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*of the*

*Atlantic States Marine Fisheries Commission*


# Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sturgeon

**July 1998**

# AMENDMENT 1 TO THE INTERSTATE FISHERY MANAGEMENT PLAN FOR ATLANTIC STURGEON

Prepared by
Atlantic States Marine Fisheries Commission
Atlantic Sturgeon Plan Development Team

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This Amendment was prepared in cooperation with the Atlantic States Marine Fisheries Commission's Sturgeon Management Board, Atlantic Sturgeon Technical Committee, Atlantic Sturgeon Stock Assessment Subcommittee, and Atlantic Sturgeon Advisory Panel.

A report of the Atlantic States Marine Fisheries Commission pursuant to: U.S. Department of Commerce, National Ocean and Atmospheric Administration Award Nos. NA87FG0025 and NA77FG0029.

## EXECUTIVE SUMMARY

1. Introduction

Atlantic sturgeon range from Hamilton River in Canada south to the St. John's River in Florida. Ecologically, they are representative of a unique taxon which is in serious trouble globally due to high demand primarily, but also secondarily in some ecosystems due to blockages which prevent access to historic spawning grounds. The species is managed in the U.S. by the states in partnership with the Atlantic States Marine Fisheries Commission (ASMFC) and federal fishery management agency partners. All indications are that the Atlantic sturgeon spawning stocks of the entire east coast were severely overfished, in some cases to the point of extirpation.

Pursuant to the authority contained in the Compact and the Rules and Regulations, the ASMFC finds, and recommends to the governors, legislature and executive agencies of the respective states that the coordination of the exercise of the police powers of the states within their respective jurisdictions, including appropriate regulations, according to the terms as set forth in this fishery management plan, are essential to promote the preservation of the Atlantic coastal Atlantic sturgeon fisheries, and their protection against overfishing, waste, depletion or any abuse whatsoever and to assure a continuing yield therefrom. This Amendment supersedes the previous ASMFC Fishery Management Plan (Taub 1990) for the species.

Preparation of the initial *ASMFC Fishery Management Plan (FMP) for Atlantic Sturgeon* was motivated by a desire to effect better management of the species throughout its range in the U. S. Despite preparation of the 1990 FMP and implementation of many of its recommendations, some Atlantic sturgeon spawning stocks, most notably the Hudson River stock, continued to deteriorate through 1996. The 1990 FMP simply did not contain conservation measures sufficient to protect the portion of the Atlantic sturgeon population and individual spawning remaining at that time. Further, the 1990 FMP does not contain the required standards now mandated under the Atlantic Coastal Fisheries Cooperative Management Act. In 1996, ASMFC's Sturgeon Management Board decided to amend the Plan, and notified the public that the preferred management measure would be a moratorium.

Implementation of Amendment 1 is designed to result in stock recovery, with consequent ecological and economic benefits to coastal ecosystems and fishermen. Recovery of the stock should reestablish Atlantic sturgeon as a unique component of east coast rivers, estuaries and the Atlantic Ocean. Management of a restored and recovered population of Atlantic sturgeon will establish and maintain, subsequent to stock recovery in the future, fishing mortality targets and a fishery monitoring program that should: allow managed exploitation; increase market stability; stabilize commercial, and possibly recreational, landings (within the limits of environmental variability in recruitment); and reduce the risk of recruitment failure.

The Amendment describes the life history of the species, including spawning locations where known, hatching requirements for eggs, and juvenile nursery area requirements and migrations. The stock assessment (Kahnle et al. 1998) indicates that the stock was overfished prior to the closure of all east coast fisheries, completed in April 1998.

Bycatch of Atlantic sturgeon, although not deemed to be excessive at this time, based on analysis performed by the Stock Assessment Subcommittee, is of concern as a factor which could inhibit recovery of the stocks. Little data exist on bycatch occurrence and discard mortality rates, and additional studies are needed for complete assessment of this factor.

From a habitat perspective, Atlantic sturgeon were once abundant in almost every major river-estuary system on the east coast. While some of the systems were historically impacted by dam construction and extremely poor water quality as a result of inputs of untreated sewage and industrial effluents, most are currently in much better condition. Improvements have resulted from imposition of standards for industrial discharges, construction of sewage treatment facilities, and removal of some historical blockages to upstream migration. A few systems are still adversely affected by poor water quality and dams which prevent access to historic spawning grounds.

Social impacts of the termination of the Atlantic sturgeon fishery are discussed. It appears that approximately 65 commercial fishermen were involved in taking of sturgeon. Cultural heritage loss also will occur as a result of closure of the fishery. While sales, incomes and jobs have been directly impacted by the closure, it is reasonable to assume that the aggregate economic impacts of the closure of the Atlantic sturgeon fishery is insignificant to the ASMFC region's economy, given the relatively small sales generated by the fisheries during the 1990s (see Table 1).

Details of the information summarized in the Executive Summary are provided in the Plan, as well as in the Atlantic Sturgeon Source Document (ASMFC in preparation).

2. Amendment 1 Goal and Objectives

The goal of the Amendment is to restore Atlantic sturgeon spawning stocks to population levels which will provide for sustainable fisheries, and ensure viable spawning populations.

Objectives of the Amendment are to:

- Establish 20 protected year classes of females in each spawning stock;
- Close the fishery for a sufficient time period to reestablish spawning stocks and increase numbers in current spawning stocks;
- Reduce or eliminate bycatch mortality of Atlantic sturgeon;
- Determine the spawning sites and provide protection of spawning habitats for each spawning stock;
- Where feasible, reestablish access to historical spawning habitats for Atlantic sturgeon; and
- Conduct appropriate research as needed, especially to define unit stocks of Atlantic sturgeon.

3. Monitoring and Enhancement Program Specifications/Elements

The following recommendations apply to monitoring and enhancement of the Atlantic sturgeon stocks:

- At least every five years, each jurisdiction with reproducing populations of Atlantic sturgeon should survey abundance and calculate catch per unit effort (CPUE) estimates of juveniles, conduct tag and release programs of juveniles with data being supplied to the U. S. Fish and Wildlife Service (USFWS) Maryland Fisheries Resources Office in Annapolis, Maryland, and obtain age analysis of the spawning populations.
- Jurisdictions should cooperate with the USFWS and NMFS to monitor and analyze movements of fish tagged and recaptured.

- Any jurisdiction supporting fisheries which result in incidental mortality of Atlantic sturgeon should develop a reporting mechanism or conduct sufficient field evaluations to determine the relative numbers and sizes of Atlantic sturgeon being killed in these fisheries.

- Jurisdictions which host both shortnose and Atlantic sturgeon are urged to observe and record information on both species and include shortnose sturgeon in tag and release and age analysis studies.

- Once fisheries are reopened, consumptive use and non-consumptive use surveys focusing on social benefits should be conducted periodically.

- Encourage an expanded aquaculture effort to develop techniques to rear Atlantic sturgeon and evaluate hatchery fish for stock restoration.

- Encourage aquaculture research to identify and control early life stage diseases, synchronize spawning times of males and females, and reduce handling stress problems.

- If stocks are defined by river then genetic integrity of spawning stocks within river basins should be maintained by stocking only progeny of native brood stock.

- If genetic substructure exists then restoration programs should employ only genetically compatible stocking (i.e., reintroduction of progeny cultured from one stock into waters inhabited by that same stock).

- If native brood stock no longer exist, or are in such low abundance as to preclude effective collection, priority should be given to stocking fish from adjacent or hydrologically similar river systems.

- An adequate effective breeding population size should be maintained to the extent possible in culturing Atlantic sturgeon for restoration purposes so that genetic integrity of the local recipient stock is maintained.

- The ASMFC Atlantic Sturgeon Aquaculture and Stocking Committee should prepare a separate discussion paper to address inter-basin transfer of brood stock and/or hatchery produced progeny and other interjurisdictional problems associated with sturgeon culture.

- States may be allowed to authorize private aquaculture of Atlantic sturgeon under Section 4.5, provided such operations are conducted in accordance with the recommendations identified in ASMFC Special Report No. 22 (Atlantic Sturgeon Aquaculture and Stocking Committee 1992) and the ASMFC Breeding and Stocking Protocol for Cultured Atlantic Sturgeon (ASMFC, in press). In any case, privately aquacultured sturgeon (Atlantic sturgeon or other species) should be distinctly and permanently marked as aquacultured fish. Furthermore, any imported sturgeon (Atlantics or other species) should be certified as disease-free by the appropriate state or federal agency. States must report annually on the status of private aquaculture operations authorized, regulations pertaining to private aquaculture operations, and disease-free certification as per Section 5.1.2.1.

- Whenever possible, use broodfish from the same river in which stocking will occur. When this is not possible, the source of broodfish used to produce fish for stocking should be taken from the same regional genetic grouping as the area being stocked.

- With regard to stocking programs, highest priority should be placed on populations perceived to be extirpated with a lower priority placed on populations exhibiting little, if any, natural reproduction.

- The minimum effective population size of brood fish to be used in culture for stocking programs should be 100 (with an inbreeding rate of 0.50%). Year-class effective population sizes should be at least six (preferably three of each sex). Year-class effective population sizes of six or greater may be obtained using unbalanced sex ratios, but sperm from multiple male donors should not be mixed for artificial fertilization.

- Agencies involved with stocking programs for Atlantic sturgeon should commit to the necessary period of time to achieve the desired generation effective population size. For example, 10 years at an average year class effective population size of 10.

- If fewer breeding fish are available than prescribed in Recommendation 3, their progeny may be used for captive research (i.e. not released into public waters) or provided to private aquaculture interests for captive use (provided that the receiving facility has obtained a state permit satisfying the conditions for protection of wild stocks specified in Section 3.6.2 and Section 4.5).

- Broodfish should be spawned only once and after spawning they should be externally marked and returned to their river of origin whenever feasible.

- In order to avoid gene swamping from small numbers of breeding pairs, numbers of progeny stocked from individual matings in any one year should be within 50% of each other, not to exceed 50,000 fish per pair. All fish stocked should be distinctively marked or tagged to at least indicate release location and time and parental origin.

- Management jurisdictions involved in culture and stocking programs for Atlantic sturgeon should annually monitor the status of their populations and the effects of stocking. They should provide a detailed proposal to ASMFC for review which includes goals and objectives, methods, monitoring activities, and time lines. Monitoring results should be reported to ASMFC each year.

- Jurisdictions interested in restoration stocking are encouraged to prepare recovery plans, follow Protocol guidelines to maximize genetic diversity and minimize inbreeding depression, and thoroughly evaluate and report on their results.

- In cases where sturgeon populations are so depressed that collection of adequate numbers of breeders for propagation purposes is unlikely and/or poorly advised, nearby jurisdictions with healthy breeding populations are encouraged to share their resources.

- Jurisdictions must monitor bycatch of Atlantic sturgeon in other fisheries under their jurisdiction.

- Each state will work with the ASMFC Habitat, and Habitat and FMPs Committees to assess historic and present Atlantic sturgeon habitat within its jurisdiction.

- Each jurisdiction will identify habitat appropriate for restoration and use by Atlantic sturgeon.

4. Management Program Implementation

- States in which Atlantic sturgeon habitat occurs, especially spawning and other essential habitats such as nursery areas, should notify in writing the appropriate federal and state regulatory agencies of the locations of habitats used by Atlantic sturgeon.

- Where sufficient knowledge is available, states should seek to designate Atlantic sturgeon essential habitats for special protection.

- State fishery regulatory agencies should develop protocols and schedules for providing input on water quality regulations to the responsible agency, to ensure to the extent possible that water quality needs for Atlantic sturgeon are restored, met and maintained.

- 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 Atlantic sturgeon habitats are protected.

- Water quality criteria for Atlantic sturgeon spawning and nursery areas should be established or existing criteria should be upgraded to levels which are sufficient to ensure successful reproduction.

- All state and federal agencies, including regional fishery management councils, responsible for reviewing impact statements and permit applications for projects or facilities which may impact Atlantic sturgeon spawning and nursery areas should provide appropriate recommendations or mandate measures to ensure that those projects will have no or only minimal impact on sturgeon spawning stocks.

- Federal and state fishery management agencies should take steps to limit the introduction of compounds which are known or suspected to accumulate in Atlantic sturgeon tissue and which pose a threat to human health or Atlantic sturgeon health.

- Each state should establish windows of compatibility for activities known or suspected to adversely affect Atlantic sturgeon life stages and their habitats, such as navigational dredging, bridge construction, and dredged material disposal, and notify the appropriate construction or regulatory agencies in writing.

- Projects involving water withdrawal from spawning or nursery habitats (e.g. power plants, irrigation, water supply projects) should be scrutinized to ensure that adverse impacts resulting from larval/juvenile impingement, entrainment, and/or modification of flow, temperature and salinity regimes due to water removal will not adversely impact Atlantic sturgeon spawning stocks, including early life stages.

- Each state which contains spawning and nursery areas within its jurisdiction should develop water use and flow regime guidelines which are protective of Atlantic sturgeon spawning and nursery areas and which will ensure to the extent possible the long-term health and sustainability of the stock.

- The use of any fishing gear or practice which is documented by management agencies to have an unacceptable impact on Atlantic sturgeon (e.g. habitat damage, or bycatch mortality) should be prohibited within the effected essential habitats (e.g. trawling in spawning areas or primary nursery areas should be prohibited).

- Each state should review existing literature and data sources to determine the historical extent

of Atlantic sturgeon occurrence and use within its jurisdiction.

- An assessment should be conducted of areas historically but not presently used by Atlantic sturgeon, for which restoration is feasible.

- Every effort should be made to eliminate existing contaminants from Atlantic sturgeon habitats where a documented adverse impact occurs.

- States should work in concert with the USFWS, Divisions of Fish and Wildlife Management Assistance and Ecological Services, and NMFS, Office of Fisheries Conservation and Management and Office of Habitat Conservation, to identify hydropower dams which pose significant threat to maintenance of appropriate freshwater flows to, or migration routes for, Atlantic sturgeon spawning areas and target them for appropriate recommendations during Federal Energy Regulatory Commission (FERC) relicensing evaluation.

- State moratoria on the harvest of Atlantic sturgeon also should apply to Atlantic sturgeon that may inadvertently be caught recreationally by hook and line.

- States should prohibit the intentional snagging of Atlantic sturgeon, and require the immediate release of any incidentally hooked fish.

- The ASMFC Sturgeon Management Board may require area or season closures, gear restrictions, and/or conservation engineering in fisheries that are documented to cause excessive bycatch mortality of Atlantic sturgeon (i.e., threatening ASMFC's ability to achieve this Plan's goal and objectives), as recommended to it by the Plan Review Team, Technical Committee and Advisory Panel, through Section 3.7.

- All states shall implement the moratorium provision of this Amendment no later than June 30, 1998. All other provisions must be implemented by January 1, 1999.

The role of each of the components of the ASMFC and its affiliated federal partners is described in the Plan.

At the time of passage of Amendment 1, no council had prepared a management plan for Atlantic sturgeon. The Commission has consulted the three east coast councils throughout the development of Amendment 1 via several methods: the councils received regular reports from the Director of the Interstate Fisheries Management Program; and, all relevant documents were sent to the councils for review and comment.

By copy of this Amendment, the Commission reminds Councils of their mandated responsibility for commenting on proposed actions which may adversely affect Atlantic sturgeon (as an anadromous species) habitat, including Essential Fish Habitat as specified in the Magnuson-Stevens Act. The Commission requests that the Sturgeon Management Board be copied with all correspondence pertaining to projects which may adversely affect Atlantic sturgeon habitats.

As contemplated in 16 U.S.C. 5102(1)(C) and 5103(b), the ASMFC recommends that the Secretary of Commerce take the following steps by October 1, 1998, concerning management of Atlantic sturgeon in the Exclusive Economic Zone (EEZ):

- institute a complete closure, through prohibiting possession of Atlantic sturgeon, and any and all parts thereof including eggs, and of any directed fishery for and landings of Atlantic sturgeon

until the fishery management plan is modified to reopen fishing in that jurisdiction;

- conduct, or specify that the appropriate Fishery Management Council conduct, monitoring of Atlantic sturgeon bycatch and bycatch mortality in at least the monkfish and spiny dogfish fisheries, and report the results annually to the Management Board and Technical Committee. If the Technical Committee and Management Board determine this bycatch is excessive and threatens ASMFC's ability to achieve the goal and objectives of this Plan, the Secretary or appropriate fishery management council shall implement means to reduce or eliminate this bycatch in the subject fishery; and

- continue support for and development of forensic techniques to be used for federal and state enforcement of the plan

The Sturgeon Management Board will annually review their position with regard to EEZ regulations and may provide recommendations for any changes to the NMFS.

The ASMFC recognizes that the Secretary of Commerce may take this action through the fishery management planning process contained in the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) or the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA).

The ASMFC recommends the following to the Secretary of the Interior for implementation by the USFWS:

- continue support for and development of forensic techniques to be used for federal and state enforcement of the Plan;

- continue coordination and support of the Southeast Area Monitoring and Assessment Program (SEAMAP) Cooperative Winter Tagging Cruise, with an increased emphasis on intercepting and tagging subadult and adult Atlantic sturgeon on their offshore wintering grounds;

- continue establishment, operation and maintenance of the coastwide Atlantic sturgeon tagging program and tag recapture database;

- continue and support international trade restrictions on Atlantic sturgeon as per Appendix II of the Convention on the International Trade in Endangered Species (CITES); and

- The Plan Review Team, Management Board, and Technical Committee shall regularly communicate with fishery managers in Canadian agencies to help ensure stock recovery of Atlantic sturgeon. Canadian fishery managers and other officials shall be invited to ASMFC discussions on Atlantic sturgeon conservation as needed, especially when discussing importation of Atlantic sturgeon from Canada to the U.S.

5. Compliance

A state will be determined to be out of compliance with the provisions of this FMP, according to the terms of Section 7 of the Interstate Fisheries Management Program (ISFMP) Charter if:

- its regulatory and management programs to implement Sections 4.2 and 4.3 for Atlantic sturgeon have not been approved by the Management Board; or

- it fails to meet any schedule to implement Sections 4.2 or 4.3 established for this Amendment (see Section 5.1.2).

- In addition, the Board will monitor bycatch of Atlantic sturgeon and report excessive bycatch problems to the management authority for the fishery causing the bycatch. The Management Board may take action under ACFCMA and Section 4.3.9

- Each jurisdiction must maintain complete closure, through prohibiting possession of Atlantic sturgeon, and any and all parts thereof including eggs, and of any directed fishery for and landings of Atlantic sturgeon until the fishery management plan is modified to reopen fishing in that jurisdiction.

- In addition, states shall implement any restrictions in other fisheries as outlined in Section 4.3.9 and implemented through Section 4.5.

- Under Section 4.5, the Management Board may vary certain requirements specified in this Amendment as a part of adaptive management. Specifically, the Management Board may permit: 1) importation of non-U.S. origin Atlantic sturgeon (whole or parts thereof) that are legally harvested outside of the U.S. and in conformity with all provisions of CITES, or 2) the establishment of private aquaculture facilities for Atlantic sturgeon within ASMFC jurisdictions with a declared interest in Atlantic sturgeon.

Mandatory closure of Atlantic sturgeon fisheries implemented through this Amendment precludes enforcement of some other compliance requirements for Atlantic sturgeon through ACFCMA. It is noted that other fisheries which are documented to cause significant bycatch mortality of Atlantic sturgeon, once "significant" is defined, may be recommended for closure should a state fail to take action to reduce or eliminate bycatch mortality in that fishery. States are encouraged to implement the biological monitoring programs and reporting time lines outlined in Section 3.

Compliance reports from jurisdictions must include the following information:

- Results of bycatch monitoring for Atlantic sturgeon in other fisheries;

- Monitoring results (tagging, five-year juvenile abundance index studies);

- Habitat status (restoration efforts, FERC relicensing studies, etc.), in accordance with the recommendations in Sections 4.1.1, 4.1.2, and 4.1.4.; and

- Aquaculture operations authorized, status of regulations, disease-free certification status, etc.

Reports on compliance should be submitted by each jurisdiction annually, no later than October 1 each year, beginning in 1999.

6. Research and Data Needs

6.3.1 Biological/Captive Propagation

- Standardize and obtain baseline data on population status for important sturgeon rivers. Data should include assessment of stock status in various rivers, size and composition of the spawning population, reproductive success and juvenile production;

- Develop long-term marking/tagging procedures to provide information on individual tagged Atlantic sturgeon for up to 20 years;
- Establish success criteria in order to evaluate the effectiveness of stocking programs;
- Determine size at maturity for Mid- and North Atlantic sturgeon;
- Monitor catch/effort and size/age composition of landings of any future authorized directed fisheries;
- Determine length at age by sex for North, Mid- and South Atlantic stocks;
- Determine maturity at age by sex for North, Mid- and South Atlantic stocks;
- Determine fecundity at age, length, and weight for North, Mid-, and South Atlantic stocks;
- Characterize size and condition of Atlantic sturgeon by gear and season taken as bycatch in various fisheries;
- Establish environmental tolerance levels (D.O., pH, temperature, etc.) for different life stages;
- Establish coastal tagging projects to delineate migratory patterns (This measure is being implemented by the USFWS and member states.);
- Expand tagging of juveniles in major spawning rivers to allow estimates of rates of loss to bycatch;
- Establish a tag recovery clearinghouse and database for consolidation and evaluation of tagging and tag return information including associated biological, geographic, and hydrographic data (This measure is being implemented by the USFWS through the Maryland Fisheries Resources Office located in Annapolis, Maryland.);
- Encourage shortnose sturgeon researchers to include Atlantic sturgeon research in their projects;
- Establish methods for the recovery of tags and associated information (This measure is being implemented through ASMFC/USFWS cooperative efforts.);
- Evaluate existing groundfish survey data to determine what can be learned about at-sea migratory behavior;
- Conduct basic culture experiments to provide information on: a) efficacy of alternative spawning techniques, b) egg incubation and fry production techniques, c) holding and rearing densities, d) prophylactic treatments, e) nutritional requirements and feeding techniques, and f) optimal environmental rearing conditions and systems;
- Determine the extent to which Atlantic sturgeon are genetically differentiable among rivers;
- Conduct research to identify suitable fish sizes, and time of year for stocking cultured fish;
- Conduct and monitor pilot-scale stocking programs before conducting large-scale efforts over

broad geographic areas;

- Determine effects of contaminants on early life stages;
- Develop methods to determine sex and maturity of captured sturgeon;
- Develop sperm cryopreservation techniques and refine to assure availability of male gametes;
- Refine induced spawning procedures;
- Develop the capability to capture wild broodstock and develop adequate holding and transport techniques for large broodstock ;
- Conduct studies to identify tissue(s) suitable for genetic analyses and the techniques for their collection and storage. In those states which permit future harvest of Atlantic sturgeon, material for genetic analysis should be collected from up to 50 percent of the fish landed in the commercial fisheries. In states with no future directed fisheries, federal and state programs which encounter sturgeon should be encouraged to collect specified tissues for genetic analysis;
- Standardize collection procedures to obtain biological tissues, and identify a suitable repository to archive all materials;
- Conduct research to determine the susceptibility of Atlantic sturgeon to sturgeon adenovirus and white sturgeon iridovirus. Methods should be developed to isolate the sturgeon adenovirus and an Atlantic sturgeon cell line should be established for infection trials;
- Conduct research to identify the major pathogens of Atlantic sturgeon and a cell line for this species should be developed .

6.3.2 Social

- To evaluate the social impacts the needed data might include the following for consumptive and non-consumptive users: demographic information (e.g. age, gender, ethnicity/race, etc.), social structure information (e.g. historical participation, affiliation with NGOs, perceived conflicts, etc.), other cultural information (e.g. occupational motivation, cultural traditions related to resource's use), and community information.
- A cost and benefit analysis (CBA) of possible stocking protocols is needed.

## ACKNOWLEDGMENTS

The Plan Development Team (PDT) for Amendment 1 consisted of: William Andrews (New Jersey Division of Fish, Game and Wildlife), John Field (Atlantic States Marine Fisheries Commission, Chair), Dr. Wilson Laney (U.S. Fish and Wildlife Service, South Atlantic Fisheries Resources Coordination Office, Principal Plan Writer), Jim Markham and Ben Florence (Maryland Department of Natural Resources, Fisheries Service), Kim McKown (New York Department of Environmental Conservation, Marine Resources), Paul Perra (National Marine Fisheries Service, Office of Fisheries Conservation), Raymond Rhodes and Dr. Ted Smith (South Carolina Department of Natural Resources, Marine Resources Division) and Richard St. Pierre (U.S. Fish and Wildlife Service, Susquehanna River Coordination Office).

The Team worked under the direction of the ASMFC Atlantic Sturgeon Advisory Panel (Chair, Mike D'Amico), Sturgeon Management Board (Chair, Susan Shipman, Georgia Department of Natural Resources, Division of Marine Fisheries) and Atlantic Sturgeon Technical Committee (Chair, Andy Kahnle, New York Department of Environmental Conservation, Division of Marine Resources). Addresses, telephone and faxform numbers for these individuals can be obtained from the Atlantic Sturgeon Source Document as well as by contacting the ASMFC.

Funding for preparation of Amendment 1 was provided to the ASMFC from several sources: by NOAA/DOC National Marine Fisheries Service Cooperative Agreement Nos. NA87FG0025 and NA77FG0029, and by the National Marine Fisheries Service and U.S. Fish and Wildlife Service through provision of the services of their personnel. Mr. George Lapointe, Director, ASMFC Interstate Fisheries Management Program, and Mr. John Field, Anadromous Species Coordinator, served as principal contacts at ASMFC. Extensive support and input required for preparation of this document were provided by state and federal agency representatives on the ASMFC Atlantic Sturgeon Technical Committee and Atlantic Sturgeon Stock Assessment Subcommittee, by commercial fishery and conservation representatives on the Atlantic Sturgeon Advisory Panel, and by the ASMFC Sturgeon Management Board.

The Team expresses gratitude to the many individuals who made contributions to the preparation of Amendment 1. These include the professional staff of the state and federal fishery management agencies, primarily those responsible for management of interjurisdictional fishery resources, who have reviewed the Amendment and provided their comments and suggestions for improvements. Included also are the representatives of conservation groups and interested commercial Atlantic sturgeon fishermen who have written letters and attended public hearings to express their opinions and ideas. Special appreciation is extended to the authors of the Stock Assessment Document, specifically Andrew Kahnle, Kathryn Hattala, Kim McKown, Craig Shirey, Mark Collins, Thomas Squiers and Thomas Savoy. Special appreciation is extended also to Anne Hecht, U.S. Fish and Wildlife Service, and Mary Colligan, National Marine Fisheries Service, co-leaders of the Atlantic Sturgeon Status Review Team, who have worked closely with the Team and the ASMFC to keep the Team and Management Board informed of the progress of the Status Review.

Amendment 1 was prepared in accordance with the approved Fishery Management Plan and habitat outlines as developed by the Habitat Committee and the Standards and Procedures Working Group, and adopted by the Interstate Fisheries Management Program Policy Board and full Commission. Appreciation is extended to the ASMFC support staff for overseeing final production and distribution of this report.

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# 1. INTRODUCTION

Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) range from Hamilton River and George River, Ungava Bay, both in Labrador, south to the St. Johns River, Florida (Gilbert 1989). They may range southward in winter to Port Canaveral and Hutchison Island, Florida (Van Den Avyle 1984; Gilbert 1989). Historically, Atlantic sturgeon were the basis of a significant commercial fishery at the turn of the century (Kahnle et al. 1998). Coastwide landings were in excess of 7,260,000 pounds (lbs) (3,300,000 kilograms(kg)). Since the 1920s, landings declined significantly from those early years of "clear- cutting" the spawning stocks. Landings have remained at relatively low levels through the present. In New York and New Jersey the Hudson River population formed the basis of the last viable commercial fishery. However, landings declined to 33,000 lbs (15,000 kg) or less per year and remained at those levels through the early 1980s, at which point they temporarily increased, reaching a peak in 1990s of 266,200 lbs (121,000 kg) before declining again. The New York fishery was closed in 1996.

Ecologically, Atlantic sturgeon are representative of a unique taxon which is in serious trouble globally, largely as a result of the high demand for their flesh and eggs (sold as caviar), but secondarily in some ecosystems due to blockage of access to historical spawning grounds. They are managed in state waters by the states in partnership with the Atlantic States Marine Fisheries Commission (ASMFC). The Sturgeon Management Board, with assistance from the Atlantic Sturgeon Technical Committee, Atlantic Sturgeon Advisory Panel and currently from the Atlantic Sturgeon Plan Development Team (PDT) implements the management program. In federal waters of the Exclusive Economic Zone (EEZ) from 3 to 200 miles offshore, they are under the jurisdiction of the Fishery Management Councils and/or the U.S. Department of Commerce, National Marine Fisheries Service (NMFS). States may regulate vessels registered in their own state in the EEZ, since currently there is no federal fishery management plan for Atlantic sturgeon.

All indications are that the Atlantic sturgeon spawning stocks of the entire east coast were severely overfished, in some cases apparently to the point of extirpation (Connecticut River, most Chesapeake Bay tributaries, and St. Johns River, Florida). While there are some spawning stocks in which reproduction appears to be occurring (Kennebec River, Maine; Hudson River, New York; Delaware River, Delaware and New Jersey; James and possibly York Rivers, Virginia; Roanoke and Cape Fear Rivers, North Carolina; Waccamaw, Santee, ACE Basin (Ashepoo, Combahee, Edisto), Savannah and possibly Cooper Rivers, South Carolina; and Savannah and Altamaha Rivers, Georgia) the Management Board has determined that the present Fishery Management Plan (FMP) should be modified to increase its effectiveness and has directed the PDT to prepare this Amendment. The U.S. Department of Commerce, NMFS, and U.S. Department of the Interior, U.S. Fish and Wildlife Service (USFWS), are currently conducting a Status Review of the species in response to a Listing Petition received in 1997 (NMFS and USFWS, in preparation). The results of that review will determine whether the agencies recommend that the species be federally listed as threatened or endangered, or whether ASMFC management measures, as specified in this Amendment, as well as other factors affecting the species' viability, are sufficient to assure continued existence of the species.

The ASMFC was formed by the fifteen Atlantic coast states in 1942 through an Interstate Compact. The following provisions of the Compact establish the basis for the actions taken by the Commission in adopting this FMP:

ARTICLE I

*The purpose of this compact is to promote the better utilization of the fisheries, marine, shell and anadromous, of the Atlantic seaboard by the development of a joint program for the promotion and*

*protection of such fisheries, and by the prevention of the physical waste of the fisheries from any cause...*

ARTICLE IV

*...The duty of the said Commission shall be to make inquiry and ascertain from time to time such methods, practices, circumstances and conditions as may be disclosed for bringing about the conservation of, the prevention of the depletion and physical waste of the fisheries, marine, shell and anadromous of the Atlantic seaboard. The Commission shall have power to recommend the coordination of the exercise of the police powers of the several states within their respective jurisdictions to promote the preservation of those fisheries and their protection against overfishing, waste, depletion or any abuse whatsoever and to assure a continuing yield from the fisheries resources of the aforementioned states.*

*To that end, the Commission shall draft and, after consultation with the Advisory Committee hereinafter authorized, recommend to the governors and legislatures of the various signatory states, legislation dealing with the conservation of the marine, shell and anadromous fisheries of the Atlantic seaboard...*

The Rules and Regulations of the Commission authorize the Interstate Fishery Management Program to promote the cooperative and coordinated development and implementation of conservation programs for Atlantic coastal fisheries.

Pursuant to the authority contained in the Compact and the Rules and Regulations, the ASMFC finds, and recommends to the governors, legislature and executive agencies of the respective states that the coordination of the exercise of the police powers of the states within their respective jurisdictions, including appropriate regulations, according to the terms as set forth in this fishery management plan, are essential to promote the preservation of the Atlantic coastal Atlantic sturgeon fisheries, and their protection against overfishing, waste, depletion or any abuse whatsoever and to assure a continuing yield therefrom.

This Amendment supersedes the previous ASMFC FMP (Taub 1990s) for the species. This Amendment does not preclude state-authorized aquaculture operations that meet all requirements, as specified in Sections 3.5 and 3.6, to preclude adverse effects on wild stocks.

## 1.1 BACKGROUND INFORMATION

Preparation of the initial *ASMFC FMP for Atlantic Sturgeon* (Plan) in 1990s was motivated by a desire to effect better management of the species throughout its range in the U.S. (Taub 1990s). Problems identified as concerns in the Plan were that: 1) regulations in some states allowed harvest before females had the opportunity to spawn once; 2) there were serious gaps in the knowledge of the species; and 3) Atlantic sturgeon culture was hampered by the general scarcity of brood sources, difficulty of holding and handling large fish, difficulty in obtaining ripe males and females simultaneously, and the lack of suitable captive rearing systems.

The management objectives contained in the Plan were to: 1) protect Atlantic sturgeon from further depletion; 2) improve knowledge of the Atlantic sturgeon stock; 3) enhance and restore the stock of Atlantic sturgeon; and 4) coordinate Atlantic sturgeon research and management activities throughout the U.S. Atlantic coastal range.

To achieve the objectives, the Plan made the following management recommendations:

1. Each state should control harvest to increase spawning biomass by adopting either:

   A. A minimum total length (TL) of at least seven (7) feet (75 inches fork length-FL) and institute a monitoring program, with at least mandatory reporting of commercial landings, or

   B. A moratorium on all harvest, or

   C. If a state deviates from the above, the state should submit alternative measures to the ASMFC Atlantic Sturgeon Plan Review Team (PRT) for determination of conservation equivalency.

2. Each state should identify, characterize, and protect critical spawning and nursery areas.

3. Each state should establish tagging projects to delineate migratory patterns and to assess age and growth, population estimates, and mortality rates.

4. Each state should identify critical habitat characteristics of staging and oceanic areas.

5 .The ASMFC should encourage and coordinate a coastwide depository of data and information required to effectively monitor and assess management efforts.

6. The ASMFC should encourage an expanded aquaculture effort to develop techniques to rear Atlantic sturgeon and evaluate hatchery fish for stock restoration.

- The ASMFC should encourage shortnose sturgeon researchers to also incorporate Atlantic sturgeon into their projects.

- The ASMFC should encourage determination of environmental tolerance levels (D.O., pH, temperature, river flow, salinity, etc.) for all life stages.

- The ASMFC should encourage the determination of effects of contaminants on all life stages, especially eggs, larvae, and juveniles.

- The ASMFC should encourage the evaluation of existing fisheries survey data to aid in determining at-sea migratory behavior and stock composition.

- The ASMFC should encourage aquaculture research to identify and control early life stage diseases, synchronize spawning times of males and females, and reduce handling stress problems.

- The ASMFC should encourage the appropriate federal fisheries management agencies to manage the Atlantic sturgeon fishery in the EEZ.

- The ASMFC should establish an aquaculture and stocking committee to provide guidelines for aquaculture and restoration stocking of sturgeon.

Many of the management recommendations contained in the Plan were implemented. All states either imposed a moratorium on the Atlantic sturgeon fishery in their waters, instituted a 7-foot size limit, or instituted a limit which achieved conservation equivalency (New Jersey and New York) (Rec. No. 1). Work is underway in New York, North Carolina and South Carolina to identify habitat use, including potential spawning and nursery areas (Rec.No. 2). Other states, notably Connecticut, Maine and

Delaware, have collected information on Atlantic sturgeon habitat use in conjunction with studies on other species, such as shortnose sturgeon. A coastwide Atlantic sturgeon tagging program, administered by the USFWS Annapolis, Maryland, Fishery Resources Office (FRO), was established, although participation has been somewhat limited, in that only the states of Connecticut, New York, New Jersey, Delaware and North Carolina are currently participating (J. Skjeveland, USFWS, Annapolis, Maryland, personal communication to RWL)(Rec. No. 3). While all sturgeon tag and release data have been gathered at the Annapolis FRO of USFWS, the data have as yet not been completely entered into a database (Rec. No.5, in part). The database has undergone modifications, however, which will facilitate inclusion of those data and some have been entered into the system. Compilation of additional data has effectively occurred as the Technical Committee and Stock Assessment Subcommittee have prepared the current stock assessment (Kahnle et al. 1998)(Rec. No. 5, in part). Some shortnose sturgeon researchers (e.g., M. Collins and T. Smith, SC Department of Natural Resources, Marine Resources Division) have gathered data and information on Atlantic sturgeon during the course of conducting field investigations on shortnose (Rec. No. 7). Some limited work has been done by the USFWS at the Northeast Fishery Center to assess the effect of temperature on egg incubation, and additional work has been conducted by the University of Maryland to assess the effect of hypoxia on juveniles (M. Hendrix, USFWS, Northeast Fishery Center, Lamar, Pennsylvania, personal communication to RWL, March 19, 1998). The USFWS plans additional work in the near future to assess the effect of environmental variables on Atlantic sturgeon juveniles (Rec. No. 8). FWS has developed a culture program for Atlantic sturgeon at its Lamar, Pennsylvania, Fish Technology Center (Rec. Nos. 6 and 11) which has successfully held brood stock and propagated the species, using Hudson River Atlantic sturgeon. The ASMFC formed an Atlantic Sturgeon Aquaculture and Stocking Committee, which, in cooperation with the Management and Science Committee, published recommendations for culture and stocking of the species in 1992 and 1996 (Atlantic Sturgeon Aquaculture and Stocking Committee 1992, 1996). Little if any work has been performed to address measures 4, 10, and 12.

### 1.1.1 Statement of the Problem

Despite preparation of the 1990s Plan and implementation of many of its recommendations, some Atlantic sturgeon spawning stocks, most notably the Hudson River stock, have continued to deteriorate through 1996 (Kahnle et al. 1998). In the last decade, landings of Atlantic sturgeon have declined dramatically along the east coast. This FMP discusses Atlantic sturgeon life history and the problems associated with their decline. It also summarizes the status of the spawning stocks, past ocean and in-river fisheries, and monitoring and information needs. Its contents are the result of a public process of FMP development which included dialogue with interested commercial fishermen, potential recreational users, conservation groups and members of the public, to develop final alternatives for implementation in state management programs.

To address the problem of voluntary FMP implementation, the 1993 Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA) required states to adopt mandatory management measures in approved ASMFC Fishery Management Plans. In the event that a state does not implement a Commission FMP, the law provided that the U.S. Secretary of Commerce may impose a moratorium in that state's particular fishery. Under this law, all Commission FMPs must include specific measurable standards to improve the status of the spawning stocks and to determine if states comply with these standards.

The 1990s Plan simply did not contain conservation measures sufficient to protect the portion of the Atlantic sturgeon population and individual spawning stocks remaining at that time. Further, the 1990 FMP for Atlantic sturgeon does not contain the required standards now mandated under the ACFCMA, and some spawning stocks continued to decline. Therefore, in 1996 ASMFC's Sturgeon Board of state fisheries' directors and federal agency representatives decided to amend the Plan. The Board took action

in 1996 to notify the public of the proposal to amend the Plan, and also specified that the preferred management measure would be a moratorium. All interested users, particularly commercial and potential recreational fishermen, were encouraged to participate by expressing their concerns and opinions. Comments on the potential management measures available for Atlantic sturgeon were solicited through the circulation of a Public Information Document (Field et al. 1996).

### 1.1.2 Benefits of Implementation

Implementation of Amendment 1 is designed to result in stock recovery, with consequent ecological and economic benefits to coastal ecosystems and fishermen. Restoration of the stock should reestablish Atlantic sturgeon as a unique component of east coast rivers, estuaries and the Atlantic Ocean. Management of a restored and recovered population of Atlantic sturgeon will establish and maintain, subsequent to stock recovery in the future, fishing mortality targets and a fishery monitoring program that should: allow managed exploitation; increase market stability; stabilize commercial, and possibly recreational, landings (within the limits of environmental variability in recruitment); and reduce the risk of recruitment failure.

#### *1.1.2.1 Social and Economic Benefits*

Implementation of the Amendment will continue the process of restoration of the Atlantic sturgeon population and its component spawning stocks which historically formed the basis of significant and highly valuable commercial fisheries on the east coast of the U.S. and Canada. Loss of the fisheries has resulted in significant economic loss as well as cultural loss due to the demise of a relatively specialized heritage fishery. When restoration targets, as established in future Amendments or addenda to the plan, are met, the fishery may be reopened and an important component of east coast culture and heritage reestablished.

Restoring the population of Atlantic sturgeon would be beneficial because such management action would generally increase the total use and non-consumptive (existence) values of this species in the ASMFC member states and the nation. Increases in consumptive use values could include future allowances for commercial and recreational fishing harvest, while improvements in non-consumptive use values might include increases in ecotourism activities related to the restored Atlantic sturgeon stocks. Population restoration might also stabilize harvesting and related commercial markets if Atlantic sturgeon commercial fisheries are reopened in the future.

#### *1.1.2.2 Ecological Benefits*

Extant Atlantic sturgeon spawning stocks are severely depleted compared to historical high levels (Kahnle et al. 1998, NMFS and USFWS in preparation). Some southern stocks appear to be recovering, based on recent sampling (Moser et al. 1998). Implementation of the Amendment will begin the process of restoring and increasing the population of what is the largest fish on the east coast to enter and spawn in fresh or tidal fresh waters. Additionally, reestablishment of historical levels of abundance, and appropriate reintroductions, will reestablish aquatic biodiversity in those systems where Atlantic sturgeon were historically present.

## 1.2 DESCRIPTION OF THE RESOURCE

### 1.2.1 Atlantic Sturgeon Life History

Atlantic sturgeon have been taken for food by humans in North America for at least 3,000-4,000 years, based on the presence of Atlantic sturgeon scutes in archaeological sites on the Penobscot River (Kahnle

et al. 1998). Sturgeon were found along the Atlantic coast from Labrador, Canada to the St. Johns River on the east coast of Florida; however current documented distribution of spawning stocks extends only as far south as the Altamaha River in Georgia. The Atlantic sturgeon was historically one of the largest and longest-lived anadromous fish in North America, with a maximum total documented length of 14-18 feet (4.3-5.5 meters), living up to 60 years. Atlantic sturgeon are bottom feeders whose prey includes mussels, worms, shrimp and small bottom-dwelling fish. Atlantic sturgeon live as adults in the ocean, undertaking spawning migrations beginning in February-March in South Atlantic waters, April-May in Mid-Atlantic waters, and May-July in New England and Canadian waters. Female Atlantic sturgeon mature at about 7-19 years of age in South Carolina, 10-20 years for the Hudson River stock, and 27-28 years in the St. Lawrence River. Females spawn only once in a 2-6 year period. Recruitment can therefore be low, even though individual females produce many eggs. In some areas, a small fall spawning migration consisting of ripe Atlantic sturgeon adults has also been reported.

Actual spawning locations for Atlantic sturgeon are not well known. In the Delaware River, Pennsylvania, sturgeon were found spawning at depths of 36-42.6 ft (11-13 m) over a hard clay bottom at water temperatures of 13.3-17.8 degrees C (Borodin 1925). Spawning sites in the Pee Dee River, South Carolina, were characterized by relatively slow current, turbid water, and bottom substrates of sand and silt with abundant organic debris (Van Den Avyle 1984). However, spawning was not definitively documented at these sites since no eggs were collected (T. Smith, South Carolina Department of Natural Resources, personal communication). Generally, Atlantic sturgeon are thought to prefer hard substrates such as rock, rubble or hard clay (Gilbert 1989).

The highly adhesive eggs require incubation time of 94 hours (at 20 degrees C) to 140 hours (at 18 degrees C). The yolk sac is absorbed in about 10 days, and the small fish begin a bottom-dwelling existence. Little is known of the behavior and habitat requirements of these small fish and it is assumed that they slowly move downriver from the spawning sites. Once Atlantic sturgeon subadults attain a size of 12 inches (30 centimeters), they are regularly captured in tidally-influenced lower river and estuarine areas. Some movement of juveniles between river systems occurs. Most juvenile Atlantic sturgeon remain in slightly brackish water near the river mouth/estuarine zone for a number of months or years and then move into coastal and continental shelf waters where they grow and mature.

Based on tagging studies, Atlantic sturgeon are known to undertake extensive coastal migrations. Genetic analysis undertaken in recent years determined that the Hudson River stock contributed most of the Atlantic sturgeon captured in the New Jersey ocean intercept fishery in the spring and also a substantial portion of the fish taken in the autumn fishery (Waldman et al. 1996). In addition, it is believed that the Hudson River produced a substantial number of the juveniles that aggregate in the Connecticut River, Delaware Bay and Chesapeake Bay.

### 1.2.2 Stock Assessment Summary

It was initially envisioned by the Technical Committee, Stock Assessment Subcommittee and Plan Development Team that the Amendment would summarize stock condition and provide a definition of a restored stock along with management recommendations. However, the Stock Assessment Subcommittee is unable to address the definition of a restored stock under the accelerated time frame by which this Amendment must be finalized and approved. Therefore, this Amendment focuses primarily on recent spawning stock status and the management recommendations necessary to sustain and promote the growth of the population of Atlantic sturgeon in U.S. waters. However, information on techniques to reestablish extirpated stocks is included. At such time as an assessment is completed for all spawning stocks for which sufficient information is available, that information will be published by the ASMFC. The Stock Assessment Subcommittee will continue work on defining a restored population and/or individual spawning stocks. When completed, that information will be summarized

in a future addendum to this Amendment.

The current stock assessment (Kahnle et al. 1998) is the source of the information provided below.

## 1.3 DESCRIPTION OF THE FISHERY

The fishery in waters under the jurisdiction of the ASMFC is closed. Every jurisdiction has a moratorium or closure in place which bans possession of Atlantic sturgeon. There are no directed fisheries for the species. The only fishing-related mortality which occurs is that resulting from discard mortality in other fisheries, an issue which is addressed in Sections 1.3.5.1 and 3.7. This Amendment proposes to maintain the existing moratoria until such time as the population and individual spawning stocks are recovered to levels deemed satisfactory for reopening fisheries.

A description of the historical U.S. east coast commercial fishery is provided in this Amendment to indicate the previous levels of exploitation the population experienced in the past.

### 1.3.1 Commercial

Commercial landings for Atlantic sturgeon are compiled and reported in Kahnle et al. (1998) for the U.S. east coast, period 1849 to 1995.

#### *1.3.1.1 Coastwide*

Reported coastwide landings peaked in 1890 at an estimated level of 7,374,449 lbs (3,348,000 kg)(see Kahnle et al. 1998, Table B1). After the period of "clear-cutting" of the spawning stocks, which occurred in each river system during approximately 1849 through 1900, reported landings declined. During the period 1900 through 1910, maximum estimated landings were 678,414 lbs (308,000 kg). Post-1910 reported landings declined even further, with a mean of 52,588 lbs (23,875 kg) for the period 1911 through 1950. After 1950, reported landings began to gradually increase again, with a mean value of 158,394 lbs (71,911 kg) per year from 1951 through 1995, inclusive. Maximum landings in the last decade occurred in 1990s, at a level of 292,952 lbs (133,000 kg) (all mean values provided in this section are derived from Table B1 of Kahnle et al. 1998).

#### *1.3.1.2 By State*

Throughout the period of the historical record, Atlantic sturgeon have been taken predominantly in the Mid- and South Atlantic states from New York through Georgia. Analysis of the entire time series of reported landings from 1849 through 1995 inclusive indicates that approximately 46.3 percent of the commercial take was landed in New Jersey, followed by Delaware with 19.4 percent and Virginia (6.8), South Carolina (6.6), North Carolina (5.8), Georgia (4.9) and New York (4.4). The vast majority of the landings in the last decade came from New York and New Jersey, and were based on Hudson River fish (Waldman et al. 1996). Landings in other states declined primarily as a result of overfishing. Eventually all fisheries were closed through regulation.

### 1.3.2 Recreational

Based on review of the literature and interviews with federal and state fishery biologists, there is currently no significant recreational fishery for Atlantic sturgeon. There are rare anecdotal reports of fish being hooked in the Hudson River (K. McKown, New York Department of Environmental Conservation, personal communication to PDT March 10, 1998) and Quinnipac River, Connecticut (T. Savoy, Connecticut Department of Marine Fisheries, personal communication) by recreational anglers.

However, there is no historical information to indicate that Atlantic sturgeon supported recreational fisheries.

### 1.3.3 Subsistence Fishing

Native American tribes harvested Atlantic sturgeon, as documented from the presence of scutes at archaeological sites which date from 4,000 to 1,000 years ago (Kahnle et al. 1998). However, there are currently no Native American tribes which have known subsistence fishing rights for harvest of Atlantic sturgeon.

### 1.3.4 Non-consumptive Factors

Normal consumptive uses for Atlantic sturgeon in the Atlantic states have involved commercial and perhaps some limited recreational fishing. In contrast, non-consumptive use would involve existence value only, including visual sightings. For example, a field trip by a biology class to view the stocking of hatchery raised fish for educational purposes would be one type of non-consumptive use, as well as live displays in public aquaria and during public events.

It has been reported that tourists and naturalists in some areas have taken boat tours to view large sturgeon released alive from fishermen's nets (Field et al. 1996). Moreover, nongovernment organization (NGO) involvement in sturgeon research, like the Hudson River Foundation and the Caribbean Conservation Corporation, are not only positive indicators of non-consumptive use interests, but the NGOs may also be stimulating demand for ecotourism activities related to the Atlantic sturgeon. Therefore, with the apparent growth of ecotourism in the U.S., it is conceivable that the demand to view Atlantic sturgeon could gradually escalate.

### 1.3.5 Interactions With Other Fisheries, Species and Other Users

Since all commercial fisheries for Atlantic sturgeon are currently closed, there are no interactions of Atlantic sturgeon gear or fishermen with other fisheries or species. There are interactions through bycatch of Atlantic sturgeon in other fisheries.

#### *1.3.5.1 Bycatch in Other Fisheries*

Available information concerning bycatch of Atlantic sturgeon in other fisheries is provided in the stock assessment document (Kahnle et al. 1998). Atlantic sturgeon occur as bycatch of commercial fisheries along the entire U.S. Atlantic Coast. Fisheries in which Atlantic sturgeon have been captured include the American shad (gill nets), Atlantic cod (gill net, incidental hook and line), bluefish (gill nets, trawl), groundfish (trawl), horseshoe crab (trawl), monkfish (gill nets), river herring (gill nets), southern shrimp (trawls), spiny dogfish (gill nets), striped bass (gill nets, pound nets), summer flounder (trawl, perhaps gill nets in North Carolina), weakfish (gill nets) and northeastern and southeastern whelk (trawls). With the exception of New York and New Jersey landings, most landings in other states which occurred since 1990s were incidental to other fisheries (see Tables 4.1 ff. in Kahnle et al. 1998). Limited bycatch of juvenile Atlantic sturgeon has been documented in lobster, crab and fish pots.

Atlantic sturgeon mortality which results from bycatch in the monkfish and spiny dogfish fisheries in the Atlantic Ocean should decline in the near future. Both of those fisheries have been determined overfished and the Mid-Atlantic Fishery Management Council will likely impose additional restrictions on the take of those species. This action in turn should reduce bycatch of Atlantic sturgeon.

The relative importance of bycatch of juvenile Atlantic sturgeon from rivers and estuaries, territorial

ocean waters and the EEZ is apparent from tagging and recapture data collected by the Delaware Division of Fish and Wildlife (Craig Shirey, unpublished data). As noted by Kahnle et al. (1998), recaptures of sub-adult Atlantic sturgeon tagged in the lower Delaware River from 1991-1997 came from ocean waters within three miles of shore (61%), rivers and estuaries (20%), and the EEZ (18%). An additional 1% were of unknown origin.

Geographic distribution of bycatch was also summarized by Kahnle et al. (1998). Bycatch of Atlantic sturgeon in ocean fisheries north of South Carolina appears to be a rare event. The bycatch which did occur in northeast ocean fisheries occurred year round, but was concentrated in June through October. In the southeast, ocean captures occurred during the spring, summer and fall. In rivers and estuaries, most bycatch of Atlantic sturgeon consisted of juveniles captured in late winter, spring and fall, primarily in American shad gill net fisheries and in pound net fisheries.

Survival rate of Atlantic sturgeon in commercial fishing gears is poorly documented (Kahnle et al. 1998). Generally, the longer the gear is set, the higher the mortality. Survival also decreases as water temperature increases. Mortality rates of Atlantic sturgeon captured in American shad gill net sets in South Carolina averaged 13 percent during 1994-1996 (Collins and Smith 1996). An additional 19 percent were released with some injury during the three-year period. Mortality of juveniles tagged in the Delaware River and recaptured elsewhere was 10% in anchored gill nets (C. Shirey, unpublished data). Spells (1997) reports essentially no mortality for juvenile Atlantic sturgeon captured in various gears in the Chesapeake Bay and Virginia rivers; however, this result may be biased by the fact that fishermen were paid rewards only for live fish.

Since there are no directed Atlantic sturgeon fisheries, and the population is depressed, mortality resulting from bycatch can be an important factor affecting the rate of recovery. An effort to assess the effects of bycatch mortality at the population level, for the Hudson River stock, was undertaken by Kahnle et al. (1998).

Kahnle et al. (1998) obtained perspective on rates of bycatch which would permit sustainable recovery by inference from an $F_{50}$ calculated for bycatch from yield and egg per recruit modeling. Yield and egg per recruit modeling was revised to initiate bycatch at age three (age at which Atlantic sturgeon emigrate from estuaries). The resultant estimate was $F_{50} = 0.03$. This calculation applies to the Hudson River population only and presumably suggests a bycatch rate that would permit the population to remain stable or increasing.

Recent levels of mortality from bycatch can be inferred for the Hudson River and Delaware River populations from recaptures of subadult Atlantic sturgeon tagged in the lower Delaware River by the Delaware Division of Fish and Wildlife (C. Shirey, unpublished data). Fish were generally tagged from June through October each year. They emigrated from the estuary starting in November and were recaptured by commercial fisheries from North Carolina through Maine (see Table 3.4.6 in Kahnle et al. 1998). For the purposes of calculating bycatch exploitation rate, a recapture year of 1 November through 31 October was assumed. Mortality rates of 0.10-0.40, 0.1, and 0.0 were applied to recaptures in gill net, trawl and pound net, respectively. Bycatch exploitation was then estimated as number of dead recaptures divided by the number of tagged fish released during the previous summer. Resulting estimates of mortality caused by reported bycatch ranged from a high of 0.0031-0.0125 in 1991-1992, to a low of 0.0009-0.0037 in 1995-1996. At such low levels of fishing, instantaneous rates of fishing (F) are equal to rates of exploitation. Thus, these estimates translate directly into instantaneous rates of bycatch mortality of 0.0031-0.0125 and 0.0009-0.0037. The lowest estimates occurred in the last three years of the study. It was noted that a range of estimates was calculated each year because a range of values was used for mortality of sturgeon caught in gill nets.

Accuracy of estimated bycatch mortality rates for the Hudson River population is affected by several factors. Estimates are biased low by probable violations of assumptions inherent in use of tag/recapture data to estimate the rates. In particular, the method assumes a 100 percent reporting rate of tagged fish recaptured, zero tag loss, and zero tag-induced mortality. Violations of any of these assumptions would mean that estimates are lower than the actual rates. On the other hand, the upper bound of mortality used for fish caught in gill nets (0.40) is probably high. This estimate is from a small sample size and is from a time of year when inclement weather can delay tending of nets and increase mortality.

Although sample sizes were small, bycatch rates estimated for the Hudson River and Delaware River populations do not appear to be a cause for concern at the current time. Estimates from the Delaware River tagging data are well below the $F_{50}$ rate of 0.03 calculated for the Hudson River population. Estimated rates are also well below the assumed instantaneous rates of natural mortality (M) of 0.07-0.10 used in population modeling. Finally, and most importantly, estimates of current bycatch rate from tagging data suggest a decreasing trend among years. This is likely to continue given efforts at conservation engineering and increased restrictions on fisheries which encounter sturgeon.

The rate of mortality caused by bycatch of southern populations of Atlantic sturgeon is currently unknown.

Any level of bycatch mortality will delay recovery of Atlantic sturgeon. However, changes in rate of recovery cannot be quantified with available data. Given uncertainties about bycatch estimates for the Hudson River stock, and the lack of estimates for southeastern populations, Kahnle et al. (1998) believe that there is a clear need to better document bycatch, mortality in various gears, and population level impact.

## 1.4 HABITAT CONSIDERATIONS

Habitats used by Atlantic sturgeon range from riverine freshwater or tidal fresh spawning sites, through riverine and estuarine nursery areas, to marine nursery and adult wintering habitats. Spawning, nursery and wintering habitats are discussed and described in the Source Document in detail, and briefly summarized in this Amendment.

### 1.4.1 Habitat Important to the Spawning stocks

Historically, Atlantic sturgeon were present in many of the river systems in New England, including the Kennebec River system in Maine, the Merrimack River in Massachusetts and New Hampshire, Thames River to a limited degree, and Connecticut and Housatonic Rivers (Kahnle et al. 1998). Currently, it is likely that the estuarine complex of the Kennebec, Androscoggin and Sheepscot Rivers in Maine is the only system in New England which supports a spawning population of Atlantic sturgeon, as documented by the capture of spawning adults in 1994, 1996 and 1997 (Kahnle et al. 1998). Although juvenile Atlantic sturgeon have been captured in the Connecticut River, no spawning adults have been documented to date.

In the mid-Atlantic, the Hudson and Delaware Rivers and their associated estuaries and the Atlantic Ocean offshore historically and currently support Atlantic sturgeon.

Atlantic sturgeon were once abundant in the Chesapeake Bay and tributaries, and historically important fisheries for the species occurred in the Susquehanna, Potomac, York and James Rivers. Currently, there is evidence for sturgeon spawning only in the James and perhaps the York Rivers in Virginia. The entire Chesapeake historically served as nursery habitat for sturgeon spawned in its tributaries and should still be so considered, despite the relatively low abundance of the species at present.

Atlantic sturgeon were historically present in all of the larger coastal rivers and their associated estuaries in the South Atlantic region. Presently, there is evidence of spawning only in the Albemarle Sound and Cape Fear River systems in North Carolina; Winyah Bay and tributaries (Waccamaw, Black, Little Pee Dee and Great Pee Dee), Santee River, Cooper River, ACE Basin Rivers (Ashepoo, Edisto and Combahee), and Savannah River, South Carolina; Altamaha River, Ogeechee River, and Satilla River, Georgia. Additional systems which hosted Atlantic sturgeon and should be considered functional habitat for the purposes of restoration include the Pamlico Sound and tributaries, North Carolina; St. Marys River, Georgia, and St. Johns River in Florida.

### 1.4.2. Description of the Habitat

The Winyah Bay system in South Carolina is supplied with fresh water inflow by its major tributaries the Waccamaw, Pee Dee, and Black Rivers (Mathews et al. 1980). The Waccamaw River extends into southeastern North Carolina. The Pee Dee is further subdivided into the Great and Little Pee Dee systems, as well as the Lumber River drainage which lies almost entirely in North Carolina. Collectively, the Black, Pee Dee and Waccamaw system drains approximately 14,014 square miles (36,296 square km) in North and South Carolina. The flood plain varies in width from 1-9 (1.6-14.5 km) miles wide and extends landward from the coast approximately 205 miles. Tidal range is about 3.5 feet (1.1 m)in the tidal portion of the system. Tidal influence extends approximately 46 miles (74 km)up the Black River, 38 (61 km) miles up the Pee Dee and 82 miles (132 km)up the Waccamaw. The Pee Dee River flows unimpeded to the sea from the first dam on the system, Blewitt Falls, which is located in North Carolina. Winyah Bay is traversed by a shipping channel which is dredged with some regularity to provide navigational access to the port of Georgetown.

The Santee and Cooper River Basins originate on the eastern slopes of the Blue Ridge Mountains in western North Carolina (Mathews et al. 1980). The rivers flow approximately 300 miles (480 km) southeasterly to the coast, emptying between Charleston and the south edge of Winyah Bay. Flood plains in the system are from 1-6 miles (1.6-10 km)wide, and the drainage area of the basins is approximately 16,800 square miles (43,512 square km). Tidal influence extends upriver approximately 48 miles (77 km), with tidal range of 3.3-6.3 feet (1-1.9 m). The Santee River basin has been dammed (rm 87; km 90), forming Lake Marion. The lake occupies the upper 56 miles (90 km) section of the 143 mile length (230 km) of the Santee River. The Cooper River has been dammed at the headwaters in Berkeley County, South Carolina to form Lake Moultrie.

The three rivers which form the estuarine complex commonly known as the ACE Basin are the Ashepoo, Combahee and Edisto. This system originates in the west central portion of South Carolina and extends approximately 100 miles (160 km) in a southeasterly direction to discharge between Morgan Island and the western end of Seabrook Island (Mathews et al. 1980). There are no dams on the system. The floodplain of the Edisto River is approximately 200 miles (322 km)in length, and that of the Combahee approximately 125 miles (201 km). The Edisto drains approximately 3,100 square miles (8,029 square km), and the Combahee about 1,325 square miles (3,432 square km). Tidal range in these systems is from 6.2 to 7.5 feet (1.9-2.3 m), with a tidal extent of about 40 river miles (64 km). These rivers are among the least developed in the region, and water quality is generally very good.

The Savannah River Basin covers approximately 10,574 square miles (27,394 square kilometers) of Georgia, South Carolina and North Carolina (Mathews et al. 1980, Schmitt and Hornsby 1985). The Savannah is formed by the confluence of the Seneca and Tugaloo Rivers near Hartwell and flows southeasterly for approximately 296-300 mi (476 km) before discharging into the Atlantic Ocean near Savannah, Georgia. The Savannah River Basin encompasses portions of three provinces, the Blue Ridge, Piedmont and Coastal Plain. The watershed is predominantly forested and rises to elevations of 5,499 feet (1,676 meters) at the headwaters of the Tallulah River. Land use in the upper basin is largely

recreation and timber production. The relatively undeveloped Coastal Plain portion of the basin is characterized by bottomland hardwoods, southern pine forests and cypress-tupelo swamp communities. A salt-marsh delta with a network of tidal creeks predominates in the lower reaches of the river (28 mi; 45 km). Estuarine marsh habitat in the river extends from river mi 28 (km 45) downstream to the Atlantic Ocean. The lower river is tidal in extent, with a tidal range of 6.9 to 8.1 feet (2.1 to 2.5 m). Tidal effects extend to river mi 43 (km 69), to Ebenezer Creek. The lower Savannah River forms three channels near the Atlantic Ocean.

The Altamaha River is located entirely within Georgia, flowing over 497 mi (800 km) from its headwaters to the Atlantic Ocean (Hottell et al. 1983, Rogers et al. 1994). Its two tributaries are the Ocmulgee and Oconee, which merge to form the Altamaha at river mi 132 (km 212). The Altamaha system drains 18,605 square miles (48,200 square km), making it the largest drainage east of the Mississippi River. The width of the main channel varies from 361 feet (110 m) near the confluence of the Ocmulgee and Oconee to 820 feet (320 m) in the lower, tidally influenced reaches where it radiates into several channels of equal width in the delta. The delta discharges into the Atlantic Ocean over a 22-mile (35 km)stretch of shoreline. The flood plains of the Ocmulgee and Oconee range in width from 0.6 to 4.3 mi (1-7 km). Flood plain width in the lower river is as wide as 10.6 mi (17 km). The Altamaha is very sinuous, with its 132 mi (212 km) length contained in 87 air mi (140 air km). The meandering has created a large number of oxbows in the system, most of which are bordered by cypress-tupelo swamp forest. The estuarine portions of the system extend from the Atlantic Ocean inland to river mi 23.5 (km 38). The river in this reach is bordered by brackish or salt marsh with many interconnecting tidal creeks and rivers. Tidal influence usually extends approximately 42 mi (68 km) up the river, with tidal range of 5.2 to 7.7 feet (1.6 to 2.3 m).

The Ogeechee River originates in the lower Piedmont province of Georgia and discharges to the Atlantic Ocean through the Ossabaw Sound estuary (Weber et al. 1995). The one major tributary, the Canoochee River, originates in the upper Coastal Plain and flows through minimally disturbed habitat owned by the U.S. Army for the last 52.4 miles (84.4 km) of its length. It joins the Ogeechee main stem at river mile 34 (km 55) near the head of tidal influence and in the vicinity of the fresh/salt water interface. The flood plain of the Ogeechee system is from 1-7 mi (1.6-11.3 km) wide and approximately 170 mi (274 km) long. The Ogeechee drains approximately 5,535 square miles (14,336 square km). Tidal range in the tidal portion of the system is 6.9 to 8.1 feet (2.1 to 2.5 m), with tidal influence extending inland to river mile 30-35 (48-56 km). Vegetation adjacent to the lower reaches of the system consists of mixed hardwood and cypress swamp inland, grading to black needlerush and salt marsh cordgrass marsh nearer the Atlantic Ocean.

The Satilla River originates in Ben Hill County, Georgia, and flows 225 miles (362 km) to the Atlantic Ocean at St. Andrews Sound (Sandow et al. 1975, Michaels et al. 1981). The Satilla is one of only two rivers in Georgia that originate and flow to the Atlantic Ocean entirely within the Coastal Plain. The drainage basin is approximately 1,200 square miles (3,110 square km). Tidal range in the tidally-influenced portion of the system is 6.7 to 7.8 feet (2-2.4 m). The lower 67 mi (108 km) is tidal. It is a blackwater stream, with a pH range of 4.5 to 6.0. The River is bordered by numerous cypress swamps, lowlands and pine forests. Development of the floodplain has historically been limited due to widely fluctuating water levels. The flood plain varies in width from 1 to 6 miles (1.6 to 9.7 km). Its primary substrate is sand, with limited sandstone outcroppings and rubble. There are no dams on the system.

The St. Mary's River Basin spans an area of northeast Florida and southeast Georgia which encompasses approximately 1,580 square miles (4,100 square km)(Weber et al. 1995). The watershed contains a wide variety of upland and wetland habitats, including pocosins, Carolina Bays, cypress ponds, river swamps and tidal wetlands communities similar to those of the Ogeechee River. The actual

area of the drainage basin is somewhat uncertain due to the fact that the headwaters of the system lie in the Okefenokee Swamp, which drains to both the Atlantic Ocean (through the St. Mary's) and to the Gulf of Mexico (through the Suwannee). The Georgia portion of the watershed occupies 51 percent of the total and is drained by the North Prong of the St. Mary's. The Florida portion contains 49 percent and includes the Middle and South Prongs and the Little St. Mary's River. The waters of the basin are acidic, low pH, poorly buffered, and nutrient poor to a greater extent than those of the Ogeechee, due in part to the lack of any inputs from the Piedmont and Upper Coastal Plan. The river flows 148 mi (239 km) from the Okefenokee Swamp to the Atlantic Ocean. Average width of the river floodplain is 1-3 miles (1.6-4.8 km). The tidally-influenced portion of the river extends 60 mi (96.5 km) inland. Tidal range is 5.8 to 6.8 feet (1.8-2.1 m).

The St. John's River Basin occupies approximately 3,505 square miles (9,080 square km) of north central Florida, and is one of the few river systems in the United States which flows northwards (Livingston 1990s). The St. Johns River is about 270 mi (435 km) long. The Oklawaha is the single major tributary. Both the St. Johns and the Oklawaha are meandering, rather sluggish rivers, which contribute a broad range of seasonal freshwater flows to the estuary.

### 1.4.3 Present Status of Habitats and Impacts on Fisheries

The present status of habitats in the Connecticut River was not assessed by Kahnle et al. (1998); however, they do indicate that adequate habitat is thought to exist in the estuarine portion of the system, given the seasonal presence of juvenile Atlantic sturgeon. Additionally, the lower portion of the river was restored due to the breeching of the Enfield Dam, making the river accessible all the way to the base of the Holyoke Dam in Massachusetts.

The Cape Fear River estuary has been heavily altered by dredging for use by both military and commercial shipping. Ports located at Sunny Point and Wilmington necessitate the maintenance of shipping channels and turning basins. Continued deepening of the channels and expansion of port facilities has resulted in extension of the salt wedge upstream, with consequent alteration of adjacent wetland ecosystems as salt-intolerant vegetation is replaced by more salt-tolerant species. Industrialization of the river corridor has resulted in both point and non-point source pollution, including several toxic waste sites. The water regime of the entire system is influenced by upstream dams located in the Piedmont region of North Carolina, as well as by water withdrawals for industrial, municipal and agricultural use. Concern has arisen in recent years over dissolved oxygen levels in the lower river. Access to historical spawning habitat is likely blocked by three locks and dams on the system. The system does still support both Atlantic and shortnose sturgeon.

The Winyah Bay system is dredged regularly to maintain the shipping channel to the Port of Georgetown. The Sampit River arm of the bay is industrialized (paper mill, steel mill) which has reduced water quality. Certain portions of the bay are high in various toxins such as dioxin (Kahnle et al. 1998).

The Santee and Cooper River systems have been the subject of much experimentation by the U.S. Army Corps of Engineers and as noted above have been developed for hydropower. Hydropower facilities on both rivers have been provided with fish passage facilities. American shad and river herring are locked through the Pinopolis Lock and Dam on the Cooper River; however the facility has proven ineffective for passage of shortnose sturgeon in that river. A fish lift at St. Stephens Dam on the Santee River has proven effective access for all species of anadromous fish, including some sturgeon.

The ACE Basin rivers are among the least developed in the region, and water quality is generally good. The Savannah River has three major dams forming three lakes, Hartwell, Richard B. Russell and J.

Strom Thurmond. The three lakes cover nearly 120 mi (193 km) of the upper reaches of the river. An additional dam located near Augusta, Georgia, the New Savannah Bluff Lock and Dam, is the first blockage on the main stem of the river. The locks have historically been operated to provide passage for fish during the spring, but recent efforts have focused on provision of sufficient flows over the dam to provide for upstream passage. The river serves as a source of municipal water supply for many users in Georgia and South Carolina, as well as a source of industrial water use for many commercial facilities, including power plants. A navigational channel has been constructed on the river from the port of Savannah to Augusta and serves terminals at Augusta, Sylvania and Savannah. A deep water ocean port is maintained at 42 feet to the Kings Island Turning Basin, and at 30 feet to river mi 21 (km 34). A tide gate was constructed across the Back River in the delta adjacent to the city of Savannah; however the gate has since been modified to alleviate documented adverse impacts to spawning striped bass and saltwater intrusion into the Savannah National Wildlife Refuge. Salinity currently extends to river mi 26 (42 km). The naturally winding channel of the river has been altered by natural and manmade cuts. U.S. Army Corps of Engineers dredging during the 1950s and 60s reduced main channel length by 13 percent (Schmitt and Hornsby 1985). Water quality in the river has been reported as degraded in two areas: downstream of Augusta and in the Savannah harbor (Schmitt and Hornsby 1985). Degradation was attributed to discharges from municipal and industrial dischargers.

The Altamaha River Basin has experienced significant changes over the last 130 years (Rogers et al. 1994). Following colonization through the Civil War, the landscape was converted from virgin forest to agriculture, dominated by cotton. Cotton farming led to extensive soil erosion from the Piedmont portion of the drainage basin. After 1870 and more so after 1925, land use reverted to forest, and hydropower dams were constructed on the upper tributaries, which resulted in decreased erosion rates. The basin is presently characterized by significant silvicultural and agricultural land use. Widespread clear-cutting of hardwood bottomlands, and conversion of thousands of acres of freshwater wetlands to infrequently inundated pine plantations has occurred. Two kraft process paper mills are located in the basin, one each at Macon (Ocmulgee river mile 194, km 312) and Jesup (Altamaha mi 60s, km 97). There are 28 industrial or municipal wastewater discharges to the basin. Hydroelectric dams have been constructed in the headwaters at or above the Fall Line. The Oconee is dammed to form Lake Sinclair at the fall line (river mi 142, km 229), and the Ocmulgee is dammed several dozen km above the fall line, forming Lake Jackson. Other impoundments are upstream of these reservoirs, causing the reaches in the upper coastal plain to experience the effects of controlled flow.

The Ogeechee River, over the last two decades, has shown increasing eutrophication (Weber et al. 1995). Land use patterns include small municipalities, significant agricultural and silvicultural interests, and light industry throughout the basin. Only along the Canoochee tributary within the military lands does the landscape approach pre-European condition, but even there are significant anthropogenic inputs. There are 41 industrial and municipal discharges to the waters of the basin (Weber et al. 1995). In contrast, less than two decades before (Schmitt 1988) there were only 25 discharges and the river was noted as one of the cleanest in Georgia. There has been substantial population growth in the counties adjacent to the river, fueled by military expansion and industrial development. Increased population and industrial growth placed additional demands on the already depressed Floridan Aquifer, which is the major aquifer underlying the Savannah metropolitan area. Heavy localized pumping along the coast produced cones of depression around Savannah and Brunswick, prompting the U.S. Army Corps of Engineers to identify the Ogeechee as a supplementary municipal water source for the City of Savannah. Significant water withdrawals could significantly impact fisheries and fish habitat.

The Satilla River basin has been extensively developed for agricultural production (Michaels et al. 1981). Much of the land adjacent to the river is used for timber production. Sturgeon populations in this river system, both Atlantic and shortnose, are thought to be either extirpated or highly stressed due to reduced dissolved oxygen levels and elimination of summer thermal refugia from lowering of the

aquifer (Kahnle et al. 1998).

The St. Mary's River has 14 permitted discharges, including six which are seaward of the tidally-influenced portions of the river (Weber et al. 1995). Upland land use in the basin is much less complex than that of other basins in Georgia due to the predominance of silvicultural use. Forests and timberlands comprise 86 percent of the land use in the four major counties of the basin. Water quality is generally good in the basin, although blackwater streams naturally carry low dissolved oxygen levels. Absence of Atlantic sturgeon from the system has been attributed, however, to reduced dissolved oxygen levels during summer in the nursery habitat, which are thought to result from eutrophication due to non-point source pollution (Kanhle et al. 1998).

The St. John's River's Oklawaha tributary was dammed to create Rodman Reservoir, and it is speculated that this resulted in the elimination of Atlantic sturgeon from the system due to blocked access to spawning habitat. Major portions of the system have been severely altered by agriculture and industrial activities in the basin. Currently, the St. John's River estuary is polluted by a variety of sources, both point and non-point (Livingston 1995).

### 1.4.4 Identification and Distribution of Essential Habitats

The ASMFC considers all presently identified spawning, nursery, migration and wintering habitats, both historical and currently used by Atlantic sturgeon, as summarized above and described in detail in the Source Document (ASMFC in preparation) and the Stock Assessment (Kahnle et al. 1998), essential habitats for the purposes of restoration and recovery of the species.

## 1.5 IMPACTS OF THE FISHERY MANAGEMENT PROGRAM

The presently proposed fishery management program (moratorium with monitoring and bycatch reduction provisions) is intended to ultimately result in a recovered stock and restoration of biological diversity in riverine, estuarine and ocean ecosystems. A restored stock should ultimately stimulate the economy through providing a stable resource base for commercial and potential recreational harvest as well as potential ecotourism. Measures which may be required to reduce or eliminate bycatch of Atlantic sturgeon in other fisheries should benefit other species as well and improve overall ecosystem health.

### 1.5.1 Biological and Environmental Impacts

A major biological concern at the present time is that the prior fisheries, coupled in some systems with blocked spawning runs (Connecticut River prior to breaching of Enfield Dam, Susquehanna River, St. Johns River) and poor water quality (St. Marys River), have apparently extirpated the species from several river systems and may adversely affect its existence in others. "Extirpated" as used in this context means that the species no longer occurs in these systems, based on the failure of sampling programs to capture age 0 or 1 juveniles and/or sexually mature adults. Imposition of moratoria on harvest, possession and landings in all jurisdictions should facilitate recovery of the stocks which still are reproducing. Implementation of the moratorium on a coastwide basis should allow all females to reach sexual maturity and spawn, which will facilitate restoration of the age structure. An expanded age structure should lessen the risk of recruitment failure. Elimination of fishing for the foreseeable future should increase overall survival of all spawning stocks and facilitate recovery and long-term sustainability of the fishery.

### 1.5.2 Social Impacts

In 1996, it was estimated that about 65 U.S. commercial fishermen were involved in harvesting Atlantic sturgeon as a source of "supplemental income" (Field et al. 1996). The New York Department of Environmental Conservation (NYDEC) estimated that the number in commercial fisheries harvesting Atlantic sturgeon in New York ranged between 24 in 1993 up to 40 in 1995 (NYS, 1996). Since all Atlantic sturgeon fisheries are closed throughout the U.S. range of the species, it appears that at least 65 commercial fishermen have been impacted by the closures related to ASMFC member states complying with the current ASMFC Atlantic sturgeon FMP. Obviously, the continuation of the fishery closures as mandated by Amendment 1 will not allow those commercial fishermen the legal alternative of returning to their past Atlantic sturgeon harvesting activities in the near future. The severity of social impacts of fishery closures, if any, on these commercial fishermen and related communities is unknown partly because socio-demographic and other social information related to these commercial fisheries has not been compiled.

A loss of cultural heritage may also occur when traditional fisheries are closed. In some cases, fisheries which have existed for literally centuries will be lost unless documentation is undertaken by maritime museums, local historical societies or other such institutions, given the age of some of the participants. The Plan Development Team recommends that the Advisory Panel undertake a project to record oral histories of the former Atlantic sturgeon fishermen and fisheries before this information is irretrievably lost. Some oral history work has been done on the Hudson River, but it has not yet been published (J. Waldman, Hudson River Foundation, personal communication). Capturing the history of southern sturgeon fisheries may be of higher priority at this time, since we are not aware of any work in that area.

### 1.5.3 Economic Impacts

The economic impacts of Amendment 1 will be addressed relative to (1) aggregate direct and secondary effects[1] on the economy of the member ASMFC states and (2) the possible effects on small business revenues. Neither of these approaches should be interpreted as a cost and benefit analysis (CBA) of the management actions proposed in this document. Others (e.g. Herrick et al. 1994 and Edwards 1990s) have discussed the limitation of economic impact analysis especially from a federal fishery management perspective. In general, the information generated by an economic impact analysis is at most a subset of that required in a CBA (Davis 1993).

Since all commercial Atlantic sturgeon fisheries are closed throughout the U.S. range of the species, it appears that sales, incomes and jobs have been directly or indirectly impacted by the closures related to ASMFC members states complying with the current ASMFC Atlantic sturgeon FMP. Again, the continuation of the commercial fishery closures as supported by Amendment 1 will not allow those commercial fishermen the legal alternative of returning to their past Atlantic sturgeon harvesting activities in the near future. The aggregate economic impacts (e.g. income, jobs, etc.) of past and future closures on the economies of the individual states or the fifteen state region comprised of the ASMFC states, if any, is unknown. Given the relatively small sales generated by the Atlantic sturgeon commercial fisheries in the entire ASMFC region during the 1990s (Table 1), it is reasonable to assume that the aggregate economic impacts of these commercial fishery closures would be insignificant to at least the ASMFC region's economy, if not at the individual state level. This assumption does not

[1] Examples of direct effects are fishermen expenditures on fishing supplies and equipment. Secondary effects usually includes indirect and induced effects. Indirect effects are due to purchases by firms responding to initial round (direct effect) and subsequent rounds of fishermen expenditures. For example, fishermen purchasing boat fuel causes the fuel retailer to purchase fuel from a distributor that pays wages to tank truck drivers and other employees. Induced effects are caused by local spending of income by employees (e.g. fuel retailer ) of businesses impacted by direct and indirect effects of the fishermen's spending. The money eventually "leaks out" of the local area after several rounds.

preclude the possibility that the aggregate economic impacts of these closures have and/or will have significant economic impacts on sub-regions (e.g. counties, local areas, etc.) of a given individual state belonging to the ASMFC.

During the New York State regulatory impact analysis process, the NYDEC concluded that the New York sturgeon fishery closure starting in 1996 "...will have an impact on small businesses [linked to commercial harvest] as a result of eliminating the availability of Atlantic sturgeon and Atlantic sturgeon product." In contrast, NYDEC determined that the New York closure would have "...limited or no effect..." on small businesses linked to recreational Atlantic sturgeon fishing because there is little or no direct recreational fishing for this species (NYS, 1996). NYDEC concluded that the total moratorium on harvesting and possessing Atlantic sturgeon was necessary for rebuilding the Hudson River population and "...for New York State to remain in compliance with the Atlantic States Marine Fisheries Commission Atlantic Sturgeon Fishery Management Plan."

If aquaculture operations can be developed without adversely affecting conservation, restoration and recovery of wild spawning stocks, there may be some potential for offsetting some of the economic loss resulting from the closure of the fisheries for wild fish, through provision of aquaculture-produced products. Some analyses suggest, however, that commercial culture operations based on the production of species of sturgeon which are slow to reach maturity may not be economically viable and/or attractive to investors (Serfling 1997). A further concern is that establishment of commercial aquaculture operations and subsequent legitimate sale of farmed fish also provides a potential market for poached wild fish to enter, if not properly regulated. Because aquaculturists and commercial fishermen are two independent sets of people, development of sturgeon aquaculture will not offset losses to sturgeon fishermen.

There could conceivably be a positive economic benefit resulting from ecotourism activity increasing as Atlantic sturgeon populations recover, should there be localities where sturgeon spawning could be observed safely, or should local communities develop festivals around Atlantic sturgeon spawning activity.

Table 1. Sturgeon landings and associated value in the U.S. Atlantic states, 1990-96. (Source: NMFS; preliminary and subject to change)

| | | | EXVESSEL | |
|---|---|---|---|---|
| **YEAR** | **MT** | **POUNDS** | **VALUE** | **$/LB** |
| **1990** | 92.8 | 204,524 | $ 368,536 | $ 1.80 |
| **1991** | 96.5 | 212,749 | $ 283,672 | $ 1.33 |
| **1992** | 58.8 | 129,557 | $ 231,265 | $ 1.79 |
| **1993** | 30.6 | 67,382 | $ 105,283 | $ 1.56 |
| **1994** | 43.4 | 95,639 | $ 207,079 | $ 2.17 |
| **1995** | 16.9 | 37,275 | $ 85,468 | $ 2.29 |
| **1996** | 2.8 | 6,195 | $ 15,756 | $ 2.54 |

MT - Metric tons.

### 1.5.4 Protected Species Considerations

Since there is currently no directed fishery for Atlantic sturgeon, there are no interactions of the nonexistent fishery with any protected species. At such time as the fishery is reopened, this issue should be evaluated and needed measures should be addressed through addendum or Amendment to the FMP. Some concern has been expressed that use of stocking as a measure to expedite restoration and recovery of Atlantic sturgeon spawning stocks could adversely affect spawning stocks of the federally listed endangered shortnose sturgeon through increasing competition between juvenile and adult shortnose and stocked juvenile Atlantics (Shortnose Sturgeon Recovery Team 1997). However, based on studies of food habitats, salinity preferences and spatial and temporal distribution of the two species, this does not appear to be a major concern for at least northern stocks of the two species (NMFS and USFWS, in preparation and Dadswell 1979, Haley in press, Haley and Bain 1997). In the Hudson River, the two species exhibit differences in dietary preference, with shortnose feeding primarily on crustaceans and Atlantics on polychaete worms. They also occupy different physical strata even when they co-occur, with shortnose in cooler, shallower, fresher water and Atlantics in deeper, warmer more saline areas (Haley and Bain 1997). This may not necessarily be the case in southern rivers; however, additional studies are needed to determine if overlap exists (M. Collins, South Carolina Department of Natural Resources, personal communication to RWL).

If the Atlantic sturgeon is federally listed, certain recommendations in this Amendment will likely require modification and/or federal permits for implementation.

## 1.6 LOCATION OF TECHNICAL DOCUMENTATION FOR THE FISHERY MANAGEMENT PLAN

Technical documentation for the Atlantic Sturgeon FMP is contained in the various documents cited below.

### 1.6.1 Review of Resource Life History and Biological Relationships

Information on the life history and biological relationships of Atlantic sturgeon is summarized in this Amendment. Detailed information can be found in the Source Document (ASMFC, in preparation), Stock Assessment (Kahnle et al. 1998) and in the Status Review prepared by the USFWS and NMFS (NMFS and USFWS in preparation).

### 1.6.2 Stock Assessment Document

The stock assessment document (Kahnle et al. 1998)is included in its entirety in the ASMFC Source Document for this Amendment.

## 2. AMENDMENT 1 GOAL AND OBJECTIVES

The goal of the Amendment is the recovery of Atlantic sturgeon spawning stocks to population levels which will provide for sustainable fisheries, and ensure viable spawning populations.

Objectives of the Amendment are to:

- Establish 20 protected year classes of females in each spawning stock;
- Close the fishery for a sufficient time period to reestablish spawning stocks and increase numbers in current spawning stocks;
- Reduce or eliminate bycatch mortality of Atlantic sturgeon;
- Determine the spawning sites and provide protection of spawning habitats for each spawning stock;
- Where feasible, reestablish access to historical spawning habitats for Atlantic sturgeon; and
- Conduct appropriate research as needed, especially to define unit stocks of Atlantic sturgeon.

### 2.1 SPECIFICATION OF MANAGEMENT UNIT

Management unit are the Atlantic sturgeon stocks of the east coast of the U.S., from the Canadian border to Cape Canaveral in Florida. While spawning stocks likely home to natal rivers and may ultimately be managed separately to some extent, juvenile Atlantic sturgeon range widely and may occur in many coastal estuaries apart from their natal system, based on tagging studies. Thus, consideration of the population as a single management unit is necessary. Adults also likely mix together on offshore wintering grounds and during ocean migrations.

All ASMFC jurisdictions plus the two federal agency partners have declared interest in the Atlantic sturgeon.

### 2.2 STOCK REBUILDING PROGRAM

The goal of the Amendment is the recovery of individual spawning stocks, including extirpated stocks to the extent feasible, to sustainable levels. However, spawning stock specific-levels will be specified in subsequent addenda or Amendments.

#### 2.2.1 Stock Rebuilding Targets

The only stock rebuilding target presently defined is for age structure (see Section 2.3 below). The target is to have at least 20 protected age classes of females in each spawning stock. Additional stock rebuilding targets may be established once the Technical Committee has refined the definition of a restored stock.

#### 2.2.2 Stock Rebuilding Schedules

At a minimum, present harvest moratoria must remain in effect for about 20-40 years from initiation, depending on a number of factors, including: individual spawning stocks' maturity rate; longevity; geographic area; and the length of prior fishery closures.

## 2.3 MAINTENANCE OF STOCK STRUCTURE

Maintenance of stock structure will occur through strict regulation of the fishery. Since Atlantic sturgeon historically exhibited up to 40 year classes in the spawning population, the Stock Assessment Subcommittee recommends that the spawning populations include as least 20 protected year classes of females. Given that full maturity of female Atlantic sturgeon in the Hudson River population does not occur until age 21 (Young et al. 1988), the moratorium can be expected to remain in place for approximately 41 years from the initiation of the harvest moratorium on the Hudson River stock. Length of harvest moratoria may differ among rivers since a clinal variation in age of maturation is likely for Atlantic coast stocks. Southern stocks grow more quickly and mature at earlier ages than northern stocks (Smith 1985).

## 2.4 DEFINITION OF OVERFISHING

For the purpose of this Amendment, and for the foreseeable future, no directed harvest of Atlantic sturgeon will be allowed, therefore any directed harvest is considered overfishing. If mortality of Atlantic sturgeon captured incidentally in other fisheries is demonstrated to adversely affect stock recovery, that also will be considered overfishing. Future definitions of overfishing will be developed on a spawning stock basis as stock specific information is available.

## 3. MONITORING AND ENHANCEMENT PROGRAM SPECIFICATIONS/ELEMENTS

### 3.1 ASSESSING RECRUITMENT

It is recommended that at least every five years, each jurisdiction with reproducing populations of Atlantic sturgeon should survey juvenile abundance and calculate CPUE estimates of juveniles, and conduct tag and release programs of juveniles with data being supplied to the USFWS Maryland Fisheries Resources Office in Annapolis. States without reproducing populations but having access to migrant fish of unknown origin should also commit, at least every five years, to tag and release efforts and collection of tissue samples to be archived for genetic analysis. Given the infrequent interval between monitoring efforts, initial baseline programs should be carefully designed and both methods and results completely documented. States may wish to conduct pilot studies to generate a good protocol, then perform baseline studies the following year.

### 3.2 ASSESSING MIGRATION

Jurisdictions should cooperate with the USFWS and NMFS to monitor and analyze the movements of fish tagged and subsequently recaptured. Recapture data should be analyzed to the extent possible to establish seasonal patterns and specific areas of habitat use, including spawning, nursery and wintering areas.

### 3.3 ASSESSING SPAWNING STOCK STATUS

In addition to recruitment parameters above, jurisdictions with spawning populations of Atlantic sturgeon should also commit, at least every five years, to examining sex ratio and size and age structure by sex of the larger subadults and adults.

### 3.4 ASSESSING BYCATCH FISHING MORTALITY

Jurisdictions must monitor bycatch of Atlantic sturgeon in other fisheries under their jurisdiction. Monitoring may be implemented through several means, including: law enforcement observations, fishery independent surveys, and at-sea observer programs. In the future, bycatch monitoring may also be conducted under the auspices of the Atlantic Coast Cooperative Statistics Program (ACCSP) bycatch module.

Any jurisdiction supporting fisheries which result in incidental mortality of Atlantic sturgeon (e.g. shad gill nets, trawl fisheries) should develop a reporting mechanism or conduct sufficient field evaluations to determine the relative numbers and sizes of Atlantic sturgeon being killed in these fisheries.

Estimates of bycatch losses of Atlantic sturgeon must be reported annually to the Plan Review Team as per Section 5.1.2. The Atlantic Sturgeon Plan Review Team, Technical Committee and Advisory Panel will annually review bycatch data and make recommendations to the Management Board for reducing bycatch in those fisheries which may be causing unacceptable levels of mortality that threaten ASMFC's ability to achieve this plan's goal and objectives. The Management Board may take action on these recommendations under Section 4.3.9.

### 3.5 ADDITIONAL MONITORING PROGRAMS

### 3.5.1 Biological Information

In conjunction with or in addition to specific survey work described in sections 3.1-3.3, jurisdictions which host both shortnose and Atlantic sturgeon are urged to observe and record information on both species (size, location, abundance, sex, etc.) and, with appropriate federal permits, include shortnose sturgeon in tag and release and age analysis studies.

### 3.5.2 Social Information

Consumptive use (e.g. commercial fishing activities before closures) and non-consumptive use (e.g. ecotourism activities) surveys focusing on social benefits data should be conducted periodically in a manner consistent with the intent of ACFCMA and the ACCSP Implementation Plan (Kline, 1996).

### 3.5.3 Economic Information

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

The expected future role of private aquaculture in marketing sturgeon flesh and roe and the value of these products should be monitored by those jurisdictions which permit such operations and markets under Sections 3.6.2 and 4.5 of this Plan.

## 3.6 STOCKING MEASURES

### 3.6.1. Captive Propagation Research

One of the management objectives of the 1990 FMP is to "Enhance and restore Atlantic sturgeon stocks". In addition to curbing fishing mortality and protecting essential spawning and nursery habitats, recommendations specifically aimed at achieving that objective include:

- Encourage an expanded aquaculture effort to develop techniques to rear Atlantic sturgeon and evaluate hatchery fish for stock restoration.

- Encourage aquaculture research to identify and control early life stage diseases, synchronize spawning times of males and females, and reduce handling stress problems.

- Establish an aquaculture and stocking committee to provide guidelines for aquaculture and restoration stocking of sturgeon.

With regard to the first two recommendations, the USFWS Northeast Fishery Center (NEFC) at Lamar, Pennsylvania initiated sturgeon propagation research in 1991. Working with the National Biological Service Laboratory (now U.S. Geological Survey -Biological Resources Division) at Wellsboro, Pennsylvania and others, NEFC collected Atlantic sturgeon broodfish from the Hudson River in 1991 and 1993-1996. Adult handling, hauling and holding capability and short-term sperm preservation have been refined. Hormone induced-spawning with surgical removal of eggs, fertilization, egg de-adhesion and incubation, larval and juvenile culture were adapted and modified as needed from techniques developed for white sturgeon (Conte et al, 1988). Sub-adult Atlantic sturgeon collected from the upper Delaware Bay have been held on-site at Lamar since 1991 and shown dramatic gains in growth with artificial diets. Males from this source were induced to spermiate in 1997. The principal purpose for the sturgeon work at Lamar is to develop a culture manual for this species.

Small numbers of juvenile Atlantic sturgeon were produced each year at NEFC and have supported numerous cooperative research studies. These have included investigations on feed types and feeding rates, desirable rearing densities and water quality parameters, disease challenges and treatments, marking studies, and more. Juvenile sturgeon excess to research needs were stocked (with state permission) into the Hudson River in October, 1994 (5,000 at about 3 months of age), and the Nanticoke River (Maryland) in July, 1996 (3,500 at 12 months). In each instance, all fish were marked with coded wire tags in the first dorsal scute and Hudson fish were also fin clipped. Though not considered "restoration" stockings, these fish have provided useful information about movements, distribution and growth of young sturgeon. In the Hudson, relative frequency of cultured and wild fish in juvenile collections has been used to document the low level of natural recruitment in that river.

### 3.6.2. General Propagation and Stocking Recommendations

The third 1990 FMP culture recommendation resulted in establishing an Atlantic Sturgeon Aquaculture and Stocking Committee in 1991 which prepared and presented 34 recommendations to the ASMFC Management and Science Committee related to culture and stocking of this species (Atlantic Sturgeon Aquaculture and Stocking Committee 1992). These were grouped into several categories including aquaculture research and development; collection of brood stock and release of cultured progeny; translocation of sturgeons and inadvertent spread of diseases; introduction of non-native sturgeons for commercial aquaculture; collection and archiving tissue samples for genetic analysis; and, monitoring effectiveness of restoration programs. Recommendations specifically concerning stocking included:

- If stocks are defined by river then genetic integrity of spawning stocks within river basins should be maintained by stocking only progeny of native brood stock.

- If genetic substructure exists then restoration programs should employ only genetically compatible stocking (i.e., reintroduction of progeny cultured from one stock into waters inhabited by that same stock).

- If native brood stock no longer exist, or are in such low abundance as to preclude effective collection, priority should be given to stocking fish from adjacent or hydrologically similar river systems.

- An adequate effective breeding population size should be maintained to the extent possible in culturing Atlantic sturgeon for restoration purposes so that genetic integrity of the local recipient stock is maintained.

- The ASMFC Atlantic Sturgeon Aquaculture and Stocking Committee should prepare a separate discussion paper to address inter-basin transfer of brood stock and/or hatchery produced progeny and other interjurisdictional problems associated with sturgeon culture.

- States may authorize aquaculture of Atlantic sturgeon, provided such operations are conducted in accordance with the recommendations identified in ASMFC Special Report No. 22 (Atlantic Sturgeon Aquaculture and Stocking Committee 1992) and ASMFC, in press. Privately aquacultured sturgeon (Atlantic sturgeon or other species) should be distinctly and permanently marked as aquacultured fish. Furthermore, any imported sturgeon (Atlantics or other species) should be certified as disease-free by the appropriate state or federal agency. States must report annually on the status of private Atlantic sturgeon aquaculture operations authorized under approved Addenda via Section 4.5, and the provisions of Section 5.1.1.1, regulations pertaining to private

aquaculture operations, and disease-free certification as per Section 5.1.2. For nonindigenous species of sturgeon, states should notify the Management Board of any plans to initiate or authorize aquaculture operations in their jurisdiction.

3.6.3. Breeding and Stocking Protocol

A recommendation of the Aquaculture and Stocking Committee resulted in preparation of a Breeding and Stocking Protocol for Cultured Atlantic Sturgeon (Atlantic Sturgeon Stocking and Aquaculture Committee 1996) which discusses genetic issues with regard to brood stock selection and numbers, inter-basin transfers, stocking numbers, duration and priorities, and monitoring and reporting requirements. Specific recommendations in the Protocol are:

1. Whenever possible, use broodfish from the same river in which stocking will occur. When this is not possible, the source of broodfish used to produce fish for stocking should be taken from the same regional genetic grouping as the area being stocked.

2. With regard to stocking programs, highest priority should be placed on populations perceived to be extirpated with a lower priority placed on populations exhibiting little, if any, natural reproduction.

3. The minimum effective population size of brood fish to be used in culture for stocking programs should be 100 (with an inbreeding rate of 0.50%). Year-class effective population sizes should be at least six (preferably three of each sex). Year-class effective population sizes of six or greater may be obtained using unbalanced sex ratios, but sperm from multiple male donors should not be mixed for artificial fertilization.

4 Agencies involved with stocking programs for Atlantic sturgeon should commit to the necessary period of time to achieve the desired generation effective population size. For example, 10 years at an average year class effective population size of 10.

5. If fewer breeding fish are available than prescribed in Recommendation 3, their progeny may be used for captive research (i. e. not released into public waters) or provided to private aquaculture interests for captive use (provided that the receiving facility has obtained a state permit satisfying the conditions for protection of wild stocks specified in Section 3.6.2 and is authorized under Sections 4.5 and 5.1.1.1).

6. Broodfish should be spawned only once and after spawning they should be externally marked and returned to their river of origin whenever feasible.

7. In order to avoid gene swamping from small numbers of breeding pairs, numbers of progeny stocked from individual matings in any one year should be within 50% of each other, not to exceed 50,000 fish per pair. All fish stocked should be distinctively marked or tagged to at least indicate release location and time and parental origin.
8. Management jurisdictions involved in culture and stocking programs for Atlantic sturgeon should annually monitor the status of their populations and the effects of stocking. They should provide a detailed proposal to ASMFC for review which includes goals and objectives, methods, monitoring activities, and time lines. Monitoring results should be reported to ASMFC each year.

3.6.4 Use of Stocked Sturgeon

Brood stock collection, culture of juvenile sturgeon, and evaluation of multi-year stockings is a long-term and expensive commitment. Ultimate results in terms of stock restoration are uncertain and may take decades to be effective. Jurisdictions interested in restoration stocking are encouraged to prepare recovery plans, follow Protocol guidelines to maximize genetic diversity and minimize inbreeding depression, and thoroughly evaluate and report on their results.

As noted in the Protocol, brood stock native to the individual river being stocked are preferable to the use of any out-of-basin source. However, most sturgeon populations are so depressed that collection of adequate numbers of breeders for culture purposes is unlikely, and also poorly advised. In this instance, nearby jurisdictions with relatively healthy breeding populations are encouraged to share their resource.

Culture and stocking should be considered as a tool to provide fish for research studies and ultimately for enhancement of weak and extirpated stocks. It does not preclude other management approaches and the need or desirability of identifying and protecting essential breeding, nursery, riverine feeding, or adjacent estuarine and ocean staging habitats. Obvious habitat limitations should be addressed prior to stocking sturgeon.

## 3.7 HABITAT

Each state will work with the ASMFC Habitat, and Habitat and FMPs, Committees to assess historic and present Atlantic sturgeon habitat within its jurisdiction. Further, appropriate protective measures and habitats appropriate for restoration and use by Atlantic sturgeon will be identified by each jurisdiction.

# 4. MANAGEMENT PROGRAM IMPLEMENTATION

## 4.1 HABITAT CONSERVATION AND RESTORATION RECOMMENDATIONS

Each state should implement identification and protection of Atlantic sturgeon habitat within its jurisdiction, in order to ensure the sustainability of that portion of the spawning stock that either is produced or resides within its boundaries. Such efforts should inventory historical habitats, identify habitats presently used and specify those that are targeted for recovery, and impose or encourage measures to retain or increase the quantity and quality of Atlantic sturgeon essential habitats.

### 4.1.1 Preservation of Existing Habitat

States in which Atlantic sturgeon habitat, especially spawning and other essential habitats such as nursery areas, should notify in writing the appropriate federal and state regulatory agencies of the locations of habitats used by Atlantic sturgeon. Regulatory agencies should be advised of the types of threats to Atlantic sturgeon populations and recommended measures that should be employed to avoid, minimize or eliminate any threat to current habitat extent or quality.

Where sufficient knowledge is available, states should seek to designate Atlantic sturgeon essential habitats for special protection. These locations should be designated High Quality Waters or Outstanding Resource Waters and should be accompanied by requirements for non-degradation of habitat quality, including minimization of non-point source runoff, prevention of significant increases in contaminant loadings, and prevention of the introduction of any new categories of contaminants into the area (via restrictions on National Pollutant Discharge Elimination System (NPDES) discharge permits for facilities in those areas).
State fishery regulatory agencies should develop protocols and schedules for providing input on water quality regulations to the responsible agency, to ensure to the extent possible that water quality needs for Atlantic sturgeon are restored, met and maintained.

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 Atlantic sturgeon habitats are protected.

Water quality criteria for Atlantic sturgeon spawning and nursery areas should be established or existing criteria should be upgraded to levels which are sufficient to ensure successful reproduction (reference Mercer (1989) for suggested criteria). Any action taken should be consistent with Federal Clean Water Act guidelines and specifications.

All state and federal agencies, including regional fishery management councils, responsible for reviewing impact statements and permit applications for projects or facilities which may impact Atlantic sturgeon spawning and nursery areas should provide appropriate recommendations or mandate measures to ensure that those projects will have no or only minimal impact on sturgeon spawning stocks. Any project which would result in the elimination or significant degradation of essential habitat should be avoided.

### 4.1.2 Avoidance of Incompatible Activities

Federal and state fishery management agencies should take steps to limit the introduction of compounds which are known or suspected to accumulate in Atlantic sturgeon tissue and which pose a threat to human health or Atlantic sturgeon health [see Table 10.1 in Taub (1990)].

Each state should establish windows of compatibility for activities known or suspected to adversely affect Atlantic sturgeon life stages and their habitats, such as navigational dredging, bridge construction, and dredged material disposal, and notify the appropriate construction or regulatory agencies in writing.

Projects involving water withdrawal from spawning or nursery habitats (e.g. power plants, irrigation, water supply projects) should be scrutinized to ensure that adverse impacts resulting from larval/ juvenile impingement, entrainment, and/or modification of flow, temperature and salinity regimes due to water removal will not adversely impact Atlantic sturgeon spawning stocks, including early life stages.

Each state which contains spawning and nursery areas within its jurisdiction should develop water use and flow regime guidelines which are protective of Atlantic sturgeon spawning and nursery areas and which will ensure to the extent possible the long-term health and sustainability of the stock. States should endeavor to ensure that proposed water diversions/withdrawals from rivers tributary to spawning and nursery habitats will not reduce or eliminate conditions favorable to Atlantic sturgeon use of these habitats.

#### 4.1.3 Fisheries Practices

The use of any fishing gear or practice which is documented by management agencies to have an unacceptable impact on Atlantic sturgeon (e.g. habitat damage, or bycatch mortality) should be prohibited within the effected essential habitats (e.g. trawling in spawning areas or primary nursery areas should be prohibited).

#### 4.1.4 Habitat Restoration, Improvement And Enhancement

Each state should review existing literature and data sources to determine the historical extent of Atlantic sturgeon occurrence and use within its jurisdiction. Further, an assessment should be conducted of areas historically but not presently used by Atlantic sturgeon, for which restoration is feasible.

Every effort should be made to eliminate existing contaminants from Atlantic sturgeon habitats where a documented adverse impact occurs.

States should work in concert with the USFWS, Divisions of Fish and Wildlife Management Assistance and Ecological Services, and NMFS, Office of Habitat Conservation, to identify hydropower dams which pose significant threat to maintenance of appropriate freshwater flows to, or migration routes for, Atlantic sturgeon spawning areas and target them for appropriate recommendations during Federal Energy Regulatory Commission relicensing evaluation.

### 4.2 RECREATIONAL FISHERIES MANAGEMENT MEASURES

State moratoria on the harvest and possession of Atlantic sturgeon (whole or parts) also shall apply to Atlantic sturgeon that may inadvertently be caught recreationally by hook and line. Although other species of sturgeon such as the white sturgeon, *Acipenser transmontanus* in the Pacific Northwest, support significant recreational fisheries, the feeding habits of Atlantic sturgeon may preclude significant angler capture of this species. White sturgeon have a diverse diet that commonly includes a variety of fish species, mollusks and crustaceans (Pacific States Marine Fisheries Commission 1992), while the Atlantic sturgeon's primary prey is small polychaetes and isopods (U.S. Geological Survey-Biological Resources Division, unpublished data). Recreational fisheries for Gulf sturgeon (Gulf Sturgeon Recovery/Management Task Team 1995) did exist on the Apalachicola River, Florida. The fishery employed large treble hooks baited with algae to catch Gulf sturgeon during the 1950s to

1960s and continued until 1984 when the State of Florida enacted protective measures (Burgess 1963; Swift et al. 1977).

States shall prohibit the intentional snagging of Atlantic sturgeon, and require the immediate release of any incidentally hooked fish.

Tagging programs of Atlantic sturgeon in the Delaware River (C. Shirey, Delaware Division of Fish and Wildlife, unpublished data) and off the New Jersey coast (USFWS, unpublished data) have had no returns of tagged fish captured recreationally by hook and line. There is no indication that a recreational hook and line fishery could have any significant impact on Atlantic sturgeon stock recovery, therefore precluding the need for the implementation of further recreational management measures by the states.

## 4.3 COMMERCIAL FISHERIES MANAGEMENT MEASURES

As of April 1, 1998, all Atlantic coastal states have enacted a closure or moratorium on the harvest of Atlantic sturgeon. The primary goal of Amendment 1 is to implement measures to achieve stock recovery. To further reduce fishing mortality levels following a total moratorium on harvest, the Plan must address nonharvest mortality associated with bycatch losses attributed to other fisheries.

### 4.3.1 Definition of Directed Fishery

A “directed fishery” is defined by the ASMFC ISFMP Charter as “fishing for a stock using gear or strategies intended to catch a given target species, group of species or size class.”

For Atlantic sturgeon, since all fisheries are closed and will be for the foreseeable future, there is no allowable directed kill, or kill in other fisheries.

### 4.3.2 Minimum Fish Size

No minimum size limits will be specified until such time as the fishery is reopened.

### 4.3.3 Minimum Mesh Size for Nets

No mesh size(s) will be specified for the fishery until such time as the fishery is reopened.

### 4.3.4 Closed Seasons

All state waters, both internal and ocean, are closed to the harvest and possession of Atlantic sturgeon on a year round basis. Further, states in which bycatch of Atlantic sturgeon is identified as a concern in other fisheries may implement closed seasons in such fisheries to reduce or eliminate Atlantic sturgeon bycatch mortality.

### 4.3.5 Closed Areas

All areas in all internal and ocean state waters are closed to the harvest and possession of wild Atlantic sturgeon. Further, states in which bycatch of Atlantic sturgeon is identified as a concern in particular areas may implement area closures to reduce or eliminate bycatch mortality of Atlantic sturgeon.

### 4.3.6 Dealer, Vessel, Or Operator Permits And/Or Reports

At such time as the fishery reopens, dealers, vessels and operators must obtain appropriate permits and

provide reports on a by-trip basis as specified in the regulations in effect for implementation of the ACCSP.

### 4.3.7 Per Trip Catch Limits

Trip limits are zero for the foreseeable future until such time as the fishery reopens.

### 4.3.8 Fishing License/Effort Limits

The issue of license/effort limits will be addressed by the Advisory Panel, Technical Committee and Plan Review Team at such time as the fishery is reopened.

### 4.3.9 Bycatch Reduction Methods

The ASMFC Sturgeon Management Board may require area or season closures, gear restrictions, and/or conservation engineering in fisheries that are documented to cause excessive bycatch mortality of Atlantic sturgeon (i.e., threatening ASMFC's ability to achieve this plan's goal and objectives), as recommended to it by the PRT, Technical Committee and Advisory Panel, through Section 3.7. These measures would be intended to eliminate Atlantic sturgeon bycatch to the extent possible. Such measures shall be implemented by addendum to the Amendment following four public hearings on the proposed measures (ASMFC 1998, Section 6E). Should a jurisdiction fail to take appropriate action to reduce bycatch in a specified fishery, upon recommendation of the PRT, Technical Committee and/or Management Board, the jurisdiction may be considered out of compliance with this Plan, and the Commission may recommend to the Secretary of Commerce that the subject fishery be closed until specified corrective action is taken by the jurisdiction for the subject fishery. If the Secretary agrees with the Commission's finding, he or she may take action under the auspices of ACFCMA to close the subject fishery until specified corrective action is taken by the jurisdiction for the subject fishery.

## 4.4 SCHEDULE FOR STATE IMPLEMENTATION

All states shall implement the moratorium provision of this Amendment no later than June 30, 1998. All other provisions in Section 5.1.1 must be implemented by January 1, 1999.

## 4.5 ADAPTIVE MANAGEMENT

The Management Board may vary certain requirements specified in this Amendment by adopting addenda to the FMP as a part of adaptive management. Specifically, the Management Board may adopt addenda which permit: 1) importation of non-U.S. origin Atlantic sturgeon (whole or parts thereof) that are legally harvested outside of the U.S. and in conformity with all provisions of CITES, or 2) the establishment of private aquaculture facilities for Atlantic sturgeon within ASMFC jurisdictions with a declared interest in Atlantic sturgeon.

### 4.5.1 General Procedures

Parties interested in either importation or culture of Atlantic sturgeon for commercial purposes shall contact one or more members of the Sturgeon Management Board in writing to initiate the adaptive management process and delineate any proposed enterprise. If the contacted Management Board member(s) are amenable to the proposal, they shall circulate the written correspondence to the other Management Board members at least 2 weeks prior to the next scheduled Management Board meeting, and request that the Management Board consider development of an addendum to implement the addenda.

The Management Board will review the proposal, and may consult further with the Technical Committee, the Stock Assessment Subcommittee or the Advisory Panel. The Management Board may direct the PRT to prepare an addendum to make any changes it deems necessary. The draft addendum shall specify the terms, limitations and enforcement requirements for each exception to the harvest and possession moratoria outlined in Section 4.

It is intended that each such addendum shall be developed by the PRT, in consultation with representatives from NMFS, USFWS, applicable state aquaculture authorities, the ASMFC Law Enforcement Committee, and the state(s) for which shipments or aquaculture operations are intended, and in consultation with party(ies) requesting the exception. The addendum shall contain a schedule for the states to implement its provisions.

The PRT will prepare a draft addendum as directed by the Management Board, and shall distribute it to all states for review and comment. A public hearing will be held in any state that requests one. The PRT will also request comment from the public at large. After a 30-day review period, the PRT will summarize the comments and prepare a final version of the addendum for the Management Board.

The Management Board shall review the final version of the addendum prepared by the PRT, and shall also consider the public comments received and the recommendations of the Technical Committee, the Stock Assessment Subcommittee and the Advisory Panel; and shall then decide whether to adopt or revise and adopt the addendum.

Upon adoption of an addendum by the Management Board, states shall prepare plans to carry out the addendum, and submit them to the Management Board for approval, according to the schedule contained in the addendum.

## 4.6 EMERGENCY PROCEDURES

Emergency procedures may be used by the Sturgeon Management Board to require any emergency action that is not covered by or is an exception or change to any provision in Amendment 1. Procedures for implementation are addressed in the ASMFC Interstate Fisheries Management Program Charter, Section 6(c)(10) (ASMFC 1998).

## 4.7 MANAGEMENT INSTITUTIONS AND THEIR ROLES

Where not inconsistent with the following provisions, the management institutions for Atlantic sturgeon are subject to the provisions of the ISFMP Charter (ASMFC 1998).

### 4.7.1 ASMFC and the ISFMP Policy Board

The ASFMC and the ISFMP 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 1; and must also make all final determinations concerning state compliance or noncompliance. The ISFMP Policy Board reviews recommendations of the various Management Boards and, if it concurs, forwards them on to the Commission for action.

### 4.7.2 Sturgeon Management Board

The Sturgeon 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 Development or Review Team, the Technical Committee and the Stock

Assessment Subcommittee; and requests the establishment of the Commission's Atlantic Sturgeon Advisory Panel. Among other things, the Management Board makes changes to the management program under adaptive management and approves state programs implementing the Amendment and alternative state programs under Sections 4.5 and 4.6. The Management Board reviews the status of state compliance with the FMP at least annually, and if it determines that a state is out of compliance, reports that determination to the ISFMP Policy Board under the terms of the ISFMP Charter.

### 4.7.3 Atlantic Sturgeon Plan Development/Review Team

The Plan Development Team (PDT) and the PRT are composed of a small group of scientists and managers whose responsibility is to provide all of the technical support necessary to carry out and document the decisions of the Management Board. Both are chaired by an ASMFC Anadromous Species Coordinator. The Atlantic Sturgeon PDT/PRT is directly responsible to the Management Board for providing information and documentation concerning the implementation, review, monitoring and enforcement of Amendment 1. The Atlantic Sturgeon PDT/PRT is comprised of personnel from state and federal agencies who have scientific and management ability and knowledge of Atlantic sturgeon. It serves also as the primary advocacy group for Atlantic sturgeon. The PDT is responsible for preparing all documentation necessary for the development of Amendment 1, using the best scientific information available and the most current stock assessment information. The PDT will either disband or assume inactive status upon completion of Amendment 1. Alternatively, the Management Board may elect to retain PDT members as members of the PRT.

### 4.7.4 Atlantic Sturgeon Technical Committee

The Atlantic Sturgeon Technical Committee will consist of representatives from state and federal agencies with an interest in the Atlantic sturgeon fishery. Its role is to act as a liaison to the individual state agencies, provide information to the management process, and review and make recommendations concerning the management program. The Technical Committee will report to the Management Board, normally through the PRT. The Management Board may authorize additional seats on the Technical Committee.

### 4.7.5 Atlantic Sturgeon Stock Assessment Subcommittee

The Stock Assessment Subcommittee will consist of scientists with expertise in the assessment of Atlantic sturgeon populations. Its role is to assess Atlantic sturgeon populations and provide scientific advice concerning the implications of proposed or potential management alternatives, or to respond to other scientific questions from the Management Board. The Stock Assessment Subcommittee will report to the Management Board, normally through the PRT.

### 4.7.6 Atlantic Sturgeon Advisory Panel

The Atlantic Sturgeon 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 fishing interests and others who are concerned about Atlantic sturgeon conservation and management. The Advisory Panel provides the Management Board with advice directly concerning the Commission's Atlantic sturgeon management program. Normally, the Advisory Panel meetings will be held in conjunction with Management Board meetings insofar as possible.

### 4.7.7 Federal Agencies

#### *4.7.7.1 Management in the Exclusive Economic Zone (EEZ)*

Management of Atlantic sturgeon in the EEZ is within the jurisdiction of the appropriate regional fishery management council. If there is no council plan, management is the responsibility of the NMFS, as mandated by ACFCMA (16 U.S.C. 5105 et. seq.) and the Magnuson-Stevens Act (16 U.S.C. 1801 et seq.). At present, there is no council plan for Atlantic sturgeon.

#### *4.7.7.2 Federal Agency Participation in the Management Process*

The Commission has accorded USFWS and NMFS voting status on the ISFMP Policy Board and the Sturgeon Management Board; and the federal agencies participate on the Plan Development and Plan Review Teams, the Technical Committee and the Stock Assessment Subcommittee.

#### *4.7.7.3 Consultation with Fishery Management Councils*

At the time of passage of Amendment 1, no council had prepared a management plan for Atlantic sturgeon. The Commission has consulted the three east coast councils throughout the development of Amendment 1 via several methods: the councils received regular reports from the Director of the ISFMP; and, all relevant documents were sent to the councils for review and comment.

By copy of this Amendment, the Commission reminds Councils of their mandated responsibility for commenting on proposed actions which are likely to substantially affect Atlantic sturgeon (as an anadromous species) habitat, including Essential Fish Habitat as specified in the Magnuson-Stevens Act. The Commission requests that the Sturgeon Management Board be copied with all correspondence pertaining to projects which may adversely affect Atlantic sturgeon habitats.

### 4.7.8 Recommendations to the Secretary of Commerce for Management in the Exclusive Economic Zone

Despite the fact that all jurisdictions had moratoria in effect in 1997 (with the exception of Delaware), some landings of Atlantic sturgeon, likely amounting to only three or four individual fish, took place in three jurisdictions (Rhode Island, New York, Maryland), according to NMFS commercial landings data (A. Kahnle, New York Department of Environmental Conservation, personal communication to RWL). It therefore appears that some uncertainty may exist as to whether take of sturgeon from the EEZ is still allowed, despite the fact that most jurisdictions prohibit landings as well as possession.

As contemplated in 16 U.S.C. 5102(1)(C) and 5103(b), the ASMFC recommends that the Secretary of Commerce take the following steps by October 1, 1998, concerning management of Atlantic sturgeon in the EEZ:

- initiate complete closure, through prohibiting possession of Atlantic sturgeon, and any and all parts thereof including eggs, of any directed fishery for and landings of Atlantic sturgeon until the FMP is modified to reopen fishing

- conduct, or specify that the appropriate fishery management council conduct, monitoring of Atlantic sturgeon bycatch and bycatch mortality in at least the monkfish and spiny dogfish fisheries, and report the results annually to the Management Board and Technical Committee. If the Technical Committee and Management Board determine this bycatch is excessive and threatens ASMFC's ability to achieve the goal and objectives of this Plan, the Secretary or appropriate fishery management council shall implement means to reduce or eliminate this bycatch in the subject fishery.

- continue support for and development of forensic techniques to be used for federal and state

enforcement of the Plan

The Sturgeon Management Board will annually review their position with regard to EEZ regulations and may provide recommendations for any changes to NMFS.

The ASMFC recognizes that the Secretary of Commerce may take this action through the fishery management planning process contained in the Magnuson-Stevens Act or ACFCMA.

4.7.9 Recommendations to the Secretary of the Interior

The ASMFC recommends the following to the Secretary of the Interior for implementation by the USFWS:

- continue support for and development of forensic techniques to be used for federal and state enforcement of the Plan

- continue coordination and support of the Southeast Area Monitoring and Assessment Program (SEAMAP) Cooperative Winter Tagging Cruise, with an increased emphasis on intercepting and tagging subadult and adult Atlantic sturgeon on their offshore wintering grounds

- continue establishment, operation and maintenance of the coastwide Atlantic sturgeon tagging program and tag recapture database

- continue and support international trade restrictions on Atlantic sturgeon as per Appendix II of CITES.

4.7.10 Cooperation with Canada

The PRT, Management Board, and Technical Committee shall regularly communicate with fishery managers in Canadian agencies to help ensure stock recovery of Atlantic sturgeon. Canadian fishery managers and other officials shall be invited to ASMFC discussions on Atlantic sturgeon conservation as needed, especially when discussing importation of Atlantic sturgeon from Canada to the U.S.

# 5. COMPLIANCE

Full implementation of the provisions of this Amendment is necessary for the management program to be equitable, efficient and effective. States are expected to implement these measures faithfully under state laws. Although the ASMFC 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 FMP. This section sets forth the specific elements that the Commission will consider in determining state compliance with this FMP, and the procedures that will govern the evaluation of compliance. Additional details of the procedures are found in the ASMFC ISFMP Charter (ASMFC 1998).

## 5.1 MANDATORY COMPLIANCE ELEMENTS FOR STATES

### 5.1.1 Mandatory Elements of State Programs

A state will be determined to be out of compliance with the provisions of this FMP, according to the terms of Section 7 of the ISFMP Charter if:

- its regulatory and management programs to implement Sections 4.2 and 4.3 for Atlantic sturgeon have not been approved by the Management Board; or

- it fails to meet any schedule to implement Sections 4.2 or 4.3 established for this Amendment (see Section 5.1.2).

In addition, the Board will monitor bycatch of Atlantic sturgeon and report excessive bycatch problems to the management authority for the fishery causing the bycatch. The Management Board may take action under ACFMA and Section 4.3.9 of this Plan.

#### *5.1.1.1 Regulatory Requirements*

1. Each jurisdiction must maintain complete closure, through prohibiting possession of Atlantic sturgeon, and any and all parts thereof including eggs, and of any directed fishery for and landings of Atlantic sturgeon until the fishery management plan is modified to reopen fishing in that jurisdiction.

2. In addition, states shall implement any restrictions in other fisheries as outlined in Section 4.3.9 and implemented through Section 4.5.

3. Jurisdictions may grant limited specific exceptions to prohibitions on possession for imports of non-U.S. Atlantic sturgeon and/or cultured Atlantic sturgeon upon adoption of a FMP addenda under Section 4.5 that specify the terms, limitations and enforcement requirements for each such exception. It is intended that each such addendum shall be developed by a PRT, in consultation with representatives of the ASMFC federal partners, applicable state aquaculture authorities, the ASMFC Law Enforcement Committee, the state(s) for which shipments are intended, and the party(ies) requesting the exception.

#### *5.1.1.2 Monitoring Requirements*

Mandatory closure of Atlantic sturgeon fisheries implemented through this Amendment precludes enforcement of some other compliance requirements for Atlantic sturgeon through ACFCMA. It is noted that other fisheries which are documented, under Section 3.4, to cause significant bycatch

mortality of Atlantic sturgeon, once "significant" is defined, may be recommended for closure should a state fail to take action to reduce or eliminate bycatch mortality in that fishery. States are encouraged to implement the biological monitoring programs and reporting time lines outlined in Section 3.

#### *5.1.1.3 Research Requirements*

No mandatory research requirements are specified at this time.

### 5.1.2 Compliance and Reporting Schedule

Compliance reports from jurisdictions must include the following information:

- Results of bycatch monitoring for Atlantic sturgeon in other fisheries as per Section 3.4;
- Monitoring results (tagging, five-year juvenile abundance index studies);
- Habitat status (restoration efforts, FERC relicensing studies, etc.), in accordance with the recommendations in Sections 4.1.1, 4.1.2 and 4.1.4; and
- Aquaculture operations authorized, status of regulations, disease-free certification status, etc.

Reports on compliance should be submitted by each jurisdiction annually, no later than October 1 each year, beginning in 1999.

In addition, states must report on regulatory status in their jurisdiction as of June 30, 1998 by September 15, 1998.

## 5.2 PROCEDURES FOR DETERMINING COMPLIANCE

The process for determination of compliance is described in detail in Section 7 of the Charter (ASMFC 1998).

## 6. MANAGEMENT RESEARCH NEEDS

Prioritized research needs for Atlantic sturgeon are included in Special Report No. 62 of the Atlantic States Marine Fisheries Commission, Prioritized Research Needs in Support of Interjurisdictional Fisheries Management (ASMFC 1997), and are included below (number in parenthesis is the priority assigned to the need by ASMFC). New research needs identified by various reviewers have no priority designation at this time.

### 6.1 HABITAT

- Standardize and obtain baseline data on habitat status for important sturgeon rivers. Data should include assessment of spawning and nursery habitat (1).

### 6.2 STOCK ASSESSMENT AND POPULATION DYNAMICS

- Standardize and obtain baseline data on population status for important sturgeon rivers. Data should include assessment of stock status in various rivers, size and composition of the spawning population, reproductive success and juvenile production (1).

- Develop long-term marking/tagging procedures to provide information on individual tagged Atlantic sturgeon for up to 20 years (2).

- Establish success criteria in order to evaluate the effectiveness of stocking programs (11).

- Determine size at maturity for mid- and north Atlantic sturgeon (14).

- Monitor catch/effort and size/age composition of landings of any future authorized directed fisheries (18).

- Determine length at age by sex for north, mid- and south Atlantic stocks.

- Determine maturity at age by sex for north, mid- and south Atlantic stocks.

- Determine fecundity at age, length, and weight for north, mid, and south Atlantic stocks.

- Characterize size and condition of Atlantic sturgeon by gear and season taken as bycatch in various fisheries.

#### 6.2.1 Biology/Community Ecology

- Establish environmental tolerance levels (D.O., pH, temperature, etc.) for different life stages (3).

- Establish coastal tagging projects to delineate migratory patterns (8). (This measure is being implemented by the USFWS and member states.)

- Expand tagging of juveniles in major spawning rivers to allow estimates of rates of loss to bycatch.

- Establish a tag recovery clearinghouse and database for consolidation and evaluation of tagging and tag return information including associated biological, geographic, and hydrographic data

(9). (This measure is being implemented by the USFWS through the Maryland Fisheries Resources Office located in Annapolis, Maryland.)

- Encourage shortnose sturgeon researchers to include Atlantic sturgeon research in their projects (13).

- Establish methods for the recovery of tags and associated information (16). (This measure is being implemented through ASMFC/USFWS cooperative efforts.)

- Evaluate existing groundfish survey data to determine what can be learned about at-sea migratory behavior (19).

## 6.3 RESEARCH AND DATA NEEDS

### 6.3.1 Biological/Captive Propagation

- Conduct basic culture experiments to provide information on: a) efficacy of alternative spawning techniques, b) egg incubation and fry production techniques, c) holding and rearing densities, d) prophylactic treatments, e) nutritional requirements and feeding techniques, and f) optimal environmental rearing conditions and systems (4).

- Determine the extent to which Atlantic sturgeon are genetically differentiable among rivers (5).

- Conduct research to identify suitable fish sizes, and time of year for stocking cultured fish. Conduct and monitor pilot-scale stocking programs before conducting large-scale efforts over broad geographic areas (6).

- Determine effects of contaminants on early life stages (6).

- Develop methods to determine sex and maturity of captured sturgeon.

- Develop sperm cryopreservation techniques and refine to assure availability of male gametes. Refine induced spawning procedures (10).

- Develop the capability to capture wild broodstock and develop adequate holding and transport techniques for large broodstock (12).

- Studies should be conducted to identify tissue(s) suitable for genetic analyses and the techniques for their collection and storage. In those states which permit future harvest of Atlantic sturgeon, material for genetic analysis should be collected from up to 50 percent of the fish landed in the commercial fisheries. In states with no ***future*** directed fisheries, federal and state programs which encounter sturgeon should be encouraged to collect specified tissues for genetic analysis (15).

- Standardize collection procedures to obtain biological tissues, and identify a suitable repository to archive all materials (17).

- Conduct research to determine the susceptibility of Atlantic sturgeon to sturgeon adenovirus and white sturgeon iridovirus. Methods should be developed to isolate the sturgeon adenovirus and an Atlantic sturgeon cell line should be established for infection trials (20).

- Conduct research to identify the major pathogens of Atlantic sturgeon and a cell line for this species should be developed (21).

### 6.3.2 Social

To evaluate the social impacts the needed data might include the following for consumptive and non-consumptive users: demographic information (e.g. age, gender, ethnicity/race, etc.), social structure information (e.g. historical participation, affiliation with NGOs, perceived conflicts, etc.), other cultural information (e.g. occupational motivation, cultural traditions related to resource's use), and community information.

### 6.3.3 Economic

Genetically compatible stocking of Atlantic sturgeon is recommended as a management tool for restoring Atlantic sturgeon stocks. Consequently, applied research germane to Atlantic sturgeon breeding and stocking protocol needs to be continued. In addition, a cost and benefit analysis (CBA) of possible stocking protocols is needed. A stocking CBA study could also be designed in a manner to provide much-needed estimates of the non-consumptive use and nonuse economic value of Atlantic sturgeon. Moreover, if the decline of Atlantic sturgeon stocks is also linked to habitat degradation (Smith and Clugston, 1997), a CBA could include a comparison of possible habitat improvement projects, especially if the efficacy of stocking relative to habitat improvements might vary between river systems.

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