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# Atlantic Anadromous Fisheries

## Unit 3



Jim Turek, NOAA Restoration Center

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JOHN KOCIK

RUTH HAAS-CASTRO

GARY SHEPHERD

CHRISTINE LIPSKY

NMFS Northeast Fisheries  
Science Center

Orono, ME  
Woods Hole, MA

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### INTRODUCTION

The anadromous fishes of the Northeast Atlantic are a diverse group and include river herrings (alewife and blueback herring), American shad, hickory shad, striped bass, Atlantic salmon, sturgeons (Atlantic sturgeon and shortnose sturgeon), sea lamprey, and rainbow smelt. Regulation of these stocks is diverse as well. The Atlantic States Marine Fisheries Commission (ASMFC) has implemented fishery management plans (FMP's) for shad, river herrings, and Atlantic sturgeon. Shortnose sturgeon is Federally listed as endangered under the Endangered Species Act (ESA) and managed under a 1998 recovery plan that identifies a recovery strategy and associated tasks. The Gulf of Maine Distinct Population Segment of Atlantic salmon was listed as endangered in 2000 and is managed under a 2005 recovery plan. All other U.S.-origin Atlantic salmon are managed through a New England Fishery Management Council (NEFMC) FMP and by

the North Atlantic Salmon Conservation Organization (NASCO). Striped bass are regulated under an ASMFC FMP and by special Congressional authority under the Striped Bass Conservation Act (implemented by the National Marine Fisheries Service and the U.S. Fish and Wildlife Service).

Recent average landings (2004–06) of Atlantic anadromous species are over 16,000 metric tons (t; Table 3-1, Figure 3-1). This level is higher than a decade ago, but far below historic levels. The recent increase is due to increased striped bass landings; other anadromous species remain low or in decline. Several species have regional importance to recreational fisheries, including American shad, striped bass, and rainbow smelt. Recreational landings are dominated by striped bass, with average landings in recent years exceeding 10,000 t annually. All recreational fisheries for sea-run Atlantic salmon in the United States are closed, with the exception of catch-and-release angling in Maine's Penobscot River. There is a coast-wide moratorium in both

Photo above:  
Alewife in the Nemasket  
River, Massachusetts.

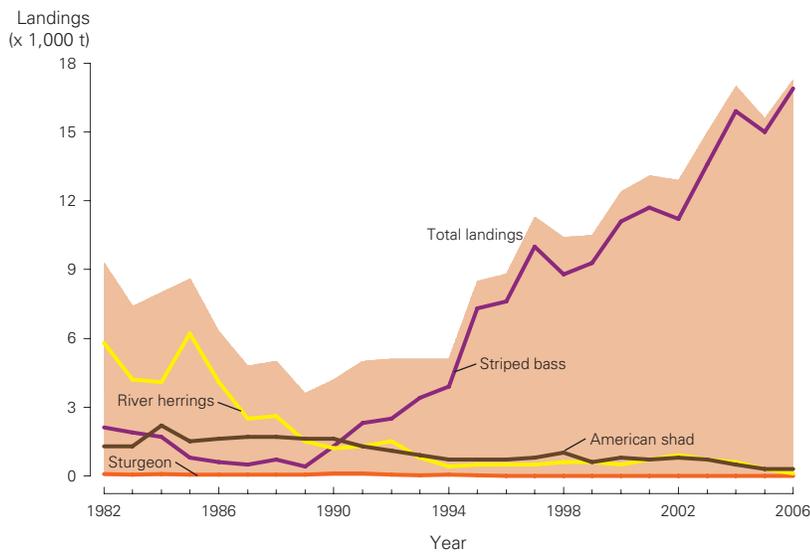
**Table 3-1**  
Productivity in metric tons (t) and status of Atlantic anadromous fisheries resources.

Species/Stock	Recent average yield (RAY) <sup>1</sup>	Current yield (CY)	Sustainable yield (MSY)	Stock level relative to $B_{MSY}$	Harvest rate	Stock status
American shad	367	Unknown	Unknown	Below	Unknown	Unknown
Atlantic salmon	0	Unknown	Unknown	Below	Not overfishing	Overfished
Atlantic sturgeon	0	Unknown	Unknown	Below	Not overfishing	Overfished
River herrings <sup>2</sup>	333	Unknown	Unknown	Unknown	Unknown	Unknown
Striped bass <sup>3</sup>	15,933	Unknown	16,427	Below	Not overfishing	Not overfished
<b>Total</b>	<b>16,633</b>	<b>16,633</b>	<b>17,127</b>			

<sup>1</sup>2004–06 average; includes recreational landings.

<sup>2</sup>Includes alewife and blueback herring, with some localized stocks; the status of aggregate harvest and stock cannot be determined.

<sup>3</sup>Includes significant recreational landings.



**Figure 3-1**  
Landings in metric tons (t) of anadromous stocks, 1982–2006. Atlantic salmon mariculture production is not included (see Figure 3-2).

Federal and state waters for Atlantic sturgeon.

Landings of most Atlantic anadromous species have declined greatly in recent years. River herring catches peaked in 1965 at about 28,000 t coast-wide, declined to less than 500 t, and are remaining at this relatively low level (Table 3-1). Likewise, commercial landings of American shad peaked at over 2,500 t in 1970, but now average around 500 t as well (Table 3-1). Striped bass commercial landings exceeded 6,000 t in 1973, but by 1985 had declined to less than 1,000 t. Following several years of strict management restrictions and reduced annual landings, striped bass populations have recovered and support increased commercial landings that have averaged around 3,000 t annually since 1999. Currently, domestic fisheries for U.S.-origin Atlantic salmon are closed to capture

(catch and release only) and foreign fisheries are under conservation-based quotas. However, sea-cage rearing (aquaculture) of Atlantic salmon in Maine averaged over 11,000 t annually between 1995 and 2001 but has declined to lower levels since, due to revised management plans to reduce disease risks that include fallowing as a key component.

## SPECIES AND STATUS

Unlike most of the offshore resources in the Northeast region, Atlantic anadromous stocks are greatly influenced by human non-fishing activities in the coastal zone. Alteration of river migration routes, thereby blocking access to historic spawning grounds, and pollution have been major factors in the decline of Atlantic salmon, sturgeons, river herrings, and shad. Today, anadromous species face continued threats from coastal development and pollution; when considered along with reduced population sizes, recovery of some stocks is uncertain.

### River Herrings (Alewife and Blueback Herring)

River herrings is the name commonly applied to two species, alewife and blueback herring. The coastal ranges of the two species overlap, with blueback herring found from Nova Scotia to Florida, and alewife from Labrador to South Carolina (Haas-Castro, 2006a). In coastal rivers where both species are present, catches of fisheries targeting these species are typically mixed. Both species are anadromous, migrating upriver from coastal

habitats to spawn during the spring. Alewives are known to live as long as 10 years and reach a length of 36 cm. Blueback herring may live for about 7 or 8 years and reach a maximum length of about 32 cm.

The river herring fishery is one of the oldest documented fisheries in North America. It was exclusively a U.S. inshore fishery until the late 1960's when foreign fleets began to fish for river herrings off the Mid-Atlantic coast, with catches sometimes exceeding 25,000 t. A sharp decline in catches began in the early 1970's and has continued to the present, with total landing levels of less than 1,000 t annually since 1993 (Figure 3-1). Currently, the principal methods of harvesting river herrings include fish weirs, pound nets, and gill nets. Recreational fishing on these species is minimal.

ASMFC prepared a comprehensive coastwide FMP for shad and river herrings to facilitate cooperative management and restoration efforts between the coastal states in 1985 (amended in 1999; ASMFC, 1999). Restoration efforts have involved habitat improvement, fish passage, stocking, and transfer programs. In response to the decline in landings and population abundance, fisheries managers have expressed a need for a more quantitative assessment of river herring. At present, there is limited information available on which to base regulations, but additional data is being collected under provisions of the FMP Amendment I that will provide a better understanding of resource status and a stronger basis for regulatory actions (ASMFC, 2002). A benchmark assessment of river herring populations is scheduled to be completed in 2012. Amendment 1, Technical Addendum 1, and Addendum I to the FMP for American Shad and River Herring (ASMFC, 1999, 2002) are the current management documents for alewife and blueback herring. At present, the Commission is developing an amendment to the FMP intended to address declines in river herring stocks by controlling fishing mortality. At present, all jurisdictions must maintain existing or more conservative recreational regulations for river herring. In 2006, NMFS listed river herring as a species of concern (NMFS, 2007). Four states—Massachusetts, Rhode Island, Connecticut, and North Carolina—have closed their river herring fisheries in response to declining stocks within their waters.



### American Shad

American shad are anadromous members of the Clupeid family. They are found between southern Labrador and northern Florida (Haas-Castro, 2006b). An introduced stock of American shad occurs along the Pacific coast as well. American shad are highly migratory, feeding at sea along the Canadian coast, particularly the Bay of Fundy, in large pelagic schools during the summer, traveling southward along the Continental Shelf during the winter, and then returning to natal rivers to spawn in the spring. Life history patterns vary among individual populations of shad and depend on the latitudinal location of their natal rivers. Most shad remain in the ocean for 4 years before returning to their natal river for their first spawning, although the mean age at first spawning increases to 5 for the more northerly populations. After spawning, American shad north of Cape Hatteras begin a feeding migration and may later return to their rivers to spawn for several subsequent years; more southerly members of the species typically die after a single spawning.

Most major rivers along the Atlantic coast have historically supported spawning stocks of American shad. Shad have been exploited for their meat as well as their roe since the late 19<sup>th</sup> century and are harvested primarily by gillnets in a coastal intercept

Restoration partners and volunteers collect migrating river herrings to move them in trucks above dams to their spawning grounds.

fishery. Recreational angling occurs and is locally significant; however, no comprehensive data are available. Commercial landings remained around 3,000 t during the 1960's, but began to decline in the early 1970's; annual landings since 1999 have been below 900 t (Figure 3-1). Overfishing has been blamed for declines in abundance in the Hudson and Connecticut Rivers, as well as in rivers in Maryland, North Carolina, and Florida. However, dam construction along many larger rivers throughout North America has led to an almost complete disappearance of shad in many watersheds and the loss of their associated fisheries. Additionally, pollution in the lower Delaware River has been cited as the primary cause for the past decline of the fishery in that system.

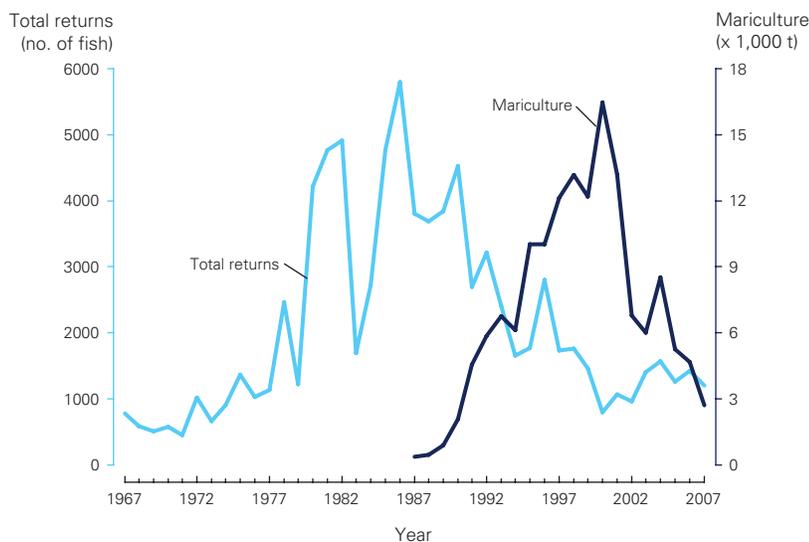
The ASMFC has implemented a coast-wide FMP for American shad and river herring to facilitate cooperative management and restoration plans between the states. Restoration efforts include habitat improvement, fish passage, stocking, and transfer programs. Despite improved runs in some major river systems such as the Susquehanna, Delaware, and Connecticut Rivers, the coast-wide abundance of American shad remains well below historic levels. The 1985 FMP was amended in 1999 with specific measures to control exploita-

tion of American shad populations (ASMFC, 1999). Amendment 1, Technical Addendum 1, and Addendum I to the FMP for American Shad and River Herring are the current management documents for American shad (ASMFC, 1999, 2002). Amendment 1 established a 5-year phase-out of the ocean-intercept fishery for American shad, which closed the fishery by 1 January 2005. In addition, Amendment 1 set fishing mortality targets for specific American shad in-river fisheries and implemented a creel limit of 10 fish daily in recreational fisheries. At present, the Commission is developing an amendment to the FMP in response to the 2007 American shad assessment.

### Atlantic Salmon

Atlantic salmon reside in freshwater streams as juveniles for 2 or 3 years before migrating to the sea, where U.S. populations typically remain for 2 winters (Kocik and Sheehan, 2006). While at sea, U.S. stocks generally undergo extensive migrations to waters off Canada and Greenland before returning to their natal rivers in June and spawning in November. In the United States, Atlantic salmon were once indigenous from the Housatonic River, Connecticut, northward to tributaries of the St. John River, Maine. As a consequence of industrial and agricultural development, all native runs south of the Kennebec River in Maine were extirpated (Fay et al., 2006). The only remaining populations with documented substantial natural reproduction occur in eight small (<100 km) rivers in eastern Maine; these populations are perilously small, with total run sizes of less than 100 spawners annually since 2005. The Penobscot River in Maine retains the largest sea-run U.S. population, averaging about 1,100 returns annually for the past 10 years. The Penobscot population is almost exclusively supplemented by hatchery production (i.e. little natural reproduction is occurring) but is genetically linked to ancestral stocks and thought to be locally-adapted to that watershed (Fay et al., 2006).

The abundance of Atlantic salmon stocks in U.S. rivers is represented by direct counts of adult returns (Figure 3-2). U.S. population abundances, as for most stocks throughout North America, have declined during the past decade, and domestic fish-



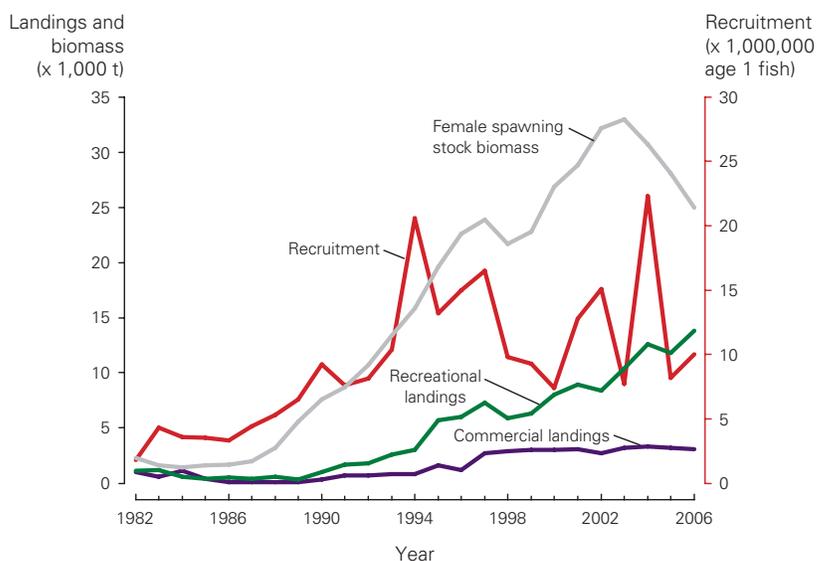
**Figure 3-2**  
Number of Atlantic salmon returning to U.S. rivers and mariculture production in metric tons (t), 1967–2007.

eries in U.S. waters are all closed with the exception of very limited catch-and-release in the Penobscot River. Distant-water commercial gillnet fisheries off Canada and Greenland, which previously exploited U.S. stocks in the high seas, are now regulated more stringently under the auspices of NASCO. Canadian interception fisheries have been closed, and the Greenland fishery is quota-controlled to allow for adequate spawning escapement. Despite these conservation measures, the overall abundance of Atlantic salmon throughout North America continues to decline, and several southern populations may go extinct if they are not supplemented with hatchery fish. Current population recovery efforts in Maine focus on stocking, although expanded efforts in habitat management and conservation are also occurring under the current recovery plan. Restoration efforts, in the form of stocking and fish passage construction, are underway in the Connecticut, Pawcatuck, Merrimack, and Saco Rivers. Most stocking programs operate in a river-specific fashion, collecting broodstock from juveniles or adults in these river systems after 1.5 to 5 years of natural rearing. However, donor stocks are used for the Merrimack and Saco River programs (from the Penobscot River) as well as the Pawcatuck River program (from the Connecticut River).

In the face of declining natural populations, the Atlantic salmon aquaculture industry has grown to fill the production void. In eastern Maine, companies typically rear fish to smolt stage in private freshwater facilities, transfer them into anchored net pens or sea cages, feed them until they reach market size, and then harvest the fish. As a fledgling industry in the early 1980's, growth was rapid and by 1995 annual production exceeded 10,000 t in round weight, peaking in 2000 at over 16,000 t (Figure 3-2). Following to eradicate diseases and changing management practices, however, have reduced annual production to below 5,000 t in recent years, though some rebuilding is expected.

### Striped Bass

Four primary stocks of striped bass occur along the Atlantic coast, in the Hudson River, Delaware Bay, Chesapeake Bay, and Roanoke River, North Carolina (Shepherd, 2006). Striped bass stocks historically have supported important commercial



**Figure 3-3**

Striped bass landings and female spawning stock biomass in metric tons (t) and recruitment in number of fish at age 1, 1980–2006.

and recreational fisheries, with recreational harvests often equaling or exceeding commercial landings (Figure 3-3).

Commercial fisheries use a variety of gears including haul seines, trawls, pound nets, gillnets, and hook-and-line. Commercial landings peaked in 1973 and began to steeply decline thereafter. This decline, coupled with consistently poor recruitment indices in the Chesapeake Bay, required highly restrictive management actions taken by ASMFC in the mid 1980's to conserve and recover the stocks. Improved recruitment and reduced fishing mortality allowed the stocks to rebound to abundance levels similar to the years prior to the decline, and the fishery was partially reopened in 1990. The ASMFC declared Atlantic striped bass fully rebuilt in 1995, permitting further relaxation of management restrictions on the commercial and recreational fisheries.

A recent assessment of the striped bass coastal complex (NEFSC, 2008) indicates that the current level of fishing mortality is below the threshold level, but slightly above the target mortality established in Amendment 6 to the FMP. The large recreational fishery, which includes removals from both landings and discards, accounts for the majority of the fishing mortality. The recent average yield (2004–06) is about 16,000 t (Table 3-1); of that, 80% is attributed to recreational landings. The female spawning stock biomass increased steadily after 1984, reaching a peak in 2003 at 33,000 t,

but declined to 25,000 t in 2006. Spawning stock biomass remains well above the threshold biomass of 14,000 t and has resulted in the production of historically large year-classes in 2001 and 2003 (Figure 3-3). This high recruitment should foster continued population growth under targeted levels of fishing mortality.

### Atlantic and Shortnose Sturgeon

Sturgeon species are distributed along the east coast of the United States and Canada from Florida to New Brunswick. Atlantic and shortnose sturgeons are two species native to this range. Both species supported a substantial commercial fishery during the late 1800's, but today only remnant populations remain. Sturgeons have been adversely affected by degradation of rivers, starting during the industrial revolution, and from overfishing. Recovery is hampered by the lack of effective fish passage facilities at dams, bycatch of sturgeon in other directed fisheries, and poor habitat conditions.

The life history patterns for the two species of sturgeon are very similar. Both are benthic (bottom) feeders and consume a variety of crustaceans, bivalves, and worms. Atlantic sturgeon migrate from the marine environment to fresh water to spawn during late winter through early summer, with migrations occurring later in the year at higher latitudes. Shortnose sturgeon are considered amphidromous<sup>1</sup> in the northern part of their range—juveniles and adults regularly enter estuarine environments during various times of the year, but adults migrate to freshwater spawning areas, predominantly in their natal rivers. In waters where the species co-occur, the shortnose sturgeon tends to begin its migration earlier than the Atlantic sturgeon. For Atlantic sturgeon, spawning generally occurs in the lower sections of rivers, below the fall line. In populations of shortnose sturgeon that have free access to the total length of a river (e.g. no dam within the species' range in the river), spawning areas are located at the most upstream reach of the river used by sturgeon. The two species are long-lived, with lifespans exceeding 20 years.

<sup>1</sup>Amphidromous fish move between fresh and salt water during some part of their life cycle, but not for breeding.

Maturing late in life, sturgeons are highly fecund and show increases in egg production as females grow larger. The most obvious difference between Atlantic and shortnose sturgeon is their adult size; shortnose sturgeon reach body lengths of approximately 100 cm (40 in) whereas Atlantic sturgeon can attain more than twice that length.

Shortnose sturgeon was listed as endangered throughout its range in 1967 under the Endangered Species Preservation Act of 1966 (a predecessor to the Endangered Species Act of 1973). The species' status was last officially examined in 1987; the status review was never finalized but information was used to develop a recovery plan for the shortnose sturgeon in 1998. Research and monitoring programs and conservation actions by Federal, state, and private entities have been ongoing. As a result, new information is available, and a new status review is ongoing, with expected completion in 2009.

Atlantic sturgeon was commercially harvested throughout much of its range through the early 1990's under ASMFC management plans. Managers believe that overharvesting of sturgeon continued through the 1990's until ASMFC and Federal agencies implemented a coast-wide moratorium in 1998. The result has been cessation of targeted fisheries for sturgeon (Figure 3-1). Because the population has been severely overfished, the ASMFC Interstate FMP for Atlantic Sturgeon calls for a rebuilding of 20 year-classes, which is estimated to take about 40 years from 1998. In 2005, NOAA updated the Atlantic sturgeon status review to reevaluate whether this species required protection under the ESA. The Status Review Team (SRT) determined that Atlantic sturgeon populations function within five distinct population segments (DPS's) from the Gulf of Maine unit in the north to the South Atlantic unit in the south (ASSRT, 2007). The most significant threats to all of the DPS's are bycatch mortality, poor water quality, lack of adequate state and/or Federal regulatory mechanisms, and dredging activities. Additional stressors that are unique to some DPS's include habitat impediments and ship strikes. This additional information is currently being used to determine whether listing is warranted under the ESA.



Eileen McEvoy, NOAA Central Library

Juvenile Atlantic sturgeon in a conservation culture project at the University of Florida, Department of Fisheries and Aquatic Sciences Program.

## ISSUES

### Transboundary Stocks and Jurisdiction

The interception of U.S.-origin Atlantic salmon in commercial fisheries off Canada and western Greenland was thought to be an impediment to the restoration of runs and U.S. fisheries. However, beginning in 1992, the largest portion of the Canadian fishery was closed. Likewise, the Greenland fishery quota, set to meet spawning escapements to North American rivers, should provide adequate protection. If these conservation tools, implemented through NASCO, remain in place, the threat of the interception fisheries to U.S. stocks should be greatly reduced.

The St. Croix International Waterway Commission was established by the Maine and New Brunswick legislatures to plan for a heritage management plan for the St. Croix boundary corridor in 1987. This commission is often in the center of U.S.–Canada anadromous fish issues, especially those related to Atlantic salmon and river herrings, and facilitates a unified approach to management. The passage of river herrings to upstream lakes remains a controversial issue, with U.S. Federal agencies and Canada supporting restoration of access for river herrings while some state agencies and tribal entities in Maine are concerned about impacts on smallmouth bass fisheries and understanding the historical extent of herring distribution.

### Endangered Species Concerns

Anadromous Atlantic salmon throughout their U.S. range are at low levels of abundance. The Gulf of Maine DPS of Atlantic salmon has been listed as endangered under the ESA. The remaining populations in the Gulf of Maine tributaries and those of the Penobscot River represent the last naturally spawning populations in the United States.

Shortnose sturgeon is listed as endangered throughout its entire range. The recently completed status review of Atlantic sturgeon resulted in a delineation of five DPS's; three of these are at critically low levels of abundance, and the review recommended ESA protection (ASSRT, 2007). A formal decision is pending but active research and protection measures are moving forward. NMFS is

committed to improving the health of these species to make them viable populations with sustainable fisheries through its partnership with the states and other Federal partners as well as non-governmental organizations.

### Management Controls

An issue of particular concern for striped bass is the potential impact of discard mortality. Recreational fishing effort for striped bass currently far exceeds commercial effort, and over 90% of the recreational catch was released alive during the last decade. Even with high survival rates of catch-and-release striped bass, the potential for hooking mortality in recreationally caught fish may reduce the conservation benefit of large minimum-size regulations. As striped bass populations increase, another concern is the greater likelihood of striped bass bycatch in commercial fisheries targeting other species. There is a desire among all parties not to reverse the progress made in rebuilding the severely depleted spawning stocks in Chesapeake Bay.



William B. Folsom, NMFS

A recreational angler prepares to release an undersize striped bass from the pier at Pirates' Cove Marina in Manteo, North Carolina.

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