or jurisdiction is out of compliance, reports that determination to the ISFMP Policy Board under the terms of the ISFMP Charter.

8.3 Shad and River Herring Plan Review Team and Plan Development Team

The Shad and River Herring Plan Review Team and Plan Development Team are small groups whose responsibility is to provide all necessary staff support to carry out and document the decisions of the Management Board. Both teams are directly responsible to the Management

Board for providing all of the information and documentation necessary to carry out the Board's decisions.

The teams shall be comprised of personnel from state and federal agencies who have scientific or management knowledge of shad and river herring and will be chaired by the Commission's Shad and River Herring FMP Coordinator. The Plan Development Team will be responsible for preparing all documentation necessary for the development of Amendment 3, using the best scientific information available and the most current stock assessment information. Once the Commission adopts Amendment 3, the Plan Review Team will provide annual advice concerning implementation, review, monitoring and enforcement of the amendment.

8.4 Shad and River Herring Technical Committee

The Shad and River Herring Technical Committee will consist of representatives from each state, jurisdiction, and federal agency with a declared interest in shad and river herring fisheries. Its role is to act as a liaison to the individual jurisdictions and federal agencies, providing information to the management process and reviewing and making recommendations concerning the management program. The Technical Committee will provide scientific advice to the Management Board, Plan Development Team and Plan Review Team in the development and monitoring of a fishery management plan or amendment, when requested.

8.5 Shad and River Herring Stock Assessment Subcommittee

The Shad and River Herring Stock Assessment Subcommittee will consist of scientists with expertise in stock assessment methods or the assessment of shad and river herring populations. Its role is to assess shad and river herring populations and provide scientific advice concerning the implications of proposed or potential management alternatives for the stocks, as well as to respond to other scientific questions from the Management Board, Technical Committee, Plan Development Team or Plan Review Team. The Stock Assessment Subcommittee will report to the Management Board as well as to the Technical Committee, when requested.

8.6 Shad and River Herring Advisory Panel

The Shad and River Herring Advisory Panel is established according to the Commission's Advisory Committee Charter. Members of the Advisory Panel are citizens who represent a cross-section of commercial and recreational fishing interests and other who are concerned about shad and river herring conservation and management. The Advisory Panel provides the Management Board with advice directly concerning the Commission's shad and river herring management program.

8.7 Secretaries of Commerce and the Interior

Under the Atlantic Coastal Fisheries Cooperative Management Act, if the Commission determines that a state or jurisdiction is out of compliance with the Fishery Management Plan, it reports that finding to the Secretary of Commerce. The Secretary of Commerce must determine

that the measures not taken by the state or jurisdiction are necessary for conservation and if such a finding is determined, the Secretary is then required by federal law to impose a moratorium on fishing for shad or river herring in that jurisdiction's waters until the state comes back into compliance. In addition, the Commission has accorded the National Marine Fisheries Service and the U.S. Fish and Wildlife Service voting status on the ISFMP Policy Board and the Shad and River Herring Management Board; the federal agencies participate on the Plan Review Team, Plan Development Team, Technical Committee and Stock Assessment Subcommittee.

8.8 Recommendations to Secretaries

[Once the specific management programs are adopted, Section 8.8 will be written to recommend complementary actions in Federal waters.]

9. COMPLIANCE

Full implementation of the provisions in this amendment is necessary for the management program to be equitable, efficient and effective. States (to include states as well as the District of Columbia and Potomac River Fisheries Commission) are expected to implement these measures faithfully under state laws. Although the Atlantic States Marine Fisheries Commission does not have authority to directly compel state implementation of these measures, it will continually monitor the effectiveness of state implementation and determine whether states are in compliance with the provisions of this amendment. This section sets forth the specific elements that the Commission will consider in determining state compliance with this amendment and the procedures that govern the evaluation of compliance. Additional details of the procedures are found in the 2003 ASMFC Interstate Fisheries Management Program (ISFMP) Charter. States and jurisdictions should be aware that federal law requires their compliance with the provisions of this amendment.

9.1 MANDATORY COMPLIANCE ELEMENTS FOR STATES

A state or jurisdiction will be determined out of compliance with the provision of this fishery management plan according to the terms of Section 7 of the ISFMP Charter if:

1. It's Implementation Plan or its annual compliance reports have not been approved by the Shad and River Herring Management Board; or
2. It fails to meet any scheduled action required by Section 9.2, or any addendum prepared under adaptive management (Section 7.2); or
3. It has failed to implement a change to its monitoring program (Section 3) or its regulations when determined necessary by the Shad and River Herring Management Board; or
4. It makes a change to its monitoring programs required under Section 3 or its regulations required under Section 4 without prior approval of the Shad and River Herring Management Board.

9.1.1 Mandatory Elements of State Programs

[The Shad and River Herring Management Board may elect to designate specific sections of this Amendment as mandatory elements of a state program.]

9.1.2 Regulatory Requirements

States and jurisdictions may begin to implement Amendment 3 after final approval by the Commission. Each state and jurisdiction must submit its required shad and river herring regulatory program (part of the Fishing/Recovery Plans, Section 6) to the Commission through Commission staff for approval by the Management Board. During the period between submission of the regulatory plan and the Management Board's decision to approve or reject it, a state or jurisdiction may not adopt a less protective management program than contained in this Amendment or contained in current state law. Once a regulatory program is approved by the Management Board, states and jurisdictions may not implement any regulatory changes concerning shad and river herring, or any management program changes that affect their responsibilities under this Amendment, without first having those changes approved by the Management Board.

[Once the specific management program is adopted, the requirement will be listed along with reference to the relevant sections.]

9.1.3 Monitoring Requirements

All state and jurisdictional programs must include the mandatory monitoring requirements contained in Section 3 unless the Management Board approves an alternative program as outlined in Section 6.0. States and jurisdictions must submit proposals as part of the Fishing/Recovery Plan for all intended changes to required monitoring programs that may affect the quality of the data or the ability of the program to fulfill the needs of the amendment. In the event that a state or jurisdiction realizes that it will not be able to fulfill its monitoring requirements, it should immediately notify the Commission in writing. The Commission will work with the state or jurisdiction to develop a plan to secure funding or plan an alternative program to satisfy the needs outlined in Amendment 3. If the plan is not implemented 90 days after it has been adopted, the state or jurisdiction may be found out of compliance with Amendment 3.

9.1.4 Research Requirements

No mandatory research requirements have been identified at this time; however, elements of state Implementation Plans may be added to address any needs identified during the course of developing Amendment 3.

9.1.5 Law Enforcement Requirements

All state and jurisdictional programs must include law enforcement capabilities adequate for successfully implementing the state's shad and river herring regulations. The adequacy of a state's enforcement activity will be measured by an annual report to the Commission's Law Enforcement Committee and the Plan Review Team.

9.1.6 Habitat Requirements

No mandatory habitat requirements have been identified at this time; however, elements of state habitat plans (Section 6) may be added to address any needs identified during the course of developing Amendment 3.

9.2 COMPLIANCE SCHEDULE

States and jurisdictions must implement the provisions of this Amendment according to a schedule determined by the Shad and River Herring Management Board at the time that Amendment 3 is approved.

Reports on compliance should be submitted to the Commission by each jurisdiction annually, no later than July 1 each year. These reports are separate from the Implementation plans which are one time submissions to the Commission.

9.3 COMPLIANCE REPORT CONTENT

Each state must submit an annual report concerning its shad and river herring fisheries and management program for the previous years. The report shall cover:

1. The previous calendar year's fishery and management program including, activity and results of monitoring, regulations that were in effect, harvest, and estimates of non-harvest losses, following the outline contained in Table 5.
2. All data from monitoring programs must be added to Excel spreadsheets used in the recent stock assessment. Updated spreadsheets must be submitted annually as an appendix to the annual report and at the same time as the annual report unless determined otherwise by the Board.
3. The planned management program for the current calendar year, summarizing regulations that will be in effect and monitoring programs that will be performed, and highlighting any changes from the previous year.

Table 5. Required format for annual state compliance reports.

General Format	
Introduction	Summary of the year: highlight any significant changes in monitoring, regulations or harvest.
Request for <i>de minimis</i>	If applicable.
Previous year's fishery and management program	Activity and result of fishery-dependent monitoring (provide general results and references to technical documentation) including bycatch monitoring.
	Activity and results of fishery-independent monitoring (provide general results and references to technical documentation).
	Copy of regulations that were in effect, including a reference to the specific compliance criteria as mandated in the FMP.
	Harvest broken down by commercial (gear type where applicable) and recreational fishing, and non-harvest losses, when available.
	Review of progress in implementing habitat recommendations.
Planned management programs for the current calendar year	Summarize regulations that will be in effect (copy of current regulations if different from previous year).
	Summarize monitoring programs that will be performed.
	Highlight any changes from the previous year.
Plan-Specific Requirements	
Harvest and losses for all alosines	Characterization of the fishery (seasons, caps, gears, regulations).
	Commercial Fishery
	Characterization of directed harvest.
	Harvest composition
	Age frequency
	Length frequency
	Sex ration
	Degree of repeat spawning (estimated from scales)
	Estimation of Effort
	Characterization of other losses (poaching, bycatch, etc.).
Estimate and method of estimation	
Estimate of composition (length and/or age)	
Characterization of the fishery (seasons, caps, gears, regulations).	
Recreational Fishery	
Characterization of directed harvest.	
Landings and method of estimation	
Estimation of effort or Annual CPUE from a subsample	
Characterization of other losses (poaching, catch-and-release mortality, etc.)	
Estimate and method of estimation	
Other Losses	
Fish passage mortality, discarded males, brood stock capture, research losses, etc.	
Harvest and Losses Table	
Include all above estimates in numbers and weight (pounds) of fish and mean weight per fish for each gear type.	
Protected Species	
Atlantic sturgeon bycatch estimates.	
Required Fishery-Independent Monitoring	Description of requirement as outlined in Section 3.
	Brief description of work performed.
	Results [To be determined upon final approval of Amendment 3]

9.4 PROCEDURES FOR DETERMINING COMPLIANCE

Detailed procedures regarding compliance determinations are contained in the ISFMP Charter, Section Seven.

In brief, all states and jurisdictions are responsible for the full and effective implementation and enforcement of fishery management plans in areas subject to their jurisdiction. Written compliance reports as specified in the Plan or Amendment must be submitted annually by each state with a declared interest. Compliance with Amendment 3 will be reviewed at least annually. The Shad and River Herring Management Board, ISFMP Policy Board or the Commission may request the Plan Review Team to conduct a review of Plan implementation and compliance at any time.

The Management Board will review the written findings of the PRT within 60 days of receipt of a state or jurisdiction's compliance report. Should the Management Board recommend to the Policy Board that a state or jurisdiction be determined to be out of compliance, a rationale for the recommended noncompliance finding will be included addressing specifically the required measures of Amendment 3 that the state or jurisdiction has not implemented or enforced, a statement of how failure to implement or enforce required measures jeopardizes shad and river herring conservation, and the actions a state must take in order to comply with Amendment 3 requirements.

The ISFMP Policy Board will review any recommendation of noncompliance from the Management Board within 30 days. If it concurs in the recommendation, it shall recommend at that time to the Commission that a state or jurisdiction be found out of compliance.

The Commission shall consider any noncompliance recommendation from the ISFMP Policy Board within 30 days. Any state or jurisdiction that is the subject of a recommendation for a noncompliance finding is given an opportunity to present written and/or oral testimony concerning whether it should be found out of compliance. If the Commission agrees with the recommendation of the ISFMP Policy Board, it may determine that a state or jurisdiction is not in compliance with the Amendment 3, and specify the actions the state or jurisdiction must take to come into compliance.

Any state or jurisdiction that has been determined to be out of compliance may request that the Commission rescind its noncompliance findings, provided the state or jurisdiction has revised its shad and river herring conservation measures.

9.5 RECOMMENDED (NON-MANDATORY) MANAGEMENT MEASURES

[The Shad and River Herring Management Board will have to determine which elements of the management program are mandatory and which are recommended.]

9.6 ANALYSIS OF THE ENFORCEABILITY OF PROPOSED MEASURES

[This section will be developed once management measures have been selected by the Shad and River Herring Management Board.]

10. MANAGEMENT AND RESEARCH NEEDS

The following list of research needs have been identified in order to enhance the state or knowledge of the shad and river herring resources, population dynamics, ecology and the various fisheries for alosine species. The Technical Committee, Advisory Panel, and Management Board will review this list annually and an updated prioritized list will be included in the Annual Shad and River Herring FMP Review. The below items should be prioritized, from most critical to least critical, by the Technical Committee.

10.1 STOCK ASSESSMENT AND POPULATION DYNAMICS

- Continue to assess current aging techniques for shad and river herring, using known-age fish, scales, otoliths and spawning marks. Known age fish will be available from larval stocking programs that mark each year class. Conduct biannual aging workshops to maintain consistency and accuracy in aging fish sampled in state programs.
- Investigate the relation between juvenile production and subsequent year class strength for alosine species, with emphasis on the validity of juvenile abundance indices, rates and sources of immature mortality, migratory behavior of juveniles, natural history and ecology of juveniles, and essential nursery habitat in the first few years of life.
- Validate estimates of M for American shad stocks.
- Establish management benchmarks for data poor river systems identified within the stock assessment.
- Estimate and evaluate sources of mortality for alosine species from bycatch, and bait and reduction fisheries.
- Determine fishery specific catch, harvest, bycatch, and discard reporting rates.
- Estimate and evaluate river specific mortality from upstream and downstream passage of adults and downriver passage of juveniles past migratory barriers.
- Determine which stocks are impacted by mixed stock fisheries (including bycatch fisheries). Methods to be considered could include otolith microchemistry, oxy-tetracycline otolith marking, and/or tagging.
- Evaluate assumptions critical to in-river tagging programs in Georgia, South Carolina, and Maryland that are used to estimate exploitation rate and population size.
- Develop approaches to estimating relative abundance of spawning stocks in rivers without passage facilities and in rivers with passage facilities with unknown passage efficiencies.
- Evaluate predation by striped bass and other predators as a factor of mortality for alosines. Research predation rates and impacts on alosines.
- Quantify fishing mortality (in-river, ocean bycatch, bait fisheries) for major river stocks after ocean closure of directed fisheries.
- Develop comprehensive and cost effective angler use and harvest survey techniques for use by Atlantic coastal states to assess recreational fisheries for American shad.
- Determine and update biological data inputs 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.

- 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.

10.2 RESEARCH AND DATA NEEDS

10.2.1 Habitat

- Identify ways to improve fish passage efficiency using hydroacoustics to repel alosines from turbine intakes or discharges or pheromones or other chemical substances to attract them to passage entrances. Test commercially available acoustic equipment at existing fish passage facility to determine effectiveness. Develop methods to isolate/manufacture pheromones or other alosine attractants.
- Determine the effects of passage impediments on all life history stages of American shad including turbine mortality and river and barrier specific passage efficiencies. Highest priority would be the lowermost obstruction.
- Develop and implement techniques to determine shad and herring population targets for tributaries undergoing restoration (dam removals, fishways, supplemental stocking, etc.).
- Characterize tributary habitat quality and quantity for Alosine reintroductions and fish passage development.
- Determine impacts to American shad populations from changing ocean environment
- Identify and quantify potential American shad spawning and rearing habitat not presently utilized and conduct an analysis of the cost of recovery.
- Develop appropriate Habitat Suitability Index Models for alosine species in the fishery management plan. Possibly consider expansion of species of importance or go with the most protective criteria for the most susceptible species.
- Determine factors that regulate and potentially limit downstream migration, seawater tolerance, and early ocean survival of juvenile alosines.
- Review studies dealing with the effects of acid deposition on anadromous alosines.
- Determine effects of change in temperature and pH for all life stages.
- Determine optima and tolerance for salinity, dissolved oxygen, pH, substrate, current velocity, depth, temperature, and suspended solids.
- Determine hard limits and range levels for water quality deemed appropriate and defensible for all alosines with emphasis on freshwater migratory, spawning, and nursery areas.
- There has been little research conducted on habitat requirements for hickory shad. Although there are reported ranges of values for some variables, such as temperature or depth, there is no information on tolerances or optima for all life stages. Research on all life stages is necessary to determine habitat requirements.
- Determine impacts of declining submerged aquatic vegetation beds on juvenile cover and rearing habitat.
- Determine impacts of thermal power generation projects (e.g., nuclear and coal) that withdraw water for cooling (potential entrainment and impingement of fish) and discharge heated water (thermal barriers to migration, habitat degradation) on estuarine juvenile rearing and migration corridors.

- Determine impacts to migrating American shad (both spawning adults and out-migrating juveniles and adults) by proposed in-stream power generation developments such as tidal stream generation that draws energy from currents.
- Determine potential threats and their level of impact to coastal American shad habitat from: marine acidification; pharmaceutical, wastewater, pesticide contamination; invasive species; niche displacement; and global climate change are in need of further study.
- Determine the impacts to migrating American shad (both spawning adults and migrating juveniles) by proposed wind power generation developments in near shore ocean environments.
- Conduct fish passage research and development with the goal of improving the efficiency of existing and future installations of fish passage measures and facilities in order to restore desired access to and utilization of critical American shad spawning and juvenile rearing habitat.
- Conduct studies to determine whether passing migrating adults upstream earlier in the year in some rivers would increase production and larval survival, and opening downstream bypass facilities sooner would reduce mortality of early emigrants (both adult and early-hatched juveniles).
- Conduct studies to determine the effects of dredging on diadromous habitat and migration.

10.2.2 Life History

- Conduct studies on energetics of feeding and spawning migrations of alosines on the Atlantic coast.
- Evaluate impacts of invasive species such as zebra mussels and flathead catfish on larval and juvenile survival.
- Conduct studies of egg and larval survival and development.
- 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.
- Ascertain how abundance and distribution of potential prey affect growth and mortality of early life stages.
- Conduct research on hickory shad migratory behavior. This may explain why hickory shad populations continue to increase while other alosines are in decline.

10.2.3 Stocking and Hatcheries

- Refine techniques for hormone induced tank spawning of American shad. Secure adequate eggs for culture programs using native broodstock.
- Refine larval marking techniques such that river and year class can be identified when year classes are later recaptured as juveniles or adults.

10.2.4 Socioeconomic

- Conduct and evaluate historical characterization of socio-economic development (potential pollutant sources and habitat modification) of selected alosine rivers along the Atlantic coast.
- Collect information from consumptive and non-consumptive users on: demographic information (e.g., age, gender, ethnicity/race), social structure information (e.g., historical participation, affiliation with NGOs, perceived conflicts), other cultural information (e.g., occupational motivation, cultural traditions related to resource's use), and community information.
- In order to improve the management-oriented understanding of historical stock trends and related assessments, the social and economic history of the river herring fisheries should be documented for time periods equivalent to the stock return level sought by the biological standards and this analysis should including documenting market trends, consumer preferences including recreational anglers, the role of product substitutes such as Atlantic herring and menhaden, and the levels of subsistence fisheries as can be obtained.
- Before recommending, re-authorizing and/or implementing stock enhancement programs for a given river system, it is recommended that state agencies or other appropriate management organization conduct *ex-ante* socioeconomic cost and benefit (e.g., estimate non-consumptive and existence values, etc.) analysis of proposed stocking programs.