

Atlantic States Marine Fisheries Commission

PUBLIC INFORMATION DOCUMENT

**For Amendment 3 to the
Interstate Fishery Management Plan
For**

SHAD AND RIVER HERRING



ASMFC Vision Statement:

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

May 2008

PUBLIC COMMENT PROCESS AND PROPOSED TIMELINE

The public is encouraged to submit comments regarding this document during the public comment period. Comments will be accepted until **5:00 PM (EST) on July 25, 2008**. Regardless of when they were sent, comments received after that time will not be included in the official record. The Shad and River Herring Management Board will use public comment on this Public Information Document to develop the first draft of Amendment 3 to the Shad and River Herring Fishery Management Plan.

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

1. Attend public hearings held in your state or jurisdiction.
2. Refer comments to your state's members on the Shad and River Herring Management Board or Advisory Panel, if applicable.
3. Mail, fax, or email written comments to the following address:

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Fax: (202) 289-6051
comments@asmfc.org (subject line: American Shad).

If you have any questions please call Erika Robbins at (202) 289-6400.

Tentative Timeline for Completion of Amendment 3

	MAY 2008	JUN 2008	JUL 2008	AUG 2008	SEP 2008	OCT 2008	NOV 2008	DEC 2008	JAN 2009	FEB 2009	MAR 2009	APR 2009	MAY 2009
Approval of Draft PID by Management Board	X												
Public review and comment on PID		X	X										
Board review of public comment; Board direction on what to include in Draft Amendment 3				X									
Preparation of Draft Amendment 3				X	X	X							
Review and approval of Draft Amendment 3 by Management Board						X							
Public review and comment on Draft Amendment 3							X	X	X				
Board review of public comment on Draft Amendment 3										X			
Preparation of final Amendment 3										X	X	X	
Review and approval of the final Amendment 3 by the Management Board, Policy Board and Commission													X

TABLE OF CONTENTS

Tentative Timeline for Completion of Amendment 33

Introduction5

Management Issues5

The Process5

Purpose of the Public Information Document.....6

Current Management6

 Background6

 Monitoring and Enhancement Programs7

 Management Program8

 Recommendation to the Secretaries8

 Other Management Measures9

Description of the Fishery10

 Maine10

 New Hampshire10

 Massachusetts11

 Rhode Island11

 Connecticut11

 Hudson River12

 Delaware River12

 Susquehanna River12

 Upper Chesapeake Bay12

 Potomac River12

 Virginia13

 North Carolina13

 South Carolina14

 Georgia14

 Florida15

Status of the Stock15

Public Comment Issues18

 Issue 1. Incorporate the biological reference points and restoration goals of the American Shad Stock Assessment Report for Peer Review (2007) into the Fishery Management Plan.....18

 Issue 2. Do not increase directed fisheries for American shad19

 Issue 3. Restrict fisheries operating on stocks where total mortality is increasing and relative abundance is decreasing.....19

Tables22

Figures28

SHAD AND RIVER HERRING PUBLIC INFORMATION DOCUMENT FOR AMENDMENT 3

Introduction

The Atlantic States Marine Fisheries Commission (Commission) is developing an amendment to its Interstate Fishery Management Plan for Shad and River Herring (FMP) under the authority of the Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA). Shad and river herring management authority lies with the coastal states and is coordinated through the Commission. Responsibility for compatible management action in the Exclusive Economic Zone (EEZ), located 3-200 miles from shore, lies with the Secretary of Commerce through the ACFCMA in the absence of a federal FMP.

Management Issues

The American shad was, historically, one of the most important exploited fish species in North America (Stevenson 1899; Limburg *et al.* 2003). In the late 19th century, annual harvests of American shad reached over 50 million pounds. Since then, stocks declined due to a combination of overfishing, pollution, and habitat loss (over 4,000 km of spawning habitat have been lost due to dam construction; Limburg *et al.* 2003). In recent years, coastwide harvests have been 1-2 million pounds, nearly two orders of magnitude lower than in the late 19th century (Figure 1).

The *American Shad Stock Assessment Report for Peer Review (Stock Assessment, ASMFC 2007a)* and the *Terms of Reference & Advisory Report to the American Shad Stock Assessment Peer Review (Peer Review, ASMFC 2007b)* have found that American shad stocks are currently at all-time lows. The Shad and River Herring Management Board is concerned that current American shad management is not meeting the goal of Amendment 1 to the Shad and River Herring FMP: “protect, enhance, and restore East Coast migratory spawning stocks of American shad...in order to achieve stock restoration and maintain sustainable levels of spawning stock biomass” (ASMFC 1999). This document has been developed to address this concern by seeking comment on regulations to (1) incorporate the benchmarks and restoration goals of the *Stock Assessment*; (2) limit directed fisheries for American shad; and (3) restrict fisheries operating on stocks where total mortality (Z) is increasing and relative abundance is decreasing.

The Process

The publication of this document and announcement of the Commission’s intent to amend the existing Shad and River Herring FMP is the first step of the formal amendment process. Following the initial phase of information gathering and public comment, the Commission will evaluate potential management alternatives and the impacts of those alternatives. The Commission will then develop a Draft Amendment to the FMP with the management measures identified for public review. Following that review and public comment, the Commission will specify the management measures to be included in the new amendment. The tentative schedule for the completion of Amendment 3 is included on page 3 of this document. Please note that these dates are subject to change.

This is your opportunity to inform the Commission about: changes observed in the fishery; actions you feel should or should not be taken in terms of management, regulation, enforcement, research, development, and enhancement; and any other concerns you have about the resource or the fishery, as well as the reasons for your concerns.

Purpose of the Public Information Document

The purpose of this document is to inform the public of the Commission's intent to gather information concerning the American shad fishery and to provide an opportunity for the public to identify major issues and alternatives relative to the management of American shad. Input received at the start of the amendment development process can have a major influence in the final outcome of the amendment. The purpose of this document is to draw out observations and suggestions from fishermen, the public, and other interested parties, as well as any supporting documentation and additional data sources. To facilitate public input, this document provides a broad overview of the issues facing American shad populations and the fishing industry, as well as a wide range of potential management measures that may impact the stocks and dependent fisheries.

Current Management

Background

Migratory stocks of shad and river herring have been managed under the Commission's FMP since 1985. These alosine species are currently managed under Amendment 1 to the FMP, Technical Addendum #1, and Addendum 1. The Goal of Amendment 1 is to protect, enhance, and restore East Coast migratory spawning stocks of American shad (*Alosa sapidissima*), hickory shad (*Alosa mediocris*), alewife (*Alosa pseudoharengus*), and blueback herring (*Alosa aestivalis*) in order to achieve stock restoration and maintain sustainable levels of spawning stock biomass. To achieve this goal, the plan adopts the following objectives:

1. Prevent overfishing of American shad stocks by constraining fishing mortality below F_{30} .
2. Develop definitions of stock restoration, determine appropriate target mortality rates and specify rebuilding schedules for American shad populations within the management unit.
3. Maintain existing or more conservative regulations for hickory shad and river herring fisheries until new stock assessments suggest changes are necessary. This should keep fishing mortality sufficiently low to ensure survival and enhancement of depressed stocks and the maintenance of stabilized stocks.
4. Promote improvements in degraded or historic alosine habitat throughout the species' range.
5. Establish criteria, standards, and procedures for plan implementation as well as determination of states' compliance with management provisions.

The management unit for shad and river herring is all migratory American shad, hickory shad, blueback herring, and alewife stocks of the East Coast of the United States.

Amendment 1 considers American shad overfished if a stock exhibits a fishing mortality rate (F) at or above F_{30} . A fishing mortality rate of F_{30} will result in 30% of the maximum spawning potential (biomass per recruit) in the female component of an un-fished population. Estimates of F_{30} were calculated for each of seven studied river systems (Table 1).

The overfishing definition is not a target for commercial or recreational fisheries to achieve, nor is it suitable for rebuilding depleted stocks. Rather, the overfishing definition of F_{30} serves as a reference point that should not be exceeded in any given year. Target fishing mortality rates for rebuilding or protecting individual stocks are to be developed by the Shad and River Herring Technical Committee (TC) as data become available and restoration goals are established.

Amendment 1 focuses primarily on American shad monitoring programs and regulations. To improve data collection and stock assessment capabilities, states and jurisdictions are required to assess annual recruitment, population size and distribution; measure annual fishing mortality; and make efforts to assess the magnitude of bycatch discard mortality occurring in waters in their jurisdiction (Tables 2 and 3). To control exploitation of American shad populations, Amendment 1 contains three primary regulatory requirements: (1) a closure of the ocean-intercept fishery, which occurred on December 31, 2004; (2) fishing mortality targets for specific in-river fisheries (Table 1); and (3) a maximum aggregate 10-fish daily creel limit in recreational fisheries for American and hickory shad. The monitoring and management programs are described below in more detail.

Monitoring and Enhancement Programs

Operational procedures required by Amendment 1 concern both fishery-independent and fishery-dependent monitoring programs as well as stocking and hatchery operations (see Tables 2 and 3). Note: Technical Addendum #1 and Addendum I have modified the monitoring program requirements from Amendment 1. References to monitoring program requirements from Amendment 1 reflect any changes implemented through Technical Addendum #1 and Addendum I.

Annual juvenile recruitment of American shad is measured in order to assess juvenile production, predict future year-class strength, provide a signal for recruitment failure or major habitat changes, and assess the effect of hatchery-released larvae. Recruitment is measured by sampling current-year juvenile fish abundance in estuaries or river systems. The states required to report an annual juvenile abundance index (JAI) for American shad are listed in Table 2. The TC annually examines trends in all required JAI surveys. If any JAI shows recruitment failure (i.e., JAI is lower than 90% of all other values in the dataset) for three consecutive years, then appropriate action should be recommended to the Management Board.

In order to assess adult population size and distribution, Amendment 1 requires states to implement surveys in Table 2. Indices of adult spawning stocks are important when determining the efficacy of a particular management approach; they clarify population dynamics and progress toward restoration goals. States may employ a variety of survey techniques in adult spawning stock surveys in river systems within their jurisdiction. As part of spawning stock surveys, states are required to take representative samples of adults to determine sex and age composition, repeat spawning frequency, and size distribution of each stock within their jurisdiction. If states allow an ocean bycatch fishery, they are required to sub-sample for tags and/or otoliths. Each year, the TC is to review the results of the surveys and analyze progress made toward individual stock restoration goals. If restoration milestones are not achieved within five years after they have been established, the Shad and River Herring Plan Review Team (PRT) will recommend to the Management Board appropriate regulatory changes for implementation.

States that reopen or establish new in-river or ocean bycatch fisheries must implement the following requirements:

1. Collection of catch composition data from in-river and ocean fisheries.
2. Collection of representative catch and effort data from in-river and ocean fisheries. States are encouraged to collect catch and effort data from in-river subsistence fisheries, including personal consumption and bait harvest.
3. Completion of existing recreational catch and effort monitoring programs every 5 years.

4. For river systems listed in Table 3, development of annual estimates of fishing mortality (F).

The TC can recommend additional monitoring programs for newly restored or colonized American shad populations as stock status or habitat improvements warrant.

States and jurisdictions with active hatchery programs for American shad must report annually on hatchery contributions (percent wild versus hatchery fish). States should work in cooperation with appropriate federal or regional programs to ensure unique marking of fish in their operations.

States, jurisdictions, and federal agencies shall make every effort to assess the magnitude of alosine bycatch discard mortality (including hook-and-release mortality) occurring in waters under their authority. In cases where excessive American shad bycatch is documented, the involved jurisdiction(s) shall make such documentation available immediately to the Shad and River Herring TC, Advisory Panel (AP), and Management Board.

States and jurisdictions must report any estimates of Atlantic sturgeon bycatch in their American shad fisheries to the Sturgeon Management Board, regardless of fishery location.

Management Program

Amendment 1 requires mandatory reporting on catch and effort in active commercial fisheries. All commercial ocean-intercept fisheries were phased out by January 2005. States are permitted to allow non-directed ocean harvest of American shad, as long as the weight of American shad landed does not exceed 5% of the total landings of other species from a given trip.

Amendment 1 permits in-river fisheries for American shad at levels not to exceed F_{30} for the following systems: Connecticut, Hudson, Delaware, Upper Chesapeake Bay, Santee, Edisto, and Altamaha (Table 1). For all other systems with an American shad stock, states must develop and adopt recovery plans. States shall not exceed any specified target F suitable for attaining adopted restoration goals.

Amendment 1 restricts all jurisdictions to a maximum aggregate 10-fish daily creel limit in recreational fisheries for American and hickory shad. For American or hickory shad stocks under restoration, states must adopt recreational creel limits consistent with restoration targets.

Recommendation to the Secretaries

Through Amendment 1, the Commission requests that the Secretary of the Interior provide necessary funding to expand the state-federal cooperative tagging program for migratory and mixed stocks of American shad. An enhanced program would greatly improve the current understanding of stock contributions to mixed stock fisheries, annual survivorship, migration, growth rates, and the efficacy of state restoration plans.

In addition, the Commission recommends that the Secretary of Commerce direct the National Marine Fisheries Service (NMFS) to examine existing databases for information on distribution and habitat use of offshore areas by American shad and river herring. In addition, NMFS should expand at-sea observer programs to further quantify the extent of American shad and river herring bycatch in oceanic fisheries. Finally, the Commission recommends that NMFS expand the Marine Recreational Fisheries Statistics Survey (MRFSS) coverage to include riverine or estuarine areas used by anglers to intercept American shad and river herring.

Other Management Measures

Under Amendment 1, the Management Board may vary the requirements specified in the amendment as part of adaptive management in order to achieve the goals and objectives specified in Section 2 of Amendment 1. Specifically, the Management Board may change target fishing mortality rates, creel limits, seasonal restrictions, commercial fishery quotas and the restoration status of riverine and estuarine (producer) areas. All other changes must be implemented through an amendment.

Description of the Resource

A comprehensive and river-specific description of the Atlantic Coast stocks of American shad can be found in the *Stock Assessment* (ASMFC 2007a). This section provides the basic information necessary to understand American shad life histories and habitat use.

The American shad is currently distributed from the Bay of Fundy in Canada to the St. Johns River in Florida. As an anadromous fish they spend the majority of their life at sea and only enter freshwater in the spring to spawn. They spawn throughout their range, and each major river along the Atlantic Coast appears to have a discrete spawning stock of American shad. Historically, they probably spawned in every accessible river and tributary along the Atlantic Coast; however, since colonial times, blockage of spawning rivers by dams and other impediments, and degradation of water quality and physical habitat in spawning reaches have severely depleted suitable American shad spawning habitat.

Adult American shad migrate to freshwater spawning grounds as early as mid-November in Florida and as late as July in some Canadian rivers (MacKenzie *et al.* 1985). Those fish that return to rivers north of Cape Hatteras usually begin migration later in the spring and follow a route farther seaward into the mid-Atlantic Bight when water temperatures have risen sufficiently; spawning begins when water temperatures reach between about 16-19°C. While water temperature is the primary factor that triggers spawning, photoperiod, water velocity, and turbidity also exert some influence (Leggett and Whitney 1972). Depending on geographical location, American shad may be semelparous (spawn once and die) or they may be iteroparous (spawn multiple times over their lifetime). Most American shad native to rivers south of the Cape Fear River, North Carolina, die after spawning (Carscadden and Leggett 1975); however, in rivers to the north, the incidence of repeat spawning increases with latitude.

If possible, adults migrate far upstream and typically spawn in freshwater areas dominated by extensive flats and over sandy or rocky shallows, including mouths of larger tributary streams (Davis *et al.* 1970); however, substrate should be relatively unimportant as American shad broadcast their eggs into the water column and most are carried downstream (Mansueti and Kolb 1953; Jones *et al.* 1978; MacKenzie *et al.* 1985). Only in areas where the eggs are settled on the bottom and smothered by silt or sand does substrate become a critical habitat problem.

After spawning is complete, adult and immature American shad migrate out of rivers and tributaries and move northward along the Atlantic Coast to their summer feeding grounds in the Gulf of Maine, Bay of Fundy, St. Lawrence Estuary, and the Labrador coast (Dadswell *et al.* 1987). They remain there throughout the summer and into fall, feeding on zooplankton and small fishes. In mid-fall, a southward migration begins, with over-wintering occurring off Florida, in the mid-Atlantic area, and in the Scotian Shelf-Gulf of Maine (Talbot and Sykes 1958; Leggett and Whitney 1972; Dadswell *et al.* 1987).

Fertilized eggs hatch within 2-17 days, depending on water temperature (Jones *et al.* 1978). Larvae drift with river currents until they mature into juveniles. Nursery habitats for American shad are downstream of spawning grounds because juveniles begin to disperse upon transformation from the larval stage

(Chittenden 1969). These nursery habitats usually occur in deep pools away from the shoreline in non-tidal areas, although juveniles occasionally move into shallow water areas (Chittenden 1969; Milstein 1981). In the Chesapeake Bay system, juveniles are usually found in tidal freshwater reaches of the spawning rivers. Juveniles remain in nursery areas, feeding on copepods, other crustaceans, zooplankton, chironomid larvae, and aquatic and terrestrial insects (Levesque and Reed 1972; Marcy and Jacobson 1976).

Juvenile American shad leave the nursery areas by late fall and may remain in the estuaries and nearshore ocean until they reach one year of age. As young-of-year, they join other schools of young American shad in the ocean. Immature American shad will remain in the ocean for three to six years before returning to spawn. Sub-adults appear to migrate further offshore than sexually mature adults (Neves and Depres 1979). Little information is available on the life history of sub-adult and adult American shad after they emigrate to the ocean.

Description of the Fishery

American shad formerly supported important commercial and recreational fisheries along the entire Atlantic Coast; however, all of these fisheries have declined dramatically. Traditionally, two types of fisheries exploited spring spawning migrations of American shad: in-river and coastal ocean. In-river fisheries have dominated the commercial harvest. The coastal ocean fishery was phased out beginning in 2000 and was completely closed by 2005 (note: limited landings of American shad bycatch are permitted).

Catch statistics for both ocean and in-river American shad fisheries on the Atlantic Coast are compiled by NMFS and state agencies.

The following are brief descriptions of the fisheries from specific rivers or states along the U.S. Atlantic Coast. For more comprehensive descriptions of the commercial, recreational, and subsistence fisheries, please see the *Stock Assessment* (ASMFC 2007a). This public information document provides the basic information necessary to understand American shad fisheries.

Maine

American shad were historically harvested from all the major rivers along the coast of Maine. Commercial landings peaked at 3.3 million lbs in 1912 and dropped to a mean of about 113,000 lbs between 1928-1933; American shad became commercially extinct through 1940. Commercial landings increased to 1.1 million lbs in 1945 and remained at a relatively low level from 1948-1976 (Figure 2). From 1978-1990, commercial landings averaged 31,678 lbs. Since the directed American shad commercial fishery closed in 1995, annual landings have been less than 440 lbs.

A limited recreational fishery occurs in the Saco River and several small coastal rivers.

New Hampshire

Recorded commercial harvest of American shad, available since 1975, are of fish with mixed stock origin and are caught outside of state waters in the EEZ (Figure 3). They are harvested with gillnets and trawls. Peaks in commercial landings occurred in 1988 and 1996. Current commercial landings are minimal.

The recreational creel limit is two fish per day and a recreational permit is required.

Massachusetts

Massachusetts's fishermen have used purse seine, gillnet, and pound net to catch American shad. Historical records for commercial landings begin in the late 1880s. Annual reporting began around 1928. Since 1950, all commercial landings have been caught in ocean waters. The highest catch of 2,109,824 lbs occurred in 1957 (Figure 4). After 1967, catches became more sporadic; one exception was a period of increased landings from 1981-1989. Since 1987, a moratorium has been in place on commercial American shad harvest in all waters of the Commonwealth of Massachusetts. Current landings are minimal and most likely from fisheries in the EEZ.

In state waters, a recreational catch of six fish per day by hook-and-line only is permitted. Most American shad fisheries are believed to be predominantly catch-and-release efforts.

Rhode Island

All commercial landings of American shad in Rhode Island from about 1950-2005 were from ocean waters (Figure 5). Reported commercial landings of American shad peaked in 1896 and in 1940 (53,000 lbs). The commercial fishery took an upswing in 1981 and continued to increase to the peak of 120,000 lbs in 1989, with most landings from floating traps. In 1990, landings dropped by two-thirds and remained there until another small peak of 88,000 lbs in 2002. Rhode Island's commercial American shad fishery has been closed since 2005.

Recreational catch-and-release fishing is permitted; no take is allowed.

Connecticut

A commercial gillnet fishery and a recreational hook-and-line fishery have harvested American shad in the Connecticut River since the late 1800s. The commercial American shad fishery in the Connecticut River is a spring gillnet fishery (April-June). The fishery has changed little since the adoption of outboard-powered vessels, with the exception of the change to drift gillnets from haul seine, fixed gillnet, trap, and pound net gears. The number of commercial American shad fishing licenses (effort) has declined since peaks during and after World War II and is expected to stay low or further decrease.

Commercial fishermen report in-river landings and effort. Commercial landings (numbers) of Connecticut River American shad varied greatly from 1981-2005; they fell steadily from 1981-1999 before rebounding and then declining again (Figure 6). In-river commercial effort declined from 1981 through the present. Studies indicate that in-river commercial fishermen might have underreported their landings from 1966-1983 by 35-67% annually.

Recreational American shad landings were estimated from 1980-1996 and periodically thereafter by a roving creel census. Prior to 1994, recreational landings comprised up to 82% of annual total in-river landings. Recreational landings fell dramatically thereafter and estimates became unreliable and imprecise as reflected by high (>80%) proportional standard errors (PSE). Estimates from MRFSS of American shad harvested in the ocean had excessive PSE estimates (>80%) and were considered unreliable. Discard mortality of recreationally caught American shad is assumed to be 100%.

Both commercial and recreational in-river landings remained relatively high from 1981-1992 with peak total landings of 159,000 fish occurring in 1986.

Hudson River

Commercial harvest records of American shad from the Hudson River begin in the late 1800s. The highest peak of commercial landings, 4.2 million lbs, occurred in 1889. From the turn of the 20th century until 1936, landings were relatively low. Just prior to, during, and after World War II, sustained commercial landings ranged from 2.4-4.2 million lbs annually. By 1949 and through the 1950s, the stock rapidly collapsed (Figure 7). Commercial fishing slowed for 20 years until another resurgence in the 1980s. Commercial landings have declined since. During this last resurgence, a mixed-stock commercial fishery developed in ocean waters. A regulated 40% decrease in commercial effort occurred in 2002, followed by a complete closure in 2005. Current ocean bycatch of Hudson River American shad remains undocumented.

Delaware River

The commercial fishery for American shad in the Delaware River occurs during the spring spawning migration. New Jersey commercial landings are likely underreported prior to 1999 and there are no estimates of harvest for the state of Delaware before 1985. American shad harvested in the Delaware River or Upper Bay area are considered to be Delaware River stock while those from the Lower Bay areas are from mixed stock, termed *mixed stock*. Commercial harvest numbers in Delaware River and Bay have increased in recent years, likely due to mandatory reporting (Figure 8).

Many recreational surveys have been conducted within the Delaware River since 1965. Recreational catch estimates have fluctuated with a peak in 1992 at 83,141 American shad caught throughout the Delaware River.

Susquehanna River

The historic commercial American shad fisheries in the Susquehanna River targeted American shad until Maryland closed the directed fishery in 1980 (Figure 9). After 1980, a significant recreational catch-and-release American shad fishery has developed below Conowingo Dam.

Upper Chesapeake Bay

Commercial American shad fishing increased beyond a subsistence fishery after the Revolutionary War and, by the late 1800s, American shad supported the most important commercial fishery in Chesapeake Bay. Maryland American shad commercial landings peaked in 1890, declined until the late 1940s, increased through the 1950s, and then declined to precarious levels by the late 1970s (Figure 10). The commercial American shad fishery in Chesapeake Bay was virtually unregulated with only minimal gear, area, and time restrictions. It was the most important commercial fishery in Chesapeake Bay until the 1950s.

The commercial fishery targeted female American shad for their roe. Due to the scarcity of American shad in the 1960s, the demand dropped and consumers sought other fish. Although limited effort during World War II allowed the stock to rebuild, commercial harvest continued to deplete stocks until Maryland closed its commercial and recreational fisheries in 1980.

Potomac River

The historical record of American shad fisheries in the Potomac River date back to the Colonial period and most reports are anecdotal. In 1899, commercial landings from the Potomac River were over 2.5 million lbs (Tilp 1978). From 1964-1981 the commercial fishery on the Potomac was operating relatively

freely. Commercial landings declined from about 466,000 lbs to 4,200 lbs but averaged about 222,000 lbs for the period (Figure 11). Regulations in 1982 on the commercial fishery were so limiting that it became a bycatch only fishery. Landings have averaged about 2,300 lbs a year since then.

Currently, bycatch of American shad is permitted by pound nets and gillnets set to catch other fish species. Commercial fishers are limited to one bushel (approximately 60 lbs) per licensee, per day. Gillnets are fished from November 1 to March 25 and pound nets can operate from February 15 to December 15 each year. Both gear types are limited entry fisheries such that no new licenses are sold. All licensed fishermen are required to submit reports of their daily harvest of all species by gear type to the Potomac River Fisheries Commission.

The recreational fishery for American shad is currently closed.

Virginia

Commercial landings in the York River were low (~100,000 lbs annually) in the 1930s but rose abruptly in the years following World War II, reaching the highest levels (400,000-700,000 lbs annually) in the 1950s (Nichols and Massmann 1963). During this latter period of higher annual landings, catch-per-unit-effort remained relatively constant. Of the major gears used in the fishery in 1959 (pound nets, haul seines, fyke nets, stake gill nets, and drift gill nets), gill nets (both stake and drift) accounted for the greatest effort expended and the highest total catches.

Commercial American shad landings in Virginia decreased from 11.5 million pounds in 1897 to less than a million pounds in 1982. Historically, the majority of American shad were captured within the rivers. Beginning in 1984, the largest proportion of American shad taken in Virginia's commercial fishery was captured offshore. Genetic studies of the catch composition of Virginia and Maryland's coastal landings have suggested that the ocean-intercept fishery claimed a highly variable proportion of Virginia's riverine stocks (Brown and Epifanio 1994).

Responding to sharp declines in commercial landings (Figure 12), the Virginia Marine Resources Commission imposed a moratorium on the taking of American shad in Virginia rivers and Chesapeake Bay in 1994. The ocean-intercept fishery in Virginia coastal waters was closed in December 2004. Drift-net fishing by two Native American tribal governments and the taking of brood stock by the Virginia Department of Game and Inland Fisheries on the spawning grounds of the York River system for stock restoration in the James River are permitted.

Recreational fishermen target American shad in Virginia but the full extent and success of this activity is not easily assessed. An active catch-and-release recreational fishery exists on the James and Rappahannock rivers and to a lesser extent on the York River (especially the Mattaponi River).

North Carolina

North Carolina commercial landings of American shad peaked in 1897 at 8.8 million lbs and decreased to 1.5 million lbs by 1918. A second peak of just over 3.1 million lbs was reached in 1928. Commercial landings declined and stabilized from 1930-1970, averaging 891,000 lbs. Commercial landings further declined since the early 1970s to an average of 282,000 lbs from 1973-2005 (Figure 13).

Pound nets were a large component of the commercial harvest in the 1970s but now the vast majority of American shad are harvested with gillnets. Commercial landings fluctuate greatly over time, but are currently around the long-term average of 128,448 lbs for Albemarle Sound and 29,028 lbs for the Neuse

River. Current commercial landings are below the long-term averages for the Pamlico River (mean=23,135 lbs) and the Cape Fear River (mean=29,912 lbs). Commercial landings have been declining for the past 3-4 years in all systems except the Pamlico River, which remains low but stable.

South Carolina

The commercial anchored and drift gillnet fisheries in South Carolina target female American shad. South Carolina Department of Natural Resources (SCDNR) has collected landings data by river system since 1979 and instituted mandatory catch and effort reporting in 1998 (Figure 14). Historical South Carolina commercial American shad landings data dating back to 1880 are available from NMFS. NMFS port agents compiled landings data until 1979. The highest reported commercial landings occurred in 1896 (672,011 lbs).

Commercial landings generally declined from the late 1800s throughout the 20th century, reaching a low in the 1970s (24,300 lbs). From 1979 to the mid-1990s, ocean-intercept landings were typically greater than in-river landings. Since then, the ratio of ocean landings to in-river landings has declined, culminating with the ocean-intercept fishery closure in 2005. Commercial fishing effort (number of trips) has declined since 2000. Santee River and Winyah Bay are currently the largest commercial American shad fisheries in South Carolina. Commercial American shad fisheries in the Savannah, Lynches, and Black rivers have been in decline since the 1960s. There has been a reduced level of effort in the Edisto River commercial American shad fishery. Landings have been stable in the Combahee River.

There is a recreational American shad fishery on the Edisto, Combahee, Cooper, Santee, and Savannah rivers. A recreational creel survey conducted by SCDNR in the Santee River, before and after completion of the Rediversion Canal, showed that total annual effort and recreational landings for all species increased in the post-Rediversion survey.

Georgia

Statewide records of American shad commercial landings date back to 1880. Landings peaked in the early 1900s, and again in the 1960s, with average annual harvests of nearly 441,000 lbs. Since the 1970s, commercial landings have consistently declined to current low levels (Figure 15). An all-time low of 25,527 lbs of American shad was landed in 2002.

Reported commercial landings of American shad in the Altamaha River peaked in 1968 at 471,708 lbs and then declined steadily to the early 1980s. From 1983-1988, commercial landings averaged 269,295 lbs before declining to an average of 98,492 lbs from 1989-1994. Commercial landings increased briefly from 1995-1998 and then declined to a mean of 67,318 lbs a year from 1999-2005. Commercial landings in 2005 were 56,555 lbs. A roving commercial gillnet survey was conducted by Georgia Department of Natural Resources from 1982-1991 to collect catch and effort for the entire Altamaha River American shad fishery. Catch and effort data were available for the commercial drift gillnet fishery since 2000.

A total of 208,754 lbs of American shad was commercially harvested from the Ogeechee River in 1896, all of which was caught using drift gillnets. Commercial landings averaged 3,269 lbs per year from 1989-1997, with a low of 269 lbs in 1992. Since 1998, commercial landings averaged 591 lbs annually, with lows of 37 lbs in 2003 and 152 lbs in 2005. Historically, commercial harvests greater than 22,000 lbs per year occurred on both the Satilla and St. Marys rivers; however, no commercial harvest has been reported from either river since the late 1980s.

Recreational harvest of American shad and hickory shad in the Ogeechee River was estimated through an

access creel survey conducted in 1996 (1,239 fish), 2000 (295 fish), and 2005 (442 fish).

Florida

Florida's American shad commercial landings were highest (1-3 million lbs) in the late 1800s and fluctuated between 200,000 and 900,000 lbs from the 1920s to the 1960s. Commercial landings have declined further, from less than 200,000 lbs in the early 1970s to zero in recent years (Figure 16). Florida's commercial landings of American shad dropped dramatically in the 1990-1991 fishing year, continued to drop during the 1990s, and no landings have been reported since 2000.

In the late 1800s, Florida's American shad were caught primarily in drifting gillnets and also in haul seines and anchored or staked gillnets. By the 1950s, most landings of American shad were made by haul seine followed by gillnets. Haul seining was discontinued during the early 1970s in the St. Johns River; gillnets were used into the 1990s. Commercial American shad fishing grounds have shifted geographically. In the 1950s, the dominant location of harvest was in the lower and the middle river (near Palatka, rkm 127), but by the early 1990s, nearly all the American shad harvested came from coastal waters offshore of Mayport, Florida.

The MRFSS does not appear to intersect the American shad recreational fishery on the St. Johns River because the fishery is concentrated well upstream. Today, Florida's American shad fishery is composed primarily of recreational anglers fishing on the spawning grounds and most anglers practice catch-and-release.

Status of the Stock

In 1950, the U.S. Fish and Wildlife Service responded to declining American shad populations by conducting a series of investigations to examine the causes of the decline, determine factors that would promote recovery, and provide management information (Walburg and Nichols 1967). Major rivers in each Atlantic Coast state were investigated to collect comprehensive catch and effort data by gear type. For a historical perspective, these were compared to the work of Stevenson (1899).

The Commission Shad and River Herring TC conducted its first coastwide assessment in 1988 (Gibson *et al.* 1988). The assessment examined the status of American shad in 12 rivers. The Shepherd stock-recruitment model was used to estimate maximum sustainable yield (MSY) and maximum sustainable fishing rate (F_{msy}). The status of American shad stocks was evaluated by comparing fishing mortality rates (F) in assessed rivers to F_{msy} .

The Commission's second coastwide assessment was completed and peer reviewed in 1998 (ASMFC 1998a, 1998b). The assessment examined stocks on a river-specific basis, although some grouping of stocks occurred (i.e., Maine rivers, upper Chesapeake Bay/Maryland, Albemarle Sound, and Waccamaw and Pee Dee rivers). The Thompson-Bell yield-per-recruit (YPR) model was used to derive the overfishing definition (F_{30}) when possible. The assessment examined catch and harvest data, exploitation rates, fish-lift counts, current and historical fishing mortality rates, and other indicators of stock status for American shad from selected stocks or river systems located from Maine to Georgia. Special attention was paid to stock dynamics between 1992 and 1996.

The 1998 stock assessment concluded that there was evidence of recent (1992-1996) and persistent stock declines in the Hudson River (NY) and York River (VA), and that stock abundance recently (1992-1996) increased in the Pawcatuck (RI) and Connecticut (CT, MA) rivers in the most recent years examined. The assessment concluded that the drop in commercial landings in the Edisto River (SC) was largely due to a

reduction in fishing effort and did not reflect trends in stock abundance. In addition, the assessment reported that there was no evidence of recent stock declines in the Merrimack (MA), Delaware (NY, PA, NJ, DE), Rappahannock (VA), James (VA), Santee (SC), and Altamaha (GA) rivers and upper Chesapeake Bay tributaries. Stock declines inferred from declining trends in commercial landings were evident in the Neuse (NC), Pamlico (NC), Cape Fear (NC), Waccamaw-Pee Dee (SC), Savannah (SC, GA), and Maine rivers, and Albemarle Sound tributaries (NC).

In the 1998 stock assessment, where estimation of recent F rates (1992-1996) was possible, all were below F_{msy} . The 1998 stock assessment also concluded that there was no evidence that the ocean-intercept fishery had an adverse impact on American shad abundance along the Atlantic Coast and that there was no evidence of recent (1992-1996) recruitment failure for Maine's rivers, Pawcatuck River, Connecticut River, Hudson River, Delaware River, upper Chesapeake Bay tributaries, Altamaha River, and Virginia's rivers.

The Peer Review Panel Report from the 1998 assessment stated that the trends in abundance over the 1992-1996 period might reflect natural variability, changes in fishing pressure, or both (ASMFC 1998a). They suggested that these trends would not necessarily reflect the long-term health of American shad stocks.

In 2007, the Commission completed an American shad stock assessment (ASMFC 2007a), which was supported by the external Peer Review Panel (ASMFC 2007b). The purpose of the 2007 stock assessment was to determine the status of the stocks and how well the management measures of Amendment 1 were performing. The Commission examined American shad populations in 64 rivers and conducted an assessment on 31 of these populations (Table 4). For 23 of these populations, stock assessments were based on trend analyses using fisheries-independent and fishery-dependent index time-series. When possible, comparisons of total mortality rates (Z) to benchmark mortality rates (Z_{30}) were developed (Figure 17).

The 2007 stock assessment identifies that all the assessed stocks are highly depressed from historical levels. Current status was identified for most stocks (Table 4). Declines in American shad abundance in recent years were indicated for Maine, New Hampshire, Rhode Island, and Georgia stocks, and for the Hudson, Susquehanna (PA, MD), James, and Edisto rivers. Low and stable, but often highly variable, stock abundance was indicated for Massachusetts, Connecticut, Delaware, upper Chesapeake Bay, Rappahannock, some South Carolina, and Florida stocks. Stocks showing some rebounding in recent years include Potomac River (MD, D.C., VA) and York River (VA) stocks; however, data from 2006 and 2007 indicate that the York River stock is declining over the time series (personal communication, John Olney, Virginia Institute of Marine Science). Data limitations and conflicting data precluded the report from saying much about the current status or trend of stocks from North and South Carolina.

The following conclusions were made based on coastwide observations in the 2007 assessment:

1. The expected benefits resulting from the ocean-intercept fishery closure were not obvious in the assessment and might take more than one generation of American shad to be evident.
2. Available total mortality (Z) estimates exceeded Z_{30} for most years in rivers where data were suitable for catch curve analysis and where data supported spawning stock biomass per recruit modeling. There is some evidence in the data that the Z values have affected the characteristics of some stocks.
3. Data on annual number of fish passed upriver at dams on several Atlantic coastal rivers exhibited a coastwide pattern of an increase followed by a decrease in numbers. Most fish passage declined

during the same period (late 1990s and early 2000s). This synchronous decline suggests a coastwide change in environmental conditions or mortality factors that affected stocks from South Carolina to Maine over the last five years.

4. Continuous fishery-dependent and independent catch-per-unit-effort data series generally only provide insight into recent stock dynamics.
5. Trends in juvenile production do not show consistent patterns coastwide; however, regional patterns and some local trends are noteworthy:
 - a. Recruitment has increased in the upper Chesapeake Bay, including Potomac River, and Merrymeeting Bay, Maine in recent years.
 - b. Recruitment patterns in the lower Chesapeake Bay (James, York, and Rappahannock rivers, VA) and in Albemarle Sound (NC) have been similar.
 - c. Relatively low young-of-year production was observed in all New England juvenile surveys in 1998 and 2001.
 - d. There has been consistently low recruitment in the Hudson River since 2002.

The 2007 assessment developed coastwide recommendations that relate to fisheries management, research, and habitat. They are:

1. Do not increase directed fisheries for American shad.
2. Restrict fisheries operating on stocks where total mortality is increasing and relative abundance is decreasing.
3. Identify all fisheries where bycatch occurs, then quantify the amount and disposition of bycatch. In fisheries where bycatch is allowed, quantify the discards.
4. Employ observer coverage to verify the reporting rate of commercial catch and harvest as well as bycatch and discards.
5. Identify directed harvest and bycatch losses of American shad in ocean and bay waters of Atlantic Maritime Canada.
6. Employ microchemistry techniques to identify stock composition in mixed stock harvest.
7. Spatially delineate mixed stock and native stock areas within the Delaware system.
8. Collect annual estimates of recreational catch, total harvest, catch-per-unit-effort, age, size, and sex composition of fish in each fishery.
9. Do not continue in-river tagging programs (conducted in Georgia, South Carolina, and Maryland) used to estimate exploitation and population size unless methods to identify reporting rate, tag mortality and loss, and movement (fallback), which are needed to estimate exploitation, are developed.
10. Continue tagging using Brownie-type models to estimate survival.
11. Require monitoring of juvenile production in semelparous stocks where it is not currently measured.
12. Mark stocked larvae with oxytetracycline (OTC) marks that allow age and year-class identification in mature fish. This is critical for verification of various aging techniques.
13. Characterize passage-associated efficiency, mortality, migration delay, and sub-lethal effects on

American shad at hydroelectric dams.

14. Annually update all summary data tables of on-going data collection for use in the next assessment in the format used in this stock assessment for use in ASMFC stock assessments only.
15. Develop safe, timely and effective upriver and downriver passage for adults and downriver passage for juvenile at all barriers within spawning reaches.
16. Maintain water quality and suitable habitat for all life stages of American shad in all rivers with shad populations. Refer to Amendment 1 for habitat issues pertaining to American shad and the ASMFC Anadromous Species Habitat Source Document (*in prep*).
17. In rivers with flow regulation, maintain flows at levels that ensure adequate fish passage, water quality, and habitat protection.
18. All rivers systems assessed in this document should have shad management (e.g., recovery and restoration) plans. Review and update these plans on a regular basis.

Public Comment Issues

Public comment is being sought on three issues for consideration in Amendment 3. The issues listed below are intended to focus the public comment and provide the Management Board the input necessary to develop Draft Amendment 3. The public is encouraged to submit comments on the issues listed below as well as any other issues that may need to be addressed in Amendment 3.

Issue 1. Incorporate the biological reference points and restoration goals of the American Shad Stock Assessment Report for Peer Review (2007) into the Fishery Management Plan

Amendment 1 established a biological reference point, based on a fishing mortality rate of F_{30} , to define overfishing for American shad stocks native to the Connecticut, Hudson, Delaware, Edisto, Santee and Altamaha rivers, and upper Chesapeake Bay (Table 1, page 22). Overfishing was considered to be occurring when fishing mortality in a given year exceeded F_{30} . Target fishing mortality rates were to be developed as data become available and restoration goals were established.

Since there are many competing theories on the relative causes of mortality for East Coast American shad stocks, the 2007 stock assessment identified new biological reference points based on total mortality (Z) and other criteria. Total mortality (Z) includes fishing mortality (F) and natural mortality (M). Unlike the 1998 American shad assessment, which focused only on fishing mortality, the 2007 assessment used Z_{30} to assess the health of American shad stocks by region. Z_{30} is defined as the total mortality rate that will preserve 30% of the unexploited spawning stock biomass per recruit. The stock assessment focused on a regional approach for biological reference points because most individual stocks did not have enough data to create stock-specific mortality rates. Further, it only identified total mortality for stocks native to waters from Albemarle Sound (NC) through Maine (Table 5, page 27). Additional river-specific reference points and restoration goals are listed in Table 6 (page 27). More information on how the benchmarks were established can be found in the full 2007 assessment.

Question:

Are the reference point mortality rates and restoration goals in Tables 5 and 6 (page 27) appropriate for rebuilding American shad stocks?

Issue 2. *Do not increase directed fisheries for American shad*

The *Stock Assessment* and *Peer Review* have determined that American shad stocks are currently at all-time lows and do not appear to be recovering. Recent declines of American shad abundance were reported for Maine, New Hampshire, Rhode Island, and Georgia stocks, and for the Hudson (NY), Susquehanna (PA), James (VA), and Edisto (SC) rivers. Low and stable stock abundance was indicated for Massachusetts, Connecticut, Delaware, Florida, Chesapeake Bay, and Rappahannock River (VA) stocks, and some South Carolina stocks.

Such evidence suggests that current American shad management is not meeting the goal of Amendment 1 to the Shad and River Herring FMP: “protect, enhance, and restore East Coast migratory spawning stocks of American shad...in order to achieve stock restoration and maintain sustainable levels of spawning stock biomass”. The *Peer Review* and *Stock Assessment* recommend a reduction in fishing mortality to address stock declines. Reductions in fishing mortality can reduce total mortality (Z), which should promote stock rebuilding.

While many stocks do not appear to be recovering, some stocks have shown rebounding in recent years (i.e., Potomac River stock). The Management Board is considering a provision to reopen or reestablish fisheries for American shad once a stock has recovered.

Questions:

What means could be implemented to prevent the expansion of American shad fisheries? Should fisheries be allowed to harvest from stocks that have been restored?

Issue 3. *Restrict fisheries operating on stocks where total mortality is increasing and relative abundance is decreasing*

Given that many East Coast American shad stocks are at all-time lows and do not appear to be recovering, the 2007 stock assessment recommends restricting fisheries operating on stocks where total mortality (Z) is increasing and relative abundance is decreasing. Such stocks cannot support commercial fisheries. Any amount of fishing on these stocks will lead to further declines in abundance.

Questions:

Should fisheries be restricted when they are operating on stocks with increasing total mortality (Z) rates and decreasing relative abundance? If so, to what extent should they be restricted?

References

- Atlantic States Marine Fisheries Commission (ASMFC). 1998a. American Shad and Atlantic Sturgeon Stock Assessment Peer Review; Terms of Reference Advisory Report. July 1998. Washington, D.C. 33p.
- ASMFC. 1998b. American Shad Stock Assessment Report. March 1998. Washington, D.C. 217p.
- ASMFC. 1999. Amendment 1 to the Interstate Fishery Management Plan for Shad & River Herring. Fishery Management Report No. 35. Washington, D.C. 76p.
- ASMFC. 2007a. American Shad Stock Assessment Report for Peer Review. Vol. I. Stock Assessment Report No. 07-01 (Supplement). 224p.
- ASMFC. 2007b. Terms of Reference & Advisory Report to the American Shad Stock Assessment Peer Review. Stock Assessment Report No. 07-01. Washington, D.C. 31p.
- Brown, B. L. and J.M. Epifanio. 1994. Mixed-stock analysis of American shad in Virginia's and Maryland's coastal intercept fisheries. Final report to the VMRC, Sport Fish Restoration Project F-110-R.
- Carscadden, J. E. and W. C. Leggett. 1975. Meristic differences in spawning populations of American shad, *Alosa sapidissima*: evidence for homing to tributaries in the St. John River, New Brunswick. Fisheries Research Board of Canada Bulletin. 32:653-660.
- Chittenden, M. E., Jr. 1969. Life history and ecology of the American shad, *Alosa sapidissima*, in the Delaware River. PhD Thesis, Rutgers University, New Brunswick, New Jersey.
- Dadswell, M. J., G. D. Melvin, P. J. Williams and D. E. Themelis. 1987. Influences of origin, life history, and chance on the Atlantic Coast migration of American shad. American Fisheries Society Symposium. 1:313-330.
- Davis, J., J. P. Miller and W. L. Wilson. 1970. Biology and utilization of anadromous alosids.
- Gibson, M. R., V. A. Crecco and D. L. Stang. 1988. Stock assessment of American shad from selected Atlantic coast rivers. Special Report No. 15. Washington, D.C. 65p.
- Jones, P. W., F. D. Martin and J. D. Hardy, Jr. 1978. Development of fishes of the mid-Atlantic Bight. An atlas of egg, larval, and juvenile stages. Vol. 1. Acipenseridae through Ictaluridae. U.S. Fish and Wildlife Service, FWS/OBS-78/12.
- Leggett, W. C. and R. R. Whitney. 1972. Water temperatures and the migrations of American American shad. Fisheries Bulletin. 70:659-670.
- Levesque, R. C. and R. J. Reed. 1972. Food availability and consumption by young Connecticut River American shad *Alosa sapidissima*. Journal of the Fisheries Research Board of Canada. 29:1495-1499.
- Limburg, K. E., K. A. Hattala and A. W. Kahnle. 2003. American shad in its native range, pp. 125-140 In K. E. Limburg and J. R. Waldman, editors. Biodiversity, Status, and Conservation of Shads Worldwide. American Fisheries Society Symposium 35.
- MacKenzie, C., L. S. Weiss-Glanz and J. R. Moring. 1985. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic)—American shad. U.S. Fish and Wildlife Service. Technical Report No. 19.
- Mansueti, A. J. and H. Kolb. 1953. A historical review of the American shad fisheries of North American. Maryland Department of Research and Education. Chesapeake Biological Laboratory

- Publication. 97:1-293. Solomons, Maryland.
- Milstein, C. 1981. Abundance and distribution of juvenile *Alosa* species off southern New Jersey. *Transactions of American Fisheries Society*. 110:306-309. Bethesda, Maryland.
- Marcy, B. C., Jr. and P. Jacobson. 1976. Early life history studies of American shad in the Lower Connecticut River and the effects of the Connecticut Yankee plant including entrainment. *American Fisheries Society Monograph*. 1:115-139.
- Neves, R. J. and L. Depres. 1979. The oceanic migration of American shad, *Alosa sapidissima*, along the Atlantic Coast. *Fisheries Bulletin*. 77:199-212.
- Nichols, P.R. and W.H. Massmann. 1963. Abundance, age and fecundity of shad, York River, VA., 1953-59.
- Stevenson, C. H. 1899. The shad fisheries of the Atlantic Coast of the United States. Pages 101-269 in U.S. Commission of Fish and Fisheries, Part XXIV. Report of the Commissioner for the year ending June 30, 1898. Government Printing Office, Washington, D.C.
- Talbot, G. and J. Sykes. 1958. Atlantic Coast migrations of American shad. *U.S. Fishery Bulletin*. 58(142):473-490.
- Tilp, F. 1978. *This Was Potomac*. Tilp, Alexandria, Virginia. 358 pp.
- Walburg, C.H., and P. R. Nichols. 1967. Biology and management of the American shad and status of the fisheries, Atlantic coast of the United States, 1960. U.S. Fish and Wildlife Special Scientific – Report – Fisheries 550:1-105.

Tables

Table 1. Estimates of F_{30} (overfishing mortality rate) for selected stocks of American shad.

River System	F_{30}
Connecticut River	0.43
Hudson River	0.39
Delaware River	0.43
Upper Chesapeake Bay	0.43
Edisto River	0.48
Santee River	0.48
Altamaha River	0.48

Table 2. Summary of mandatory fishery-independent monitoring programs for American shad as required by Addendum I.

State	System	Sampling Program*
ME	Androscoggin and Saco rivers	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates Hatchery evaluation
NH	Lamprey and Exeter rivers	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates
MA	Merrimack River	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates
RI	Pawcatuck River	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates
CT	Connecticut River	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates JAI: Juvenile abundance survey
NY	Hudson River	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates JAI: Juvenile abundance survey
	Delaware River	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates JAI: Juvenile abundance survey
NJ	Delaware River	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates JAI: Juvenile abundance survey

*Annual unless otherwise noted.

Table continued on next page.

Table 2 (cont.). Summary of mandatory fishery-independent monitoring programs for American shad as required by Addendum I.

State	System	Sampling Program*
PA	Susquehanna River	Annual spawning stock survey and representative sampling for biological data
		Calculation of mortality and/or survival estimates
		Recovery of any visibly marked animals
		JAI: Juvenile abundance survey
		Hatchery evaluation
	Lehigh River	Annual spawning stock survey and representative sampling for biological data
		Calculation of mortality and/or survival estimates
		Hatchery evaluation
	Delaware River	Annual spawning stock survey and representative sampling for biological data
Calculation of mortality and/or survival estimates		
JAI: Juvenile abundance survey		
DE	Delaware River	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates
MD	Upper Chesapeake Bay	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates JAI: Juvenile abundance survey Hatchery evaluation
D.C.	Potomac River	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates
VA	James, York and Rappahannock rivers	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates JAI: Juvenile abundance survey Hatchery evaluation
NC	Albemarle Sound and its tributaries; Tar-Pamlico, Neuse and Cape Fear rivers	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates Hatchery evaluation
SC	Santee-Cooper system; Winyah Bay and tributaries (Waccamaw and Pee Dee rivers); Edisto, Combahee, Ashepoo, Coosawatchie, and Savannah rivers	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates ** State may elect to sample these systems on a rotational basis (i.e., one system evaluated per year)
GA	Altamaha River	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates
FL	St. Johns River	Annual spawning stock survey and representative sampling for biological data Calculation of mortality and/or survival estimates

*Annual unless otherwise noted.

Table 3. Summary of mandatory fishery-dependent monitoring programs for American shad as required by Addendum I.

State	System	Sampling Program
ME	In-river	Monitor recreational landings, catch and effort every 5 years.
	Atlantic Ocean	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch.
NH	In-river/coastal	Monitor recreational landings, catch and effort every 5 years.
MA	Merrimack and Connecticut rivers	Monitor recreational landings, catch and effort every 5 years.
CT	Connecticut River	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch.
		Monitor recreational landings, catch and effort every 5 years.
RI	Pawcatuck River	Monitor recreational landings, catch and effort every 5 years.
	Atlantic Ocean	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch. Participate in ocean landings stock composition study.
NY	Hudson River	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch. Monitor recreational landings, catch and effort every 5 years.
	Delaware River	Monitor recreational landings, catch and effort every 5 years. (Cooperative effort between NJ, NY, PA and DE)
NJ	Delaware River and Bay	Monitor recreational landings, catch and effort every 5 years. (Cooperative effort between NJ, NY, PA and DE)
	Atlantic Ocean	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch. Participate in ocean landings stock composition study.
DE	Delaware River and Bay	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch. Monitor recreational landings, catch and effort every 5 years. (Cooperative effort between NJ, NY, PA and DE)
	Nanticoke River (upstream portion of the Chesapeake Bay tributary)	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch. Monitor recreational landings, catch and effort every 5 years.
	Atlantic Ocean	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch. Participate in ocean landings stock composition study.

Table continued on next page.

Table 3 (cont.). Summary of mandatory fishery-dependent monitoring programs for American shad as required by Addendum I.

State	System	Sampling Program
PA	Delaware River	Monitor recreational landings, catch and effort every 5 years. (Cooperative effort between NJ, NY, PA and DE)
MD	In-river	Monitor recreational landings, catch and effort every 5 years.
	Atlantic Ocean	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch. Participate in ocean landings stock composition study.
D.C.	Potomac River	Monitor recreational landings, catch and effort every 5 years.
VA	In-river	Monitor recreational landings, catch and effort every 5 years.
	Atlantic Ocean	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch. Participate in ocean landings stock composition study.
NC	Albemarle Sound and its tributaries;	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch.
	Tar-Pamlico, Neuse and Cape Fear rivers	Monitor recreational landings, catch and effort every 5 years.
	Atlantic Ocean	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch. Participate in ocean landings stock composition study.
SC	Edisto and Santee rivers; Winyah Bay and its tributaries (Waccamaw and Pee Dee rivers)	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch. Monitor recreational landings, catch and effort every 5 years. * State may elect to sample these systems on a rotational basis (i.e., one system evaluated per year).
	Atlantic Ocean	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch. Participate in ocean landings stock composition study.
GA	Ogeechee	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch. Monitor recreational landings, catch and effort every 5 years.
FL	St. Johns River	Mandatory reporting of catch (numbers and weight) and effort from commercial fisheries; sub-samples shall indicate size, age and sex composition of catch.

Table 4.

The 2007 assessed status (recent trend) of American shad populations compared with the status in the 1998 stock assessment. A “?” indicates that either there was insufficient data for analysis or the various data analyses gave conflicting indications of trend. “NA” indicates that information is not available.

State	System	2007 Status	1998 Status
ME	Merrymeeting Bay	Declining	NA
	Kennebec R.	?	NA
	Androscoggin R.	?	NA
	Saco R.	?	NA
NH	Exeter R.	Declining	NA
MA	Merrimack R.	Stable	Stable
RI	Pawcatuck R.	Declining	Stable
CT, MA	Connecticut R.	Stable	Stable
NY	Hudson R.	Declining	Declining
NY, PA, NJ, DE	Delaware R. and Bay	Stable	Stable
MD	Nanticoke R.	Stable	Increasing
MD, PA	Susquehanna R. and Flats	Declining	NA
MD, DC, VA	Potomac R.	Increasing	NA
	York R.	Increasing	Declining
	James R.	Declining	Stable
NC	Rappahannock R.	Stable	Stable
	Albemarle Sound	Stable	NA
	Roanoke R.	Stable	NA
	Tar-Pamlico R.	?	NA
	Neuse R.	?	NA
SC	Cape Fear R.	?	NA
	Winyah Bay	Stable	NA
	Waccamaw R.	?	NA
	Great Pee Dee R.	?	NA
	Santee R.	?	Increasing
	Cooper R.	Stable	NA
	Combahee R.	?	NA
	Edisto R.	Declining	Stable
SC, GA	Savannah R.	Stable	NA
GA	Altamaha R.	Declining	Increasing
	Ogeechee R.	?	NA
FL	St. Johns R.	Stable	NA

Table 5. Regional benchmark total mortality rates (Z_{30}) for American shad stocks as specified in the *American Shad Stock Assessment for Peer Review* (ASMFC 2007a).

Region	Z_{30}
New England	0.98
Hudson River, NY	0.73
York River, VA	0.85
Albemarle Sound, NC	1.01

Table 6. Benchmarks and restoration goals for American shad populations as specified in the *American Shad Stock Assessment for Peer Review* (ASMFC 2007a). “CPUE” stands for catch-per-unit-effort; “GM” stands for geometric mean.

System	Benchmarks/Restoration Goals
New England	<ul style="list-style-type: none"> • Total mortality rate ($Z_{30}=0.98$)
Pawcatuck River, RI	<ul style="list-style-type: none"> • Fish passage Potter Hill Dam equal or greater than the long-term mean of 1,100 fish
Hudson River, NY	<ul style="list-style-type: none"> • Total mortality rate ($Z_{30}=0.73$)
Delaware River, NY, NJ, PA, DE	<ul style="list-style-type: none"> • Shad population of 750,000 fish in the Delaware River Basin for more than 2 consecutive years, estimate • Minimum CPUE of 30 fish per haul in the Lewis haul seine fishery for 3 years
Potomac River, MD, D.C., VA	<ul style="list-style-type: none"> • Geometric mean of pound net landings equal to 31.1 pounds per net-day
York River, VA	<ul style="list-style-type: none"> • Catch rate (GM) equal to 17.44 • Fishing rate ($F_{30}=0.27$) for the Native American fishery • Total mortality rate ($Z_{30}=0.85$)
James River, VA	<ul style="list-style-type: none"> • Catch rate (GM) equal to 6.4
Rappahannock River, VA	<ul style="list-style-type: none"> • Catch rate (GM) equal to 1.45
Albemarle Sound, NC	<ul style="list-style-type: none"> • Total mortality rate ($Z_{30}=1.01$)
St. Johns River, FL	<ul style="list-style-type: none"> • Catch rate greater than 1.0 fish per angler hour

Figures

Figure 1. Coastwide American shad total commercial landings (lbs), 1950-2006 (Source: NMFS).



Figure 2. Total commercial landings (lbs) of American shad from the State of Maine, 1950-2006 (Source: ASMFC 2007a, ME Division of Marine Resources).

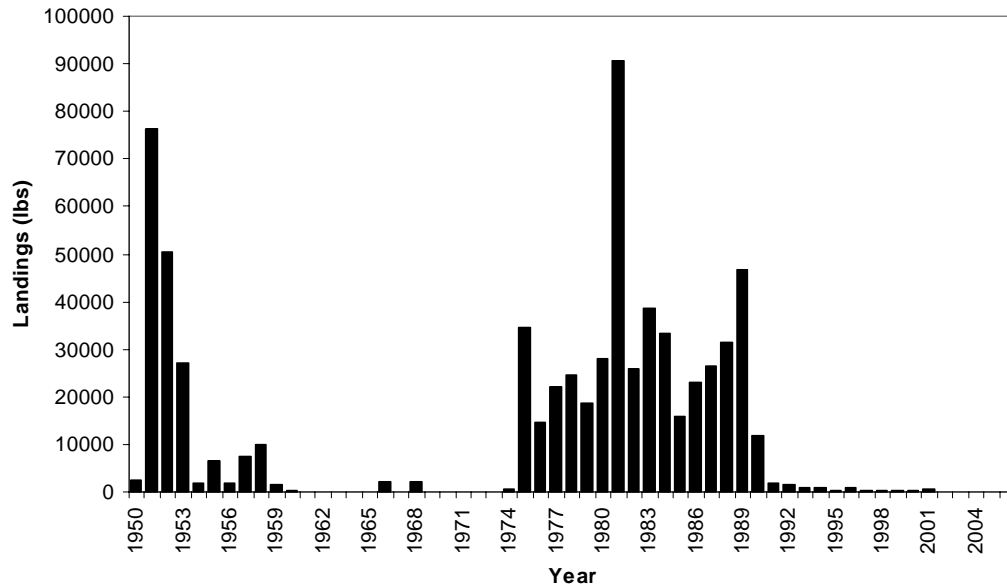


Figure 3. Commercial landings (lbs) of American shad in New Hampshire, 1975-2006
 (Source: ASMFC 2007a, NH Fish and Game).

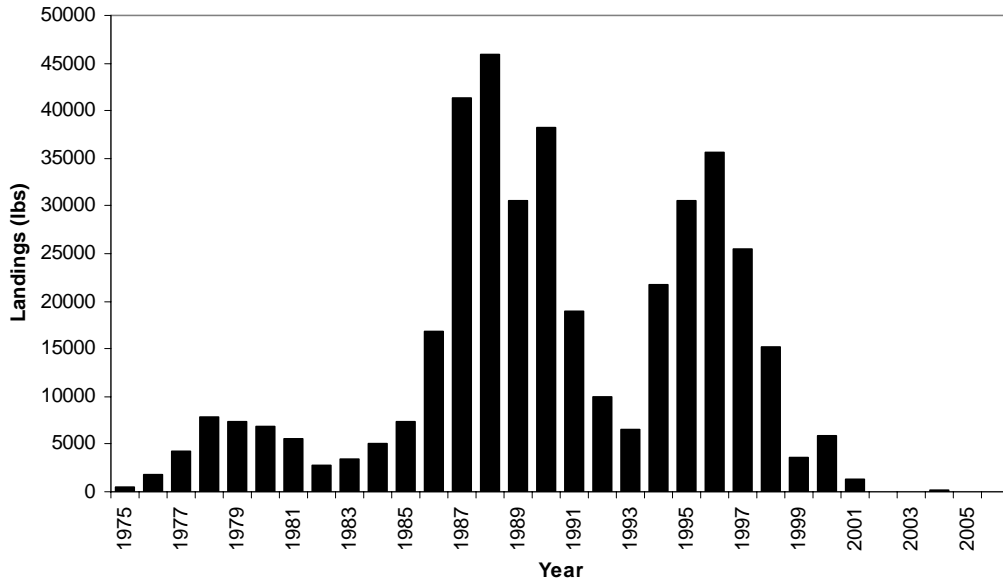


Figure 4. Commercial landings (lbs) of American shad from Massachusetts, 1950-2006
 (Source: ASMFC 2007a, MA Division of Marine Fisheries).

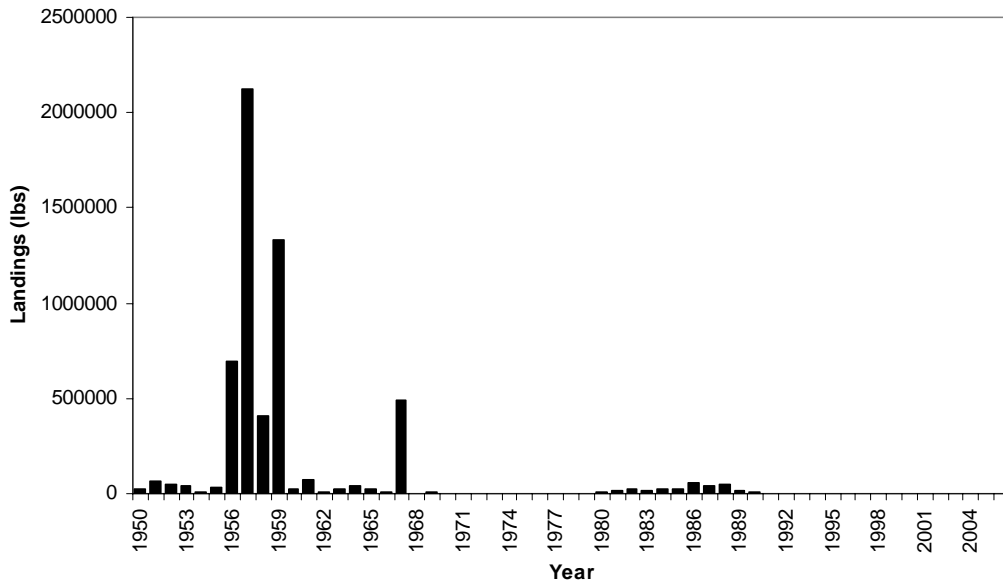


Figure 5. Commercial landings (lbs) of American shad in Rhode Island, 1950-2006 (Source: ASMFC 2007a, RI Division of Fish and Wildlife).

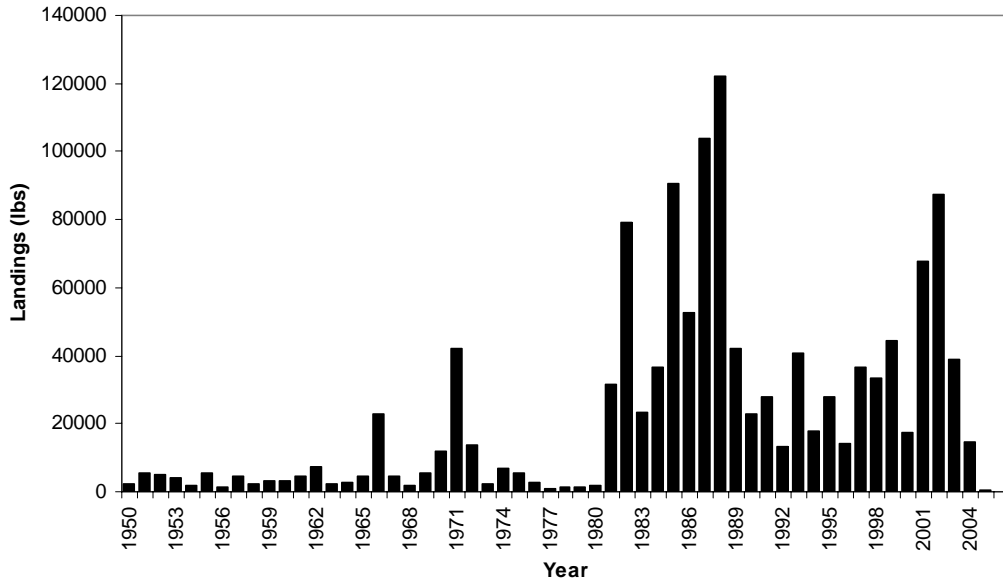


Figure 6. Commercial landings (lbs) of American shad in Connecticut waters, 1950-2006 (Source: ASMFC 2007a, CT Department of Environmental Protection).

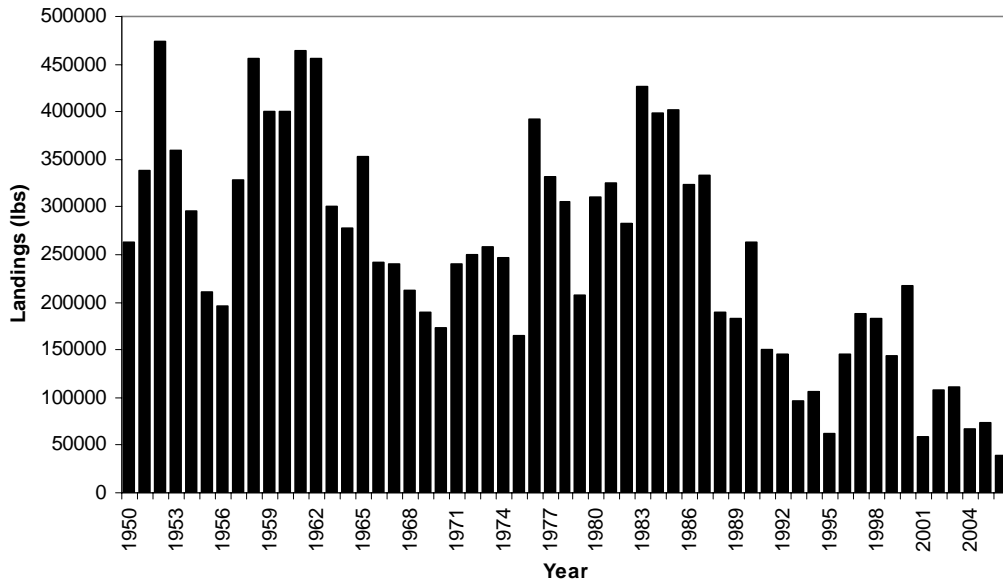


Figure 7. Commercial landings (lbs) of American shad from the Hudson River, 1950-2006 (Source: ASMFC 2007a, NY State Department of Environmental Conservation).

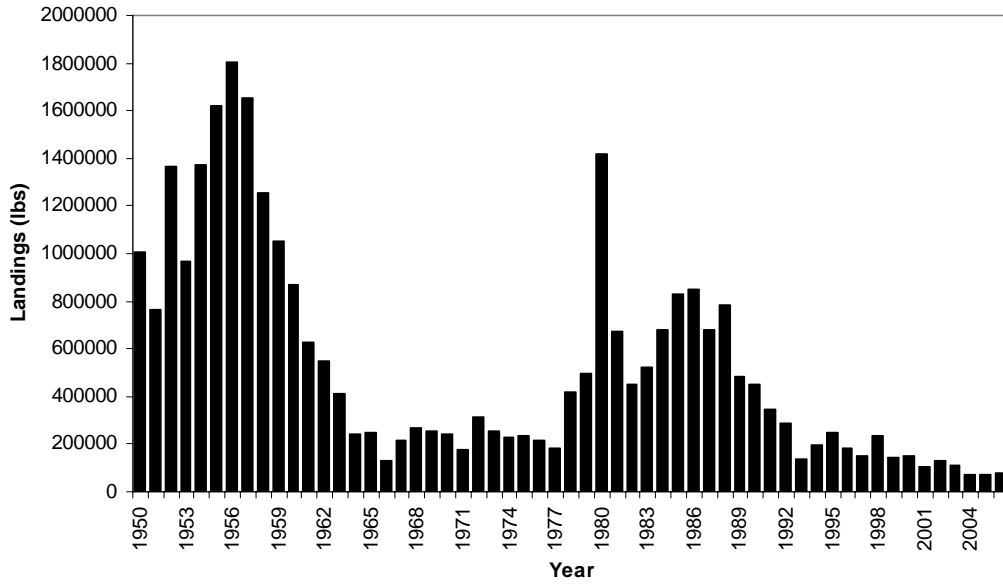


Figure 8. Commercial landings (lbs) of American shad, by state, in the Delaware River Basin, 1954-2006 (Source: ASMFC 2007a, NJ Division of Fish and Wildlife, DE Division of Fish and Wildlife). Landings from the State of Delaware are not available before 1985.

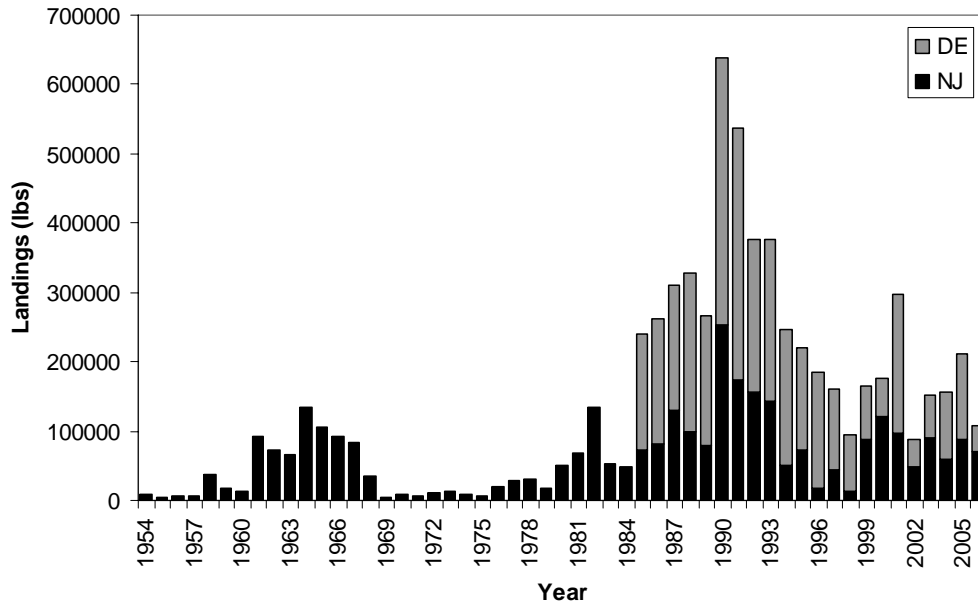


Figure 9. Susquehanna River American shad commercial landings (lbs), 1962-1979 (Source: AMSFC 2007a, MD Department of Natural Resources). The commercial fishery was closed in 1980.

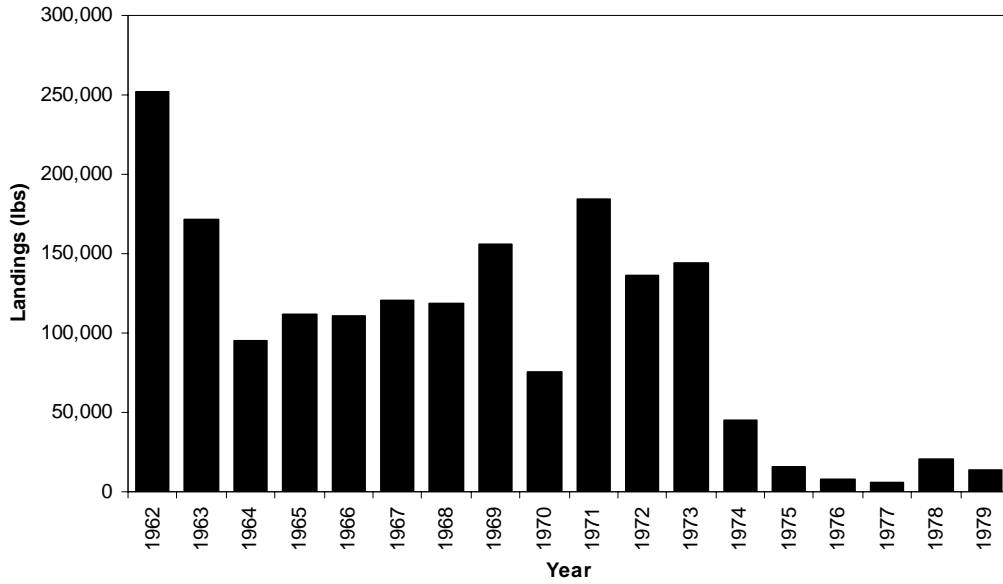


Figure 10. American shad commercial landings (lbs) in Maryland, 1950-1980 (Source: ASMFC 2007a, MD Department of Natural Resources). These data include landings from Chesapeake Bay, Chesapeake Bay tributaries, and the ocean.

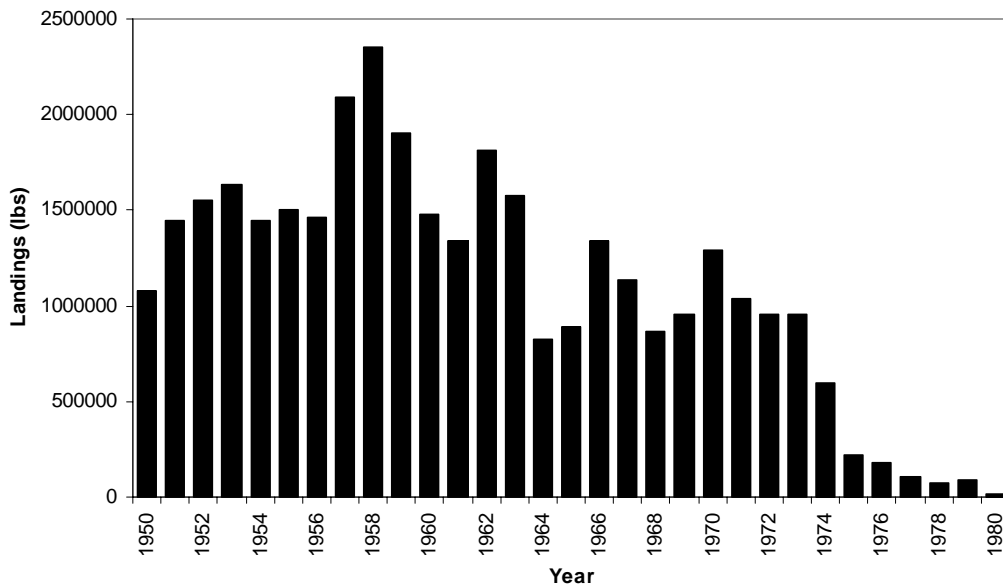


Figure 11. Potomac River American shad commercial landings (lbs) as reported to the Potomac River Fisheries Commission, 1964-2006 (Source: ASFMC 2007a, Potomac River Fisheries Commission).

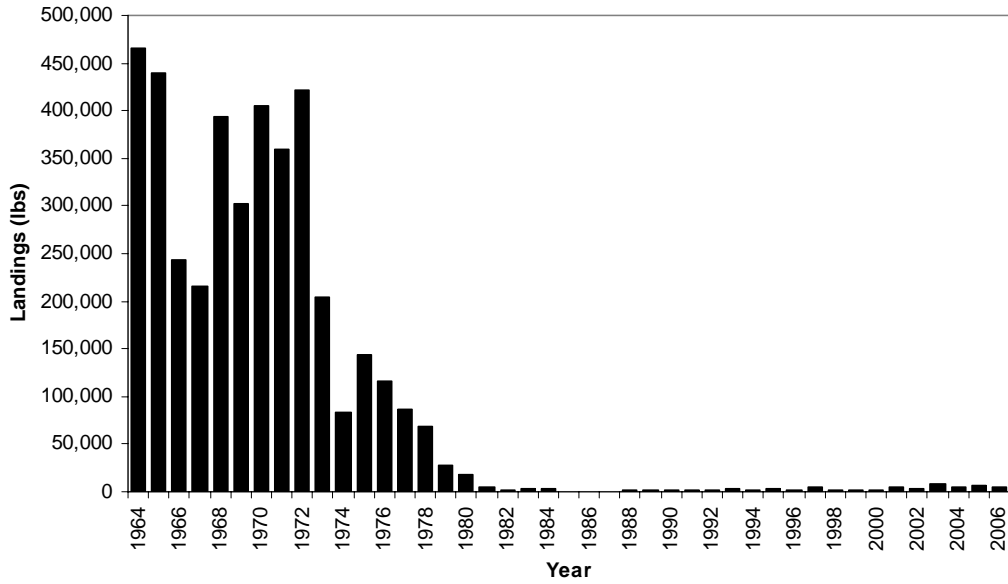


Figure 12. Commercial landings (lbs) of American shad from Virginia waters, 1980-2006 (Source: ASFMC 2007a, VA Marine Resources Commission).

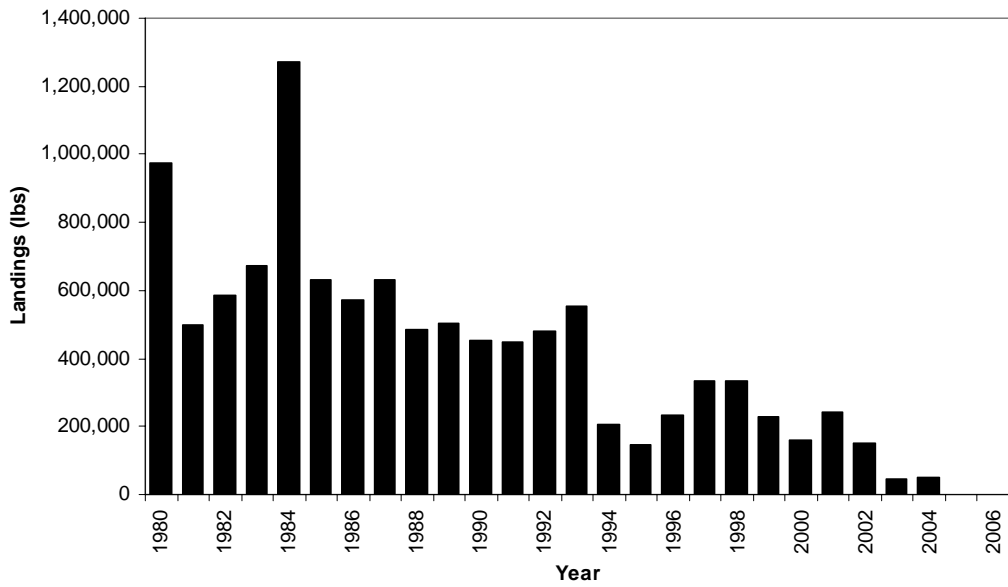


Figure 13. Total commercial landings (lbs) of American shad from North Carolina waters, 1950-2006 (Source: ASMFC 2007a, NC Division of Marine Fisheries).

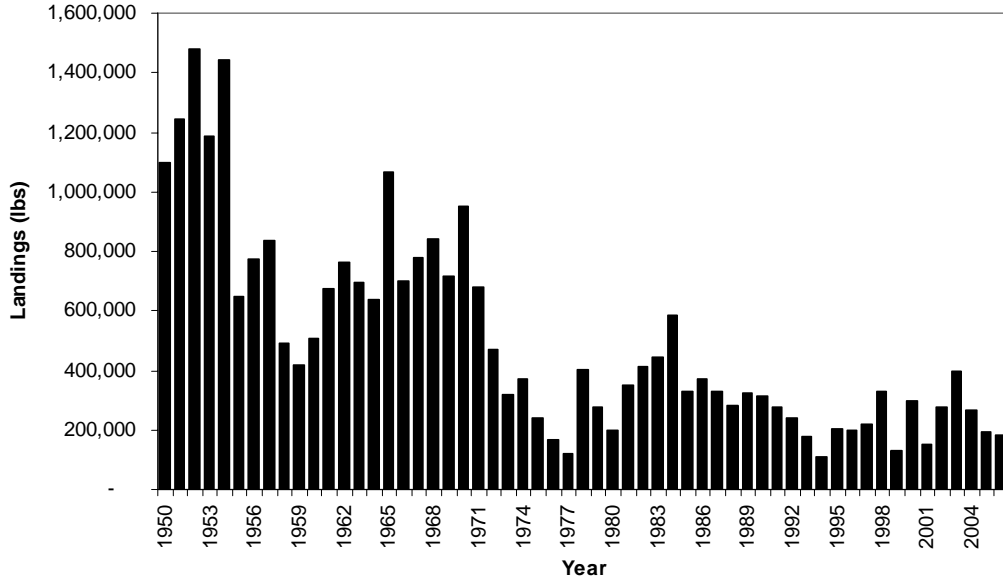


Figure 14. Reported South Carolina American shad commercial landings (lbs), 1980-2006. Beginning in 1998, landings are collected from mandatory catch and effort reports. (Source: ASMFC 2007a, SC Division of Natural Resources).

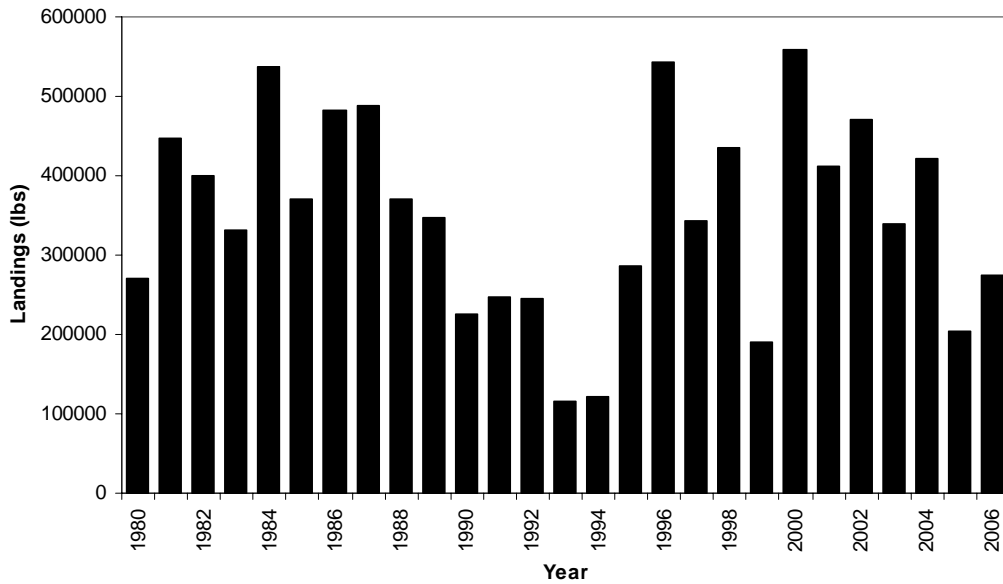


Figure 15. Directed commercial gillnet (set and drift) landings (lbs) of American shad in Georgia, 1962-2006 (Source: ASMFC 2007a, GA Department of Natural Resources).

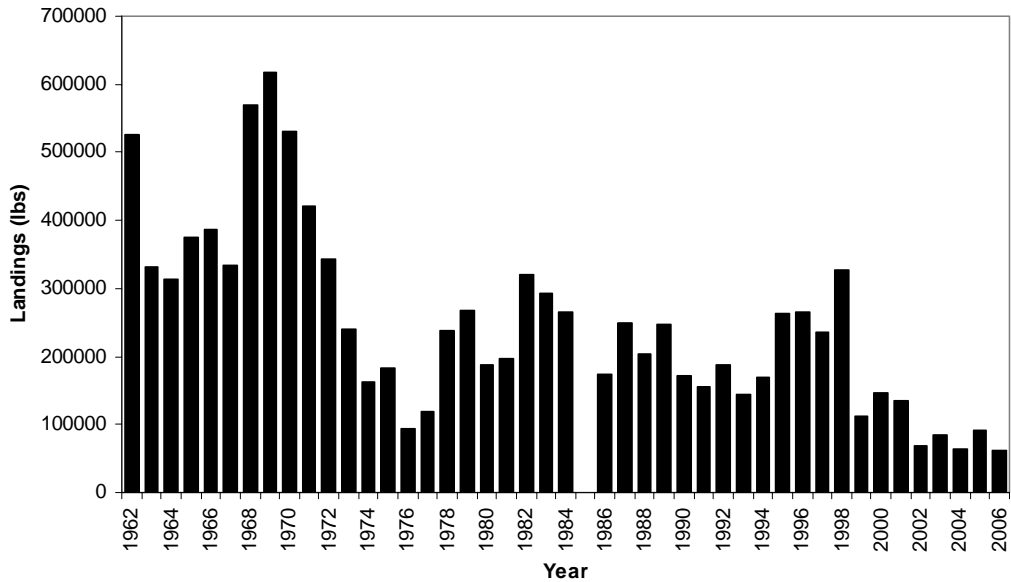


Figure 16. Annual commercial landings (lbs) of *Alosa* in Florida, 1986-2006 (Source: ASMFC 2007a, FL Fish and Wildlife Commission). Landings are presumably all American shad, but reporting did not distinguish between American and hickory shad. Data is restricted to Nassau, Duval, and St. Johns counties (all coastal), and Putnam County (inland).

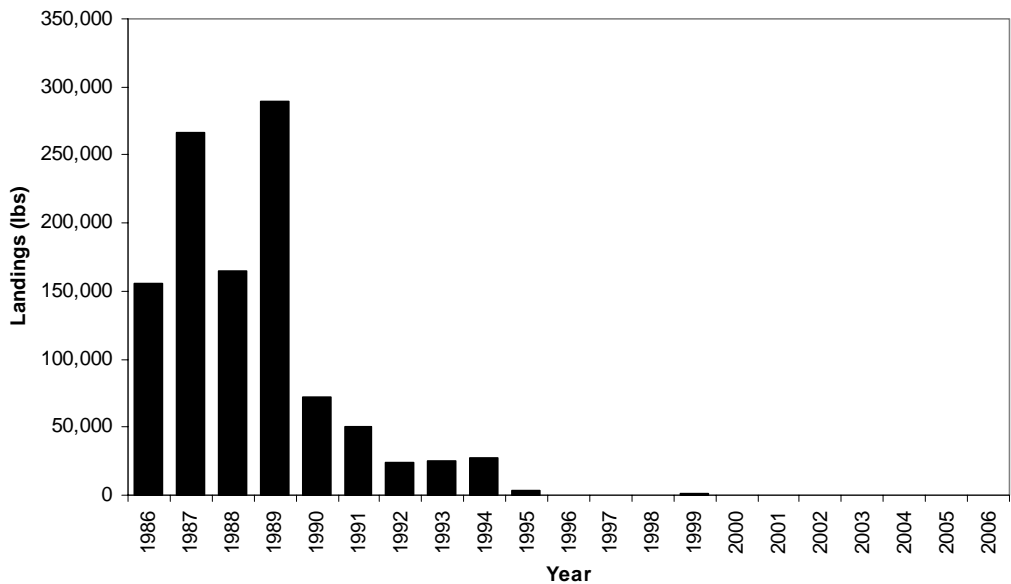


Figure 17. Plots of scale based estimates of total mortality for American shad stocks by river system on the U.S. Atlantic Coast. Z_{30} estimates are plotted for systems compared to the benchmark. “FI” stands for fishery-independent estimates and “FD” stands for fishery-dependent estimates.

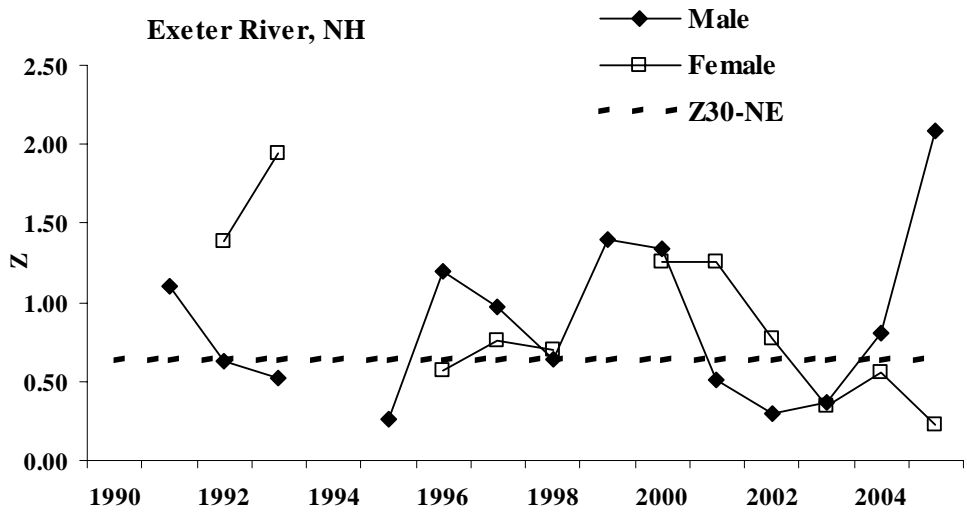
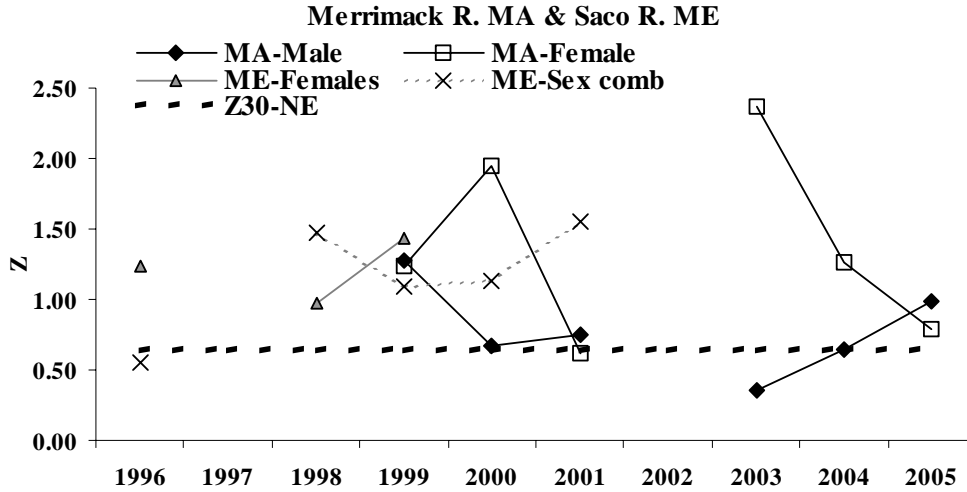


Figure 17 (cont.). Plots of scale based estimates of total mortality for American shad stocks by river system on the U.S. Atlantic Coast. Z_{30} estimates are plotted for systems compared to the benchmark. "FI" stands for fishery-independent estimates and "FD" stands for fishery-dependent estimates.

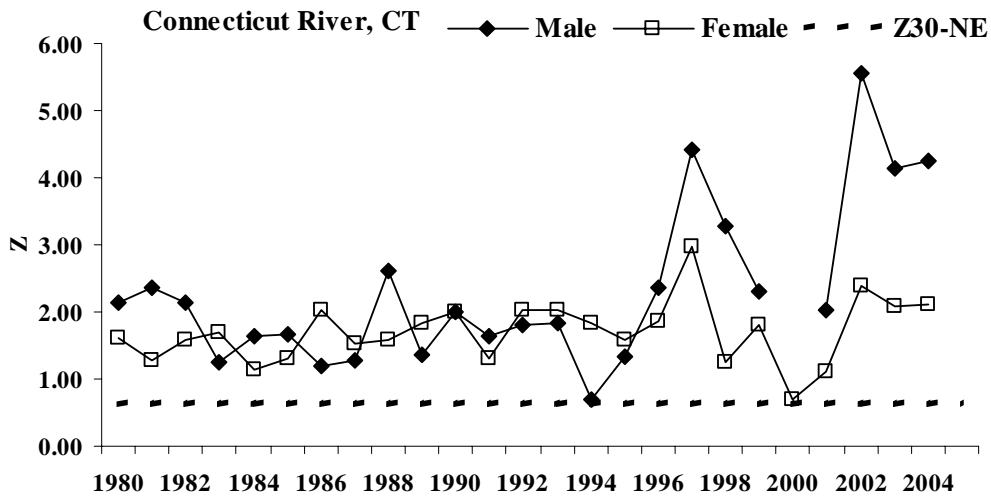
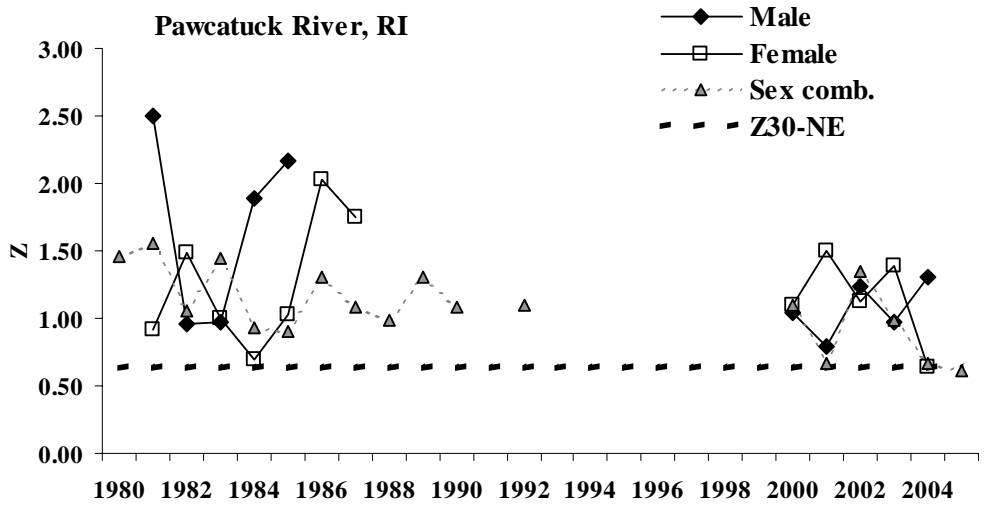


Figure 17 (cont.). Plots of scale based estimates of total mortality for American shad stocks by river system on the U.S. Atlantic Coast. Z_{30} estimates are plotted for systems compared to the benchmark. "FI" stands for fishery-independent estimates and "FD" stands for fishery-dependent estimates.

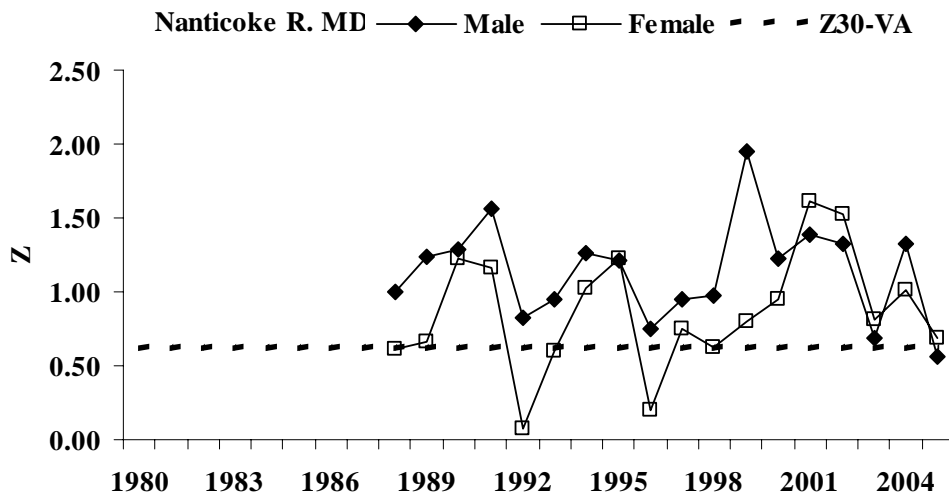
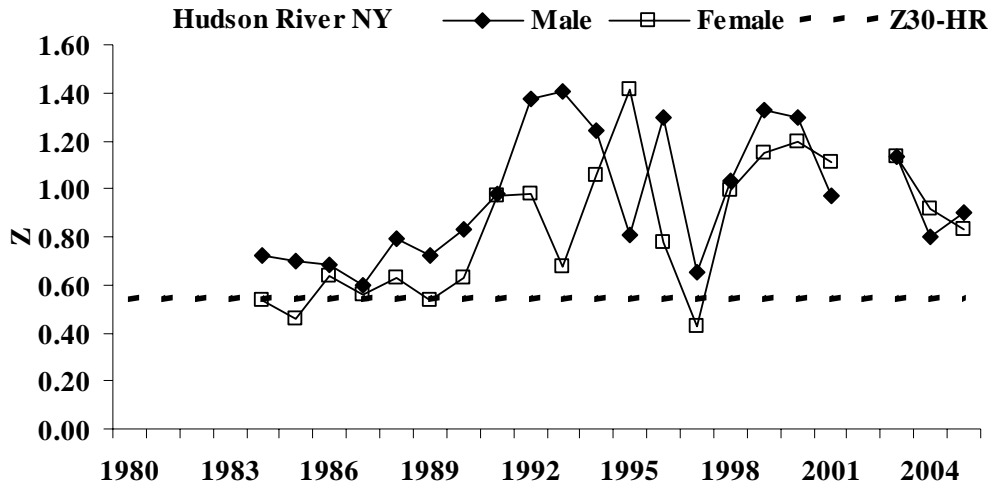


Figure 17 (cont.). Plots of scale based estimates of total mortality for American shad stocks by river system on the U.S. Atlantic Coast. Z_{30} estimates are plotted for systems compared to the benchmark. “FI” stands for fishery-independent estimates and “FD” stands for fishery-dependent estimates.

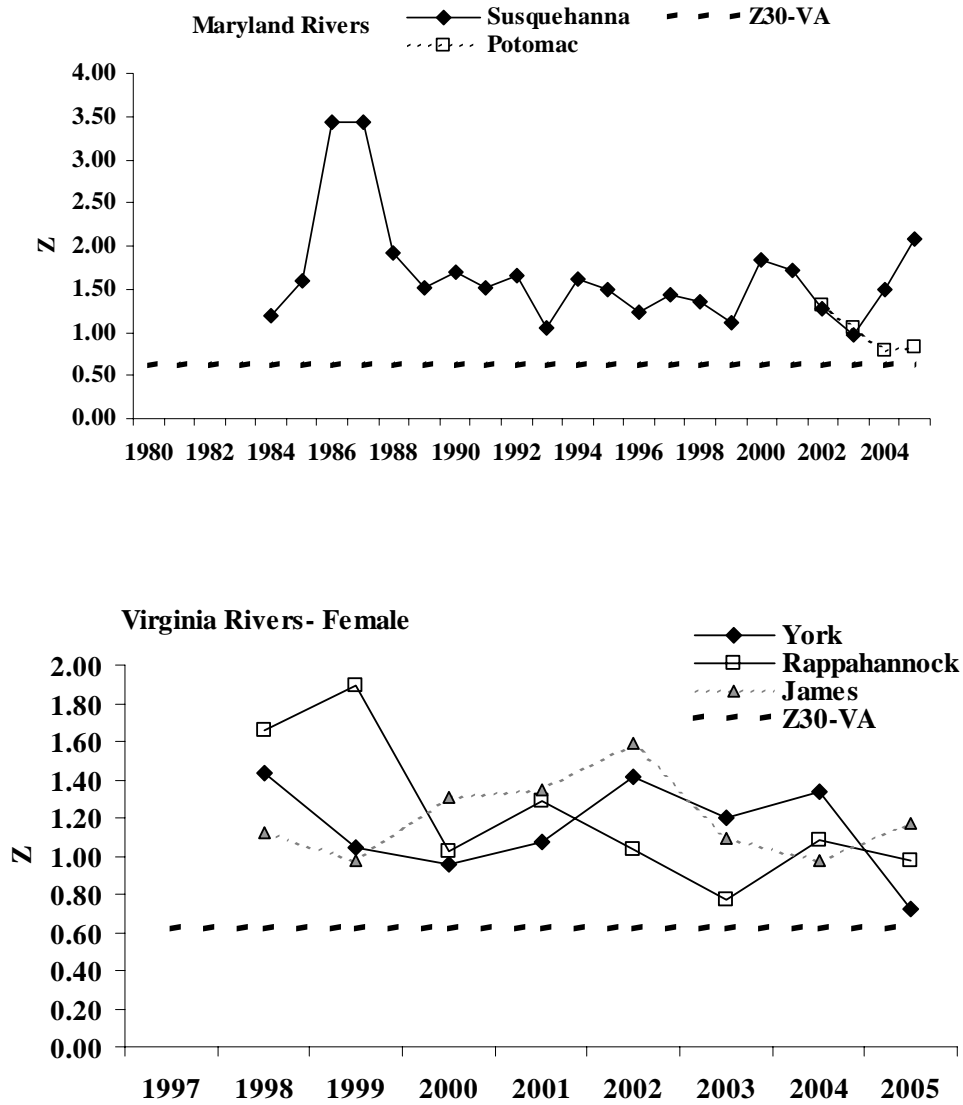


Figure 17 (cont.). Plots of scale based estimates of total mortality for American shad stocks by river system on the U.S. Atlantic Coast. Z_{30} estimates are plotted for systems compared to the benchmark. "FI" stands for fishery-independent estimates and "FD" stands for fishery-dependent estimates.

