*Atlantic States Marine Fisheries Commission*

# Amendment 3 to the Interstate Fishery Management Plan for Atlantic Herring

**February 2016**

*ASMFC Vision: Sustainably Managing Atlantic Coastal Fisheries*

# Amendment 3 to the Interstate Fishery Management Plan for Atlantic Herring

Prepared by

Atlantic States Marine Fisheries Commission
Atlantic Herring Plan Development Team

Plan Development Team Members:
Renee Zobel, New Hampshire Fish and Game
Dr. Matthew Cieri, Maine Department of Marine Resources
Micah Dean, Massachusetts Division of Marine Fisheries
Dr. Madeline Hall-Arber, MIT Sea Grant
Lori Steele, New England Fisheries Management Council
Ashton Harp (Chair), Atlantic States Marine Fisheries Commission

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# EXECUTIVE SUMMARY

Amendment 3 consolidates prior amendments (and associated addenda) and recent management decisions into a single document; it is now the comprehensive document for Atlantic herring management in state waters.

**Statement of the Problem**

The Atlantic Herring Management Section initiated Amendment 3 to review the applicability of an empty fish hold provision for category A and B vessels, consider a year-round set-aside for fixed gear fishermen west of Cutler and to re-examine the parameters of the spawning closure monitoring system in light of more than two decades worth of data.

**Description of the Resource**

Atlantic herring are distributed along the east coast of North America from Canada to North Carolina occupying major estuaries, coastal waters and offshore waters to the continental shelf. There are three recognized stocks in the Atlantic herring complex, however due to inter-seasonal mixing Atlantic herring are assessed in the United States as a single coastal stock. See *Section 1.2* for more information.

**Life History and Habitat Requirements**

Throughout its life stages Atlantic herring are an important prey species for a large number of piscivorous fish, elasmobranchs, marine mammals and seabirds in the northeastern United States. Male and female herring grow at about the same rate and become sexually mature beginning at age-3, with most maturing by age-4. Spawning occurs in the summer and fall—eggs are laid in layers and form mats as thick as 4-5 cm. Juvenile herring in all stocks tend to remain in coastal areas throughout the year. Adult herring have distinct migratory patterns relative to each spawning stock. See *Section 1.2.1* for more information.

**Fishery Description**

The fishery is predominantly commercial; recreational catch accounts for less than 1% of the overall catch. Total commercial catches during 1965-2014 ranged from 98.35 million pounds (lbs.) in 1983 to 1 billion lbs. in 1968. Total catches from 2010-2014 ranged from 175.1 million lbs. in 2010 to 224.0 million lbs. in 2013 and averaged 198.5 million lbs.

Catch in the mobile gear fishery peaked in the late 1960s and early 1970s, largely due to efforts from foreign fleets. Catch in the mobile gear fishery has been relatively stable since about 2000 and has accounted for most of the Atlantic herring catches in recent years. Catch in the fixed gear fishery has been variable, but has declined and has been relatively low since the mid-1980s. See *Section 1.3* for additional information.

**Goals and Objectives**

The goals of Amendment 3 are to manage the Atlantic herring fishery in a manner that accounts for the viability of current participants in the fishery, achieves optimum yield and prevents overfishing of the resource. The Amendment objectives are designed to protect spawning herring

and prevent overfishing of discrete spawning units, account for its value as a forage species, and maximize domestic use of the resource. See *Section 2.0* for additional information.

**Description of the Management Unit**
The management unit is defined as within United States waters of the northwest Atlantic Ocean from the shoreline to the seaward boundary of the Exclusive Economic Zone. Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, and New Jersey have declared an interest in the resource. The fishery is divided into four distinct management areas designated as 1A, 1B, 2 and 3. The boundaries of the management areas are consistent with the federal fishery management plan. See *Section 2.4* for additional information.

**Management Program Implementation**
The fishing year for Atlantic herring will be from January 1-December 31. Specifications for future fishing seasons will be implemented with the beginning of the fishing year, January 1.

**Recreational Fisheries Management Measures**
No recreational fisheries management measures are included in this amendment.

**Commercial Fisheries Management Measures**
Amendment 3 management measures are detailed in *Section 4.0*; key measures are summarized below:
*Specifications* – The Section will set specifications for up to three years, including sub-annual catch limit (ACL), quota periods and whether to allow fishing before June 1.

*Quota Rollover* – Up to 10% of quota in a management area can carry over to the first fishing year after final landings data are available, provided the ACL is not exceeded for the entire fishery.

*Harvest Control Measures* – For all management areas, directed fisheries in a management area will close when 92% of the sub-ACL is projected to be reached, and the stockwide fishery will close when 95% of the total ACL is projected to be reached.

*Bycatch Allowance* – A 2,000 pound bycatch allowance will continue when the directed fishery is closed.

*Research Set-Asides* – Up to 3% of the sub-ACL from any management area or the stockwide ACL for the herring fishery can be set-aside to support herring related research activities.

*Fixed Gear set-Aside* – Up to 500 mt of the annual Area 1A sub-ACL is set-aside for Maine fixed gear fisheries (weirs and stop seines) west of Cutler.

*Days Out* – Prior to a quota period, the Section will set the number of consecutive ‘days out’ per week for Area 1A. Harvesters are prevented from landing herring during a ‘day out’ of the fishery.

*Spawning Restrictions* – The amendment defines three spawning areas (Eastern Maine, Western Maine, Massachusetts/New Hampshire) to be monitored during the duration of herring spawning in the summer and fall. On an annual basis, each spawning area will have a four-week closure

with the possibility of a two week extension. When a spawning area is closed there is a zero tolerance provision, vessels are prohibited from fishing for, taking, landing or possessing herring from within the respective spawning area. The fixed gear fishery east of Cutler is exempt from spawning area restrictions.

*Bycatch allowance for Days Out and Spawning Area Closure* – During a 'day out' or a spawning area closure, vessels participating in other fisheries may land an incidental catch of herring that does not exceed 2,000 pounds per trip. Vessels transiting through a closed area with more than 2,000 pounds of legally caught herring on board must have all seine and trawl gear stowed.

*Prohibition of Directed Mealing* – The harvest of herring for the primary purpose of reduction to meal or meal-like product is prohibited.

*Prohibition of IWPs in State Waters* – Internal water processing are prohibited from processing herring caught in all state waters.

**De Minimis**
States may apply for *de minimis* if the combined average of the last three years of commercial landings (by weight) constitute less than one percent of the coastwide commercial landings for the same three-year period.

**Mandatory Elements of State Program**
States in the management unit must implement the regulations for Atlantic herring consistent with the requirements of *Section 4.0*; except a state may propose an alternative management program under *Section 4.5*.

**Compliance Schedule**
Each state must submit an annual compliance report no later than February 1.

**Implementation Schedule**
States are required to implement the provisions of Amendment 3 by June 1, 2016.

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# 1.0 INTRODUCTION

The Atlantic States Marine Fisheries Commission (ASMFC) is responsible for managing Atlantic Herring (*Clupea harengus*), under the authority of the Atlantic Coastal Fisheries Cooperative Management Act (ACFMA). The U.S. Atlantic herring fishery is currently managed as a single stock through complementary fishery management plans (FMPs) by ASMFC and the New England Fishery Management Council (NEFMC). ASMFC has coordinated interstate management of Atlantic herring in state waters (0-3 miles) since 1993. Management authority in the exclusive economic zone (EEZ, 3-200 miles from shore) lies with the NEFMC and NOAA Fisheries.

Amendment 3 consolidates prior amendments (and associated addenda) and recent management decisions into a single document; it is now the comprehensive document for Atlantic herring management in state waters.

## 1.1 STATEMENT OF THE PROBLEM

The Atlantic Herring Management Section initiated Amendment 3 to integrate recent data into management decisions and respond to changes in the stock structure and fishery. Specific areas of management that were evaluated in the development of this amendment include spawning area efficacy, the fixed gear set-aside and an empty fish hold provision. The rational for considering changes to these are as follows.

*Spawning Area Efficacy* – While Atlantic herring reproduce in the same general season each year, the onset, peak and duration of spawning may vary by several weeks annually because of changing oceanographic conditions (e.g., sea temperature, plankton availability). In an effort to protect the integrity of the spawning stock and allow for the potential of increased recruitment, ASMFC developed a system of seasonal spawning closures (in the early 1990s) to account for this annual variability in spawning time. At the time of development the available data to derive the parameters of the spawning closure system were limited.

Since the initiation of the spawning closure system, samples have been collected from the commercial fishery, which is dependent upon interactions with spawning fish. However, a vessel can avoid spawning fish if they are not fishing in a spawning area or through potential gear biases. Samples from Maine and Massachusetts are analyzed separately, and sometimes contained too few fish to confidently characterize spawning stages. Therefore it was not always possible to collect sufficient samples to inform managers if/when spawning fish were in a spawning area. This led to an increasing reliance on default closure dates.

Due to concerns the spawning closures did not adequately protect spawning fish in the areas they spawn the Atlantic Herring Technical Committee was tasked with analyzing over a decade of spawning sampling data to improve upon the spawning closure system. Analysis indicated the current population of herring is quite different today, as the stock has rebuilt since the early 1990s. There is a broad range of age classes, with older and larger fish, when compared to the

stock during overfished conditions and fish are arriving at the spawning grounds at different times (e.g., larger fish can swim faster and arrive earlier than smaller fish).

*November 1 Rollover in the Fixed Gear Set-Aside* – A portion of the Area 1A sub-ACL has been deducted at the beginning of the fishing year and set-aside for fixed gear fishermen west of Cutler until November 1, after such time any unused set-aside is available to mobile gears in Area 1A. November 1 was initially established as the rollover date because, traditionally, herring have migrated out of the Gulf of Maine by that time of the year. However, fixed gear fishermen report herring coming up mid-coast Maine through the month of November and requested year-round access to the fixed gear set-aside.

*Empty Fish Hold Provision* – The Atlantic herring fishery has not previously required fish holds to be empty prior to trip departure. However there are concerns that unsold herring are dumped at sea if there is not enough market demand for the resource. Therefore the requirement for fish holds on limited access herring vessels be empty before leaving the dock on any trip when declared into the Atlantic herring fishery has been proposed to encourage less wasteful fishing practices. Additionally, fish from multiple trips can be mixed if the holds are not completely emptied—this has the potential to compromise landings data used to inform harvest control measures and bycatch avoidance programs, particularly for river herring. Also, leaving fish in the vessel's hold prevents portside samplers from observing the entire catch. NEFMC included a complementary empty fish hold provision in Draft Herring Framework Adjustment 4 to the Federal Herring FMP; at the time of Amendment 3 approval NOAA Fisheries had not issued a final ruling.

### 1.1.2 Benefits of Implementation

Amendment 3 enhances spawning protections for Atlantic herring in the Gulf of Maine and creates an incentive for better managed fishing practices to reduce impacts to species which are ecologically associated with Atlantic herring while minimizing adverse effects on participants in the fishery.

#### *1.1.2.1 Social and Economic Benefits*

The goal of the Atlantic Herring FMP is to enhance spawning protections for Atlantic herring, incentivize sustainable fishing practices, and improve accountability measures for directed catch and incidental bycatch of river herring. Adequate protections of the reproductive stock of Atlantic herring is intended to result in better recruitment during favorable environmental conditions. Spawning closures therefore help ensure a stable fishery over time and in turn provides a measure of security to individuals and communities dependent on the resource. Intended outcomes include continued availability and accessibility to the fish, and better quality and prices. For more information on socioeconomic impacts, see *Section 1.5.2*.

#### *1.1.2.2 Ecological Benefits*

Amendment 3 includes a pilot program for the spawning closure monitoring system that integrates observations from more than a decade of spawning sampling data. In the 2016 fishing

year, and potentially beyond if accepted by the Atlantic Herring Section, fisheries biologists from Maine and Massachusetts (where spawning analysis is conducted) will pool samples to forecast the onset of spawning. Utilizing a forecasting method to predict the onset of spawning, instead of reacting when spawning fish hit the dock has the potential to alleviate spawning closure timing concerns. Sampling sources have been widened to include commercial catch and fishery independent samples to better ensure sufficient data to inform a closure. These measures are a refined effort to protect the integrity of the spawning stock and allow for increased recruitment. It also addresses the inter-annual variability in spawning events as dictated by oceanographic conditions, such as sea temperature. For more information on biological and ecological impacts, see *Section 1.5.1*.

## 1.2 DESCRIPTION OF THE RESOURCE

Atlantic herring are distributed along the east coast of North America from Canada to North Carolina occupying major estuaries, coastal waters and offshore waters to the continental shelf. There are three recognized stocks in the Atlantic herring complex: 1) Southwest Nova Scotia-Bay of Fundy, 2) coastal waters of the Gulf of Maine, and 3) Georges Bank, including Nantucket Shoals. Due to inter-seasonal mixing, herring are assessed in the U.S. as a single coastal stock at this time.

Evidence for separate stocks are derived from separate larval distribution patterns (Iles and Sinclair, 1982), differences in spawning times and locations (Boyar et al., 1973; Haegele and Schweigert, 1985) and distinct biological characteristics, such as growth rates (Anthony and Waring, 1980), physical characteristics (Anthony, 1981; Safford, 1985) and the incidence of parasites (McGladdery and Burt, 1985). Attempts to further differentiate geographically isolated fall spawning stocks in eastern Canada and the northeast U.S. on the basis of genetic characteristics have been unsuccessful (Kornfield et al., 1982; Kornfield and Bogdanowicz, 1987; Safford and Brooke, 1992).

The most compelling evidence supporting the existence of separate stocks was the collapse of the large Georges Bank-Nantucket Shoals stock in the early 1970s after several years of heavy fishing by foreign fleets. This stock remained in a depressed state for approximately ten years, while the smaller Gulf of Maine stock continued to support a strong coastal fishery.

Major spawning areas are restricted to the northern region (Cape Cod to Newfoundland) of the Atlantic herring distribution. The Gulf of Maine-Georges Bank stock complex contains three major spawning areas: 1) Georges Bank, 2) Nantucket Shoals, 3) coast of Gulf of Maine.

Each major spawning area is composed of smaller, discrete spawning sites—some are as close as 10-15 miles of each other (e.g., Trinity Ledge and Lurcher Shoals off the southwest coast of Nova Scotia). Observations of year-to-year changes in the abundance of adults (and age-structure) on individual spawning sites, in response to fishing pressure, tends to support discrete spawning aggregations (or sub-stocks) of herring (Stephenson, 1998). Thus, appropriate fishing levels may not be the same within the stock complex.

In recent years there has been increasing emphasis on preserving all aspects of biodiversity,

including within species diversity. The biological rationale for preserving this diversity is that such variation allows adaptation to changing conditions. The economic rationale is that the decrease or elimination of population richness may lead to the loss of fisheries, such as those occurred during the mid-1970s when the Georges Bank-Nantucket Shoals herring stock collapsed (Overholtz et al., 2004).

### 1.2.1 Species Life History

#### *1.2.1.1 Herring as a forage fish and predator*

Throughout its life stages from egg to adult, Atlantic herring serve as: (1) a source of protein for a variety of marine wildlife in the North Atlantic, (2) competition for other plankton feeders, and (3) as predators of other species eggs. Herring eggs, deposited in unprotected thick mats on the sea floor, incubate for about 10 days. They are subject to predation by a variety of demersal fish species, including winter flounder, cod, haddock, and red hake. Egg predation that results in high mortality can be a driving force on herring population trends (Richardson, et. al, 2011).

Atlantic herring is an important prey species for a large number of piscivorous fish, elasmobranchs (sharks and skates), marine mammals and seabirds in the northeastern U.S. Unlike other pelagic fishes such as Atlantic mackerel, herring are smaller and vulnerable to predation over most, if not all, of their life (Overholtz et al., 2000). Juvenile herring, especially "brit" (age-1 juveniles) are preyed upon heavily due to their abundance and small size. According to the Northeast Fisheries Science Center's Food Habits Database (NEFSC 2012), the top 13 predators of Atlantic herring are:

Spiny dogfish (*Squalus acanthias)*
Winter skate (*Leucoraja ocellata)*
Thorny skate (*Amblyraja radiate)*
Silver hake (*Merluccius bilinearis)*
Atlantic cod (*Gadus morhua)*
Pollock (*Pollachius virens)*
White hake (*Urophycis tenuis)*
Red hake (*Urophycis chuss)*
Summer flounder (*Paralichthys dentatus)*
Bluefish (*Pomatomus saltatrix)*
Striped bass (*Morone saxatilis)*
Sea raven (*Hemitripterus americanus)*
Goosefish (*Lophius americanus)*

Although its primary diet is plankton, herring are also known to prey on cod eggs when zooplankton levels are low. Cod larvae, however, is not significantly affected by herring predation due to limited spatial overlap between the two species.

*1.2.1.2 Age and Growth*

In U.S. waters, Atlantic herring reach a maximum length of about 39 cm (15.6 inches) and an age of about 15-18 years (Anthony, 1972; NEFMC, 2005). Male and female herring grow at about the same rate and become sexually mature beginning at age-3, with most maturing by age-4 (NEFMC, 2005). Growth rates vary greatly from year-to-year, and to some extent from stock-to-stock, and appear to be influenced by many factors, including temperature, food availability and population size. Juvenile growth is rapid during the first year of life, with a marked slowing at the onset of maturity. Juveniles in coastal Maine waters reach 90-125 mm (3.5–5 inches) by the end of their first year of life. There has been a marked reduction in size and weight-at-age of adult herring in U.S. waters of the northwest Atlantic beginning in the mid-1980s (Overholtz et al., 2004), a trend that appears to be related to increased population size and recovery of the Georges Bank spawning stock.

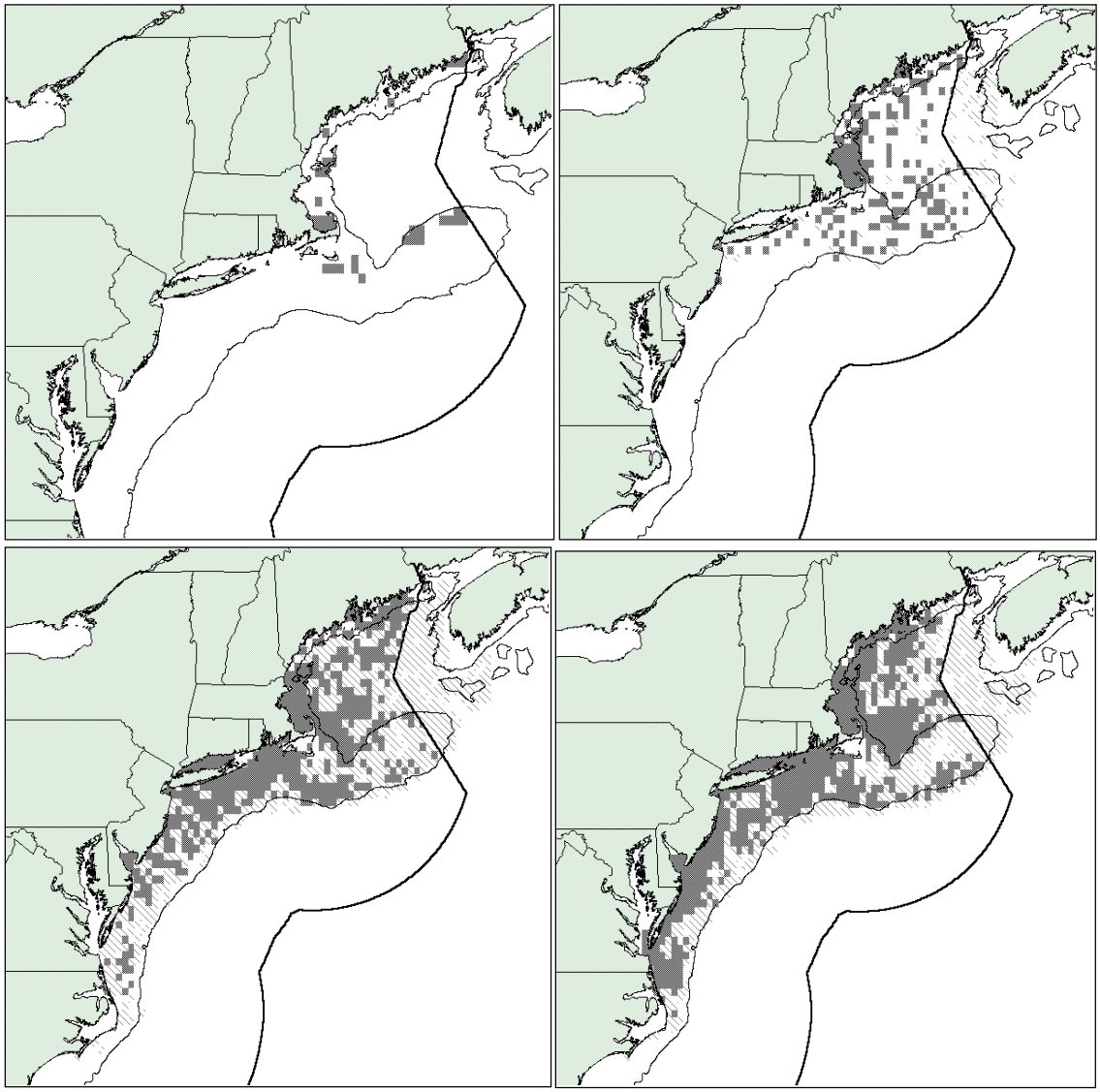
*1.2.1.3 Spawning, Reproduction, and Early Life History*

While Atlantic herring reproduce in the same general season each year, the onset, peak and duration of spawning may vary by several weeks annually (Winters and Wheeler, 1996) due to changing oceanographic conditions (e.g, temperature, plankton availability, etc.).

Atlantic herring are believed to return to natal spawning grounds throughout their lifetime to spawn (Ridgeway, 1975; Sinderman, 1979; NEFMC, 2005). This behavior is fundamental to the species' ability to maintain discrete spawning aggregations and is the basis for hypotheses concerning stock structure in the northwest Atlantic Ocean. Evidence for this homing behavior is provided by a tagging study in Newfoundland which showed a 73% return rate of adult Atlantic herring to the same spawning grounds where they were tagged (Wheeler and Winters, 1984) and by observations of year-to-year changes in the abundance and age composition of spawning aggregations on discrete banks and shoals off southwest Nova Scotia (Stephenson et al., 1998).

Spawning occurs at specific locations in the Gulf of Maine in depths of 20-50 meters (about 60-300 feet), on coastal banks such as Jeffreys Ledge and Stellwagen Bank located 8-40 km offshore, along the eastern Maine coast between the U.S.-Canada border and at various other locations along the western Gulf of Maine. Herring also spawn on Nantucket Shoals and Georges Bank, but not further south. In Canada, spawning occurs south of Grand Manan Island (in the entrance of the Bay of Fundy) and on various banks and shoals south of Nova Scotia (Figure 1). Spawning occurs in the summer and fall, starting earlier along the eastern Maine coast and southwest Nova Scotia (August-September) than in the southwestern Gulf of Maine (early to mid-October in the Jeffreys Ledge area and as late as November-December on Georges Bank) (Reid et al., 1999; NEFMC, 2005). Herring in the Gulf of Maine region usually reproduce at relatively high temperatures (10-15$^{o}$ C) and at high salinities (NEFMC, 2005). Herring do not spawn in brackish water.

**Figure 1. NEFMC EFH designation for Atlantic herring eggs (top left), larvae (top right), juveniles (bottom left), and adult (bottom right)**

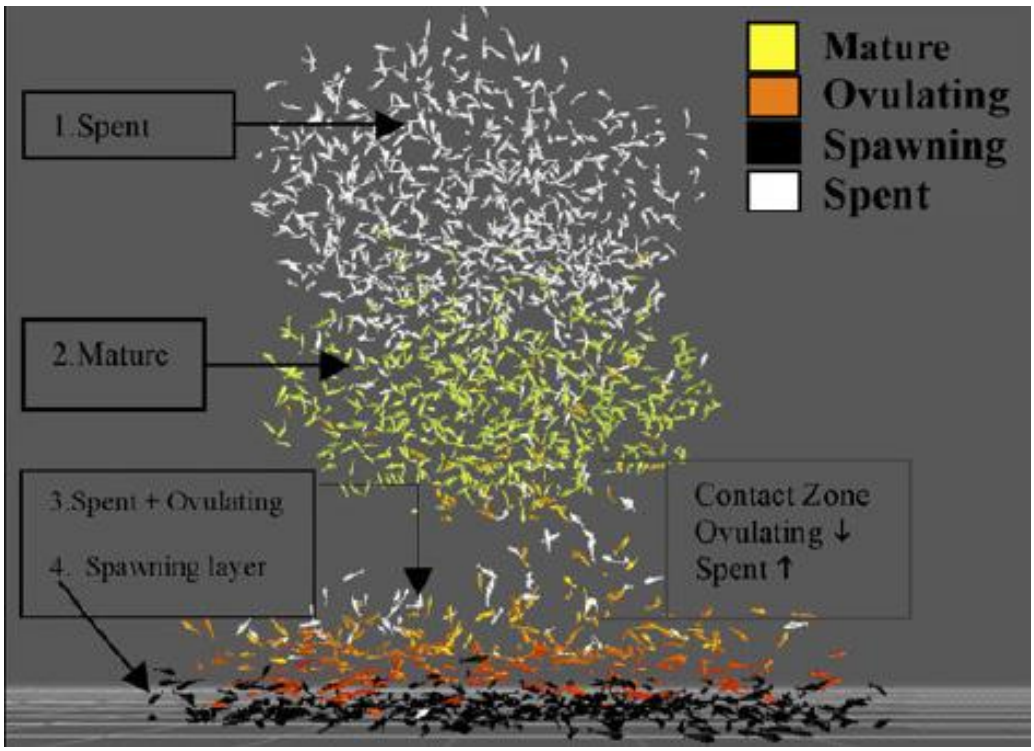


The eastern Maine-Grand Manan spawning ground is an important source of larvae, which are transported to the southwest along the Maine coast (Graham and Townsend, 1985; Townsend et al. 1986). The larvae overwinter in bays, estuaries and nearshore waters and become juveniles in the spring. Those juveniles that survive until the following spring and summer (age-2) are harvested as sardines in the coastal fishery. Larvae that hatch on Jeffreys Ledge, another important coastal spawning ground in the Gulf of Maine, are mostly transported shoreward (Cooper et al. 1975), although some overwinter in nearshore waters on the Maine coast (Lazzari and Stevenson 1991).

In some cases, the same spawning sites are used repeatedly, sometimes more than once a year (Stevenson 1989; NEFMC 2005). Jeffreys Ledge appears to be the most important spawning ground in the Gulf of Maine based on the number of spawning and near-spawning adults found there (Boyar et al. 1973).

Atlantic herring spawn on the bottom in discrete locations by depositing adhesive eggs that stick to any stable bottom substrate, including lobster pots and anchor lines. Eggs are laid in layers and form mats or carpets. In the Gulf of Maine region, egg mats as thick as 4-5 cm have been observed in discrete egg beds that have varied in size from 0.3-1.4 $km^2$. One very large egg bed surveyed on Georges Bank in 1964 covered an area of about 65 $km^2$ (Noskov and Zinkevich, 1967). Herring eggs in the Gulf of Maine region are deposited on gravel and rocky substrate, but are also found on sand, shells and shell fragments and occasionally on macroalgae (Figure 2). Spawning sites are located in areas with strong bottom currents (1.5-3 knots), which prevent the accumulation of fine sediment and provides circulation to supply oxygen and remove metabolites (Reid et al., 1999; NEFMC, 2005). Hatching success remains relatively high down to 20-25% dissolved oxygen (Aneer, 1987; NEFMC, 2005).

**Figure 2. Vertical stratification by maturity stage within a school of spawning Atlantic herring (Vabo and Skaret, 2008)**




Atlantic herring are synchronous spawners, producing eggs once a year after they reach maturity. Depending on their size and age, female herring can produce from 55,000 to 210,000 eggs (Kelly and Stevenson, 1983). Once they are laid on the bottom, herring eggs are preyed upon by a number of fish species, including cod, haddock, red hake, sand lance, winter flounder, smelt, tomcod, cunner, pollock, sculpins, skates, mackerel and even herring themselves (Munroe, 2002; NEFMC, 2005). Egg predation and adverse environmental conditions often result in high egg mortalities. Egg incubation periods are temperature dependent and range from 10-15 days in the Gulf of Maine (Munroe, 2002; NEFMC, 2005). Hatching success is also temperature dependent; in experimental studies, all eggs held at 15$^o$ C hatched and none hatched at 0-5$^o$ C or at 20$^o$ C.

Larvae are about 4-10 mm (0.25 in) in length at hatching, which occurs 10-15 days after the eggs are deposited on the bottom (Fahay, 1983). The pelagic larval phase is relatively long in Atlantic herring, lasting 4-8 months in the Gulf of Maine, depending on the timing of spawning (Reid et al., 1999; NEFMC, 2005). Larvae are transported long distances from spawning grounds where they over-winter in coastal bays and estuaries. In the Gulf of Maine, the prevailing surface currents flow westward, transporting larvae that hatch in eastern Maine to the Sheepscot estuary in mid-coast Maine, a straight-line distance of about 150 km (Graham, 1982; Townsend, 1992). Boyar et al. (1973) reported that most of the recently hatched larvae from the southern end of Jeffreys Ledge are transported shoreward. Herring larvae from Nantucket Shoals and Georges Bank are widely dispersed and tend to drift to the southwest (Sindermann, 1979; Lough et al., 1980; Grimm, 1983; NEFMC, 2005). Metamorphosis occurs in the spring at a length of about 40 mm (1.5 in). Schooling behavior begins in the late larval and early juvenile, or "brit," stages. Young-of-the-year herring undergo a general offshore movement in the summer and fall and they are believed to spend the winter in deep coastal waters.

The persistence of discrete aggregations of larvae for several months after hatching over tidally mixed continental shelf spawning grounds in the Gulf of Maine and elsewhere, despite the presence of fairly strong longshore currents, has provided the basis for a larval "retention hypothesis" (Iles and Sinclair, 1982). This hypothesis states that Atlantic herring stock structure in an area like the Gulf of Maine is determined by larval distribution and retention patterns and that the maximum stock size in that area is determined by the number, location and extent of geographically stable retention areas. Such retention areas have been described off southwest Nova Scotia, around Grand Manan Island and on Georges Bank (Iles and Sinclair, 1982). In addition, they have been described in eastern Maine waters adjacent to Grand Manan (Chenoweth et al., 1989).

Mortality of Atlantic herring in the larval stage is very high since the larvae remain vulnerable to very low temperatures and a limited food supply for a prolonged period during winter, especially in shallow nearshore and estuarine waters (Townsend and Graham, 1981; Graham et al., 1991). Campbell and Graham (1991) developed an ecological model in order to examine which factors affected larval survival to the early juvenile stage. Some of the conclusions of that study were:

- Larval herring recruitment in Maine coastal waters is the result of a complex interaction of many processes, no one of which is truly dominant;
- Two year-old recruitment to the Maine herring fishery is established in the larval stage in some years and not until the brit stage in others;
- Larval food supply in autumn and winter, along with the quantity and distribution of spawning, are primary factors controlling herring recruitment to the brit stage for those years when the larval stage is critical;
- When larval survival is above a threshold, density-dependent predation on brit can reduce year-class size (the assumption being that the brit become the food of choice for opportunistic pelagic and demersal predators when brit exceed an abundance threshold);
- Temperature and longshore transport are secondary factors determining survival that may be most important through their interaction with primary factors;
- In most years, more larvae survive the winter in the coastal areas than in the estuaries and embayments; and

- The distribution of larvae along the Maine coast in springtime is largely a function of the variable movement of larvae.

*1.2.1.4 Migration*

Adult herring undertake extensive seasonal migrations between summer spawning grounds on Georges Bank and in the Gulf of Maine and overwintering areas in southern New England and the mid-Atlantic region. Stock mixing occurs during the winter and spring as fish migrate south. Thermal oceanic fronts between colder, less saline continental shelf water and warmer, more saline continental slope water provide an abundance of plankton and other food sources and greatly influence the migratory behavior of this species (Sindermann, 1979; Kelly and Moring, 1986; NEFMC, 2005).

There are distinct migratory patterns for each spawning stock off the northeast coast of the U.S.:

- The Nova Scotia stock spends the summer and fall months in southwest Nova Scotia and overwinters in Chedabucto Bay in northeastern Nova Scotia, but also mixes to some extent with the two southern stocks.
- The Georges Bank/Nantucket Shoals stock overwinters south of Cape Cod, can be found feeding in the Gulf of Maine in the spring and early summer and spawn southeast of Nantucket or on Georges Bank in the fall (Sindermann, 1979; Tupper et al., 1998; Munro, 2002; NEFMC, 2005;). After spawning, adults from Georges Bank move south again to overwinter with the oldest and largest fish migrating as far south as Chesapeake Bay.
- The migratory patterns of the coastal Gulf of Maine herring stock are not as well documented. It is believed that they may migrate southwest along the coast after spawning to overwinter south of Cape Cod, in Massachusetts Bay and other coastal areas of southern New England (Tupper et al., 1998; Reid et al., 1999; NEFMC, 2005). The waters off Cape Cod seem to constitute a mixing area for these stocks, where different groups pass at various times of the year (Sindermann, 1979; NEFMC, 2005).

Migration patterns of individual herring stocks are usually persistent year to year (Creaser and Libby, 1988; Reid et al., 1999; NEFMC, 2005). The spatial and temporal isolation of these different stocks occurs chiefly during spawning, with intermixing occurring during the non-spawning phases of migration (Sinclair and Iles, 1985; Reid et al., 1999; Munro, 2002; NEFMC, 2005). Adults from the two U.S. stocks mix during their winter migration to southern New England and mid-Atlantic waters and separate out onto their respective spawning grounds following a return northward migration in the spring. Adults that spawn off southwest Nova Scotia are not believed to mix to any significant degree with herring that spawn on Georges Bank or in the Gulf of Maine (Stephenson et al., 1998; NEFMC, 2005).

Juvenile herring in all stocks tend to remain in coastal areas throughout the year (Stewart and Arnold, 1994; NEFMC, 2005). Juveniles overwinter closer to the coast than adult herring, moving into the deeper waters of bays or offshore in the winter where they stay close to the bottom (Reid et al., 1999; Overholtz, 2004; NEFMC, 2005). Smaller fish have greater temperature tolerances and juvenile Atlantic herring have been found to produce higher levels of antifreeze proteins than adults, adaptations that may allow them to withstand the colder coastal waters in the winter (NEFMC, 2005; Munro, 2002). Tagging studies have also indicated that

juveniles migrate little during the summer (Waring, 1981; Stobo, 1983; Overholtz et al., 2004; NEFMC, 2005). Juveniles from several populations may mix in a given area (Stewart and Arnold, 1994) and aggregations of juvenile herring along the coast of Maine and New Brunswick are likely derived from a variety of spawning grounds (Overholtz et al., 2004; NEFMC, 2005).

#### *1.2.1.5 Schooling*

Despite the vast amount of literature available on the herring resource, there still exists a significant lack of knowledge about herring behavior and the impacts of fishing and various activities on fish behavior. There are several important characteristics about herring to acknowledge:

- Herring are obligate schoolers. They prefer to swim in large schools and cease to act as individual fish, but rather act as one unit in a large school.
- The sensory systems of herring are very well developed. The ability of herring to hear, see, and sense movement (through the lateral line) allows them to sense other fish in the area, school in the dark, and react to changes in water pressure. These factors also influence the way herring react to fishing gear.
- Herring have sensitivity to a wide frequency range and are most sensitive to sounds in the frequency region where fishing vessels (and research vessels) have the maximum sound energy output. Herring are very sensitive to noise and have been shown to make directed responses to approaching vessels. Results of some studies indicate that the fish can hear trawlers at distances up to 3 kilometers.
- The visual senses of herring allow the fish to see at very low light levels ($10^{-5}$ lux). Herding responses are mainly visual, and visually elicited avoidance reactions have been observed.
- Herring exhibit distinct migratory patterns, both seasonally (large-scale) and diurnally (night/day, small-scale). Migration is also affected by food availability and other environmental conditions (temperature, salinity, predators).
- Herring have very good buoyancy control. They can gulp and release air to fill and void their swim bladders as needed. The fish can sink very quickly if necessary.

Pelagic fishes school for hydrodynamic reasons, for reproduction, migration and feeding and to aid in surviving predatory attack (Freon and Misund, 1999; NEFMC, 2005). Schooling is a natural state for pelagic fishes and given a stimulus, fish like herring will react and then return to this state. When confronted by danger such as a predator or mid-water trawl, pelagic fish will quickly decrease their interfish distance (packing density) and try to avoid the stimulus (Freon et al., 1992; NEFMC, 2005). This will result in contortion, compression and stretching of the school and may result in short-term distortion or dispersion of the fish (Freon et al., 1993; NEFMC, 2005). This avoidance behavior will cease, however, as soon as the fish are out the near field (proximity) of the trawl or predator (Freon and Misund, 1999; NEFMC, 2005).

The normal reaction of herring to a trawl or purse seine is to increase their swimming speed and dive downwards, thereby trying to avoid the gear. In a study of Finnish pair trawling, visual and acoustic observations suggest that herring displayed an avoidance reaction in 34% of 493 midwater trawl hauls where fish were near the trawl mouth (Suuronen et al., 1997; NEFMC, 2005). Fish were observed to swim rapidly downward when they were within 5 m of the trawl

and then return to their previous depth as soon as the trawl had passed. Herring react to midwater trawl and purse seines in much the same manner that they react to predators by trying to avoid and then regroup.

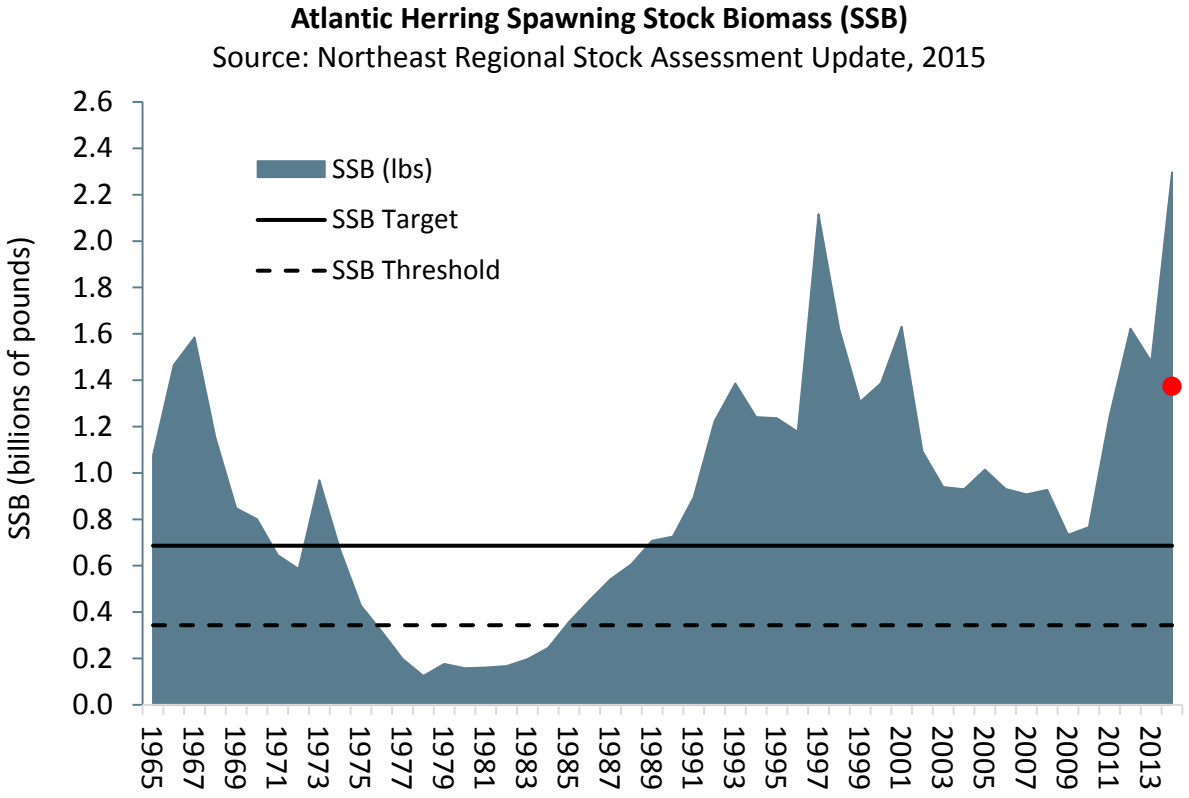
A study of the spatial dynamics of the Gulf of Maine/Georges Bank herring complex showed that herring maintained their school structure and interschool integrity in spite of very large reduction in overall biomass during the 1970s (Overholtz, 2004; NEFMC, 2005). Landings records from purse seine and midwater trawl vessels indicate that there were herring present in the Jeffreys Ledge region during all the months from April to October of 2001. Observations during herring acoustic cruises conducted by NMFS during 1997-2000 indicate nothing more than short-term disturbance of herring during midwater trawling and acoustic surveying operations. Fishing operations by at least a dozen large midwater trawlers conducted over a several month period during 2001 on Georges Bank caused no apparent changes in the distribution of pre-spawning herring as evidenced by hydroacoustic surveys conducted during September and October 2001 (NEFMC, 2005). There appears to be no scientific evidence either local or worldwide that midwater trawling or purse seining causes any long-term dispersal of herring.

### 1.2.2 Stock Assessment Summary

#### *1.2.2.1. Abundance and Present Condition*

The 2012 stock assessment resolved a persistent retrospective pattern; this pattern reappeared in the 2015 operational update and values were rho adjusted. The maximum sustainable yield (MSY) based reference points were also updated; the overfishing threshold is $F_{MSY}$ = 0.24 and the overfished threshold is ½$SSB_{MSY}$ = 342 million lbs. (155,573 mt). The results of the 2015 stock assessment update indicate the stock is not experiencing overfishing and is not overfished (Deroba 2015).

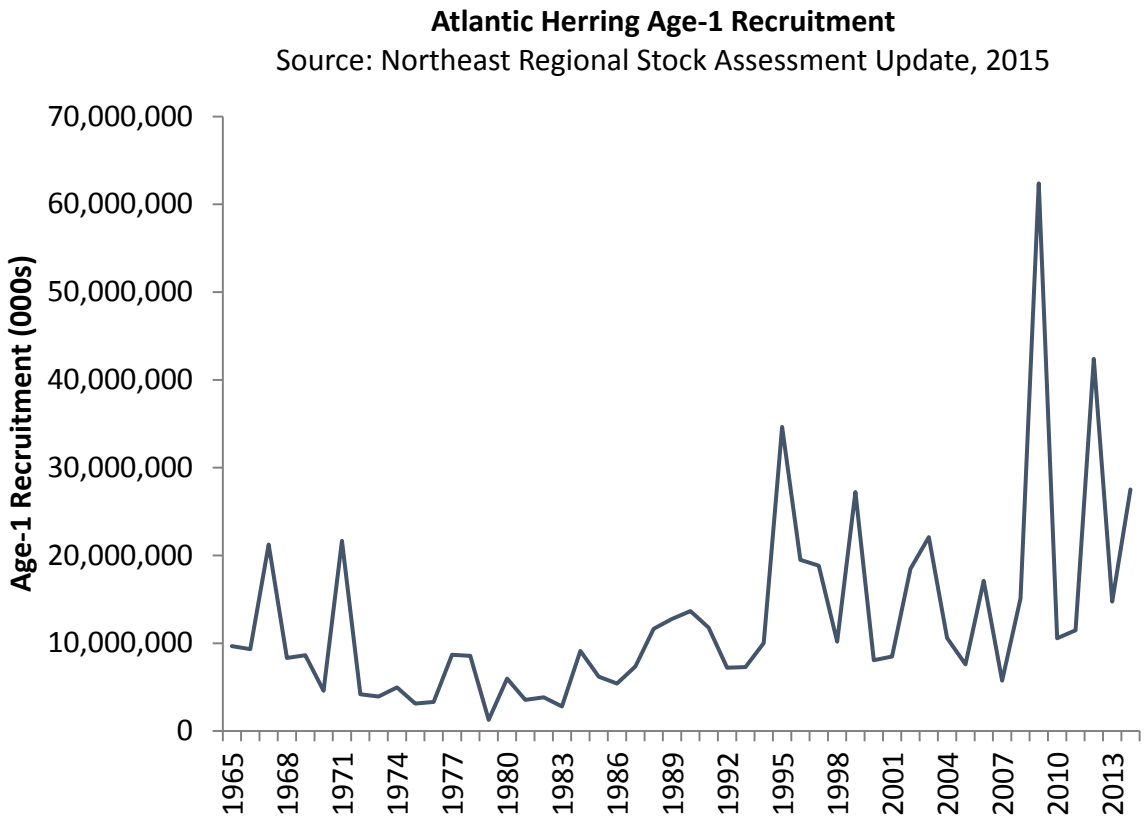
**Figure 3. Atlantic Herring Spawning Stock Biomass. The red dot represents the 2014 retrospective adjusted value; retrospective adjustments are not applied to the entire time series.**




*1.2.2.2. Spawning Stock and Total Biomass*

The point estimate of SSB in 1965 equaled 1 billion lbs. (487,791 mt). SSB generally declined from 1965 to a time series low of 124 million lbs. (56,509 mt) in 1978. SSB generally increased from 1978 through the mid-1990s. SSB declined from 1997 to 766.4 million lbs. (347,675 mt) in 2010. The retrospective adjusted value for the 2014 SSB is 1.3 billion lbs. (623,000 mt).

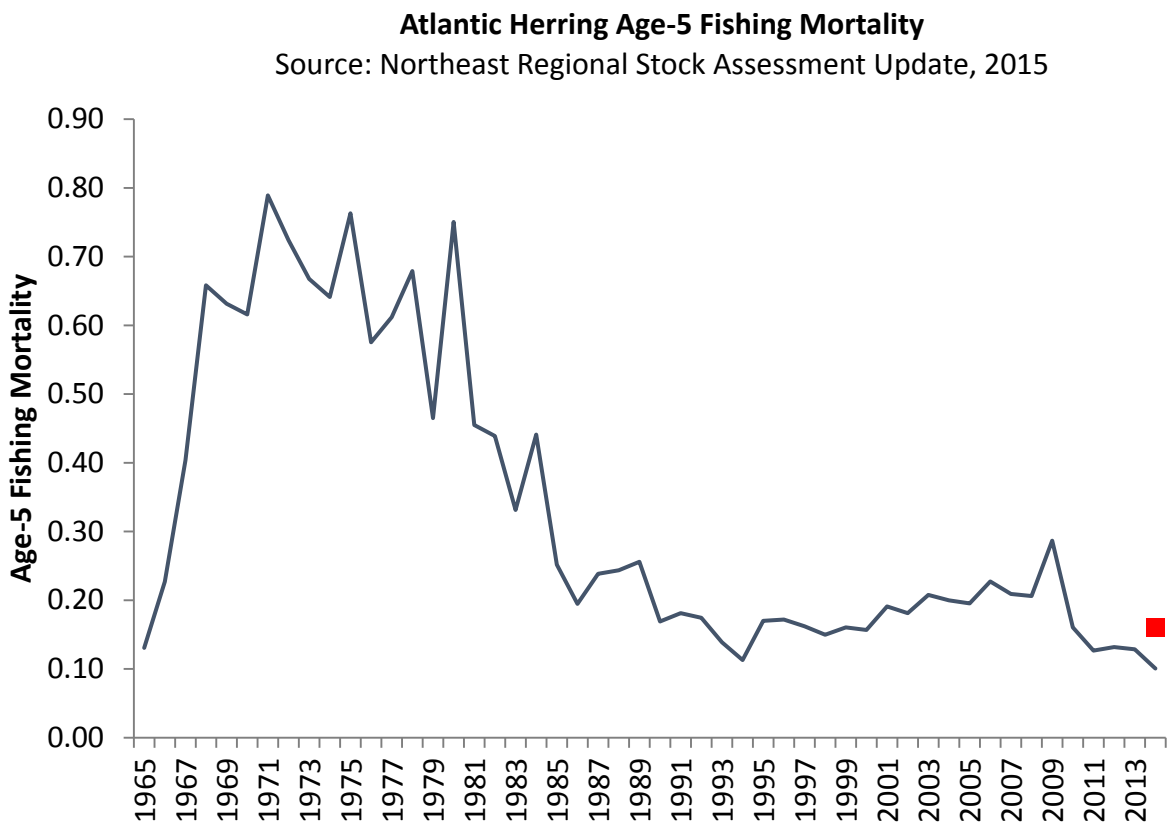
**Figure 4. Atlantic Herring Age-1 Recruitment**




*1.2.2.3. Recruitment*

Mean recruitment from 1965 to 2014 equaled 12.7 billion fish. The mean recruitment from 2000-2014 equaled 18.8 billion fish, largely due to several recent large year classes. The 2009 age-1 recruitment was the largest in the time series at 62.4 billion fish (Figure 4). The 2012 age-1 recruitment was estimated to be the second largest in the time series and equaled 42.4 billion fish.

**Figure 5. Atlantic Herring Age-5 Fishing Morality. The red square represents the 2014 retrospective adjusted value; retrospective adjustments are not applied to the entire time series.**




*1.2.2.4. Fishing Mortality*

Atlantic herring's fishing mortality (F) peaked in 1971 at a rate of 0.79. From 1971, F generally declined to a historic low of 0.13 in 1994. Since then, F has remained below the $F_{MSY}$ threshold of 0.24, with a slight increasing trend until overfishing occurred in 2009 ($F_{2009}$ = 0.32). Fishing mortality since 2009 has been relatively low because of the presence of strong cohorts that increased the stock biomass, and thus produce lower F given similar levels of catch. Fishing mortality (F) was estimated at 0.16 in 2014 after retrospective adjustment (Figure 5).

## 1.3 DESCRIPTION OF THE FISHERY

### 1.3.1 Commercial Fishery

The Atlantic herring resource occurs in waters off Canada and the United States, and fisheries exist in both countries. Based on the total catch (including discards) by the U.S. fixed and mobile gear, and Canada's New Brunswick weir fisheries, a majority of the fish are caught by the U.S. commercial fleet (time series average of 87%).

Catch in the mobile gear fishery peaked in the late 1960s and early 1970s, largely due to efforts from foreign fleets. Catch in this fishery has been relatively stable since about 2000 and has accounted for most of the Atlantic herring catches in recent years. Catch in the fixed gear fishery has been variable, but has declined and has been relatively low since the mid-1980s.

In the U.S., the Atlantic herring fishery is predominantly commercial; recreational catch accounts for less than 1% of the overall catch. Total commercial catches during 1965-2014 ranged from 98.35 million lbs. (44,613 mt) in 1983 to 1 billion lbs. (477,767 mt) in 1968. Annual catch averaged 244.4 million lbs. (110,854 mt) from 1993, when FMP was implemented, through 2014. In 2014, catch totaled 210.1 million lbs. (95,317 mt). Total catches from 2010-2014 ranged from 175.1 million lbs. (79,413 mt) in 2010 to 224.0 million lbs. (101,622 mt) in 2013 and averaged 198.5 million lbs. (90,040 mt) (Figure 6). From 2004-2015, the sub-Annual Catch Limit (ACL) for Area 1A ranged from 58.5 million lbs. (26,546 mt) to 132.3 million lbs. (60,000 mt) (Table 1).

**Figure 6. Atlantic Herring Total Catch (Source: ACCSP)**

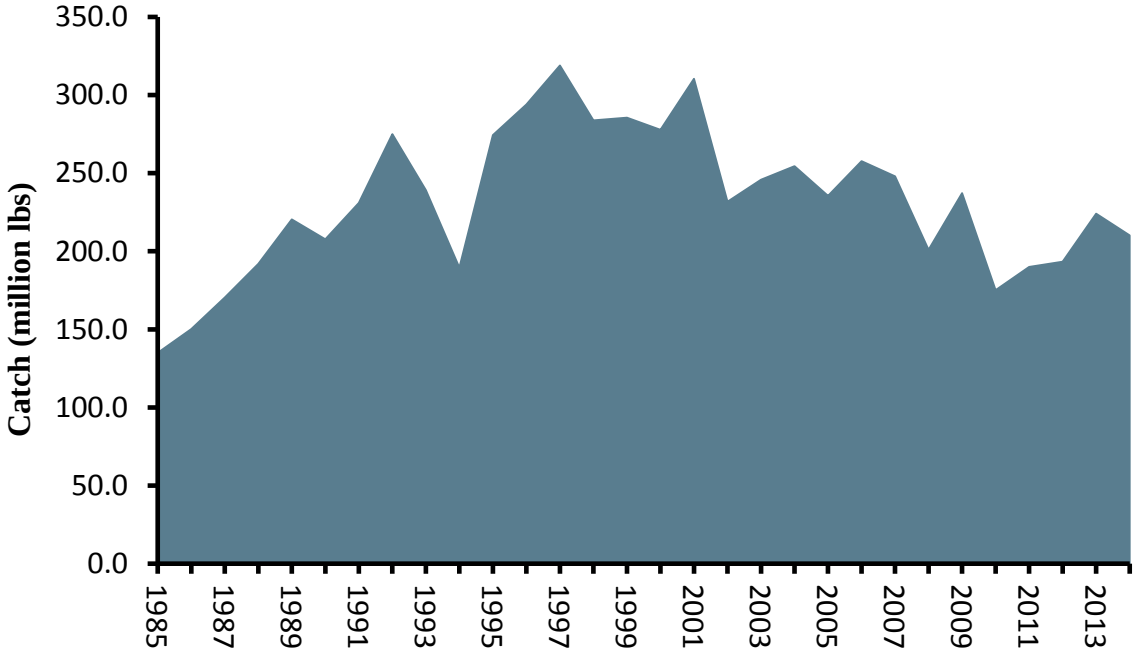


**Table 1. Atlantic herring catch by year for Area 1A, 2004-2015 (Source: NMFS)**

| Year | Sub-ACL (lbs.)** | Sub-ACL (MT) | Catch (lbs.)** | Catch (MT) | % Utilized | Sub-ACL Closure |
|---|---|---|---|---|---|---|
| 2004 | 132,276,000 | 60,000 | 132,485,437 | 60,095 | 100% | Nov-9 |
| 2005 | 132,276,000 | 60,000 | 134,705,469 | 61,102 | 102% | Dec-2 |
| 2006 | 132,276,000 | 60,000 | 132,251,749 | 59,989 | 100% | Oct-21 |
| 2007 | 110,230,000 | 50,000 | 110,212,363 | 49,992 | 100% | Oct-25 |
| 2008 | 96,230,790 | 43,650 | 93,159,782 | 42,257 | 97% | Nov-14 |
| 2009 | 96,230,790 | 43,650 | 97,196,405 | 44,088 | 101% | Nov-26 |
| 2010 | 58,523,312 | 26,546 | 62,663,550 | 28,424 | 107% | Nov-17 |
| 2011 | 64,486,755 | 29,251 | 67,628,310 | 30,676 | 105% | Oct-27 |
| 2012 | 60,996,873 | 27,668 | 53,576,189 | 24,302 | 88% | Nov-5 |
| 2013 | 65,641,965 | 29,775 | 65,741,172 | 29,820 | 100% | Oct-15 |
| 2014* | 72,820,143 | 33,031 | 73,695,369 | 33,428 | 101% | Oct-26 |
| 2015* | 66,777,334 | 30,290 | 64,934,288 | 29,454 | 97% | Nov-2 |

**Totals are preliminary*
*** 1 mt = 2,204.6 lb*

Over the past decade, the commercial Atlantic herring industry has been consistent in terms of landing states and primary gears. Based on the 10-year average from 2004-2013, a combined 88% of total sea herring catch was landed in Maine and Massachusetts. From 2011-2013, Maine harvested about 50% of the total landings each year. Atlantic herring is primarily caught by trawl gears, which accounted for nearly 70% of total landings in the past decade, followed by purse seine, accounting for 20% of landings. Table 2 shows the landings from primary gears (trawl and purse seine) by state from 2009-2013.

**Table 2. Atlantic herring landings by primary gears and state. Due to data confidentiality, landings by other gears are not provided**

| Year | State | Trawl (lbs.)* | Trawl (MT) | Purse Seine (lbs.)* | Purse Seine (MT) |
|---|---|---|---|---|---|
| 2009 | MA | 120,247,702 | 54,544 | 2,676,384 | 1,214 |
| 2009 | ME | 19,045,539 | 8,639 | 42,193,839 | 19,139 |
| 2009 | Other NE | 2,281,761 | 1,035 | 813,497 | 369 |
| 2009 | Mid-Atl | 22,804,382 | 10,344 | 0 | 0 |
| 2010 | MA | 64,330,228 | 29,180 | 2,328,058 | 1,056 |
| 2010 | ME | 33,939,817 | 15,395 | 21,336,119 | 9,678 |
| 2010 | Other NE | 2,738,113 | 1,242 | 92,593 | 42 |
| 2010 | Mid-Atl | 12,134,118 | 5,504 | 0 | 0 |
| 2011 | MA | 54,936,427 | 24,919 | 1,084,663 | 492 |
| 2011 | ME | 51,887,466 | 23,536 | 40,813,760 | 18,513 |
| 2011 | Other NE | 1,016,321 | 461 | 496,035 | 225 |
| 2011 | Mid-Atl | 7,383,205 | 3,349 | 0 | 0 |
| 2012 | MA | 66,589,943 | 30,205 | 2,407,423 | 1,092 |
| 2012 | ME | 53,887,038 | 24,443 | 38,296,107 | 17,371 |
| 2012 | Other NE | 2,389,786 | 1,084 | 0 | 0 |
| 2012 | Mid-Atl | 12,621,335 | 5,725 | 0 | 0 |
| 2013 | MA | 65,425,914 | 29,677 | 1,252,213 | 568 |
| 2013 | ME | 49,036,918 | 22,243 | 49,047,941 | 22,248 |
| 2013 | Other NE | 1,560,857 | 708 | 0 | 0 |
| 2013 | Mid-Atl | 24,512,947 | 11,119 | 0 | 0 |

** 1 mt = 2204.6 lb*

The U.S. Atlantic herring fishery is managed as four management areas: inshore Gulf of Maine (Area 1A), offshore Gulf of Maine (Area 1B), Southern New England (Area 2), and Georges Bank (Area 3). In addition to the complementary measures in the federal plan, the Interstate Atlantic Herring FMP implements specific measures for Area 1A's fishery, which supplies bait for lobster, tuna, blue crab, and striped bass fisheries. Management measures include "days out" effort control, spawning area closures, and seasonal quota allocation. Using the annual specifications process, fisheries managers adapt these measures each year to provide herring between June and December, when demand for lobster bait is highest and fishermen can sell their herring catch for premium value.

### 1.3.2 Recreational Fishery

The recreational Atlantic herring fishery accounts for less than 1% of total catch in the U.S.A small recreational fishery for Atlantic herring exists, providing late fall to early spring fishing opportunities for both shore and boat anglers. Most Atlantic herring catches are reported during March-April and November-December, with some catches reported from September-October.

The Marine Recreational Information Program (MRIP) does not sample during January-February in the north or mid-Atlantic sub-regions and because herring may be taken during this period, total recreational catch may be underestimated. The herring caught by hook and line anglers are taken as a secondary species in a mixed fishery with Atlantic mackerel (*Scomber scombrus*).

### 1.3.5 Interactions with Other Fisheries, Species, or Users

#### *1.3.5.1 Bait*

Atlantic herring serves as an important bait for many commercial and recreational fisheries, including lobster, tuna, and striped bass. Increased fishing effort in the lobster fishery, along with a decrease in other sources of lobster bait, has been observed over the past three decades and lobster landings have continued to markedly increase throughout the 1980s and early 1990s, both of which place increased pressure on the herring resource.

While bait herring for the tuna fishery can be purchased from dealers or other boats, some tuna vessels are known to catch herring for use as live bait in this fishery. The use of small pelagic gillnets to catch herring for this purpose is authorized under the Northeast Multispecies Plan. There are no statistics on the extent of this practice or the amount of herring that is taken for this purpose. Some industry participants have estimated that 50-90% of the vessels fishing for tuna in New England waters may be catching herring as bait.

#### *1.3.5.2 Forage*

Atlantic herring are an important forage species for many marine finfish, marine mammals and birds in the Northwest Atlantic ecosystem. While available information to quantify the importance of herring as a forage species is not available at this time, there is a substantial amount of literature (Volume II, *The Role of Atlantic Herring, Clupea harengus, in the Northwest Atlantic Ecosystem* by the NEFMC) that describes the role that herring plays in the ecosystem and estimates the amount of herring consumed by various fish, marine mammal and seabird species. The first step to account for the importance of herring as a forage species in the herring management program is to compile and consider available information on the subject; the second step is to identify where information is lacking and prioritize research needs to fill the data gaps.

## 1.4 HABITAT CONSIDERATIONS

The New England Fisheries Management Council has identified the Essential Fish Habitat (EFH) for herring and other species it manages, and is proposing updated designations through its Draft Omnibus Habitat Amendment 2. The applicable provisions of this document that relate to Atlantic herring are incorporated into this FMP by reference. This includes the description and identification of herring EFH, the threats to EFH from fishing and non-fishing activities, and the conservation and enhancement measures to protect EFH for Atlantic herring.

### 1.4.1 Habitat Important to the Stocks

The Northeast U.S. Shelf Ecosystem has been described as including the area from the Gulf of Maine south to Cape Hatteras, extending from the coast seaward to the edge of the continental shelf, including the slope sea offshore to the Gulf Stream (Sherman et al., 1996; NEFMC, 2005). The continental slope includes the area east of the shelf, out to a depth of 2000 m. Four distinct sub-regions comprise the NOAA Fisheries Northeast Region: the Gulf of Maine, Georges Bank, the Mid-Atlantic Bight and the continental slope. Occasionally another sub-region, southern New England, is described; however, discussions of any distinctive features of this area have been incorporated into the sections describing Georges Bank and the Mid-Atlantic Bight (NEFMC, 2005).

The Gulf of Maine is an enclosed coastal sea, characterized by relatively cold waters and deep basins, with a patchwork of various sediment types. Georges Bank is a relatively shallow coastal plateau that slopes gently from north to south and has steep submarine canyons on its eastern and southeastern edge. It is characterized by highly productive, well-mixed waters and strong currents. The Mid-Atlantic Bight is comprised of the sandy, relatively flat, gently sloping continental shelf from southern New England to Cape Hatteras, North Carolina. The continental slope begins at the continental shelf break and continues eastward with increasing depth until it becomes the continental rise. Atlantic herring do not commonly occur over the continental slope (NEFMC, 2005).

#### *1.4.1.2 Identification and Distribution of Habitat and Habitat Areas of Particular Concern (Essential Fish Habitat)*

The Atlantic States Marine Fisheries Commission does not have the authority to designate Essential Fish Habitat (EFH) as required by the Magnuson Stevens Fishery Conservation and Management Act (MSFCMA). The New England Fishery Management Council has identified EFH for a range of species, including Atlantic herring, in order to meet the requirements of MSFCMA as amended by the Sustainable Fisheries Act. The ISFMP Policy Board approved a recommendation in June 1998 to include Council EFH designation for FMPs or Amendments that are developed jointly or in association with a Council. EFH for Atlantic herring is described in NEFMC (1998a) as those areas of the coastal and offshore water (out to the offshore U.S. boundary of the EEZ) that are designated in Figure 7 through Figure 10 and in Table 3 and meet the conditions below.

The NEFMC, in cooperation with NFMS, has proposed revised EFH designations for herring and other Council managed species through the Draft Omnibus Essential Fish Habitat Amendment 2 (initiated in 2014). EFH designations help the Council identify habitats where adverse impacts should be minimized and encourage conservation of such habitat.

**Eggs:** Bottom habitats with a substrate of gravel, sand, cobble and shell fragments, but also on aquatic macrophytes, in the Gulf of Maine and Georges Bank as depicted in Figure 7. Eggs adhere to the bottom, forming extensive egg beds that may be many layers deep. Generally, the following conditions exist where Atlantic herring eggs are found: water temperature below 15$^{o}$ C, depths from 20-80 meters and salinity ranging from 32-33$^{o}/_{oo}$. Herring eggs are most often

found in areas of well-mixed water, with tidal currents between 1.5 and 3.0 knots. Herring eggs are most often observed during the months from July through November.

**Larvae:** Pelagic waters in the Gulf of Maine, Georges Bank and southern New England that comprise 90% of the observed range of Atlantic herring larvae as depicted in Figure 8. Generally, the following conditions exist where Atlantic herring larvae are found: sea surface temperatures below 16$^{o}$ C, water depths from 50-90 meters, and salinities around 32$^{o}/_{oo}$. Herring larvae are observed between August and April, with peaks from September through November.

**Juveniles:** Pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras as depicted in Figure 9. Generally, the following conditions exist where Atlantic herring juveniles are found: water temperatures below 10$^{o}$ C, water depths from 15-135 meters and salinity ranging from 26-32$^{o}/_{oo}$.

**Adults:** Pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the mid-Atlantic south to Cape Hatteras as depicted in Figure 10. Generally, the following conditions exist where Atlantic herring juveniles are found: water temperatures below 10$^{o}$ C, water depths from 20-130 meters and salinities above 28$^{o}/_{oo}$.

**Spawning Adults:** Bottom habitats with a substrate of gravel, sand, cobble and shell fragments, but also on aquatic macrophytes. Spawning areas include the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay as depicted in Figure 10. Generally, the following conditions exist where spawning Atlantic herring adults are found: water temperatures below 15$^{o}$ C, depths from 20-80 meters and salinity ranging from 32-33$^{o}/_{oo}$. Herring eggs are spawned in areas of well-mixed water, with tidal currents between 1.5 and 3.0 knots. Herring are most often observed spawning during the months from July through November.

All of the above EFH descriptions include those bays and estuaries listed in Table 3, according to life history stage. There is potential seasonal and spatial variability of the conditions generally associated with this species.

**Table 3. EFH Designation of Estuaries and Embayments for Atlantic Herring**

| Estuaries and Embayments | Eggs | Larvae | Juveniles | Adults | Spawning Adults |
|---|---|---|---|---|---|
| Passamaquoddy Bay | | m,s | m,s | m,s | |
| Englishman/Machias Bay | s | m,s | m,s | m,s | s |
| Narraguagus Bay | | m,s | m,s | m,s | |
| Blue Hill Bay | | m,s | m,s | m,s | |
| Penobscot Bay | | m,s | m,s | m,s | |
| Muscongus Bay | | m,s | m,s | m,s | |
| Damariscotta River | | m,s | m,s | m,s | |
| Sheepscot River | | m,s | m,s | m,s | |
| Kennebec / Androscoggin Rivers | | m,s | m,s | m,s | |
| Casco Bay | s | m,s | m,s | s | |
| Saco Bay | | m,s | m,s | s | |
| Wells Harbor | | m,s | m,s | s | |
| Great Bay | | m,s | m,s | s | |
| Merrimack River | | M | m | | |
| Massachusetts Bay | | s | s | s | |
| Boston Harbor | | s | m,s | m,s | |
| Cape Cod Bay | s | s | m,s | m,s | |
| Waquoit Bay | | | | | |
| Buzzards Bay | | | m,s | m,s | |
| Narragansett Bay | | s | m,s | m,s | |
| Long Island Sound | | | m,s | m,s | |
| Connecticut River | | | | | |
| Gardiners Bay | | | s | s | |
| Great South Bay | | | s | s | |
| Hudson River / Raritan Bay | | m,s | m,s | m,s | |
| Barnegat Bay | | | m,s | m,s | |
| Delaware Bay | | | m,s | s | |
| Chincoteague Bay | | | | | |
| Chesapeake Bay | | | | s | |

*S ≡ The EFH designation for this species includes the seawater salinity zone of this bay or estuary (salinity > 25.0‰).*

*M ≡ The EFH designation for this species includes the mixing water / brackish salinity zone of this bay or estuary (0.5 < salinity < 25.0‰).*

*F ≡ The EFH designation for this species includes the tidal freshwater salinity zone of this bay or estuary (0.0 < salinity < 0.5‰).*

*These EFH designations of estuaries and embayments are based on the NOAA Estuarine Living Marine Resources (ELMR) program (Jury et al. 1994; Stone et al. 1994).*

**Figure 7. EFH Designation for Atlantic Herring Eggs**

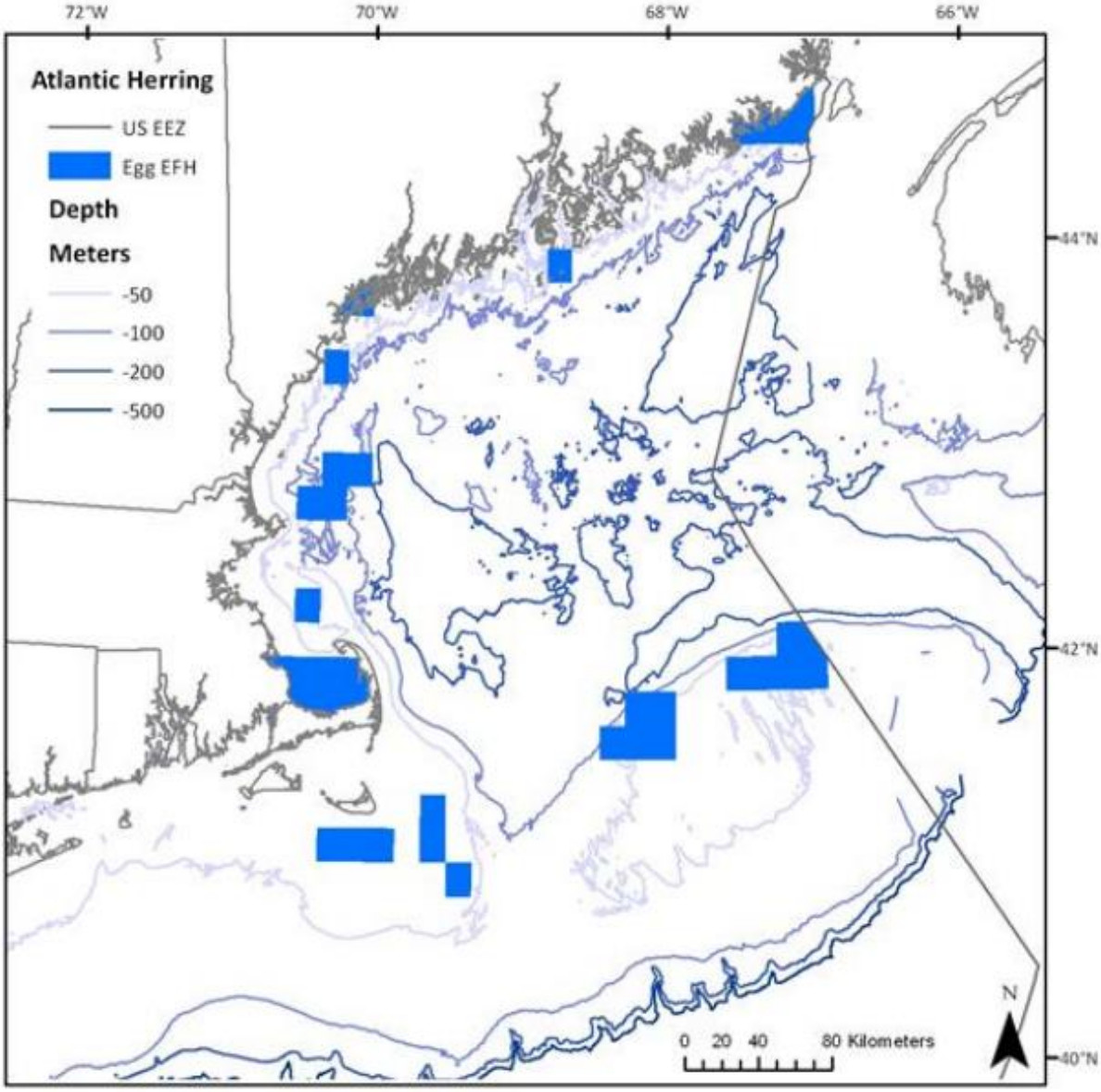


**Figure 8. EFH Designation for Atlantic Herring Larvae**

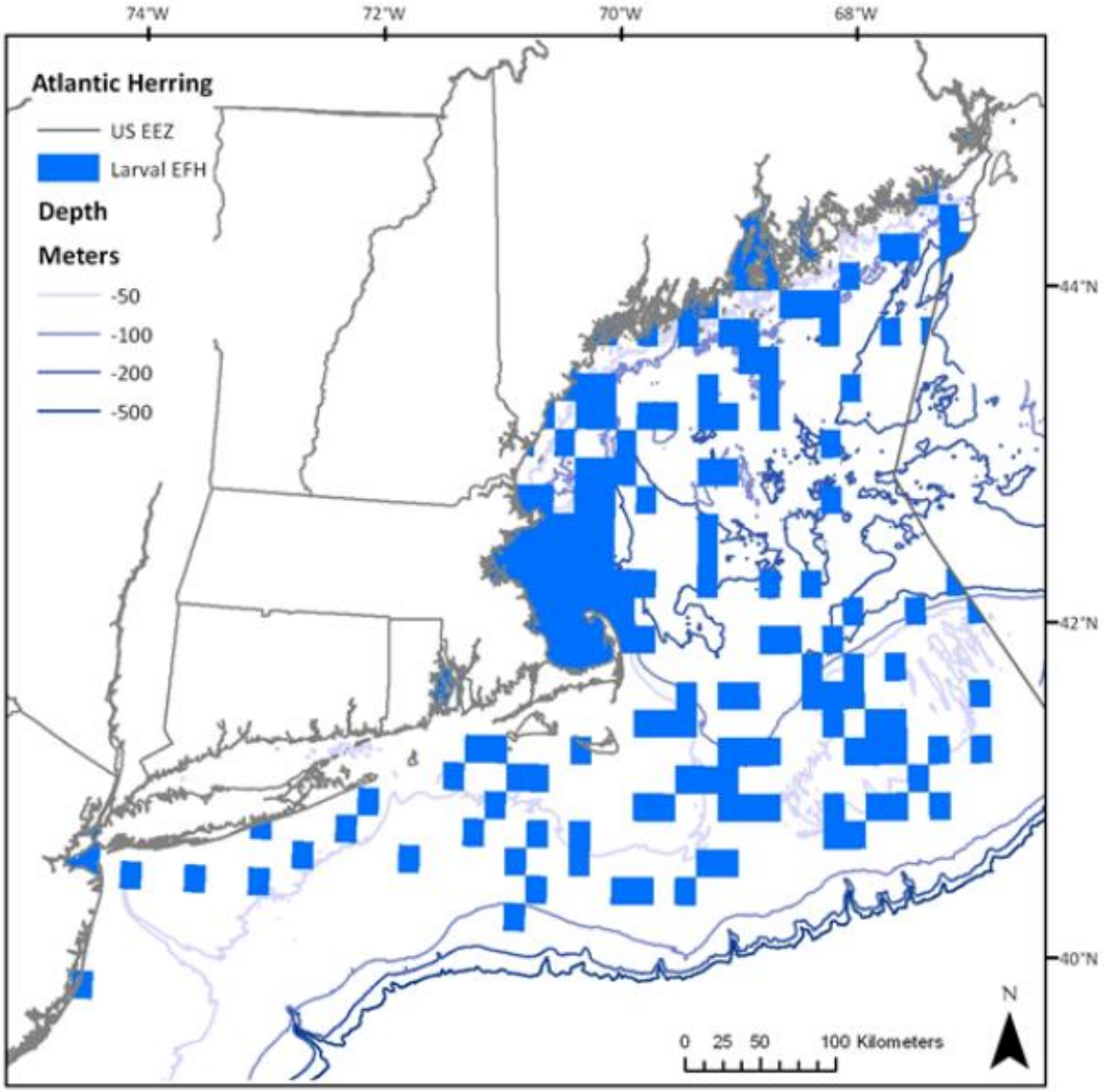


**Figure 9. EFH Designation for Atlantic Herring Juveniles**

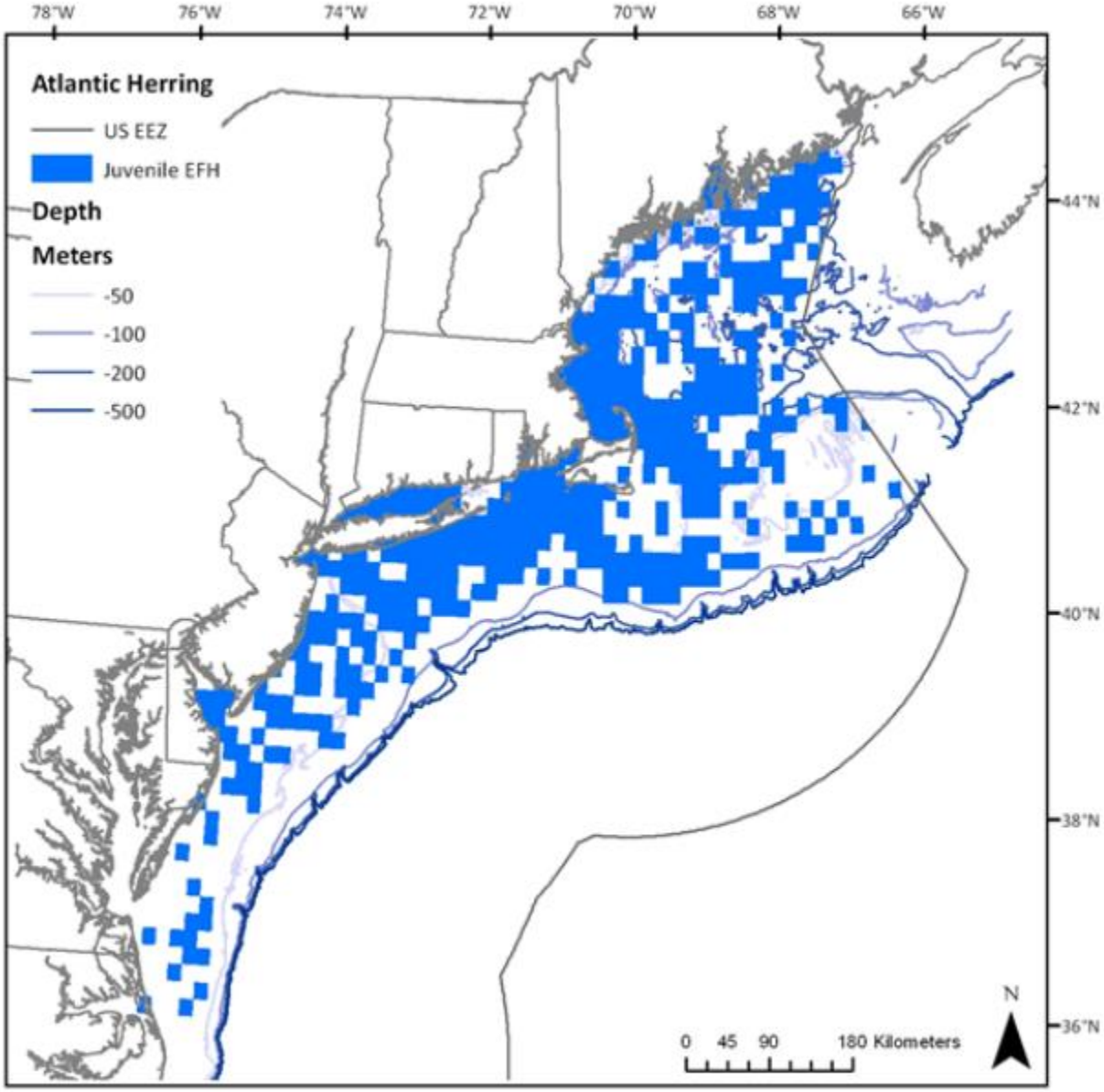
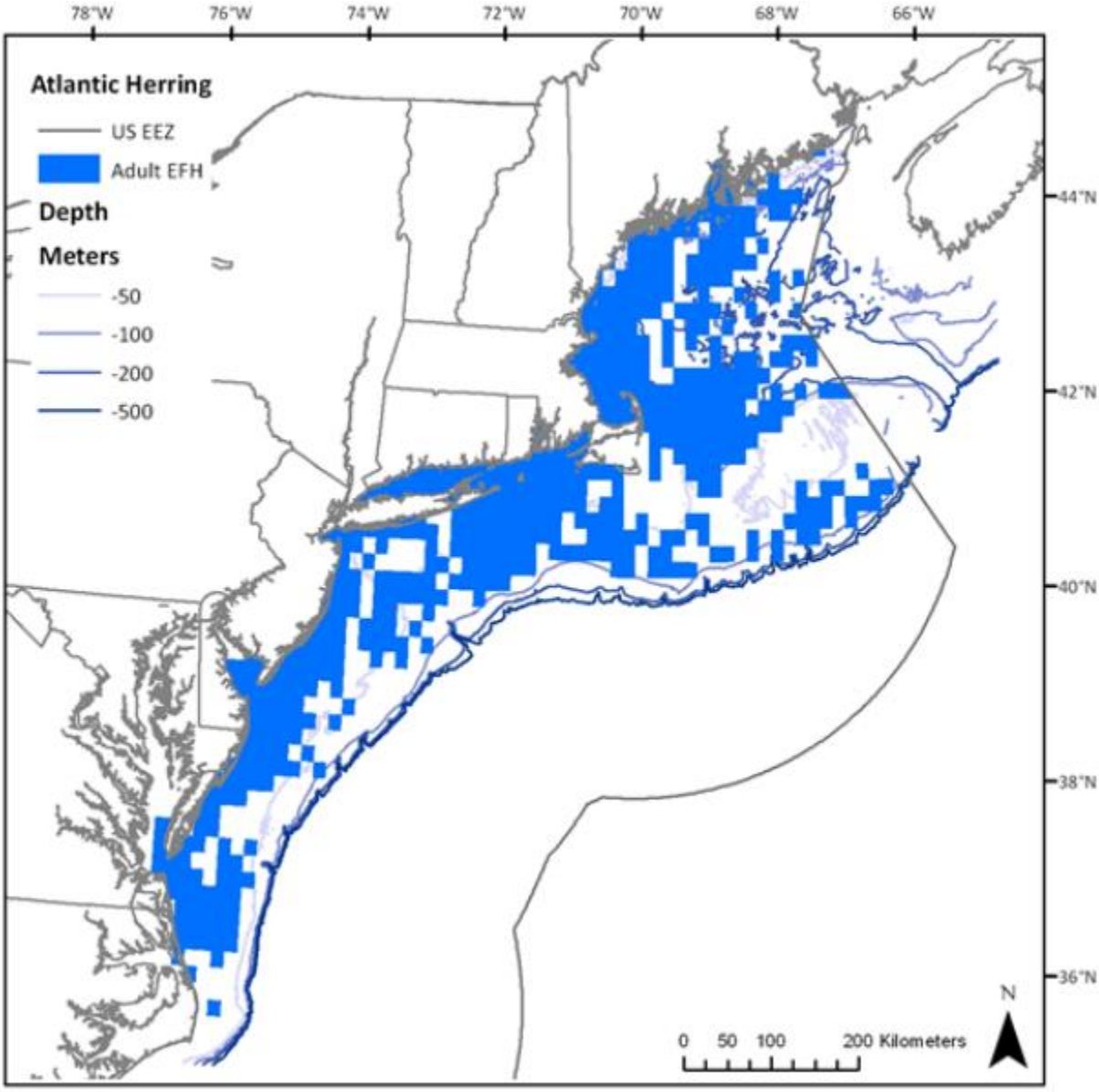


**Figure 10. EFH Designation for Atlantic Herring Adults**




*1.4.1.4. Ecosystem Considerations*

**Forage:** Atlantic herring's role as a forage species, in association with other forage species of concern (i.e. river herring and shad species) in the northwest Atlantic ecosystem, has recently become a concern to many stakeholders.

**Other Northeast Region Species:** The area where the Atlantic herring fishery takes place has been identified as EFH for species managed under the following Federal Fishery Management Plans: Northeast Multispecies; Atlantic Sea Scallop; Atlantic Monkfish; Summer Flounder, Scup and Black Seabass; Squid, Atlantic Mackerel and Butterfish; Atlantic Surf Clam and Ocean Quahog; Atlantic Bluefish; Atlantic Billfish; and Atlantic Tuna, Swordfish and Shark. All EFH

descriptions and maps can be viewed on the NMFS Northeast Regional Office website (NEFMC, 2005).

**Anthropogenic Impacts on Atlantic Herring and their Habitat:** Habitat alteration and disturbance can occur through natural processes and human activities. Natural disturbances to habitat can result from summer droughts, winter freezes, heavy precipitation, and strong winds, waves, currents and tides associated with major storms (i.e. hurricanes and northeasters) and global climatic events such as El Nino. Biotic factors, including bioturbation and predation, may also disturb habitat (Auster and Langton MS, 1998 and in press). These natural events may have detrimental effects on habitat, including disrupting and altering biological, chemical and physical processes, and may impact fish and invertebrate populations. Potential adverse effects to habitat from fishing and non-fishing activities may include direct (e.g. contamination or physical disruption), indirect (e.g. loss of prey or reduction of species diversity), site-specific or habitat wide impacts, including individual, cumulative or synergistic consequences of the actions. Non-fishing threats to habitat may include the intentional or accidental discharge of contaminants (i.e. heavy metals, oil, nutrients, pesticides, etc.) from non-point and point sources, and direct habitat degradation from human activities (i.e. channel dredging, marina/dock construction, etc.).

Riverine, inshore and offshore habitats are subject to numerous chemical, biological and physical threats. Riparian habitat is being degraded and altered by many human activities. Inshore regions are variable environments that are threatened by many sources of degradation. Deep-sea habitats are stable and contain less resilient communities than habitats found within inshore waters (Radosh et al., 1978) that are altered by unnatural stress. Pelagic environments in coastal and offshore areas are potentially essential habitat for many marine organisms throughout substantial stages of ontogenetic development. These areas can also be disrupted. Chemical, biological, and physical threats can potentially limit survivorship, growth and reproductive capacity of fish and shellfish species and populations.

The major threats to marine and aquatic habitats are a result of increasing human population, which is contributing to an increase of human generated pollutant loadings. These pollutants are being discharged directly into riverine and inshore habitats by way of point and non-point sources. The development of coastal regions to accommodate more people leads to an increase in unwanted runoff, such as toxicants, nutrients and pesticides. Humans attempt to control and alter natural processes of aquatic and marine environments for an array of reasons, including industrial uses, coastal development, port and harbor development, erosion control, water diversion, agriculture, and silviculture. Environmental conditions of fish and shellfish habitat are altered by human activities (see Wilk and Barr, 1994 for review) and threatened by non-point and point sources of pollution.

**Environmental Contaminants:** The effects of copper on eggs and larvae of Atlantic herring were reported by Blaxter (1977). Mortality of newly hatched larvae was high at copper concentrations of 1,000 micrograms per liter (mcrg/l). Eggs incubated in 30 mcrg/l had relatively high mortality and premature hatching; 70% of the larvae hatched were deformed. Larvae were more resistant to copper than eggs; survival of larvae was impaired only at concentrations $\geq$ 1,000 mcrg/l. The vertical migration of larvae was impaired at copper concentrations of $\geq$ 300 mcrg/l.

Tests on the effects of sulfuric pollutants such as iron sulfate and hydrogen sulfate, showed that a dilution of 1:8,000 significantly reduced egg fertilization and hatching success, decreased egg diameter, retarded embryonic growth, shortened the incubation period, and increased the rate of structural abnormalities in newly hatched larvae (Kinne and Rosenthal 1967). Larval prey-catching ability was impaired in 1:32,000 and 1:24,000 dilutions; locomotory performance was seriously affected at a 1:16,000 dilution. Permanent deformities and death occurred within a few days at a 1:8,000 dilution.

Studies of dinitrophenol effects on herring embryonic development indicated that low concentrations (0.01 to 0.05 micromole/l) increased embryo activity and altered heart rates significantly (Rosenthal and Stelzer 1970). Various embryonic malformations were also observed. A dinitrophenol concentration of 0.1 micromole/l caused up to a 400% increase in the normal embryonic respiration rate (Stelzer et al. 1971).

Blaxter and Hunter (1982) reported that eggs and larvae held under films of crude oil in concentrations of 1 to 20 ml/l, or in emulsions, experienced toxicities that varied with the origin of the oil. For oil from a particular source, the fractions with the lower boiling points seemed more harmful (Kuhnhold 1969; cited in Kelly and Moring, 1986). In tests on oil dispersants, larvae did not avoid horizontal gradients, but swam into surface dispersant layers and were narcotized (Wilson, 1974). The survival of herring eggs and larvae was highest in water with low biological oxygen demand and low nitrate levels (Baxter and Steele, 1973).

### 1.4.2 Description of Programs to Protect, Restore, Preserve and Enhance Atlantic Herring Habitat

Federal marine pollution research and monitoring activities are coordinated by NOAA's National Ocean Pollution Program Office. Short and long-term anthropogenic effects on the marine environment are also assessed. NOAA's Ocean Pollution Program Office coordinates interagency responsibilities while the Ocean Assessments Division (OAD) of the Office of Oceanography and Marine Assessments, National Ocean Service, manages assessments.

## 1.5 IMPACTS OF THE FISHERY MANAGEMENT PROGRAM

### 1.5.1 Biological and Environmental Impacts

The management measures in this amendment maintain the effective measures that were previously implemented and refines spawning protection measures based on new science. In the 2016 fishing season, the inshore spawning area monitoring program will test a new method to inform closures. This pilot program, known as the $GSI_{30}$-Based Forecast System (hereafter forecast system), will be evaluated after one year and has the potential to become permanent if deemed effective by the Atlantic Herring Management Section. If there are concerns with the forecast system then the Section can revert to the traditional length-based spawning closure system. In either case the spawning area monitoring system will continue to be based on the gonad-to-body weight index (also known as gonadosomatic index, GSI).

The forecast system is an outcome of the analysis performed by the Atlantic Herring Technical Committee (Appendix 1). It is different than the previously implemented length-based closure system, which assumes small herring achieve full maturity at a lower GSI than larger herring and separates fish samples into two length bins. While smaller Gulf of Maine herring generally have a lower GSI than larger fish (at a given point in time), the Technical Committee analysis postulates all sizes achieve a similar maximum GSI. Therefore, dividing samples based on length bins is not included in the forecast system—instead only samples of adult female herring in gondal stages III-V will be collected. These samples will be used to track gonad development and ultimately forecast a spawning closure date. The forecast system included in this amendment is an attempt to align the assumptions of the closure system with the current understanding of the reproductive ecology of herring to improve the accuracy of and maximize the effectiveness of spawning closures.

The Maine fixed gear fishery west of Cutler now has a year-round set-aside, up to 500 metric tons will continue to be deducted from the Area 1A sub-ACL. Previously any remaining set-aside was rolled into the overall Area 1A fishery on November 1; as a result of this amendment there is no longer a rollover provision. This is not expected to have biological or environmental impacts on Atlantic herring due to the known overwintering migrations. In the Gulf of Maine, juveniles spend the summer in inshore areas off Maine and New Brunswick. In autumn, they move south to waters off Massachusetts and Rhode Island; they return to Maine the following spring. Adults in the western Gulf of Maine may migrate southwest along the coast after spawning and overwinter at the western extremely of their migratory path, potentially south of Cape Cod. Adults in the eastern Gulf of Maine may migrate southwest and overwinter in Massachusetts Bay and southern New England.

The empty fish hold provision, if approved by NOAA Fisheries and subsequently implemented in states waters, will require fish holds on Category A and B vessels with the ability to pump to be empty of fish prior to declaring into the Atlantic herring fishery. This measure intends to discourage wasteful fishing practices and provide some incentive to harvest the resource more efficiently. In addition, it has the potential to enhance the effectiveness of the Atlantic herring catch monitoring program because vessels will not be able to leave the dock with fish in the hold, thereby reducing the potential for mixing of fish as a result of multiple trips. Mixing of fish compromises catch data used to inform harvest control measures and bycatch avoidance programs such as river herring. If implemented this measure could reduce waste in the fishery, improve catch monitoring and enhance the long-term management of the Atlantic herring fishery.

### 1.5.2 Social Impacts

#### *1.5.2.1 Recreational Fishery*

While only 1% of Atlantic herring landings are taken by the recreational fishery, it is primarily used as bait for many species. Herring management affects the recreational fishery indirectly by controlling the availability of herring for bait and for forage (drawing the target species closer to shore where they are then accessible to the recreational industry). So long as management

measures work to ensure herring is not overfished or experiencing overfishing, the recreational fishery will benefit.

*1.5.2.2 Commercial Fishery*

The spawning area monitoring program will test the $GSI_{30}$-Based Forecast System during the 2016 fishing season. As designed this method will forecast a closure date once an increase in $GSI_{30}$ is detected, all interested parties (samplers, managers, industry) will have advance notice as to when the spawning closure will occur, allowing them to plan their activities accordingly. The forecast system uses GSI information from all samples to project a closure date; there is no longer the pressure to obtain two consecutive samples just prior to spawning, a task that has proven difficult over the years. Given all samples will be used to track herring maturity over time, the use of default closure dates due to insufficient samples would occur less often. Aligning the closures with the onset of spawning, instead of relying on default dates, has the potential to benefit the industry and the resource.

The federal and state FMPs allow up to 500 MT of the Area 1A sub-ACL to be set-aside for the fixed gear fishery west of Cutler. The removal of the November 1 set-aside rollover is projected to benefit a small number of fixed gear fishermen, but have a neutral impact on the overall industry. Fixed gear fishermen will have a year-round set-aside which gives them the opportunity to take advantage of anecdotal evidence that Atlantic herring are in the Gulf of Maine after November 1, likely due to changes in oceanographic conditions. There are potential management costs to implement this adjustment because it does not complement the federal FMP.

If implemented, requiring fish holds to be empty of fish prior to declaring into the Atlantic herring fishery will have a positive impact on industry. It is an incentive for fishermen to harvest based on market demand and prohibits vessels from returning to sea with unsold fish in their holds. Because the practice of disposing unmarketable catch at-sea on a subsequent fishing trip is not known to occur widely in the Atlantic herring fishery, the impacts of this option on the herring resource, although positive, are not likely to be large.

*1.5.2.3 Subsistence Fishery*

It is uncertain to what extent herring may support subsistence fishing along the east coast. Because the amendment places harvest controls on the resource, it is believed the amendment will maintain access to herring for subsistence needs.

*1.5.2.4 Non-consumptive Factors*

As a forage species, juvenile and adult herring are preyed upon by a variety of marine species, including tuna and whales. Non-consumptive industries like whale watching and bird watching would be affected if herring were to decline. However the resource is not overfished and overfishing is not occurring. In addition, a stated objective of this amendment is to promote the utilization of the resource in a manner that takes into account its value as a forage species.

# 2.0 GOALS AND OBJECTIVES

## 2.1 HISTORY OF PRIOR MANAGEMENT ACTIONS

**Fishery Management Plan (FMP)** (November 1993)
Management of USA Northwest Atlantic herring stocks beyond territorial waters was commenced in 1972 through the International Commission for the Northwest Atlantic Fisheries (ICNAF). The international fishery was regulated by ICNAF until USA withdrawal from the organization in 1976 with Congressional passage of the Magnuson Fishery Conservation and Management Act (MFCMA). Under the aegis of the MFCMA, the New England Fishery Management Council (Council) developed a Fishery Management Plan (FMP) for herring, which was approved by the Secretary of Commerce and was implemented on December 28, 1978. Over the interim period (1976-1978), foreign fishing for herring in USA waters was regulated through a Preliminary Management Plan (PMP) prepared by the National Marine Fisheries Service (NMFS 1995). In 1982, this plan was withdrawn by NMFS and herring was placed on the prohibited species list, eliminating directed fisheries for herring by foreign nationals within the US EEZ and requiring that any herring bycatch by such vessels be discarded. In 1983, an Interstate Herring Management Plan was adopted by the states of Maine, Massachusetts, New Hampshire and Rhode Island, which implemented a series of spawning closures. The states from Maine to New Jersey, acting through the ASMFC, adopted a new FMP in 1994 to address the growth of the herring resource and interest in Internal Waters Processing (IWP) operations.

**Amendment 1** (February 1999)
ASMFC's Amendment 1 to the Atlantic Herring Fishery Management Plan (FMP) was developed to complement the NEFMC's federal management plan; it was designed to minimize regulatory differences in fisheries conducted in state and federal waters. Amendment I established management goals and objectives for the U.S. Atlantic herring resource that can only be reached through the successful implementation of both the interstate and federal management plans. The management scheme relies on a total allowable catch (TAC) with effort control measures to avoid overfishing. TACs are developed for specific management areas to reflect the current state of knowledge concerning migratory behavior and mixing rates of the sub-components of Atlantic herring.

Amendment 1 defines overfishing and biological reference points based on an estimate of maximum sustainable yield (MSY) for the entire stock complex. In order to maintain consistency between Amendment 1 and NEFMC's FMP, ASMFC's Atlantic Herring Section adopted the same overfishing definition and biological reference points as in the federal plan, which were created under guidelines stipulated in the revised Magnuson-Stevens Fishery Conservation and Management Act (MSA) prior to the 2006 re-authorization. Both FMPs provide a process for setting annual specifications and contain institutional frameworks for developing and implementing future management action involving the ASMFC, the New England and Mid-Atlantic Councils, and (possibly) Canada. The plans also include state and federal spawning closures/restrictions and recommendations to prevent damage to herring spawning habitat and egg beds. State effort controls include specific "days out" of the week to slow the fishery's catch rates and extend the fishing season in Management Area 1A.

**Addendum I to Amendment 1** (July 2000)
The Section approved Addendum I to re-address the protection of spawning areas and change the due date for annual state compliance reports to February 1. Because NOAA Fisheries disapproved the spawning closures for the federal waters of Management Area 1A (inshore Gulf of Maine), ASMFC developed Addendum I to redefine the state waters spawning areas outlined in Amendment 1. Addendum I also includes measures designed to reduce the exploitation and disruption of herring spawning aggregations by imposing a landing restriction in state ports for herring caught in the spawning areas, except that some states allow a 20% tolerance for spawn herring (Maine and Massachusetts).

**Technical Addendum #1A** (October 2001) was approved to change the delineation of the Eastern Maine spawning boundary because the spawning aggregations were not adequately protected in 2000.

**Addendum II to Amendment 1** (February 2002)
Addendum II was developed in conjunction with NEFMC's Framework Adjustment 1 to allocate the Management Area 1A's TAC on a seasonal basis. This addendum also specifies the procedures for allocating the annual IWP quota.

**Amendment 2** (March 2006)
The essential management components of ASMFC's Amendment 2 are consistent with the federal Amendment 1 (final rule published in March 2007). These provisions include identical management area boundaries, joint TAC specifications setting process between NEFMC and ASMFC, and closure of an area when 95% of TAC is harvested and reduction of the possession limit to a 5% bycatch allowance. Despite coordinated development between Amendment 2 and the federal Amendment 1, there remained some inconsistencies. The east of Cutler exemption in *Section 4.3.2.4* of Amendment 2 was not adopted in the federal plan, as it was found to be "inconsistent with National Standard 1 and 3 of the Magnuson-Stevens Act." Conversely, Amendment 1 contains a midwater trawl prohibition in Area 1A from June 1 – September 30, which is not included in the Amendment 2. It is unlikely that there are mid-water trawl vessels lacking federal permits.

**Technical Addendum I to Amendment 2** (August 2006)
Upon implementation of Amendment 2, there was inconsistent interpretation of the Zero Tolerance provision. Therefore, a technical addendum was developed to clarify that prohibits any vessel from fishing for, taking, landing, or possessing "spawn" herring within a restricted spawning area except for incidental bycatch and transiting provisions.

**Addendum I to Amendment 2** (February 2009)
Addendum I was intended to address effort in Area 1A. It includes a number of tools for the Section to use in order to maintain a steady supply of herring throughout the fishing season. Under Addendum I, states adjacent to Area 1A must set quotas, but can use bi-monthly, trimester, or seasonal quotas and can distribute quota from January – May to later on in the fishing season when the demand and price is greater—as best meets the need of the fishery. This addendum also includes measures to close the fishery when 95% of the quota allocation is

harvested and the ability to roll quota into later periods in the event of an under harvest. States are also required to implement weekly reporting in order to manage quotas in a timely manner.

**Addendum II** (December 2010)
In March 2011, NOAA Fisheries approved Amendment 4 to the federal FMP, bringing it under compliance with the MSA's annual catch limit requirements. Addendum II was developed to mirror the federal Amendment 4. It revises the specifications process and definitions to be consistent with the federal management scheme, in which specifications can be set for up to three years based on best available science. Addendum II also establishes a threshold of 95% of an area's TAC for fishery closure and overage paybacks as accountability measures.

**Addendum V** (October 2012)
Intended to provide clarity and eliminate inconsistent spawning regulations among various interstate Atlantic herring FMP documents, Addendum V replaces all spawning regulations in previous management documents. It establishes provisions for determining spawning events and the implementation of area closures, and increases the sampling size from two samples of 50 fish to two samples of 100 fish or more. Addendum V includes new boundaries for the four management areas (Figure 11) and identifies the locations of spawning areas subject to closures.

**Addendum VI** (August 2013)
Developed to complement the NEFMC's Framework Adjustment 2 (final rule published in October 2013), Addendum VI established new provisions and consistent management measures for the four Atlantic herring management areas. States were allowed to seasonally split sub-ACLs for each management area to benefit the fishery. Up to 10% of unused sub-ACL can be carried over to the following fishing year after data is available, provided that the stockwide ACL has not been caught. Addendum VI also set new triggers: a directed fishery will close when 92% of an area's sub-ACL is projected to be reached, and the stockwide fishery will close when 95% of the total ACL is projected to be reached. There is a 2,000 lb. trip limit to allow for incidental bycatch of sea herring for the remainder of the fishing year. In addition, Addendum VI allows for these the directed fishery closure triggers to be set through the specification process.

## 2.2 GOALS

The goals of Amendment 3 to the Interstate Fishery Management Plan for Atlantic Herring are:

- To achieve, on a continuing basis, optimum yield (OY) for the United States fishing industry and to prevent overfishing of the Atlantic herring resource. Optimum yield is the amount of fish that will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, taking into account the protection of marine ecosystems, including maintenance of a biomass that supports the ocean ecosystem, predator consumption of herring, and biologically sustainable human harvest. Optimum yield is based on the maximum sustainable yield (MSY) as reduced by any relevant economic, social, or ecological factor, and, in the case of an overfished fishery, provides for rebuilding to a level consistent with producing MSY.
- To provide for the orderly development of the offshore and inshore fisheries, taking into account the viability of current participants in the fishery.

## 2.3 OBJECTIVES

To meet the goals of Amendment 3, the following objectives shall guide the development of the interstate management program for Atlantic herring:

- To harvest the U.S. Northwest Atlantic herring resource consistent with the definition of overfishing contained in Amendment 3.
- To prevent the overfishing of discrete spawning units consistent with the national standards.
- To avoid patterns of fishing mortality by age which adversely affect age structure of the stock.
- To provide adequate protection for spawning herring and prevent damage to herring egg beds.
- To promote U.S. and Canadian cooperation in order to establish complementary and real-time management practices.
- To implement management measures in close coordination with other Federal and State FMPs.
- To promote research and improve the collection of information in order to better understand herring population dynamics, biology, and ecology, improve science in order to move to real-time management and to improve assessment procedures and cooperation with Canada.
- To achieve full utilization from the catch of herring, including minimizing waste from discards in the fishery.
- To maximize domestic use, such as lobster bait, sardines, and other products for human consumption, and encourage value-added product utilization.
- To promote the utilization of the resource in a manner, which maximizes social and economic benefits to the nation and taking into account the protection of marine ecosystems and its value as a forage species.

## 2.4 SPECIFICATION OF MANAGEMENT UNIT

The management unit is defined as within U.S. waters of the northwest Atlantic Ocean from the shoreline to the seaward boundary of the EEZ. Because the management unit is limited to U.S. waters, it does not include the entire range of the Atlantic herring population. Various components of the stock complex migrate through Canadian waters, beyond the Atlantic States Marine Fisheries Commission's management authority. The Atlantic herring stock complex is interstate, state-federal and transboundary in nature; therefore, effective assessment and management can be enhanced through cooperative efforts with state, federal, and Canadian scientists and fisheries managers.

Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and the National Marine Fisheries Service have declared an interest in Atlantic herring.

### 2.4.1 Management Areas

Currently, Atlantic herring is managed under four management areas in the Gulf of Maine, Georges Bank, and Southern New England (Figure 11). The Gulf of Maine is split into an inshore area (Area 1A) and offshore area (Area 1B). The boundaries of the management areas are consistent with the federal fishery management plan.

The definition of the management area boundaries is based on knowledge of the seasonal distribution and availability of juvenile and adult fish within the area of the management unit, regional differences in the nature and degree of harvesting (different gear types) and processing activity (differences in size and age of fish processed), differences between the inshore and offshore fishing grounds and habitat and the location of known spawning grounds. One of the most important reasons for distinguishing management areas is to avoid over-exploitation of individual spawning populations that are included within the stock complex. Despite the fact that the management unit extends throughout the range of the species in U.S. waters, there is evidence that the U.S. Atlantic herring resource is comprised of separate spawning populations that occupy identifiable areas prior to and during spawning. For the reasons given above, it is appropriate to establish an overall management program that is consistent with unique conditions of the resource and the fishery within separate management areas and that allows for the cooperative management of the resource by different regulatory jurisdictions (the states, the ASMFC and the New England Fishery Management Council).

Amendment 2 redefined areas 1B, 2 and 3, resulting in a larger area covered by Management Area 3. This change from Amendment 1 is based on two recommendations from the 2003 TRAC Meeting: 1) moving the boundary between Areas 1B and 3 to better reflect spawning distributions and minimize reporting errors and 2) moving the Area 2/3 boundary from its previous position (69°) west to 70° to better reflect the distribution and movement of spawning concentrations. These changes are intended to better reflect the distribution of the spawning components of the stock and have been supported by hydroacoustic sampling of the offshore component of the resource.

Area 3 is redefined as originating south of Cape Cod at 4139.00 and 7000.00, northeast to a point on the EEZ at 4253.14 and 6744.35. Continuing south along the EEZ to a point at 3754.00 and 7000.00, then north along 7000.00 longitude to the Cape Cod shoreline.

<u>Management Area 1</u> (Gulf of Maine):
All US waters of the Gulf of Maine north of a line extending from the eastern shore of Monomoy Island at 41º 35' N. latitude eastward to a point at 41º 35' N. latitude, 69º 00' W. longitude, thence northeasterly to a point along the Hague Line at 42º 53'14" N. latitude, 67º 44'35" W. longitude, thence northerly along the Hague Line to the US-Canadian border, to include State and Federal waters adjacent to the states of Maine, New Hampshire, and Massachusetts.

Management Area 1 is further divided into two sub-areas. The following points describe the line subdividing this area:

| | | |
|---|---|---|
| (1) | 70º 00' W | (Cape Cod shoreline at 70º 00'W) |
| 42º 38.4' N | 70º 00' W | |
| 42º 53' N | 69º 40' W | |
| 43º 12' N | 69º 00' W | |
| 43º 40' N | 68º 00' W | |
| 43º 58' N | 67º 22' W; | (the US-Canada maritime Boundary). |

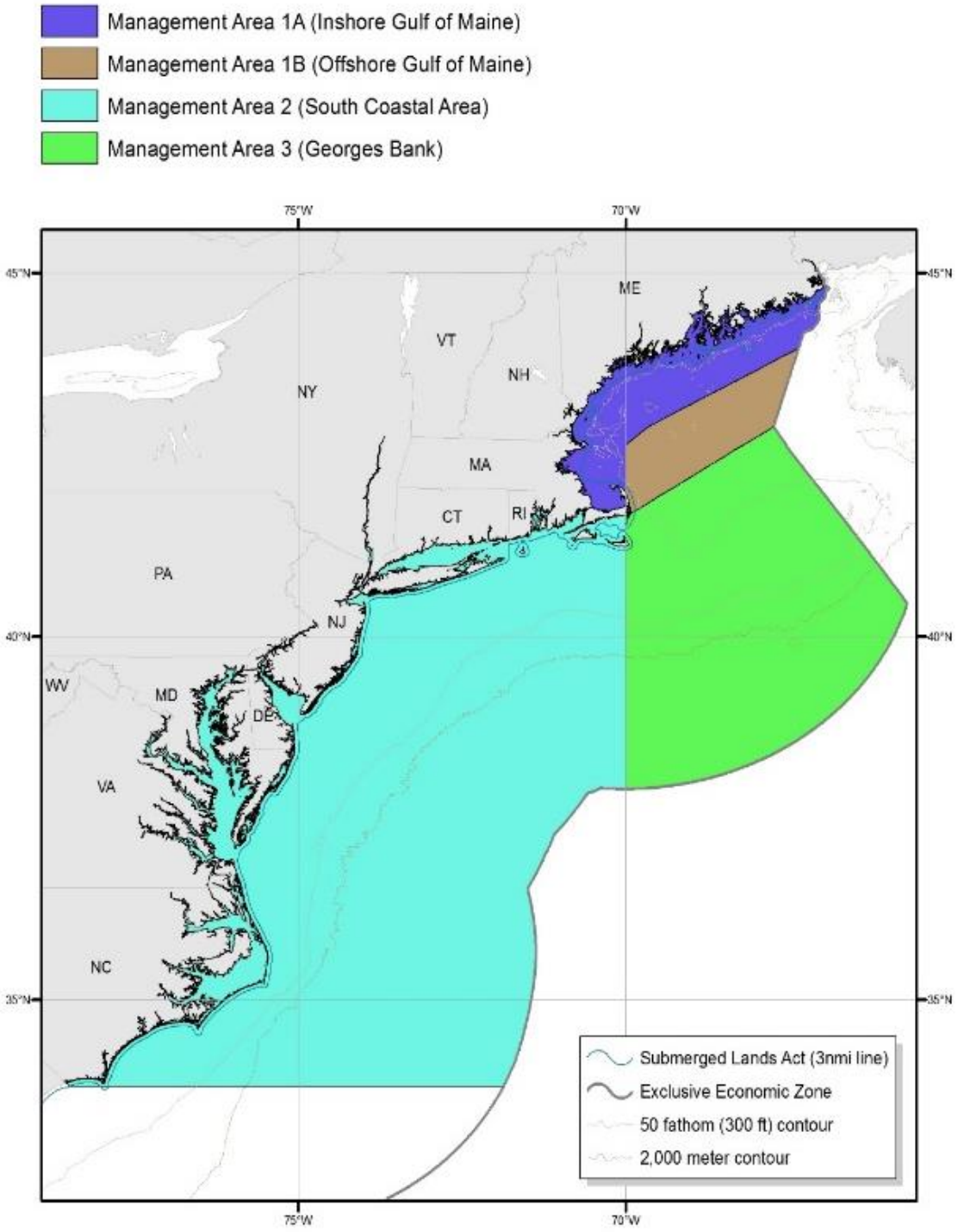
Northward along the irregular US-Canada maritime boundary to the shoreline.

The area inshore of the line is Area 1A, which includes the inshore fishing grounds that have supported most of the catch to date; the area offshore of the line is Area 1B.

Management Area 2 (South Coastal Area):
All waters west and south of the Cape Cod shoreline at 70º 00' W. longitude, to include state and Federal waters adjacent to the states of Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia and North Carolina.

Management Area 3 (Georges Bank):
All U.S. waters east of 70º 00' W. longitude and southeast of the line that runs from a point at 70º 00' W. longitude and 41º 35' N. latitude, northeasterly to the Hague Line at 67º 44' 35" W. longitude and 42º 53' 14" N. latitude.

**Figure 11. Map of Atlantic Herring Management Areas**



### 2.5 DEFINITION OF OVERFISHING

Based on the 2015 operational update, the overfishing threshold is $F_{MSY}$ = 0.24 and the overfished threshold is ½$SSB_{MSY}$ = 342 million lbs. (155,573 mt). Fishing mortality since 2009 has been relatively low because of the presence of strong cohorts that increased the stock biomass, and thus produce lower F given similar levels of catch. F was estimated at 0.16 in 2014 after retrospective adjustment (Figure 5). The stock is not overfished and overfishing is not occurring (Deroba, 2015).

### 2.6 STOCK REBUILDING PROGRAM

A rebuilding program is not applicable for the Atlantic herring complex at the present time; however, if it is determined that the herring resource is experiencing overfishing or has become overfished, the Atlantic herring Section will initiate and develop a rebuilding schedule at that time.

### 2.7 RESOURCE COMMUNITY ASPECTS

Due to the unique and important role that Atlantic herring play in the ecosystem, management considerations should be broader than just traditional fisheries management. Atlantic herring support a valuable commercial fishery for human consumption and provide bait for other fisheries. Herring also serve as an important prey species for fish, birds and marine mammals. *Section 1.3.5* describes the importance of herring as a forage species.

### 2.8 IMPLEMENTATION SCHEDULE

Amendment 3 to the Interstate Fishery Management Plan for Atlantic herring was approved by the Atlantic States Marine Fisheries Commission on February 2, 2016. States are required to implement the provisions of Amendment 3 by June 1, 2016.

## 3.0 MONITORING PROGRAMS SPECIFICATIONS/ELEMENTS

The Atlantic Herring Technical Committee will meet at least once each year to review the stock assessment and all other relevant and current data pertaining to stock status. The Technical Committee will report on all required monitoring elements outlined in *Section 3* and forward any recommendations to the Atlantic Herring Section. The Technical Committee shall also report to the Management Section the results of any other monitoring efforts or assessment activities not included in *Section 3* that may be relevant to the stock status of Atlantic Herring or indicative of ecosystem health and interactions.

The Atlantic Herring Advisory Panel will meet at least once each year to review the stock assessment and all other relevant data pertaining to stock status. The Advisory Panel will forward its report and any recommendations to the Management Section.

The Atlantic Herring Plan Review Team will annually review implementation of the management plan and any subsequent adjustments (addenda), and report to the Management

Section on any compliance issues that may arise. The PRT will also prepare the annual Atlantic Herring FMP Review and coordinate the annual update and prioritization of research needs (see *Section 6.0*).

State fishery management agencies will utilize the Atlantic Coastal Cooperative Statistics Program (ACCSP) to meet monitoring and reporting requirements of this FMP. The ACCSP partners are the 15 Atlantic coastal states (Maine through Florida), the District of Columbia, the Potomac River Fisheries Commission, the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the three Fishery Management Councils, and the Atlantic States Marine Fisheries Commission. Participation by program partners in the ACCSP does not relieve states from their responsibilities in collating and submitting harvest/monitoring reports to the Commission as may be required under this FMP.

## 3.1 ASSESSMENT OF ANNUAL RECRUITMENT

The Technical Committee and/or Stock Assessment Subcommittee will review annually the status of Atlantic herring recruitment to the coastal stock complex and "other specific groups of herring" as directed by the Section.

## 3.2 ASSESSMENT OF SPAWNING STOCK BIOMASS

The Technical Committee and/or Stock Assessment Subcommittee will review annually the spawning stock biomass of the Atlantic herring coastal stock complex and "other specific groups of herring" as directed by the Section.

## 3.3 ASSESSMENT OF FISHING MORTALITY TARGET AND MEASUREMENT

The Technical Committee and/or Stock Assessment Subcommittee will review annually the fishing mortality rate of the Atlantic herring coastal stock complex and "other specific groups of herring" as directed by the Section.

## 3.4. CATCH AND LANDINGS INFORMATION

Prior to 1994, U.S. landings were collected by a combination of canning industry reports and reports by NMFS port agents. After 1994, harvesters using Vessel Trip Reports (VTR) directly reported U.S. landings data. With implementation of the FMP in 1999, harvesters were required to use VTR and Interactive Voice Reports (IVR). In September of 2011, changes to catch reporting were instituted to more effectively monitor the sub-ACLs (76 FR 54385). Limited access harvesters are required to report their catch daily via Vessel Monitor System (VMS), while open access permit holders are still required to utilize IVR for weekly reports. All federal permit holders, both limited and open access, must submit VTRs on a weekly basis. Federally licensed dealers are also required to submit weekly reports (NEFMC 2013).

Herring harvesters are required to report discards in addition to landed catch through independent methods (NEFMC 2010). The harvester fills out a hard copy report for each catch by trip (VTR) and are required to send in these reports weekly (NMFS Gloucester). VTR data

have a lengthy processing period from the time the reports are sent in to when the data are entered into the database, however VTRs do give very specific information on catch (including location data) and are more precise, making them useful for stock assessments and effort evaluation (NEFMC 2010). VTRs contain landings and discards for all federally permitted harvesters who encounter Atlantic Herring, rather than just limited access permit holders.

Although harvesters are required to report catches with VTR forms, near real-time data is obtained through the IVR and VMS systems, allowing sub-ACLs to be monitored. The VMS system utilizes various satellite technologies and standard forms to allow limited access harvesters to record and submit daily information on catch (kept and discarded) as well as management area. The IVR system is an automated, phone-based reporting method. Open access harvesters are required to report weekly via telephone the amount of herring caught (kept and discarded) from each management area (NMFS Gloucester). VMS and IVR catch reports will be used to verify and determine catch when VTR and/or dealer records are unavailable, but VTR and dealer reports, once received, will determine final catch by area.

Any marine fishery products landed in any state must be reported by a dealer or a marine resource harvester acting as a dealer in that state. Any marine resource harvester or aquaculturist who sells, consigns, transfers, or barters marine fishery products to anyone other than a dealer would themselves be acting as a dealer and would therefore be responsible for reporting as a dealer. Dealer reports include detailed information on amounts landed, price paid and utilization of landings, on a per trip basis. The dealer reports do not contain information on area of catch.

The ACCSP commercial data collection program is a mandatory, trip-based system. All harvesters and dealers are required to report a minimum set of standard data elements (refer to the ACCSP Program Design document for details, http://www.accsp.org/data-collectionstandards). Submission of commercial harvester and dealer reports in the Atlantic herring fishery are required weekly by midnight Tuesday of the following week.

### 3.4.2 Biological Information

The ACCSP program design calls for the collection of baseline biological data on commercial, for-hire, and recreational fisheries. Biological data for commercial fisheries will be collected through port sampling programs and at-sea observers. Biological data for recreational fisheries will be collected in conjunction with the access-intercept survey. The for-hire sector includes both charter boats and headboats. Biological sampling standards for charter boats are the same as those of recreational fisheries. Sampling for headboats should use at-sea samplers to collect biological data, which may be supplemented by intercept sampling. A minimum set of standard data elements will be collected in all biological sampling programs (refer to the ACCSP Program Design document for details, http://www.accsp.org/data-collectionstandards). The ACCSP Biological Review Panel, in coordination with the Discard/Release Prioritization Committee, will determine priority and target sampling levels.

### 3.4.3 Social Information

No ongoing sociological data collection or monitoring is planned. Anecdotal information and insight on the fishery and regulatory changes are provided by the Atlantic Herring Advisory Panel, which maintains active participation. The ACCSP is currently developing standards for collecting sociological data in all fishing sectors.

### 3.4.4 Economic Information

Federal Atlantic herring dealers will continue to submit trip-level landings reports on a weekly basis (see *Section 3.4*). Data includes the vessel name, gear type, general catch area and amount purchased and can be used for future economic assessments. The ACCSP is currently developing standards for collecting economic data in all fishing sectors.

### 3.4.5 Observer Programs

The NMFS at-sea observer program is a mandatory program. As a condition of state and/or federal permitting, vessels shall be required to carry at-sea observers when requested. States will implement the ACCSP bycatch/observed module and are required to have mandatory observer coverage (~5%). A minimum set of standard data elements will be collected through the ACCSP at-sea observer program (refer to the ACCSP Program Design document for details). The ACCSP Biological Review Panel, in coordination with the Discard/Release Prioritization Committee, will determine priority and target sampling levels.

In 2015, the final rule for the Standardized Bycatch Reporting Methodology (SBRM) Omnibus Amendment was published. The amendment explains the methods and processes by which bycatch is currently monitored and assessed; determines whether these methods and processes need to be modified and/or supplemented, and establishes standards of precision for bycatch estimation for all Greater Atlantic Region fisheries. The SBRM can be viewed as a combination of sampling design, data collection procedures, and analyses used to estimate bycatch in multiple fisheries. It provides a structured approach for evaluating the effectiveness of the allocation of fisheries observer effort across multiple fisheries.

## 3.5 BYCATCH REDUCTION PROGRAM

Amendment 3 recommends each state develop a bycatch monitoring program for state permitted vessels participating in the directed herring fishery that mirrors the federal requirements. As such, no action would be taken to implement more specific requirements for observer coverage in the Atlantic herring fishery in state waters. Vessels engaged in the herring fishery and which hold a federal permit would continue to take observers on their vessels as requested by the National Marine Fisheries Service (NMFS). Observer coverage would continue at the discretion of the NMFS. The information collected from independent fisheries observers helps to improve the collection of bycatch information and improve the monitoring of bycatch in the fishery. With better information, more effective management measures are able to be implemented to discourage bycatch and discards.

NEFMC implemented haddock, river herring and shad bycatch caps, the ASMFC Atlantic Herring Section could initiate an addendum via adaptive management (*Section 4.5*) to modify the Interstate Management Program so that it is complementary to the Federal regulations.

### 3.6 TAGGING STUDIES/PROGRAM

Historically, tagging programs have been conducted by the Canadian Department of Fisheries, and Oceans and Maine Department of Marine Resources to study migration and spawning behaviors (NOAA Fisheries, 1999)

# 4.0 MANAGEMENT PROGRAM IMPLEMENTATION

## 4.1 RECREATIONAL FISHERIES MANAGEMENT MEASURES

No recreational fisheries management measures are proposed in this amendment. Recreational landings of Atlantic herring are currently so small, regulation of this fishery is unnecessary at this time.

## 4.2 COMMERCIAL FISHERIES MANAGEMENT MEASURES

Unless otherwise stated, the following regulations apply solely to Management Area 1A, inshore Gulf of Maine.

### 4.2.1 Fishing Year

The fishing year for Atlantic herring will be from January 1-December 31; under this measure, revisions developed under the specification process will be implemented with the beginning of the fishing year, January 1.

### 4.2.2 Specifications

NEFMC Amendment 4 established new terminology in the Herring FMP to be consistent with the Magnuson-Stevens Reauthorization Act of 2006 (MSRA). To avoid confusion between state and federal management, ASMFC adopted the new terminology so the state and federal FMPs have consistent terminology. The overall management scheme was not affected by the new set of definitions, described below.

**OFL: Overfishing Level.** The catch that results from applying the maximum fishing mortality threshold to a current or projected estimate of stock size. When the stock is not overfished and overfishing is not occurring, this is usually FMSY or its proxy. Catches that exceed this amount would be expected to result in overfishing. The annual OFL can fluctuate above and below MSY depending on the current size of the stock. This specification will replace the current specification of *allowable biological catch* in the herring fishery.

**ABC: Acceptable Biological Catch.** The maximum catch that is recommended for harvest, consistent with meeting the biological objectives of the management plan. ABC can equal but never exceed the OFL. ABC should be based on $F_{MSY}$ or its proxy for the stock if overfishing is not occurring and/or the stock is not in a rebuilding program, and should be based on the rebuilding fishing mortality ($F_{reb}$) rate for the stock if it is in a rebuilding program. The specification of ABC will consider scientific uncertainty.

**ACL: Annual Catch Limit.** The catch level selected such that the risk of exceeding the ABC is consistent with the management program. ACL can be equal to but can never exceed the ABC. ACL should be set lower than the ABC as necessary due to uncertainty over the effectiveness of management measures. The ACL serves as the level of catch that determines whether accountability measures (AMs) become effective.

OFL > = ABC > = ACL
OFL – Scientific Uncertainty = ABC
ABC – Management Uncertainty = Stockwide ACL = Optimal Yield

**AM: Accountability Measure(s).** Management measures established to ensure that (1) the ACL is not exceeded during the fishing year; and (2) any ACL overages, if they occur, are mitigated and corrected.

**Sub-ACLs.** Area-based sub-divisions of the stockwide/total Atlantic herring ACL, intended to minimize the risk of overfishing any stock sub-component. Directed fisheries in a management area will close when 92% of the sub-ACL is projected to be reached, see *Section 4.2.3.6.*

**Research Set-Aside (RSA).** 0-3 % of a sub-ACL in any or all of the herring management areas can be utilized for herring related research purposes see *Section 4.2.3.8.*

**Fixed Gear Set-Aside (FGSA).** This can be specified up to 500 mt in Area 1A, see *Section 4.2.7.2.*

| Acronym | Definition | Considerations |
|---|---|---|
| **OFL** | **Catch at FMAX** | Current stock size |
| **ABC** | **Catch at FMSY or Frebuild <=OFL** | Biological uncertainty over current stock size, estimate of F, or other parameters (stock mixing ratios, recruitment, etc.) |
| **ACL** | **<=ABC** | Uncertainty from other sources, evaluation of risk to achieving management goals if ABC is exceeded |
| **AM** | **Accountability Measures** | (1) minimizing risk of exceeding ACL during the fishing year; (2) addressing ACL overages, if they occur |

NEFMC Amendment 4 contains the following AM provisions:

**ACL Overage Deduction:** This option establishes a process to address ACL/sub-ACL overages in the Atlantic herring fishery. Once the final total catch for a fishing year is determined during the subsequent fishing year using the best available information (including VTR reports to account for incidental catch in other fisheries), any ACL/sub-ACL overage would result in a reduction of the corresponding ACL/sub-ACL for the fishing year after the final total catch is tallied. The ACL/sub-ACL deduction would be equal to the amount that was exceeded. NMFS would make these determinations and publish any changes to the ACLs in the *Federal Register* prior to the start of the fishing year during which the deduction would occur.

**Haddock Catch Cap Accountability Measure.** This option establishes an AM for the current haddock catch cap, consistent with the establishment of the catch cap as a sub-ACL in the groundfish fishery (NEFMC Amendment 16) and consistent with current regulations regarding the catch cap. When the Regional Administrator has determined that the haddock catch cap has been caught, all vessels issued an Atlantic herring permit or fishing in the Federal portion of the GOM/GB Herring Exemption Area, would be prohibited from fishing for, possessing, or landing herring in excess of 2,000 lb per trip in or from the GOM/GB Herring Exemption Area unless the vessel has a multispecies permit and is fishing on a declared groundfish trip. Upon this determination, possession of haddock would be prohibited for all vessels that possess a limited access Category A or B permit, regardless of where they are fishing.

In addition to changing/replacing the specifications to include OFL, ABC, and ACL, NEFMC Amendment 4 removed JVPt, JVP, IWP, TALFF, and the reserve (Table 4.) because these terms involve foreign fishing vessels who no longer fish in US waters.

**Table 4. Specification Naming Adjustments**

| SPECIFICATIONS PRIOR TO NEFMC AMENDMENT 4 | CURRENT SPECIFICATIONS, AS A RESULT OF NEFMC AMENDMENT 4 |
|---|---|
| Allowable Biological Catch (ABC) | Overfishing Limit (OFL) |
| | Acceptable Biological Catch (ABC) |
| U.S. Optimum Yield (OY) | U.S. Optimum Yield (OY)<br>(Stock-Wide ACL) |
| Domestic Annual Harvesting (DAH) | Domestic Annual Harvesting (DAH) |
| Domestic Annual Processing (DAP) | Domestic Annual Processing (DAP) |
| Total Joint Venture Processing (JVPt) | N/A |
| Joint Venture Processing (JVP) | N/A |
| Internal Waters Processing (IWP) | N/A |
| U.S. At-Sea Processing (USAP) | U.S. At-Sea Processing (USAP) |
| Border Transfer (BT) | Border Transfer (BT) |
| Total Allowable Level of Foreign Fishing (TALFF) | N/A |
| RESERVE | N/A |
| TAC Area 1A | Area 1A Sub-ACL |
| TAC Area 1B | Area 1B Sub-ACL |
| TAC Area 2 | Area 2 Sub-ACL |
| TAC Area 3 | Area 3 Sub-ACL |
| Research Set-Aside | Research Set-Aside<br>(and/or Other Set-Aside) |

#### *4.2.2.1 Specification Setting Process*

The Atlantic Herring Section will set specifications for up to three years using the following general process. If the Section does set specifications for three years, it is recommended that the TC review the specifications during each interim year and provide updates to the Section. The Section can make mid-year adjustments by a majority vote during any Section meeting that has sufficient attendance to form a quorum.

1. The TC will review the best available science, which is likely be the most recent stock assessment and/or stock assessment and fishery evaluation (SAFE) report prepared by the PDT. ASMFC staff will facilitate TC involvement in PDT meetings (or schedule joint meetings) during the development of the SAFE report. The PDT and TC currently have significant overlap of membership making joint meetings practical at this time.

2. Following the review, the TC will make recommendations to the Section for the following:
   - OFL estimates for one to three fishing years, based on the point estimates of FMSY (or its proxy) and the point estimate of future stock size.
   - ABC recommendations for one to three fishing years, based on either FMSY (if the stock is not in a rebuilding program) or FREB (if the stock is in a rebuilding program). If possible, the Herring TC recommendation should report the catch that is expected to result from the point estimates of the target fishing mortality rate and projected stock size (i.e., the OFL). If the TC recommends reducing the ABC from this amount, the recommendation should include an explicit discussion of the scientific uncertainties that are taken into account in developing the recommendation.
   - ACL recommendations, taking into account necessary adjustments for Canadian catch (New Brunswick weir fishery), state waters landings, discards, and other sources of potential management uncertainty (risk).
   - An evaluation whether the ABC and the ACLs have been exceeded in earlier years.

3. The Atlantic Herring Section will review TC recommendations and set specifications prior to the opening of the fishing season. Prior to the Section taking final action, ASMFC staff will facilitate joint meetings of the NEFMC Herring Committee and Section to review progress and give guidance to the PDT/TC during the development of the SAFE report. There is significant overlap between the Herring Committee and Section making joint meetings practical at this time.

### 4.2.3 Total Allowable Catch / Sub-Annual Catch Limit

#### *4.2.3.1 Determination of Quota Periods*

Before or at the ASMFC Annual Meeting, Section members from Maine, New Hampshire, and Massachusetts must meet and agree on quota specifications, including the quota period system, and whether to allow fishing before June 1. In the event that the states cannot come to an agreement at the meeting, the matter will be resolved by the full Section at the Annual Meeting.

#### *4.2.3.2 Quota Periods*

Quota periods shall be determined annually, as specified in *Section 4.2.3.1*. The Area 1A sub-ACL shall be distributed using bi-monthly, trimester, or seasonal quota periods whichever meets the needs of the fishery. If a quota period is closed early due to the full allocation being harvested, vessels are prohibited from landing more than 2,000 lbs. of Atlantic herring per trip until the next quota period begins.

*Bi-monthly periods are established as follows:*
Period 1: January 1 – February 28 (29)
Period 2: March 1 – April 30
Period 3: May 1 – June 30
Period 4: July 1- August 31
Period 5: September 1 – October 31
Period 6: November 1 – December 31

*Trimesters are established as follows:*
Trimester 1: January 1 – May 31
Trimester 2: June 1 – September 30
Trimester 3: October 1 – December 31

*Seasons are established as follows:*
Season 1: January 1 – September 30
Season 2: October 1 – December 31

In addition to having flexibility to choose between bi-monthly, trimester, or seasonal quotas, quota from the January 1 – May 31 period may be allocated to later in the fishing season in response to conditions in the fishery. The January 1 – May 31 period quota may be distributed to each remaining period proportional to the quota share of the remaining periods. If the bi-monthly periods with no landings before June 1 option is selected, the Section has the option to count June as its own period, or December as its own period (Table 5).

The allocations percentages for each quota period system were derived from Vessel Trip Reports from 2000 – 2007 and represent historical fishing effort that was driven by market demand for herring (Table 5 and 6). These allocation percentages are fixed and can only be changed through a subsequent addendum or amendment.

For reference, the 2016-2018 specifications allocate Area 1A's sub-ACL through seasonal quotas with no landings before June 1; 72.8% will be available from June 1 – September 30 and 27.2% will be available from October 1 – December 31.

**Table 5. Bi-monthly quota percent allocations. Percentages were calculated using vessel trip reports from 2000 – 2007**

| Bi-Monthly Quotas | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| January – December | | | No Landings Prior to June 1 (with June as a one-month period) | | | No Landings Prior to June 1 (with December as a one-month period) | | |
| **Period** | **Months** | **%** | **Period** | **Months** | **%** | **Period** | **Months** | **%** |
| 1 | Jan/Feb | 1.5% | 1 | June | 16.4% | 1 | June/July | 36.8% |
| 2 | Mar/Apr | 2.3% | 2 | July/Aug | 40.1% | 2 | Aug/Sep | 36.0% |
| 3 | May/June | 24.0% | 3 | Sep/Oct | 34.0% | 3 | Oct/Nov | 27.1% |
| 4 | July/Aug | 34.6% | 4 | Nov/Dec | 9.5% | 4 | Dec | 0.2% |
| 5 | Sep/Oct | 29.4% | | | | | | |
| 6 | Nov/Dec | 8.2% | | | | | | |

**Table 6. Trimester and seasonal quota percent allocations. Percentages were calculated using vessel trip reports from 2000 – 2007**

| Trimesters | | | Seasonal Quotas | | | | | |
|---|---|---|---|---|---|---|---|---|
| January – December | | | January - December | | | No Landings Prior to June 1 | | |
| **Trimester** | **Months** | **%** | **Season** | **Months** | **%** | **Season** | **Season** | **%** |
| 1 | Jan - May | 13.7% | 1 | Jan - Sep | 76.5% | 1 | Jun - Sep | 72.8% |
| 2 | Jun - Sept | 62.8% | 2 | Oct - Dec | 23.5% | 2 | Oct - Dec | 27.2% |
| 3 | Oct - Dec | 23.5% | | | | | | |

*4.2.3.3 Seasonal Splitting of Quota for Areas 1B, 2, and 3*

States are allowed to seasonally split the sub-ACLs in all management areas to maximize value to the Atlantic herring fisheries. The actual splits (amounts or percentages by months, trimesters, or seasons) would be set as part of the specifications process.

*4.2.3.4 Quota Rollover for All Management Areas*

For each management area, up to 10% of quota may be carried over to the first fishing year after final landings data are available, within that same management area, provided that the ACL is not exceeded for the entire fishery. The stock-wide ACL cannot be changed from the annual specification. The intent of a quota rollover is to provide some flexibility to the fishing industry. Furthermore, unused quota in one period may be rolled over to the next period within the same fishing year.

Under management measure 4.2.3.4, the following provisions apply:

- All harvest control measures continue to apply to stockwide and sub-ACLs.
- All carryovers are based on initial sub-ACL allocations for the fishery year.
- Sub-ACL underages are determined based on the same methodology used to determine sub-ACL overages.
- Sub-ACL carryovers are only authorized if the total ACL for the fishing year is not exceeded.

- Provisions for carryovers, including percentages/amounts, can be modified in the future through the herring fishery specifications process (in addition to framework adjustments and amendments).
- Unused quota may be rolled from one period to the next within the same year.

*4.2.3.5 ACL/Sub-ACL Overage Deduction (Accountability Measures)*

This measure establishes annual paybacks for ACL/Sub-ACL overages.

Once a final total catch for a fishing year is determined during the subsequent fishing year using the best available information (including VTR reports to account for incidental catch in other fisheries), ACL/Sub-ACL overage would result in a reduction of the corresponding ACL/sub-ACL for the fishing year after the final total catch is tallied. The deduction will be equal to the amount exceeded.

NEFMC is required to implement AMs as part of MSRA. NMFS' Guidelines state accountability measures are management controls implemented for stocks such that exceeding the ACL is prevented, where possible, and corrected or mitigated if it occurs. NMFS suggests that three kinds of AMs that could be considered: (1) those that can be applied in-season, designed to prevent the ACL from being reached; and (2) those that are applied after the fishing year, designed to address the operational issue that caused the ACL overage and ensure that it does not happen in subsequent fishing years, and, as necessary, address any biological harm to the stock; and (3) those that are based on multiyear average data which are reviewed and applied annually. AMs should address and minimize the frequency and magnitude of overages and should be designed so that if an ACL is exceeded, specific adjustments are effective in the next fishing year or as soon as possible. Multi-year specifications (like those for the Atlantic herring fishery) should include AMs that provide for automatic adjustments in the subsequent year's harvest if an ACL is exceeded in one year.

Several of the management measures in the Atlantic herring fishery function as AMs as described above. These measures are designed primarily to prevent the management area sub-ACL from being exceeded during the fishing year, as well as improve the likelihood that OY can be caught on a continuing basis while preventing overfishing.

Specifically, NMFS and ASMFC will close the directed fishery when 92% of a management area's sub-ACL is projected to be harvested, as specified in *Section 4.2.3.6*. This precautionary closure helps ensure that an area's sub-ACL is not exceeded.

*4.2.3.6 Harvest Control Measures: Sub-ACL Trip Limit Triggers*

For all management areas, directed fisheries in a management area will close when 92% of the sub-ACL is projected to be reached, and then the stock-wide fishery will close when 95% of the total ACL is projected to be reached. A 2,000 pound bycatch allowance will continue when the directed fishery is closed.

*4.2.3.7 Specification Process for Sub-ACL Triggers*

Sub-ACL triggers will be set using the annual specification process.

*4.2.3.8 Research Set-Asides (RSAs)*

The Atlantic Herring Section and the New England Fishery Management Council may establish a mechanism to set aside a percentage of one or more management area's sub-ACL to help support research on the herring stock complex and fishery. This measure authorizes NEFMC and ASMFC to set-aside 0 - 3% of the sub-ACL from any management area(s) or the stockwide ACL for the herring fishery to support herring related research. The Council and Section will determine the specific percentages for the research set-asides and the management area(s) to which they apply during the fishery specification process. The research set-aside is intended to be in addition to the set-aside for incidental catch once the directed fishery in a management area closes.

### 4.2.4 Effort Controls

Effort controls are designed to slow the catch rate of herring to minimize early closures and allow the sub-ACL to be utilized throughout the entire period. ASMFC controls Atlantic herring catch rates though 'days out' (i.e. 4 'days out' should be interpreted on a weekly basis, which means 4 out of 7 days in a week will be no landings days). The 'days out' is designed to allow a vessel to land fish taken from an open area with no 'days out' restrictions.

*4.2.4.1 Determination of Days Out*

To prevent an early closure of a management area or sub-area, 'days out' specifications may be set during the initial meeting between Section members from Maine, New Hampshire, and Massachusetts or can be set at specific 'days out' meetings or conference calls as necessary. The states will annually agree to the start date, the number of 'days out' of the fishery, as well as which consecutive days of the week will have landing restrictions. While the start time for the landing restriction may vary by state, the states must implement the landing restriction for the same consecutive days each week.

If Section members from Maine, New Hampshire, and Massachusetts cannot agree on the specific 'days out', then the matter will go before the full Section for review at the next ASMFC meeting week or at a special meeting of the Section called by the Chairman.

All agreements are final when the meeting is adjourned. Adjustments to 'days out' specifications can only be made if states hold another meeting or conference call and agree on the specification changes.

*4.2.4.2 Days Out*

Harvesters are prohibited from landing herring during a 'day out'. In addition, vessels may only land once per calendar day on any day that is open to landing (not a 'day out').

Vessels with an Atlantic herring permit are not prohibited from participating in other fisheries for other species in restricted areas during days out of the Atlantic herring fishery. Landing of herring taken from management areas without 'days out' restrictions will be allowed on 'days

out' in Area 1A. Any vessel transiting an area closed to fishing with legally caught herring on board must have its fishing gear stowed.

During a 'day out', vessels participating in other fisheries may land an incidental catch of herring that does not exceed 2,000 pounds per trip. Vessels may not land more than 2,000 pounds of herring per day caught in an area closed to the directed herring fishing. Vessels transiting a closed area with more than 2,000 pounds of legally caught herring on board must have all seine and trawl gear stowed.

Fixed gear fishermen may remove and land herring from the gear (weirs and stop seines) on the days designated as a 'day out' of the fishery.

### 4.2.5 Timely Reporting of State Landings

The need for accurate and timely reporting by all harvesters is necessary for successful monitoring of any of the quotas included in this document.

States are required to implement weekly reporting by all non-federally permitted fishermen on Atlantic herring (including mobile and fixed gear). Weekly reporting can be achieved by use of the existing federal interactive voice reporting (IVR), ACCSP electronic data collection methods (eTRIPS, eDR), state logbooks or a similar system which collections all required data elements. Negative reports must be included in any system implemented by a state.

States are required to prohibit non-federally permitted fishermen, directing on herring, from landing herring until they are able to report their catch weekly as described above.

### 4.2.6 Spawning Restrictions

#### *4.2.6.1 Spawning Area Closure Monitoring System*

The spawning closure monitoring system is based on the gonad-to-body weight index (also known as gonadosomatic index, GSI). Female GSI is a calculation of the gonad (ovary) mass as a proportion of the total body mass and it is used as a tool to measure herring maturity. GSI values can be interpreted as the ratio of herring body weight that is comprised of the ovary. As such, a larger GSI value indicates advanced maturity and larger ovaries.

The Atlantic Herring TC conducted a review of scientific literature and analyzed female GSI data for a decade to inform an updated GSI-based spawning monitoring system (see Appendix 1. *Technical Report on Atlantic Herring $GSI_{30}$-Based Spawning Monitoring Program*).

Upon approval of Amendment 3 the Atlantic Herring Section granted a one-year pilot of a new method, known as the $GSI_{30}$-Based Forecast System, to be tested in the 2016 fishing season, followed by a performance review. The Section has the option to permanently implement the forecast system or to revert back to the length-based closure system (from prior years).

**$GSI_{30}$-Based Forecast System**
*The following will be implemented as a pilot program during the 2016 fishing season with the possibility for permanent implementation.*

The closure date for a spawning area will be projected based on a minimum of three (3) fishery dependent or independent samples, each containing at least 25 female herring in ICNAF gonadal stages III-V. Because larger herring spawn first, female GSI values will be standardized to that of a 30 cm fish, (95th percentile of observed female herring lengths) using the following formula:

$$GSI_{30} = GSI_{obs} + 1.84 * (30 - TL_{cm})$$

When a significant positive relationship is detected between $GSI_{30}$ and date, the slope of this line will be used to forecast a closure date. The forecasted closure date will be the day where $GSI_{30}$ is projected to exceed the selected trigger value. As additional samples are collected, the forecast will be updated and fine-tuned. Once the forecasted date is within 5 days, the spawning closure will be announced. If no significant increase in $GSI_{30}$ is detected prior to the default closure date, the default closure date would apply (see *Section 4.2.6.2* for default dates).

**$GSI_{30}$ Trigger Value**: Spawning occurs at the completion of maturity stage V. Therefore, a point near the high end of observed GSI values for stage V fish should be used as the trigger. A higher value closes the fishery later and just prior to spawning, whereas a lower value provides additional protection for maturing fish. In other words, higher GSI values indicate increased maturation and spawning readiness.

**70th Percentile** : $GSI_{30}$ Trigger = 23
*Closes the fishery at an earlier date to provide more protection for maturing fish, but may not provide complete protection for spawning fish.*

**80th Percentile**: $GSI_{30}$ Trigger = 25
*Closes the fishery in the later stages of maturity, but before spawning.*

**90th Percentile**: $GSI_{30}$ Trigger= 28
*Closes the fishery just prior to spawning.*

**Length-Based Closure System**
*If the pilot program is not accepted for permanent use then the following will be implemented.*

Closures in a given area will begin based on the spawning condition of Atlantic herring as determined from fishery dependent or independent samples. Sampling shall begin by August 1 for the Eastern and Western Maine areas, and by at least September 1 for the Massachusetts/New Hampshire area. If sufficient samples are not available, closures will begin on the default dates (*see Section 4.2.6.2 for dates*).

Sufficient sample information shall mean at least two (2) samples of 100 fish or more, in either length category, taken from fishery dependent or independent sources within a spawning closure

area by Maine, New Hampshire or Massachusetts. The fishery will remain open if sufficient samples are available, and they do not contain female herring in ICNAF gonadal stages III – V.

Closures in a given area will begin seven days after the determination that female herring in ICNAF gonadal stages III - V from that specific area have reached the following spawning conditions: female herring greater than 28 cm in length have reached a mean gonadosomatic index (GSI) of 20%; or female herring greater than or equal to 23 cm and less than 28 cm in length have reached a mean GSI of 15%.

Length refers to the mean natural total length, measured from the tip of the snout to the end of the caudal fin in normal position. "GSI" shall mean gonadosomatic index calculated by the following formula. Length refers to the mean natural total length, measured from the tip of the snout to the end of the caudal fin in normal position. "GSI" shall mean gonadosomatic index calculated by the following formula:

GSI = [Gonad Weight / (Total Body Weight - Gonad Weight)] x 100 percent.

*4.2.6.2 Default Closure Dates*

**Default Dates Associated with $GSI_{30}$ Trigger Values**
*The following defaults dates are linked to the $GSI_{30}$-Based Forecast System in Section 4.2.6.1.and will apply if the forecast method is approved for permanent implementation.*

Analysis of GSI data from 2004-2013 suggests onset of spawning can vary by five or more weeks from year-to-year. This observation is corroborated by scientific studies on herring spawning times (Boyar 1968; Grimm 1983; Stevenson 1989; Winters and Wheeler 1996). Median trigger dates were calculated for the period 2004-2013 using the formula and trigger values described under the $GSI_{30}$-Based Forecast System in *Section 4.2.6.1*. Insufficient data were available for the Eastern Maine area, so the value was derived from literature sources (Stephenson 1989).

If sufficient samples are not available, closures will begin on the following dates associated with the respective $GSI_{30}$ trigger value.

**80th Percentile ($GSI_{30}$ Trigger = 25)**
*Closes the fishery in the later stages of maturity, but before spawning.*

| | |
|---|---|
| Eastern Maine Spawning Area: | August 28 |
| Western Maine Spawning Area: | October 4 |
| Massachusetts/New Hampshire Spawning Area: | October 4 |

**Default Closure Dates Associated with the Length-Based Closure System**
*If the pilot program is not accepted for permanent use then the length-based closure system and the following default dates will be implemented.*

If sufficient samples are not available, closures will begin on the following dates.

| | |
|---|---|
| Eastern Maine Spawning Area: | August 15 |
| Western Maine Spawning Area: | September 1 |
| Massachusetts/New Hampshire Spawning Area: | September 21 |

*4.2.6.3 Spawning Area Boundaries*

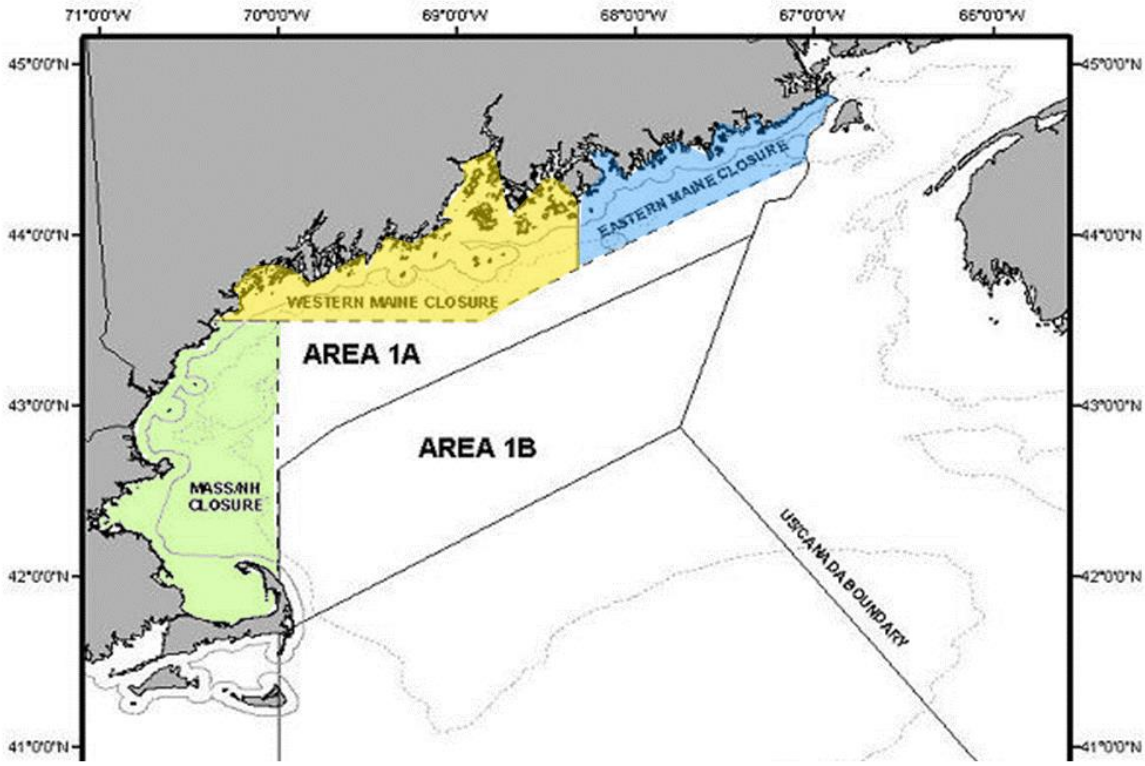
The Atlantic herring spawning area boundaries are as follows and shown in Figure 12.

*Eastern Maine Spawning Area*
All waters bounded by the following coordinates:
Maine coast 68º 20’ W
43º 48’ N 68º 20’ W
44º 25’ N 67º 03’ W
North along US/Canada border

*Western Maine Spawning Area*
All waters bounded by the following coordinates:
43º 30’ N Maine coast
43º 30’ N 68º 54.5’ W
43º 48’ N 68º 20’ W
North to Maine coast at 68º 20’ W

*Massachusetts/New Hampshire Spawning Area*
All waters bounded by the Massachusetts, New Hampshire and Maine coasts, and 43º 30’ N and 70º 00’ W

**Figure 12. Current Spawning Area Boundaries**




*4.2.6.4 Spawning Closure Period*

Analysis of GSI data from 2004-2013 suggest larger fish spawn earlier than smaller fish. This finding is corroborated by studies documenting a size-dependent maturation process (Boyar 1968; Ware and Tanasichuk, 1989; Oskarsson et al., 2002; Slotte et al., 2000). As the age structure of the herring resource expands with the recovery, it is possible spawning events will lengthen.

**Closure Period** – By default, all spawning closures in all spawning areas selected under *Section 4.2.6.3* will last four (4) weeks.

**Re-Closure Protocol** – Sampling will resume in the final week of the initial closure period or at the end of the initial closure period. If one (1) sample taken from within a spawning closure area, by Maine, New Hampshire or Massachusetts, indicates significant numbers of spawn herring then closures will resume for an additional two (2) weeks. Significant numbers of spawn herring is defined as 25% or more mature herring, by number in a sample, have yet to spawn. Mature or "spawn" herring are defined as Atlantic herring in ICNAF gonadal stages V and VI. Sample is defined as a minimum of 100 randomly selected adult sized fish from a fishery dependent or independent source.

#### *4.2.6.5 Tolerance Provision – Zero Tolerance*

Any vessel is prohibited to fish for, take, land, or possess herring from or within a restricted spawning area. Vessels are permitted to transit the restricted spawning areas with herring on board provided they comply with the provisions listed in the following two paragraphs.

Any vessel may fish for, take, land, or possess "spawn" herring from a management area outside of those identified in the Delineation of Spawning Areas. Any herring vessel having onboard spawn herring, which were caught outside of a management area that is under a herring spawning closure, may transit the closed area only if all of its fishing gear has been stowed. "Spawn" herring shall be identified as Atlantic herring in ICNAF gonadal stages V and VI.

An incidental bycatch allowance of up to 2,000 pounds of herring per trip for nondirected fisheries shall be in place during the spawning closures. This bycatch allowance will not be subject to the tolerance provision (i.e. vessels may land "spawn" herring as long as said vessel lands no more than 2,000 pounds). The amount of herring landed by one vessel in a day, as a bycatch allowance, shall not exceed 2,000 pounds (this prohibits a vessel from making multiple trips in one day to land more than the bycatch allowance). A trip shall be based on a calendar day basis.

#### *4.2.6.6 Bycatch Allowance—Spawning Area Closure*

No directed fisheries for Atlantic herring shall be allowed in a management area subject to a spawning closure. A bycatch allowance of up to 2,000 pounds of herring per trip for nondirected fisheries shall be in place during the spawning closures. The amount of herring landed by one vessel in a day, as a bycatch allowance, shall not exceed 2,000 pounds (this prohibits a vessel from making multiple trips in one day to land more than the bycatch allowance). A trip shall be based on a calendar day basis.

Any herring vessel transiting a management area that is under a herring spawning closure must have all of its fishing gear stowed.

#### *4.2.6.7 Other Spawning Area Considerations—Exemption for East of Cutler Fixed Gear Fisheries*

Under Amendment 1, all vessels fishing with fixed gear in state waters were required to obtain a permit from the appropriate state agency. While Amendment 1 did not specify an exemption for the fixed gear fisheries in the East Cutler area, these fisheries did have an exemption from the spawning restrictions prior to the amendment. The exemption was granted by the State of Maine and was later removed to comply with Amendment 1 to the Interstate FMP. The East Cutler area is defined in Figure 13 and 14. With implementation of Amendment 2 and 3, East of Cutler fixed gear fisheries are granted an exemption from spawning area considerations and are not limited on the amount of spawn herring that can be landed during a spawning closure.

### 4.2.7 Fixed Gear Fisheries

#### *4.2.7.1 Downeast Maine Fixed Gear Fisheries*

A vast majority, if not all, of fixed gear fishermen operate in state waters and obtain state permits to fish for Atlantic herring. It is difficult to get an estimate of the number of fixed gear fishermen targeting Atlantic herring in each state because permitting requirements vary by state. Several of the states do not have species-specific permits; rather, permitting is tied to gear type or individual.

The catch from the Downeast Maine fixed gear fishery will be included as part of the assumed catch from the New Brunswick (NB) weir fishery when determining area-specific sub-ACL and herring fishery specifications. During the fishing season, catch from the Downeast Maine fixed gear fishery will not be counted against the sub-ACL for Area 1A, and the fixed gear fishery will be allowed to continue to operate once the Area 1A sub-ACL has been reached. This equates to an exemption for the Downeast Maine fixed gear fishery from the Area 1A sub-ACL. Total catch in the Downeast Maine fixed gear fishery would essentially be unrestricted (with the notable exception of inshore spawning restrictions that affect catch in this fishery).

Fixed gear fishermen that qualify for the exemption must report landings weekly through the federal interactive voice reporting (IVR) system to monitor total landings (New Brunswick plus Downeast Maine), as well as report landings monthly to ME DMR. The 2016-2018 specifications estimate the NB weir fishery annual catch to be 6,200 mt; this amount is deducted from the ABC. If the exempted landings increase significantly, modifications to the exemption may be necessary. The rationale for this measure is based on the proximity between the Downeast Maine fixed gear fishery and the fixed gear fishery occurring in New Brunswick. Both fisheries operate very close to each other and catch the same fish if/when they move inshore. If the Area 1A sub-ACL is reached by the time the fish move inshore, then the Downeast Maine fixed gear fishermen lose access to the fishery, but the New Brunswick weir fishermen (only about 20 miles away) continue to catch fish.

From 2005-2014, the New Brunswick weir fishery average catch was 9,100 mt, greatly reduced from the 1993-2002, average catch of 19,605 mt (Table 7). The New Brunswick weir fishery is not restricted by ACLs in Canada, and landings from this fishery could increase in the future. With implementation of this measure, an adaptive approach may be necessary in the future so that the previous year's catch in these two fisheries could be accounted for when calculating ACLs for the following year, especially if average catch in either the New Brunswick weir fishery or the Downeast Maine fixed gear fishery increases.

Catch from the Downeast Maine fixed gear fishery east of Cutler is included as part of the assumed catch from the New Brunswick (NB) weir fishery. Up to 500 mt of the Area 1A sub-ACL, will be set aside for fixed gear fisheries operating in Area 1A (weirs and stop seines) west of Cutler (area west of the shaded area in Figure 13 and 14), see *Section 4.2.7.2 for details*.

In summary, the sub-ACL set-aside applies to the fixed gear fisheries occurring in Area 1A west of Cutler. The fixed gear fishery occurring east of Cutler will be exempt from the Area 1A sub-ACL. Both are required to report herring catch through IVR.

The definition of the Downeast Maine fixed gear fishery to which the above management measures apply is based on the definition used by the State of Maine in 1999 to establish an exemption for the Downeast Maine fixed gear fishery to spawning area restrictions:

Fixed gear (stop seine and weir) catches in waters north of a line drawn from Spruce Point (44 36.2' and 67 16.8'), Cross Island, Cutler, due east magnetic to the international boundary with Canada (see Figures 13 and 14).

**Figure 13. Downeast Maine Fixed Gear Exemption Area (shaded area)**

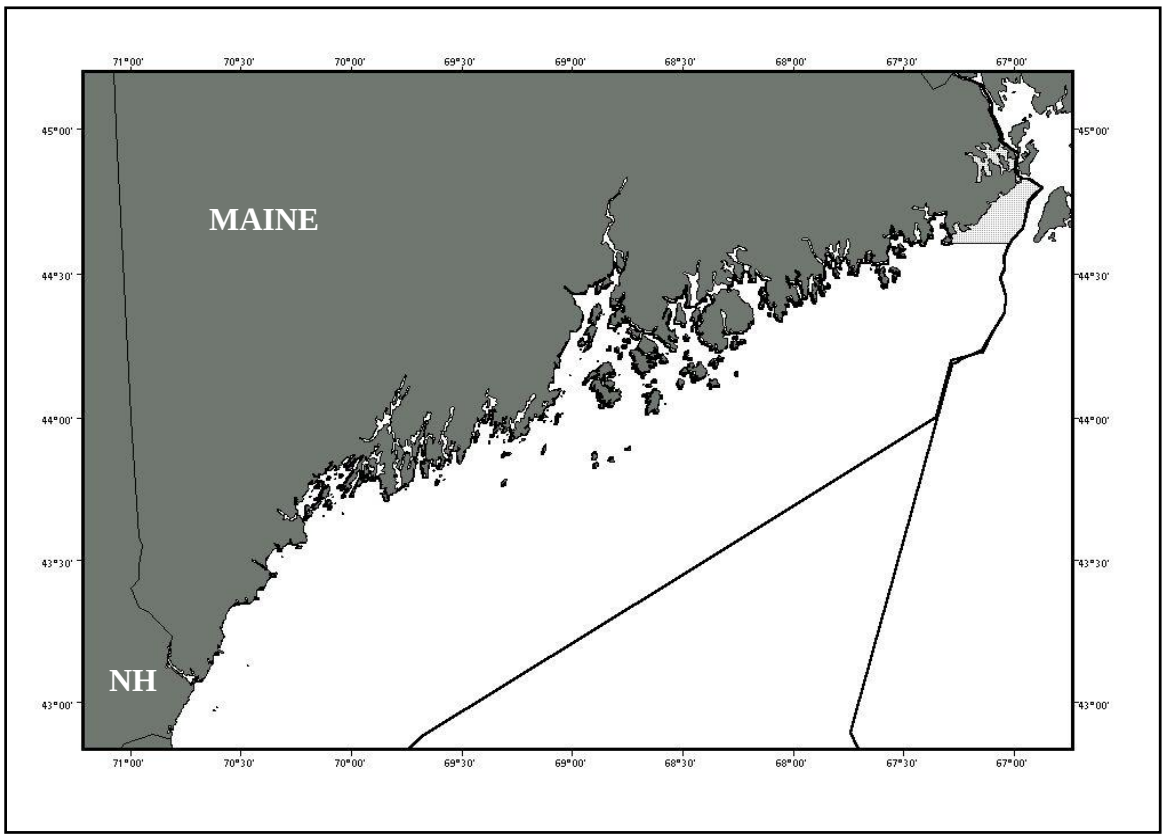


**Figure 14. Downeast Maine Fixed Gear Exemption Area (shaded), same area defined in Figure 13 at a closer resolution**

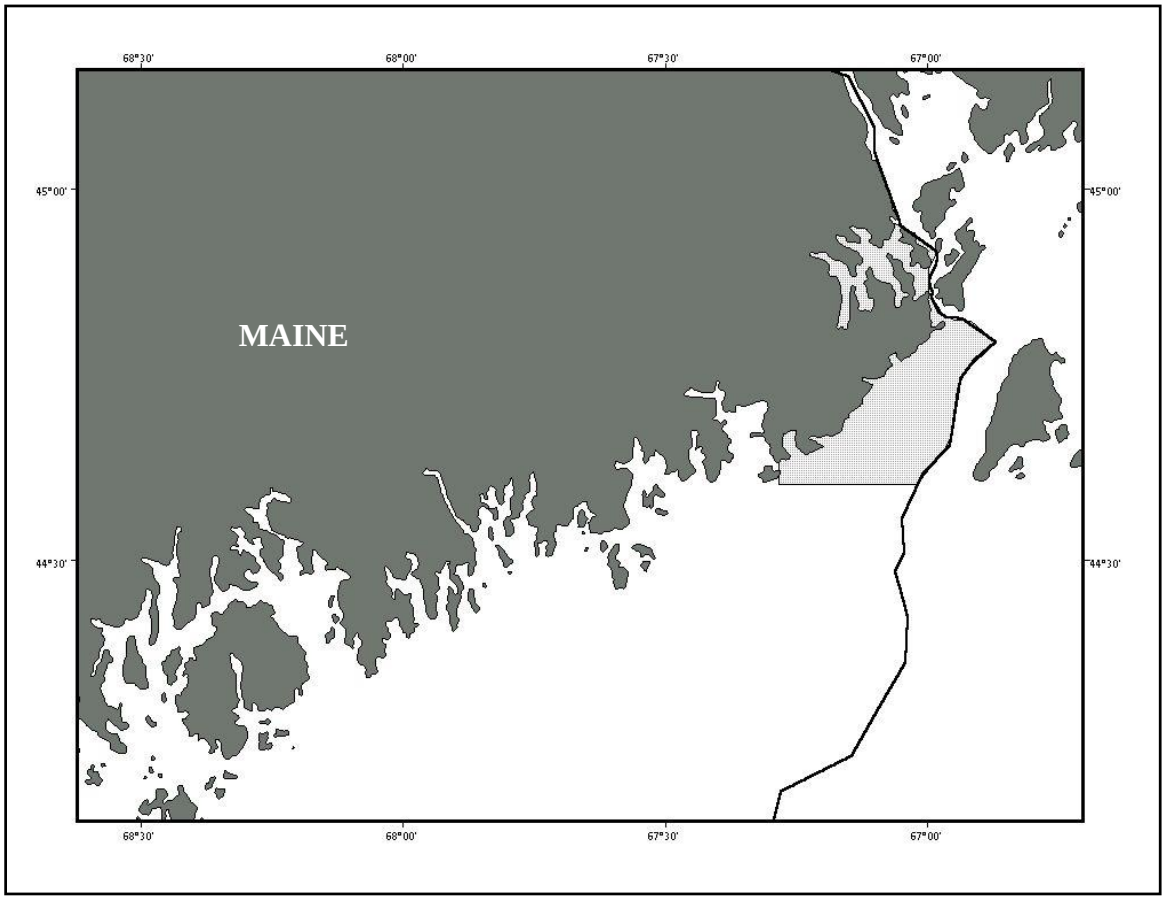


**Table 7. Number of Active Weirs and Catch per Weir in the NB Weir Fishery, 1978-2014**

| Year | NB Weir Catch (mt) | No. Active Weirs | Catch Per Weir (mt) |
|---|---|---|---|
| 1978 | 33,570 | 208 | 162 |
| 1979 | 32,477 | 210 | 155 |
| 1980 | 11,100 | 120 | 92 |
| 1981 | 15,575 | 147 | 102 |
| 1982 | 22,183 | 159 | 140 |
| 1983 | 10,594 | 143 | 88 |
| 1984 | 8,374 | 116 | 72 |
| 1985 | 26,724 | 156 | 171 |
| 1986 | 27,515 | 105 | 262 |
| 1987 | 26,622 | 123 | 216 |
| 1988 | 32,554 | 191 | 200 |
| 1989 | 43,475 | 171 | 255 |
| 1990 | 38,224 | 154 | 258 |
| 1991 | 23,713 | 143 | 166 |
| 1992 | 31,899 | 151 | 212 |
| 1993 | 31,431 | 145 | 216 |
| 1994 | 20,622 | 129 | 160 |
| 1995 | 18,198 | 106 | 172 |
| 1996 | 15,781 | 101 | 156 |
| 1997 | 20,416 | 102 | 200 |
| 1998 | 19,113 | 108 | 181 |
| 1999 | 18,234 | 100 | 191 |
| 2000 | 16,472 | 77 | 213 |
| 2001 | 20,064 | 101 | 199 |
| 2002 | 11,807 | 83 | 142 |
| 2003 | 9,003 | 78 | 115 |
| 2004 | 20,620 | 84 | 245 |
| 2005 | 12,639 | 76 | 166 |
| 2006 | 11,641 | 89 | 131 |
| 2007 | 30,145 | 97 | 311 |
| 2008 | 6,041 | 76 | 79 |
| 2009 | 3,603 | 38 | 95 |
| 2010 | 10,671 | 77 | 139 |
| 2011 | 2,643 | 37 | 71 |
| 2012 | 494 | 4 | 124 |
| 2013 | 5,902 | 49 | 120 |
| 2014 | 1,571 | 26 | 60 |

*4.2.7.2 Fixed Gear Set-Aside*

Fixed gear fisheries (weirs and stop seines) operating in Area 1A west of Cutler (area west of the shaded area in Figure 13 and 14) have a fixed gear set-aside (FGSA), up to 500 metric tons of the Area 1A sub-ACL. The 2016-2018 specifications set the FGSA at 295 MT.

The fixed gear set-aside will be available to fixed gear fishermen west of Cutler through December 31. When 92% of the Area 1A sub-ACL has been reached, all directed Atlantic herring fisheries in Area 1A will closed. Unused portions of the fixed gear set-aside will not be rolled from one year to the next.

Historically, Atlantic herring have migrated away from the GOM coast by November. In the past decade, fixed gear fishermen have not fully utilized the FGSA (e.g., utilization over a 10-year average is 197.4 mt, or 67% of the set-aside) and landings after November 1 have been 0 mt since 1993 (Table 8).

**Table 8. Atlantic Herring Landings from Fixed Gear Fishery (Stop Seine, Weir, Pound Net) Before and After November 1 Rollover Date**

| Year | Sub-ACL Closure Date | Area 1A Sub-ACL (mt) | Cumulative Catch (mt) by Dec 31 | Fixed Gear Landings (mt) | |
|---|---|---|---|---|---|
| | | | | Jan-Oct | Nov-Dec |
| 2004 | 11/19/2004 | 60,000 | 60,071 | 49 | 0 |
| 2005 | 12/2/2005 | 60,000 | 61,570 | 53 | 0 |
| 2006 | 10/21/2006 | 50,000 | 59,980 | 528 | 0 |
| 2007 | 10/25/2007 | 50,000 | 49,992 | 392 | 0 |
| 2008 | 11/14/2008 | 43,650 | 42,257 | 24 | 0 |
| 2009 | 11/26/2009 | 43,650 | 44,088 | 81 | 0 |
| 2010 | 11/17/2010 | 26,546 | 27,741 | 823 | 0 |
| 2011 | 10/27/2011 | 29,251 | 29,359 | 23 | 0 |
| 2012 | 11/5/2012 | 27,668 | 25,057 | 0 | 0 |
| 2013 | 10/15/2013 | 29,775 | 29,820 | C | C |
| 2014 | 10/26/2014 | 33,031 | 33,428 | C | C |

*Note: "C" denotes that the value cannot be reported due to confidentiality.*

*4.2.7.3 Small Scale Fixed Gear Fisheries*

The Commission received public comments on fixed gear fisheries taking place in areas such as New Jersey and Massachusetts. These comments expressed concern regarding their ability to continue harvesting herring if a limited access program is implemented in state waters. The comments also emphasized a need for a consistent small supply of fresh herring throughout the year for various bait markets (lobster and striped bass) and ethnic markets for human consumption. These small-scale fixed gear fishermen need access to about 300-400 pounds of

herring per day. As long as Amendment 3 continues the 2,000 pound bycatch provision during closures, these smaller scale fixed gear fishermen should continue to have access to the resource and have the ability to harvest enough herring to supply these markets.

### 4.2.8 Empty Fish Hold Provision

At the time of Amendment 3 approval, the interstate and federal Atlantic Herring FMPs did not require an empty fish hold prior to leaving a dock and declaring into the Atlantic herring fishery. However, there is concern that unsold herring are dumped at sea for lack of market demand. Additionally, fish from multiple trips can be mixed if the holds are not completely emptied—this has the potential to compromise landings data used to inform harvest control measures and bycatch avoidance programs, particularly for the river herring bycatch avoidance program. Furthermore, leaving fish in the vessel's hold prevents portside samplers from observing the entire catch.

The New England Fishery Management Council (NEFMC), in Draft Herring Framework Adjustment 4, approved a requirement for vessel holds to be empty of fish prior to leaving a dock. The Council approved *Alternative 2.1.2, Alternative 2, Option C in Framework Adjustment 4*, which includes that a waiver may be issued for instances when there are fish in the holds after inspection by an appropriate law enforcement officer. The Council's selected alternative (if approved by NOAA Fisheries) would apply to Category A (All Area Limited Access) and B (Areas 2/3 Limited Access) vessels. The intent is for waivers to be issued for refrigeration failure and non-marketable reported fish.

At the time of Amendment 3 approval, NOAA Fisheries had not issued a final ruling on Draft Herring Framework Adjustment 4. If the empty fish hold provision is approved by NOAA Fisheries then it will become a requirement for federal permit holders. To maintain consistency between the state and federal FMPs, the Atlantic Herring Section will adopt a complimentary empty fish hold provision if such a requirement is approved by NOAA Fisheries.

The federal language applies this provision to Category A and B Atlantic Herring vessels, ASMFC approved language that applies the provision to Category A and B Atlantic Herring vessels with an onboard fish pump. The following provides the Section's justification for such an exemption: Vessels with freezing capacity typically sort, package and freeze their catch at sea and have the ability to store processed product on board for extended periods of time. These vessels do not have an onboard fish pump. If a freezer vessel is forced to come back to the dock due to weather, mechanical failure, etc. and the fish hold is not full then vessel will go back out without unloading to avoid paying unloading costs for a small number of boxes. Because the product is processed and frozen at sea, there is minimal risk that these vessels would dump unsold herring at sea. In addition, fresh herring vessels that do not have an onboard fish pump would be unable to dispose of fish at sea.

**If NOAA Fisheries does not approve the empty fish hold provision, the following will apply.**
*No empty fish hold provision* – There is no requirement to empty vessel holds of fish prior to a fishing trip departure.

**If NOAA Fisheries approves the empty fish hold provision then the following will apply.**
*Federal/State Empty Fish Hold Provision for Select Vessels* – This option would require that fish holds on Category A/B Atlantic herring vessels with ability to pump fish are empty of fish before leaving the dock on any trip when declared into the Atlantic herring fishery. A waiver may be issued for instances when there are a pumpable quantity of fish in the hold as determined by an appropriate law enforcement officer (the intent is for waivers to be issued for refrigeration failure and non-marketable fish that have been reported by the vessel). Only vessels departing on a fishing trip (i.e. declared into the fishery) are required to have holds empty of fish. As such, waivers would not be required for vessels transporting fish from dock to dock.

### 4.2.9 Use restrictions – Prohibition of Directed Mealing

The harvest of herring for the primary purpose of reduction to meal or meal-like product is prohibited. The processing, transfer, or sale of herring cuttings, by-products, and whole herring condemned for human consumption, or waste is permitted.

The harvest of herring for the primary purpose of reduction to fishmeal or oil is a concern because of the large volume of fish necessary to support such an operation. The rapid harvest may make it difficult to track landings and implement effort controls at the appropriate time. This may lead to the ACL being exceeded. Even if effort controls can be implemented in a timely fashion, a rapid harvest could lead to an early closure of the fishery, disrupting the supply of herring to other markets.

### 4.2.10 Internal Water Processing – Prohibition of IWPs in All State Waters

Due to the uncertainty in the inshore stock status, overcapacity in Area 1 and sufficient access to the domestic shoreside processing plants in Area 1, Internal Water Processing operations will be prohibited from processing herring caught in all state waters.

## 4.3 HABITAT CONSERVATION AND RESTORATION

### 4.3.1 Preservation of Existing Habitat

Protection of habitat essential for herring spawning is vital to ensure the continued recovery and health of this species. States should identify any locations where herring consistently return to spawn in order to provide some protective measures to egg beds when and if necessary. Monitoring of these locations may also provide an indication of relative spawning component size.

### 4.3.2 Habitat Restoration, Improvement, and Enhancement

1. State marine fisheries agencies should identify state permitting and planning agencies, which regulate those activities likely to adversely affect Essential Fish Habitat (EFH) and habitats, either by destruction of habitat or degradation of quality. The marine fisheries agency should work with the relevant permitting or planning agency in each state to develop permit

conditions and planning considerations to avoid or mitigate adverse impacts on EFH. Standard permit conditions and model policies that contain mitigation techniques should be developed. The development of Memoranda of Understanding (MOU's) with other state agencies are recommended for joint review of projects and planning activities to ensure that habitat protections are adequately incorporated.

For example, dredging windows should be established to avoid impacts to Atlantic herring egg EFH and spawning activity. Dredging windows should be coordinated to ensure practical opportunities for permitted dredging to take place.

2. When it is expected that impacts will occur from an anthropogenic activity, but probably not above some *de minimis* level, prohibition of the activity may not be warranted, but the marine fisheries agency should request that the appropriate agency consider requiring application of Best Management Practices for the activity.

3. State marine fisheries agencies should coordinate with state water quality agencies and state coastal zone management agencies to ensure that Clean Water Act Section 319 non-point source control plans and Coastal Zone Act Reauthorization Amendment Section 6217 coastal non-point source control plans are developed and implemented so as to minimize adverse impacts of non-point source pollution on herring and herring EFH. In particular, marine fisheries agencies should consider whether areas such as EFH for eggs merit designation as critical coastal areas under state 6217 programs (non-point source pollution control under the Coastal Zone Management Act amendments of 1990) due to water quality impacts to fish habitat, and should provide input to the 6217 lead agencies (identified in the Source Document).

4. State marine fisheries agencies should coordinate with appropriate state agencies to strengthen compliance with National Pollutant Discharge Elimination System (NPDES) or State Pollutant Discharge Elimination System (SPDES) permits.

5. State marine fisheries agencies should work with state coastal zone management agencies to determine whether: 1) additional state policies for habitat protection should be adopted under the state coastal management program; 2) additional federal activities should be added to the state coastal management programs list of activities subject to state consistency review; and 3) the state is fully utilizing the Coastal Zone Management Act federal consistency process for protection of fish habitats.

6. When states have identified habitat restoration as a need, state marine fisheries agencies should coordinate with other agencies to ensure that habitat restoration plans are developed, and funding is actively sought for plan implementation and monitoring.

7. State marine fisheries agencies should coordinate with and provide input to the state water quality agency in development and updating of the Clean Water Act section 303(d) list (priority list of water not meeting state water quality standards). In addition, state marine fisheries agencies should review the adequacy of water quality standards to protect herring and should participate in the triennial review of the state water quality standards.

8. State marine fisheries agencies should review oil spill prevention and response plans for preventing accidental release and recommending prioritized response in EFH.

9. State marine fisheries agencies should work closely with the appropriate Coast Guard District Office in the development, amendment, and implementation of area wide oil spill contingency plans.

10. State marine fisheries agencies should work closely with water quality agencies in the development or revision of river basin plans to identify degraded or threatened resources and recommend preventative, remedial or mitigation measures.

11. State marine fisheries agencies should work with the appropriate agencies to develop contaminated sediment remediation plans or active sediment pollution prevention programs for areas with or susceptible to sediment contamination.

12. State marine fisheries agencies should coordinate with appropriate National Estuary Program (NEP) committees to ensure that NEP Comprehensive Coastal Management Plans (CCMPs) identify and implement habitat protection and restoration needs.

State marine fisheries agencies should assist industrial siting councils in siting new power plants so that impingement and entrainment of Atlantic herring are minimized.

State marine fisheries agencies should work with the appropriate agencies to establish and enforce "no discharge" zones, and promote education of recreational boaters to reduce contamination of nearshore waters from chronic fuel spills and waste disposal.

### 4.3.3 Avoidance of Incompatible Activities

Federal and state fishery management agencies should take steps to limit the introduction of compounds that are known or suspected to accumulate in Atlantic herring tissue and which pose a threat to human health or Atlantic herring health. Each state should establish windows of compatibility for activities known or suspected to adversely affect herring life stages and their habitats (such as navigational dredging, bridge construction, and dredged material disposal) and notify the appropriate construction or regulatory agencies in writing. Projects involving water withdrawal from spawning or nursery habitats (e.g. power plants, irrigation, water supply projects) should be scrutinized to ensure that adverse impacts resulting from larval/ juvenile impingement, entrainment, and/or modification of flow, temperature and salinity regimes due to water removal will not adversely impact Atlantic sturgeon spawning stocks, including early life stages. Each state which contains spawning and nursery areas within its jurisdiction should develop water use and flow regime guidelines which are protective of Atlantic sturgeon spawning and nursery areas and which will ensure to the extent possible the long-term health and sustainability of the stock. States should endeavor to ensure that proposed water diversions/withdrawals from rivers tributary to spawning and nursery habitats will not reduce or eliminate conditions favorable to Atlantic herring use of these habitats.

### 4.3.4 Fisheries Practices

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

## 4.4 ALTERNATIVE STATE MANAGEMENT REGIMES

Once approved by the Atlantic Herring Management Section, states are required to obtain prior approval from the Section of any changes to their management program for which a compliance requirement is in effect. Other non-compliance measures must be reported to the Section but may be implemented without prior approval from the Section. A state can request permission to implement an alternative to any mandatory compliance measure only if that state can show to the Section's satisfaction that its alternative proposal will have the same conservation value as the measure contained in this amendment or any addenda prepared under Adaptive Management (*Section 4.5*). States submitting alternative proposals must demonstrate that the proposed action will not contribute to overfishing of the resource. All changes in state plans must be submitted in writing to the Section and to the Commission either as part of the annual FMP Review process or the Annual Compliance Reports.

### 4.4.1 General Procedures

A state may submit a proposal for a change to its regulatory program or any mandatory compliance measure under this amendment to the Commission, including a proposal for *de minimis* status. Such changes shall be submitted to the Chair of the Plan Review Team, who shall distribute the proposal to the Management Section, the Plan Review Team, the Technical Committee, the Stock Assessment Committee and the Advisory Panel.

The Plan Review Team is responsible for gathering the comments of the Technical Committee, the Stock Assessment Committee and the Advisory Panel, and presenting these comments as soon as possible to the Section for decision.

The Atlantic Herring Section will decide to approve the state proposal for an alternative management program if it is consistent with the applicable target fishing mortality rate and the goals and objectives of this amendment.

### 4.4.2 Management Program Equivalency

The Atlantic Herring Technical Committee, under the direction of the Plan Review Team, will review any alternative state proposals under this section and provide to the Atlantic Herring Management Section its evaluation of the adequacy of such proposals.

### 4.4.3 *De Minimis* Fishery Guidelines

The ASMFC Interstate Fisheries Management Program Charter defines *de minimis* as "a situation in which, under the existing condition of the stock and scope of the fishery, conservation and enforcement actions taken by an individual state would be expected to contribute insignificantly to a coastwide conservation program required by a Fishery Management Plan or amendment" (ASMFC, 2000).

**States may apply for *de minimis* status if, for the last *three* years, the combined average commercial landings (by weight) constitute less than one percent (1%) of the coastwide commercial landings for the same *three*-year period.** States may petition the Atlantic Herring Section at any time for *de minimis* status, if their fishery falls below the threshold level. Once *de minimis* status is granted, designated states must submit annual reports to the Section justifying the continuance of *de minimis* status. States are encouraged to include *de minimis* requests as part of their annual compliance reports.

## 4.5 ADAPTIVE MANAGEMENT

The Atlantic Herring Section may vary the requirements specified in this amendment as a part of adaptive management in order to conserve the Atlantic herring resource. Specifically, the Section may change target fishing mortality rates and harvest specifications, other measures designed to prevent overfishing of the stock complex or any spawning component. Such changes will be instituted to be effective on the first fishing day of the following year, but may be put in place at an alternative time when deemed necessary by the Section. These changes should be discussed with the appropriate federal representatives and Councils prior to implementation in order to be complementary to the regulations for the EEZ.

### 4.5.1 General Procedures

The Plan Review Team will monitor the status of the fishery and the resource and report on that status to the Atlantic Herring Management Section annually, or when directed to do so by the Section. The Plan Review Team will consult with the Technical Committee, the Stock Assessment Committee and the Advisory Panel, if any, in making such review and report. The report will contain recommendations concerning proposed adaptive management revisions to the management program.

The Atlantic Herring Management Section will review the report of the Plan Review Team and may consult further with Technical Committee, the Stock Assessment Committee or the Advisory Panel. The Section may direct the PRT to prepare an addendum to make any changes it deems necessary. The addendum shall contain a schedule for the states to implement its provisions.

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

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

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

### 4.5.2 Measures Subject to Change

The following measures are subject to change under adaptive management upon approval by the Atlantic Herring Section:

1. MSY or MSY proxy;
2. Management area boundaries or additional management areas;
3. Size, timing, or location of a new or existing spawning area closure;
4. Closed area other than a spawning closure;
5. Restrictions in the amount of fishing time;
6. Days at sea system, including options transferability or leasing of DAS;
7. Adjustments to OY, TACs, DAP, DAH, JVP, IWP, or the Reserve;
8. Adjustments to the amount of Canadian catch deducted when determining specifications;
9. Distribution of the TAC to an area or time period;
10. Gear restrictions (such as *gear type*, mesh size, etc.) or requirements (such as bycatch reduction devices, etc.);
11. Measures to address bycatch and bycatch monitoring (such as seasonal, and temporal closures, bycatch caps, gear restriction, and closed fishing seasons);
12. Vessel size/horsepower restrictions; vessel size limits/upgrade restrictions
13. Closed seasons;
14. Minimum fish size;
15. Trip limits;
16. Seasonal or area quotas; seasonal allocation of area TACs
17. In-season adjustments;
18. Changes to the overfishing definition;
19. Vessel tracking system;
20. Restrictions for prohibitions on mealing or a roe fishery;
21. Quota monitoring tools, such as vessel operator or dealer reporting requirements;
22. Permit upgrading or splitting limitations, and vessel upgrading restrictions;
23. Measures to reduce gear conflicts, such as:
24. Mandatory monitoring of a radio channel by fishing vessels;
25. Gear location reporting by fixed gear fishermen and mandatory plotting by mobile gear fishermen;
26. Standards of operation when gear conflicts occur;

27. Fixed gear marking or setting practices;
28. Gear restrictions for certain areas and/or at certain times of the year;
29. Vessel monitoring systems;
30. Restrictions on the maximum number of fishing vessels;
31. Special permitting conditions;
32. Measures to address information from multispecies stock assessments;
33. Management of the roe fishery
34. Herring Processor Survey
*35.* Sector allocation/effort control
36. Any other management measures currently included in Amendment 3.

## 4.6 EMERGENCY PROCEDURES

Emergency procedures may be used by the Atlantic Herring Section to require any emergency action that is not covered by or is an exception or change to any provision in Amendment 3. Procedures for implementation are addressed in the ASMFC Interstate Fisheries Management Program Charter, Section Six (c)(10) (ASMFC, 2000).

## 4.7 MANAGEMENT INSTITUTIONS

The management institutions for Atlantic herring shall be subject to the provisions of the ISFMP Charter (ASMFC, 2000). The following is not intended to replace any or all of the provisions of the ISFMP Charter. All committee roles and responsibilities are included in detail in the ISFMP Charter and are only summarized here.

### 4.7.1 ASMFC and the ISFMP Policy Board

The ASMFC (Commission) and the ISFMP Policy Board are generally responsible for the oversight and management of the Commission's fisheries management activities. The Commission must approve all fishery management plans, and amendments, including this Amendment 3, and must also make all final determinations concerning state compliance or noncompliance. The ISFMP Policy Board reviews any non-compliance recommendations of the various Management Boards and Sections and, if it concurs, forwards them on to the Commission for action.

### 4.7.2 Atlantic Herring Section

The Atlantic Herring Section is established by Amendment 1 to the Compact creating the Commission (Public Law 539, as amended) and is generally responsible for carrying out all activities under this Amendment. It establishes and oversees the activities of the Plan Development or Plan Review Team, the Technical Committee and the Stock Assessment Subcommittee and requests the establishment of the Commission's Atlantic Herring Advisory Panel. Among other things, the Section makes changes to the management program under adaptive management and approves state programs implementing the amendment and alternative state programs under *Sections 4.5*. The Section reviews the status of state compliance with the

FMP or amendment at least annually. If it determines that a state is out of compliance, the Section reports its determination to the ISFMP Policy Board under the terms of the ISFMP Charter.

### 4.7.3 Atlantic Herring Plan Development / Plan Review Team

The Atlantic Herring Plan Development Team (PDT) and the Atlantic Herring Plan Review Team (PRT) will be composed of a small group of scientists and/or managers whose responsibility is to provide all of the technical support necessary to carry out and document the decisions of the Atlantic Herring Management Section. The ASMFC FMP Coordinator chairs both. The Atlantic Herring PDT/PRT is directly responsible to the Section for providing information and documentation concerning the implementation, review, monitoring and enforcement of Amendment 3. The Atlantic Herring PDT/PRT shall be comprised of personnel from state and federal agencies who have scientific and management ability and knowledge of Atlantic herring. The PDT will be responsible for preparing all documentation necessary for the development of Amendment 3, using the best scientific information available and the most current stock assessment information. The PDT will either disband or assume inactive status upon completion of Amendment 3. Alternatively, the Section may elect to retain PDT members as members of the PRT or appoint new members. The PRT will provide annual advice concerning the implementation, review, monitoring, and enforcement of Amendment 3 once the Commission has adopted it.

### 4.7.4 Atlantic Herring Technical Committee

The Atlantic Herring Technical Committee will consist of representatives from state or federal agencies, Regional Fishery Management Councils, Commission, university or other specialized personnel with scientific and technical expertise and knowledge of the Atlantic herring fishery. The Section will appoint the members of the Technical Committee and may authorize additional seats as it sees fit. Its role is to act as a liaison to the individual state and federal agencies, provide information to the management process, and review and develop options concerning the management program. The Technical Committee will provide scientific and technical advice to the Management Section, PDT and PRT in the development and monitoring of a fishery management plan or amendment.

### 4.7.5 Atlantic Herring Stock Assessment Subcommittee

The Atlantic Herring Stock Assessment Subcommittee shall be appointed by the Technical Committee at the request of the Section and will consist of scientists with expertise in the assessment of the Atlantic herring population. Its role is to assess the Atlantic herring population and provide scientific advice concerning the implications of proposed or potential management alternatives, or to respond to other scientific questions from the Section, Technical Committee, PDT or PRT. The Stock Assessment Subcommittee will report to the Technical Committee.

### 4.7.6 Atlantic Herring Advisory Panel

The Atlantic Herring Advisory Panel was established according to the Commission's Advisory Committee Charter. Members of the Advisory Panel are citizens who represent a cross-section of

commercial fishing interests and others who are concerned about Atlantic herring conservation and management. The Advisory Panel provides the Section with advice directly concerning the Commission's Atlantic herring management program.

## 4.8 FEDERAL AGENCIES

### 4.8.1 Management in the Exclusive Economic Zone (EEZ)

Management of Atlantic herring in the EEZ is currently under the jurisdiction of the New England Fishery Management Council under the Magnuson-Stevens Act (16 U.S.C. 1801 et seq.). In the absence of a Council Fishery Management Plan, management is the responsibility of the NMFS as mandated by the Atlantic Coastal Fishery Conservation and Management Act (16 U.S.C. 5105 et seq.) and the Magnuson-Stevens Act (16 U.S.C. 1801 et seq.). NEFMC began managing the herring fishery in 2006; management measures are currently encompassed in Amendment 5 to the herring FMP, published in 2013.

### 4.8.2 Federal Agency Participation in the Management Process

The Commission has accorded the United States Fish and Wildlife Service (USFWS) and the NMFS voting status on the ISFMP Policy Board in accordance with the Commission's ISFMP Charter. Due to the makeup of Sections under the ISFMP Charter, no federal agencies are accorded voting status on the Atlantic Herring Management Section; however, the NMFS participates on the Atlantic Herring Plan Development Team, Plan Review Team, Technical Committee and Stock Assessment Subcommittee.

### 4.8.3 Consultation with Fishery Management Councils

In carrying out the provisions of Amendment 3, the states, as members of the Atlantic Herring Section, shall closely coordinate with the New England Fishery Management Council in order to cooperatively manage the Atlantic herring population. In accordance with the Commission's ISFMP Charter, a representative of the New England Fishery Management Council may be invited to participate as a full member of the Atlantic Herring Section.

## 4.9 COOPERATION WITH OTHER MANAGEMENT INSTITUTIONS

The Atlantic Herring Plan Review Team, Technical Committee and Management Section shall regularly communicate with fishery managers in Canadian agencies to help ensure the sustainability of the Atlantic herring resource. Canadian fishery managers and their officials shall be invited to ASMFC discussions on Atlantic herring conservation as needed, especially when discussing transshipment issues and cross-border trade.

# 5.0 COMPLIANCE

Full implementation of the provisions of this amendment is necessary for the management program to be equitable, efficient and effective. States are expected to implement these measures faithfully under state laws. The Atlantic States Marine Fisheries Commission will continually monitor the effectiveness of state implementation and determine whether states are in compliance with the provisions of this fishery management plan. This section sets forth the specific elements states must implement in order to be in compliance with this fishery management plan, and the procedures that will govern the evaluation of compliance. Additional details of the procedures are found in the ASMFC Interstate Fisheries Management Program Charter (ASMFC, 2000).

## 5.1 MANDATORY COMPLIANCE ELEMENTS FOR STATES

A state will be determined to be out of compliance with the provisions of this fishery management plan, according to the terms of Section Seven of the ISFMP Charter if:

- its regulatory and management programs to implement *Section 4* have not been approved by the Atlantic Herring Section; or
- it fails to meet any schedule required by *Section 5.1.2*, or any addendum prepared under adaptive management (*Section 4.5*); or
- it has failed to implement a change to its program when determined necessary by the Atlantic Herring Section; or
- it makes a change to its regulations required under *Section 4* or any addendum prepared under adaptive management (*Section 4.5*) without prior approval of the Atlantic Herring Section.

### 5.1.1 Mandatory Elements of State Programs

To be considered in compliance with this fishery management plan, all state programs must include harvest controls/a regime of restrictions for Atlantic herring fisheries consistent with the requirements of *Sections 4.0*; except that a state may propose an alternative management program under *Section 4.5*, which, if approved by the Section, may be implemented as an alternative regulatory requirement for compliance.

In addition, the Atlantic Herring Section will monitor bycatch of Atlantic herring in other fisheries and report excessive bycatch problems to the management authority for the fishery causing the bycatch.

#### *5.1.1.1 Regulatory Requirements*

States will implement Amendment 3 after final approval by the Commission. Each state must submit its required Atlantic herring regulatory program to the Commission through the ASMFC staff for approval by the Atlantic Herring Section. During the period from submission, until the Management Section makes a decision on a state's program, a state may not adopt a less

protective management program than contained in this management plan or contained in current state law.

Management measures in the following sections are new or modified; states must implement the criteria within each section in order to be in compliance with Amendment 3:

- *Section 4.2.6.1: Spawning Area Closure Monitoring System*
- *Section 4.2.6.2: Default Closure Dates*
- *Section 4.2.6.4: Re-closure Protocol*
- *Section 4.2.7.2: Fixed Gear Set-Aside*
- *Section 4.2.8: Empty Fish Hold Provision*; contingent on federal approval

Once approved by the Atlantic Herring Management Section, states are required to obtain prior approval from the Section of any changes to their management program for which a compliance requirement is in effect. Other measures must be reported to the Section but may be implemented without prior Section approval. A state can request permission to implement an alternative to any mandatory compliance measure only if that state can show to the Section's satisfaction that its alternative proposal will have the same conservation value as the measure contained in this amendment or any addenda prepared under Adaptive Management (*Section 4.5*). States submitting alternative proposals must demonstrate that the proposed action will not contribute to overfishing of the resource. All changes in state plans must be submitted in writing to the Section and to the Commission either as part of the annual FMP Review process or the Annual Compliance Reports.

#### *5.1.1.2 Monitoring Requirements*

The PDT and Technical Committee will work to develop appropriate protocols for designing fishery-independent surveys for Atlantic herring. Such surveys may be implemented under *Section 4.5* (Adaptive Management) through the Commission's addendum process including the opportunity for public comment.

#### *5.1.1.3 Research Requirements*

The PDT and Technical Committee will prioritize the research needs for Atlantic herring. Appropriate programs for meeting these needs may be implemented under *Section 4.5* (Adaptive Management) through the Commission's addendum process including the opportunity for public comment.

#### *5.1.1.4 Law Enforcement Requirements*

All state programs must include law enforcement capabilities adequate for successfully implementing that state's Atlantic herring regulations. The adequacy of a state's enforcement activity will be monitored annually by reports of the ASMFC Law Enforcement Committee to the Atlantic Herring Plan Review Team. The first reporting period will cover the period from January 1 – December 31.

#### *5.1.1.5 Habitat Requirements*

There are no mandatory habitat requirements for Atlantic herring. See *Section 4.3* for Habitat Recommendations.

### 5.1.2 Compliance Schedule

Reports on compliance must be submitted to the Commission by each jurisdiction annually, no later than *February 1*.

Each state must submit an annual report concerning its Atlantic herring fisheries and management program for the previous calendar year. A standard compliance report format has been prepared and adopted by the ISFMP Policy Board. States should follow the format provided when completing the annual compliance report.

## 5.2 PROCEDURES FOR DETERMINING COMPLIANCE

Detailed procedures regarding compliance determinations are contained in the ISFMP Charter, Section Seven (ASMFC, 2000). The following summary is not meant in any way to replace the language found in the ISFMP Charter.

In brief, all states are responsible for the full and effective implementation and enforcement of fishery management plans in areas subject to their jurisdiction. Written compliance reports as specified in the Plan or Amendment must be submitted annually by each state with a declared interest. Compliance with Amendment 3 will be reviewed at least annually. The Atlantic Herring Section, ISFMP Policy Board or the Commission, may request the Atlantic Herring Plan Review Team to conduct a review of plan implementation and compliance at any time.
The Atlantic Herring Section will review the written findings of the PRT within 60 days of receipt of a State's compliance report. Should the Section recommend to the Policy Board that a state be determined out of compliance, a rationale for the recommended non-compliance finding will be included addressing specifically the required measures of Amendment 3 that the state has not implemented or enforced, a statement of how failure to implement or enforce the required measures jeopardizes Atlantic herring conservation, and the actions a state must take in order to comply with Amendment 3 requirements.

The ISFMP Policy Board shall, within thirty days of receiving a recommendation of non-compliance from the Atlantic Herring Section, review that recommendation of non-compliance. If it concurs in the recommendation, it shall recommend at that time to the Commission that a state be found out of compliance.

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

Any state that has been determined to be out of compliance may request that the Commission rescind its non-compliance findings, provided the state has revised its Atlantic herring conservation measures or shown to the Board and/or Commission's satisfaction that actions taken by the state provide for conservation equivalency.

### 5.3 ANALYSIS OF ENFORCEABILITY OF PROPOSED MEASURES

The ASMFC Law Enforcement Committee will, during the implementation of this amendment, analyze the enforceability of new conservation and management measures as they are proposed.

# 6.0 MANAGEMENT AND RESEARCH NEEDS

During the development of this amendment, the Council, in conjunction with ASMFC as well as the Herring PDT and Advisory Panel, identified the following data and research needs. Addressing current data deficiencies will improve the long-term management of the Atlantic herring fishery.

### 6.1 STOCK ASSESSMENT AND POPULATION DYNAMICS

- Continue commercial catch sampling of Atlantic herring fishery according to ACCSP protocols
- Continue to utilize the inshore and offshore hydroacoustic and trawl surveys to provide an independent means of estimating stock sizes. Collaborative work between NMFS, DFO, State agencies and the herring industry on acoustic surveys for herring should continue to be encouraged.
- Develop tagging and morphometric studies to explore uncertainties in stock structure and the impacts of harvest mortality on different components of the stock. Although tagging studies may be problematic for assessing survivorship for a species like herring, they may be helpful in identifying the stock components and the proportion of these components taken in the fishery on a seasonal basis.
- Examine the root causes of the discrepancy between Forward Projection and ADAPT assessments.
- Pursue the development of a dedicated pelagic survey technique utilizing hydroacoustic and trawling methods to provide another direct and independent means of estimating stock sizes. Collaborative work between NMFS, DFO, State agencies and the herring industry on acoustic surveys for herring should be encouraged.
- Potential changes in catchability within spring bottom trawl survey indices should be investigated.
- Organize annual U.S.-Canada workshops to coordinate stock assessment activities and optimize cooperation in management approaches between the two countries.

### 6.1.1 Biology/Community Ecology

- Reinvestigate the estimation of age-3 herring, the natural mortality rate assumed for all ages, the use of catch-per-unit-effort tuning indices and the use of NEFSC fall bottom trawl survey tuning indices in the analytical assessment of herring.
- Evaluate the concept of a minimum biologically-acceptable level biomass (MBAL) for the herring coastal stock complex. Determine the adequacy of present methods and data to determine MBAL if appropriate.
- Possible effects of density-dependence (e.g. reduced growth rates at high population size) on parameter estimates used in assessments should be examined.
- Synthesize predator/prey information and conduct investigations to address information gaps; investigate the role of herring in the Northwest Atlantic ecosystem and the importance of herring as a forage species for other commercial fish stocks; assess the importance of herring as forage relative to other forage species in the region.

## 6.2 RESEARCH AND DATA NEEDS

### 6.2.1 Biological

- Identify known herring spawning areas. Establish critical spawning habitat areas or special management zones to protect spawning aggregations of herring and/or demersal egg masses.
- Investigate bycatch and discards in the directed herring fishery.
- Develop a long-term strategy for assessing individual spawning stocks as a basis for more effective management of any heavily exploited portion(s) of the stock complex. Evaluate the merit of acoustic surveys and other techniques to achieve sub-stock complex monitoring.
- Develop new approaches to estimating recruitment (i.e. juvenile abundance) from fishery-independent data.
- Consider using NEFSC fall survey mean weights at age as the spawning stock mean weight at age in the estimation of biological reference points. Evaluate alternative catch weights at age.
- Investigate alternative methods of estimating mean weight at age used to determine the age composition of U.S. and Canadian landings from the coastal stock complex.
- Conduct a retrospective analysis of herring larval and assessment data to determine the role larval data plays in anticipating stock collapse and as a tuning index in the age-structured assessment.
- Continue resource monitoring activities, especially larval surveys to indicate the relative importance of individual spawning areas and stocks and the degree of spawning stock recovery on Georges Bank and Nantucket Shoals.
- Evaluate the concept of a fixed spawning stock size or spawning target for the herring coastal stock complex. Determine the adequacy of present methods and data to set a target if more appropriate.
- Investigate the effects of averaging maturity rates over blocks of years to help smooth some of the inter-annual variability in the calculation of spawning stock biomass.
- Consider potential discards if fishing mortality increases in the future.

- Investigate the validity extremely high recruitment in recent years.
- Investigate bycatch/discards in the directed herring fishery through both at-sea and portside sampling.
- Develop and test gear modifications to minimize interactions with non-target species in the herring fishery.

### 6.2.2 Social and Economic

- Develop economic analyses necessary to evaluate the costs and benefits associated with different segments of the industry.
- Develop socio-economic analyses appropriate to the determination of optimum yield.
- Organize annual US-Canada workshops to coordinate stock assessment activities and optimize cooperation in management approaches between the two countries.

# 7.0 PROTECTED SPECIES

In the fall of 1995, Commission member states, the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) began discussing ways to improve implementation and enforcement of the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA) in state waters. In November 1995, the Commission, through its Interstate Fisheries Management Program (ISFMP) Policy Board, approved an amendment of its ISFMP Charter (section 6(b)(2)) so that protected species and their interactions with ASMFC managed fisheries are addressed in the Commission's fisheries management planning process. Specifically, the Commission's fishery management plans (FMP) will describe impacts of state fisheries on certain marine mammals and endangered species (collectively termed "protected species"), and recommend ways to minimize these impacts. The following section outlines: (1) the federal legislation that guides protection of marine mammals and sea turtles, (2) the protected species with potential fishery interactions; (3) the specific type(s) of fishery interaction; (4) population status of the affected protected species; and (5) potential impacts to Atlantic coastal state and interstate fisheries.

## 7.1 MARINE MAMMAL PROTECTION ACT (MMPA) REQUIREMENTS

The 1994 amendments to the MMPA established both short- and long-term goals for reducing mortality and serious injury, or bycatch, of marine mammals incidental to commercial fisheries. The amendments also established take reduction plans (TRPs) and stakeholder-based take reduction teams (TRTs) as the mechanisms for achieving these goals. The MMPA requires NMFS to convene TRTs to develop TRPs for each strategic stock that interacts with a Category I or II fishery, fisheries with "frequent" or "occasional" marine mammal bycatch, respectively. (Fisheries that have a remote likelihood of or no known bycatch of marine mammals are classified in Category III.) A strategic stock is defined as a stock: (1) for which the level of direct human-caused mortality exceeds the potential biological removal (PBR)[1] level; (2) which is

[1] PBR is the number of human-caused deaths per year each stock can withstand and still reach an optimum population level. This is calculated by multiplying "the minimum population estimate" by "½ stock's net productivity rate" by "a recovery factor

declining and is likely to be listed under the ESA in the foreseeable future; or (3) which is listed as a threatened or endangered species under the ESA or as a depleted species under the MMPA. In the short-term (within six months of implementation), TRPs must reduce marine mammal bycatch to levels below a marine mammals stock's potential biological removal level. In the long-term (within five years of implementation), TRPs must reduce marine mammal bycatch to insignificant levels approaching a zero mortality and serious injury rate taking into account the economics of the fishery, the availability of existing technology, and existing state or regional fishery management plans.

The 1994 amendments also required fishermen in Category I and II fisheries to register under the Marine Mammal Authorization Program (MMAP), the purpose of which is to provide an exception for commercial fishermen from the general taking prohibitions of the MMPA; to take on board an observer if requested to do so by the Secretary of Commerce; and to comply with any applicable TRP or emergency regulations. All commercial fishermen, regardless of the category of the fishery in which they participate, must report all marine mammal bycatch.

Section 101(a)(5)(E) of the MMPA requires the authorization of the incidental taking of individuals from marine mammal stocks listed as threatened or endangered under the ESA in the course of commercial fishing operations if it is determined that (1) incidental mortality and serious injury will have a negligible impact on the affected species or stock; (2) a recovery plan has been developed or is being developed for such species or stock under the ESA; and (3) where required under section 118 of the MMPA, a monitoring program has been established, vessels engaged in such fisheries are registered in accordance with section 118 of the MMPA, and a take reduction plan has been developed or is being developed for such species or stock. Permits are not required for Category III fisheries; however, any serious injury or mortality of a marine mammal must be reported.

## 7.2 ENDANGERED SPECIES ACT REQUIREMENTS

The taking of endangered sea turtles and marine mammals is prohibited under section 9 of the ESA. NMFS may issue section 4(d) protective regulations necessary and advisable to provide for the conservation of threatened species. There are several mechanisms established in the ESA to avoid the takings prohibition in section 9. First, a 4(d) regulation may include less stringent requirements intended to reduce incidental take and thus allow for the exemption from the taking prohibition. Section 10(a)(1)(B) of the ESA authorizes NMFS to permit, under prescribed terms and conditions, any taking otherwise prohibited by section 9 of the ESA, if the taking is incidental to, and not the purpose of, carrying out an otherwise lawful activity. Finally, section 7(a) requires NMFS to consult with each federal agency to ensure that any action that is authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any listed species. Section 7(b) authorizes incidental take of listed species after full consultation and identification of reasonable and prudent alternatives or measure to monitor and minimize such take.

ranging from 0.1 for endangered species to 1.0 for healthy stocks."

## 7.3 PROTECTED SPECIES WITH POTENTIAL FISHERY INTERACTIONS

There are numerous species that inhabit the range of the Atlantic herring management unit covered under this FMP that are protected under the MMPA and ESA. Twelve species are classified as endangered or threatened under the ESA, while the remainder are protected by the provisions of the MMPA.

| | |
|---|---|
| <u>Cetaceans</u> | |
| Northern right whale (*Eubalaena glacialis*) | Endangered |
| Humpback whale (*Megaptera novaeangliae*) | Endangered |
| Fin whale (*Balaenoptera physalus*) | Endangered |
| Blue whale (*Balaenoptera musculus*) | Endangered |
| Sei whale (*Balaenoptera borealis*) | Endangered |
| Sperm whale (*Physeter macrocephalus*) | Endangered |
| Minke whale (*Balaenoptera acutorostrata*) | Protected |
| Harbor porpoise (*Phocoena phocoena*) | Protected |
| Risso's dolphin (*Grampus griseus*) | Protected |
| Pilot whale (*Globicephala* spp.) | Protected |
| Atlantic white-sided dolphin (*Lagenorhynchus acutus*) | Protected |
| Short-beaked common dolphin (*Delphinus delphis*) | Protected |
| Spotted and striped dolphins (*Stenella* spp.) | Protected |
| Bottlenose dolphin (*Tursiops truncatus*) | Protected |
| <u>Pinnipeds</u> | |
| Harbor seal (*Phoca vitulina*) | Protected |
| Gray seal (*Halichoerus grypus*) | Protected |
| Harp seal (*Phoca groenlandica*) | Protected |
| Hooded seal *(Cystophora cristata)* | Protected |
| <u>Sea Turtles</u> | |
| Leatherback turtle (*Dermochelys coriacea*) | Endangered |
| Kemp's ridley turtle (*Lepidochelys kempii*) | Endangered |
| Green turtle (*Chelonia mydas*)[2] | Endangered |
| Hawksbill turtle (*Eretmochelys imbricata*) | Endangered |
| Loggerhead turtle (*Caretta caretta*), Northwest Atlantic DPS | Threatened |
| <u>Fish</u> | |
| Shortnose sturgeon (*Acipenser brevirostrum*) | Endangered |
| Atlantic salmon (*Salmo salar*)[3] | Endangered |

2 Green turtles in U.S. waters are listed as threatened except for the Florida breeding population which is listed as endangered. Due to the inability to distinguish between these populations away from the nesting beach, green turtles are considered endangered wherever they occur in U.S. waters. On March 23, 2015, a proposed rule was issued to remove the current range-wide listing and, in its place, list eight DPSs as threatened and three as endangered (80 FR 15272).

3 The Gulf of Maine distinct population segment (DPS) of Atlantic salmon is endangered, all other Atlantic salmon is considered a species of concern.

NOAA Fisheries has developed a list of species of concern that include: 1) species for which there are concerns regarding danger of extinction or risk of becoming endangered but for which insufficient information is available to indicate a need to list; 2) species for which an ESA biological status review has determined that listing is not warranted but for which significant concerns or uncertainties remain; 3) species that are undergoing formal status reviews. The objectives of the Species of Concern designation are to:

- Identify species potentially at risk;
- Increase public awareness about those species;
- Identify data deficiencies and uncertainties in species' status and threats;
- Stimulate cooperative research efforts to obtain the information necessary to evaluate species status and threats; and
- Foster voluntary efforts to conserve the species before listing becomes warranted.

Species of concern in New England include:

Dusky shark (*Carcharhinus obscurus)*
Sand tiger shark (*Odontaspis Taurus)*
Barndoor skate *(Raja laevis)*
Thorny skate *(Raja radiata)*
Atlantic sturgeon *(Acipenser oyxrinchus oxyrinchus)*
Atlantic salmon *(Salmo salar)*
Rainbow smelt *(Osmerus mordax)*
Cusk *(Brosme brosme)*
Atlantic wolfish *(Anarhichas lupus)*
Atlantic halibut *(Higgoglossus hippoglossus)*
Atlantic white marlin *(Tetrapturus albidus)*

## 7.4 PROTECTED SPECIES INTERACTIONS WITH EXISTING FISHERIES

Although all of the protected species listed above may be found in the general geographical area covered by the Herring FMP not all are affected by the fishery. Some species may inhabit areas other than those in which the fishery is prosecuted, prefer a different depth or temperature zone, or may migrate through the area at times when the fishery is not in operation. In addition, certain protected species may not be vulnerable to capture or entanglement with the gear used in the fishery.

Atlantic herring occur in large schools, inhabiting coastal and continental shelf waters from Virginia to Labrador, Canada, and support a commercial fishery. Landings exceeded 150 million pounds throughout the late 1880s and early 1900s, and again in the late 1940s and 1950s. Today, landings are lower, ranging from 80 to 100 million pounds; the majority of which is taken from the Gulf of Maine. Otter trawls, both single and pair, and purse seines are used in the majority of catches in the Atlantic herring fishery.

### 7.4.1 Marine Mammals

Marine mammal interactions have been recorded in the primary fisheries (utilizing otter trawls and purse seines) that target Atlantic herring, including the Northeast mid-water trawl (including pair trawl) fishery and the Gulf of Maine Atlantic herring purse seine fishery. Marine mammal stocks of greatest concern that interact with this fishery are the western North Atlantic long-finned and short-finned pilot whales, western North Atlantic white-sided dolphin, and Gulf of Maine/Bay of Fundy harbor porpoise. The MMPA 2004 List of Fisheries (LOF) (69 FR 48408) classifies fisheries by the level of serious injury and mortality of marine mammals incidental to each fishery. The following table indicates the species encountered by the Atlantic herring fisheries.

| Fishery Description | Marine Mammal Species Incidentally Killed/Injured |
|---|---|
| CATEGORY II | |
| Northeast mid-water trawl (including pair trawl) | Harbor seal, Long-finned pilot whale, Short-finned pilot whale, White-sided dolphin |
| CATEGORY III | |
| Gulf of Maine Atlantic herring purse seine | Harbor porpoise, Harbor seal, Gray seal |

Subsequent sections discuss documented interactions with the primary species of concern, e.g., pilot whales, white-sided dolphins, and harbor porpoises. These bycatch reports do not represent a complete list, but rather available records. It should be noted that without adequate observer programs for these fisheries; actual numbers of interactions are difficult to obtain. Until very recently, the level of observer coverage has been minimal despite the 1999 re-categorization of the herring mid-water trawl fishery to Category II on the Marine Mammal Protection Act's (MMPA's) List of Fisheries. This change was to have permitted observers to collect data to more accurately document interactions. Category II fisheries have an occasional likelihood of causing incidental mortality and/or serious injury to marine mammals. The recent 2004 ramping up of observer coverage could provide additional information on protected species interactions in herring mid-water gear, whether vessels are engaged in domestic or foreign fishing.

#### *7.4.1.1 Mid-Water Trawl*

***Pilot Whale***

Interactions between both short-finned and long-finned pilot whales and the Northeast mid-water trawl (including pair trawl) fishery have been documented. These two species are difficult to distinguish at sea as separate species and, therefore, abundance estimates, PBR, and bycatch estimates are combined into one listing for pilot whales There were no domestic mid-water trawl trips observed in 1997-1998, 3 trips observed in 1999 (1 single; 2 paired), 13 trips in 2000 (12 single; 1 paired), and no trips in 2001. There were no marine mammal takes observed from the domestic mid-water trawl fishing trips during 1997-2001. A USA joint venture (JV) mid-water (pelagic) trawl fishery was conducted on Georges Bank from August - December 2001. A Total Allowable Level of Foreign Fishing (TALFF) was also granted during the same time period. Ten vessels (3 foreign and 7 American), fishing both single and paired mid-water trawls, participated in the 2001 Atlantic herring JV fishery. Two out of the three foreign vessels also participated in

the 2001 TALFF and fished with paired mid-water trawls. NMFS maintained 74% observer coverage (243 hauls) of the JV transfers and 100% observer coverage (114 hauls) of the foreign vessels granted a TALFF. Eight pilot whales were incidentally captured in a single mid-water trawl during JV fishing operations. Three pilot whales were incidentally captured in a single mid-water trawl during foreign fishing operations (TALFF). The total mortality attributed to the Atlantic herring mid-water trawl fishery in 2001 was 11 animals.

***White-sided Dolphin***

There were no domestic mid-water trawl trips observed in 1997-1998, 3 trips in 1999 (1 single; 2 paired), 13 trips in 2000 (12 single; 1 paired), and no trips in 2001. There were no marine mammal takes observed from the domestic mid-water trawl fishing trips during the period 1997-2001. A USA joint venture (JV) mid-water (pelagic) trawl fishery was conducted on Georges Bank from August -December 2001. A TALFF was also granted during the same time period. Ten vessels (3 foreign and 7 American), fishing both single and paired mid-water trawls, participated in the 2001 Atlantic herring JV fishery. Two out of the three foreign vessels also participated in the 2001 TALFF and fished with paired mid-water trawls. The NMFS maintained 74% observer coverage (243 hauls) on the JV transfers and 100% observer coverage (114 hauls) on the foreign vessels granted a TALFF. No white-sided dolphins were incidentally captured in the mid-water trawl during JV fishing operations. Two white-sided dolphins were incidentally captured in a single mid-water trawl during foreign fishing operations (TALFF). The total mortality attributed to the Atlantic herring mid-water trawl fishery in 2001 was 2 animals.

*7.4.1.2 Purse Seine*

***Harbor Porpoise***

Harbor porpoises are listed on the MMPA 2004 List of Fisheries (LOF) as interacting with the Gulf of Maine Atlantic herring purse seine fishery. However, no interactions are documented in the most recent stock assessment report for the Gulf of Maine/Bay of Fundy harbor porpoise stock.

### 7.4.2 Sea Turtles

Interactions with sea turtles may occur when fishing effort overlaps with sea turtle distribution. Interactions could occur in the summer and fall, as turtles can be found in northeastern waters from June to November. Juvenile and immature Kemp's ridleys and loggerheads utilize nearshore and inshore waters north of Cape Hatteras during the warmer months and can be found as far north as the waters in and around Cape Cod Bay. Sea turtles are likely to be present off the Virginia, Maryland and New Jersey coasts by April or May, but do not arrive in great concentrations in New York and northwards until mid-June. Although uncommon north of Cape Hatteras, immature green sea turtles also use northern inshore waters during the summer and may be found as far north as Nantucket Sound. Leatherbacks migrate north in the spring to productive foraging grounds off Nova Scotia. With the decline of water temperatures in late fall, sea turtles migrate south to warmer waters. When water temperatures are greater than approximately 11˚C, sea turtles may be present in some areas where the Atlantic herring fishery occurs.

There are not data available that can be used to estimate the number of threatened or endangered sea turtles that might be taken in herring gear. Nevertheless, based on observed takes from sea sampling data from other fisheries for gear types that may be used in the herring fishery, NMFS believes that it would be reasonable to expect, as a precaution, six loggerhead sea turtles to be taken by the proposed fishery (three of these takes would be lethal) and one green sea turtle, Kemp's ridley sea turtle and leatherback sea turtle to be taken by the proposed fishery. Based on the information available on the distribution and abundance of these sea turtle species in the actions area, NMFS does not believe the death, capture or injury of these small numbers of sea turtles would appreciably diminish the viability of sea turtle populations in the action area. Further, NMFS does not believe it would be reasonable to expect that the death, capture, harm or harassment of these numbers of sea turtles would appreciably reduce the likelihood of survival and recovery of these species in the wild (excerpted from NMFS, 1999).

Based on information collected in similar fisheries, the major gear types used in the herring fishery appear to have little or no interactions with sea turtles, although it must be acknowledged there has been an extremely low level of observer coverage in this fishery to date. In addition, there appears to be little spatial/temporal overlap in the distribution of Atlantic herring and sea turtles.

### 7.4.3 Seabirds

Like marine mammals and sea turtles, seabirds are vulnerable to entanglement in commercial fishing gear. Along with commercial fishing, human activities such as coastal development, habitat degradation and destruction, and the presence of organochlorine contaminants are considered to be major threats to some seabird populations.

The otter trawl and the purse seine are the primary commercial gears used in the Atlantic herring fishery, accounting for the vast majority of the landings. These gears do not appear to be a significant source of incidental seabird takes.

## 7.5 HERRING AS A FORAGE SPECIES

Atlantic herring is one of many important forage species in the Northeast Atlantic Ocean ecosystem. While available information to quantify the importance of herring as a forage species is not available at this time, there is a substantial amount of literature that describes the role that herring plays in the ecosystem and estimates the amount of herring consumed by various fish, marine mammal, and seabird species.

Observational and empirical evidence suggests that there are four major groups of predators (marine mammals, large pelagic fishes, seabirds, and medium demersal) that feed on Atlantic herring in the Gulf of Maine-Georges Bank region. Many marine mammal populations in the region have increased dramatically in the last 20 years (NMFS 2002). Observations on the larger marine mammals such as humpback and fin whales suggest that these large predators have changed their diets to incorporate a larger proportion of herring during the 1990s and 2000s, instead of a diet that was dominated by sand lance in the 1980s (Read and Brownstein 2003). Smaller marine mammals such as harbor porpoise and harbor seals are also relying on Atlantic

herring, based on diet studies from captured or stranded animals (Gannon et al. 1998; Williams 1999). Seabirds such as Northern gannets, shearwaters, and herring gulls are also likely preying routinely on herring (Powers and Backus 1987).

Read and Brownstein (2003) used survey-based estimates of abundance for eight species of marine mammals between 1991 and 1997 to estimate the total annual consumption of Atlantic herring by these species (Table 9). Their estimates of marine mammal consumption ranged from about 94,000 to 190,000 mt of herring per year. Their results show that minke whales, harbor porpoises, and white-sided dolphins are major predators on Atlantic herring because of high proportions of herring (34-51%) in their diets, whereas fin and humpback whales consume large quantities of herring to sustain their large body mass. Despite a three-fold increase in the harbor seal population in the Gulf of Maine between 1981 and 1997, herring only make up 13% of their diet. Consequently, the mean consumption estimate for harbor seals is below 5,000 mt a year.

Read and Brownstein's (2003) mean (or "best") estimate of Atlantic herring consumed annually by marine mammals during 1991-1997 was about 140,000 mt, with a range of 93,000-200,000 mt. Adding these estimates to the most current (1997) estimate of 100,000 mt of Atlantic herring consumed by fish and elasmobranch predators reported by Overholtz et al. (2000) produces a total mean estimate of 240,000 mt, with a range of 193,000-300,000 mt. During the 1990s, the total amount of herring consumed by all predators could have been as high as 400-450,000 mt.

**Table 9. Marine Mammal Predators and Annual Consumption Rates (Read and Brownstein, 2003)**

| **Marine Mammal Predators** | |
|---|---|
| **Species** | **Estimated Annual Consumption (mt), 1991-1997** |
| **Fin Whale** | 16,081-62,362 |
| **Minke Whale** | 11,648-22,108 |
| **Humpback Whale** | 31,046-35,507 |
| **Pilot Whale** | 149-512 |
| **Harbor Porpoise** | 20,863-27,655 |
| **White-sided Dolphin** | 7,852-35,591 |
| **Harbor Seal** | 4,853 |
| **Gray Seal** | 1,310 |

## 7.6 POPULATION STATUS REVIEW OF RELEVANT PROTECTED SPECIES

### 7.6.1 Marine Mammals

Five marine mammal species are known to become entangled in gear used by the Atlantic herring fishery, namely, harbor porpoise, pilot whale, white-sided dolphin, harbor seal and gray seal. Both short and long-finned pilot whales are classified as strategic stocks under the MMPA. The status of these and other marine mammal populations inhabiting the northwest Atlantic

Ocean has been discussed in great detail in the annual U.S. Atlantic Marine Mammal Stock Assessment Report. The reports present information on stock definition, geographic range, population size, productivity rates, potential biological removal levels (PBR – the number of human-caused deaths the stock can withstand annually and still reach and maintain an optimum population level), and fishery-specific mortality estimates and also compares the PBR to estimated human-caused mortality for each stock. To access the stock assessment report, see the NMFS website at http://www.nmfs.noaa.gov/prot_res/PR2/Stock_Assessment_Program/sars.html.

#### *7.6.1.1 Harbor Porpoise*

The Gulf of Maine harbor porpoise was proposed to be listed as threatened under the ESA on January 7, 1993 (NMFS, 1993), but NMFS determined this listing was not warranted (NMFS, 1999). NMFS removed this stock from the ESA candidate species list in 2001. The PBR for the harbor porpoise is 747 animals (NMFS, 2002). The total fishery-related mortality and serious injury for this stock is not less than 10% of the calculated PBR level, which means the human-induced mortality is not approaching a zero mortality and serious injury rate. This is not a strategic stock because average annual fishery-related mortality and serious injury has not exceeded the PBR level in recent years.

Harbor porpoises range from Labrador to North Carolina. The southern-most stock of harbor porpoise is referred to as the Gulf of Maine/Bay of Fundy stock and generally spends its winters in the Mid-Atlantic region. Harbor porpoises are generally found in coastal and inshore waters, but will also travel to deeper, offshore waters. The status of the harbor porpoise stock in U.S. waters relative to the optimum sustainable population is unknown. There are insufficient data to determine population trends for this species because harbor porpoises are widely dispersed in small groups, spend little time at the surface, and distribution varies unpredictably from year to year depending on environmental conditions (NMFS, 2002).

Shipboard line transect sighting surveys have been conducted to estimate population size of the harbor porpoise stock. The best estimate of abundance for the Gulf of Maine/Bay of Fundy harbor porpoise stock is 89,700. The minimum population estimate is 74,695 individuals (NMFS, 2002).

#### *7.6.1.2 Pilot Whale*

The two species of pilot whales in the Atlantic, long-finned and short-finned pilot whales, are difficult to distinguish to the species level at sea. The species tend to overlap from New Jersey to Cape Hatteras, North Carolina. Sightings north of this overlapping area are likely long-finned pilot whales, while sightings south of this area are more likely short-finned pilot whales.

Both long-finned and short-finned pilot whale abundance may have been affected by reduction in foreign fishing, curtailment of the Newfoundland drive fishery for pilot whales in 1971, and increased abundance of herring, mackerel, and squid stocks. The total number of long-finned and short-finned pilot whales off the eastern U.S. is unknown. Because long-finned and short-finned pilot whales are difficult to identify at sea, seasonal abundance estimates were reported for

*Globicephala* species as a whole. The best abundance estimate for pilot whales (*Globicephala sp.*) is 14,524 and the minimum population estimate is 11,343 individuals.

***Long-finned pilot whale***
The status of long-finned pilot whales, *Globicephala melas*, relative to their optimum sustainable population is unknown, and there are insufficient data to determine a population trend for this species. Long-finned pilot whales are not listed under the ESA, but are considered a strategic stock because the 1996-2000 estimated average annual fishery-related mortality exceeds the PBR level (108) for this species.

Long-finned pilot whales range from North Carolina north to Iceland and Greenland and east to North Africa. Off the northeast U.S. coast, pilot whales are distributed principally along the continental shelf edge in the winter and early spring. In late spring, pilot whales move onto Georges Bank and into the Gulf of Maine and more northern waters until late autumn. Pilot whales generally prefer areas of high relief or submerged banks, and also areas associated with the Gulf Stream north wall and thermal fronts along the continental shelf edge. Stock structure of the long-finned pilot whale is uncertain, although it has been proposed that two populations exist (a warm-water population and a cold-water population) related to sea surface temperature (Fullard et al., 2000).

***Short-finned pilot whale***
The status of short-finned pilot whales, *Globicephala macrorynchus*, relative to their optimum sustainable population, is unknown, and there are insufficient data to determine a population trend for this species. Short-finned pilot whales are not listed under the ESA, but are considered a strategic stock because the 1996-2000 estimated average annual fishery-related mortality exceeds the PBR level (108) for this species.

Short-finned pilot whales range worldwide in tropical to warm temperate waters with North Carolina considered the northern extent of their range in U.S. waters. Sightings within U.S. waters are primarily within the Gulf Stream and along the continental shelf and continental slope in the northern Gulf of Mexico. No information is available on stock structure for this species.

### 7.6.2 Sea Turtles

All sea turtles that occur in U.S. waters are listed as either endangered or threatened under the ESA. The Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbricata*) are listed as endangered. The loggerhead (*Caretta caretta*) and green turtle (*Chelonia mydas*) are listed as threatened, except for breeding populations of green turtles in Florida and on the Pacific coast of Mexico, which are listed as endangered. All five of these species inhabit the waters of the U.S. Atlantic and Gulf of Mexico.

NOAA Fisheries recognizes five loggerhead subgroups within the western Atlantic including two primary subpopulations: 1) a northern nesting subpopulation that occurs from North Carolina to northeast Florida, about 29ºN (approximately 7,500 nests in 1998); 2) a south Florida nesting subpopulation, occurring from 29ºN on the east coast to Sarasota, Florida on the west coast (mean of 73,751 nests each year). The status of the northern population based on the

number of loggerhead nests has been classified as stable or declining (TEWG, 2000). Data from all beaches within the south Florida subpopulation where nesting activity has been recorded indicate substantial increases when data are compared over the last 25 years. However, an analysis limited to nesting data from the statewide sea turtle Index Nesting Beach Survey program from 1989 to 2002, a period encompassing index surveys that are more consistent and more accurate than surveys in previous years, has shown no detectable trend (Blair Witherington, Florida Fish and Wildlife Conservation Commission (FFWCC, pers. comm., 2002).

The Kemp's ridley is one of the most endangered of the world's sea turtle species. The only major nesting site for Ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico. Estimates of the adult female nesting population reached a low of 300 in 1985. Conservation efforts by Mexican and U.S. agencies have aided this species by eliminating egg harvest, protecting eggs and hatchlings, and reducing at-sea mortality through fishing regulations. From 1985 to 1999, the number of nests observed at Rancho Nuevo, and nearby beaches increased at a mean rate of 11.3% per year (TEWG, 1998). Current totals exceed 8,000 nests per year, allowing cautious optimism that the population is on its way to recovery.

Recent population estimates for green sea turtle in the western Atlantic area are not available. However, the pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the ten years of regular monitoring since establishment of index beaches in 1989.

Leatherback populations in the eastern Atlantic (*i.e.*, off Africa) and Caribbean appear to be stable, but there is conflicting information for some sites (Spotila, pers. comm.) and it is certain that some nesting populations (*e.g.*, St. John and St. Thomas, U.S. Virgin Islands) have been extirpated (NMFS and USFWS, 1995). Data collected in southeast Florida clearly indicate increasing numbers of nests for the past twenty years (9.1-11.5% increase), although it is critical to note that there was also an increase in the survey area in Florida over time (NOAA Fisheries SEFSC, 2001).

## 7.7 EXISTING AND PROPOSED FEDERAL REGULATIONS/ACTIONS PERTAINING TO RELEVANT PROTECTED SPECIES

### 7.7.1 Marine Mammals

#### *7.7.1.1 Harbor Porpoise*

On December 1, 1998, NMFS published a final rule to implement the Harbor Porpoise Take Reduction Plan for the Gulf of Maine and the Mid-Atlantic coastal waters. The Northeast sink gillnet and Mid-Atlantic coastal gillnet fisheries are the two fisheries regulated by the HPTRP (63 FR 66464, December 2, 1998; also defines fishery boundaries). Among other measures, the HPTRP uses time/area closures in combination with acoustical devices (e.g., pingers) in Northeast waters, and time/area closures along with gear modifications for both small mesh (greater than 5 inches (12.7 cm) to less than 7 inches (17.78 cm)) and large mesh (greater than or equal to 7 inches (17.78 cm) to 18 inches (45.72 cm)) gillnets in Mid-Atlantic waters. Although

the HPTRP predominately impacts spiny dogfish and monkfish fisheries due to high rates of porpoise bycatch, other gillnet fisheries are also managed under the HPTRP.

Copies of the final rule are available from the Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910-3226. Additional information regarding the rule and its changes can also be accessed via the Internet at http://www.nero.nmfs.gov/porptrp/.

*7.7.1.2 Pilot Whale*

There are no take reduction measures currently in place for pilot whales in the Atlantic Ocean. However, NMFS plans to convene two new take reduction teams in 2005 and 2006 to address incidental takes of pilot whales in Atlantic pelagic longline and trawl fisheries. The Pelagic Longline TRT will convene in June of 2005 and the Trawl TRT will follow in 2006.

### 7.7.2 Sea Turtles

Under the ESA, and its implementing regulations, taking sea turtles – even incidentally – is prohibited, with exceptions identified in 50 CFR 223.206. The incidental take of endangered species may only legally be authorized by an incidental take statement or an incidental take permit issued pursuant to section 7 or 10 of the ESA.

Existing NMFS regulations specify procedures that NMFS may use to determine that unauthorized takings of sea turtles are occurring during fishing activities, and to impose additional restrictions to conserve sea turtles and to prevent unauthorized takings (50 CFR 223.206(d)(4)). Restrictions may be effective for a period of up to 30 days and may be renewed for additional periods of up to 30 days each.

### 7.7.3 Seabirds

Under the Migratory Bird Treaty Act it is unlawful "by any means or in any manner, to pursue, hunt, take, capture, [or] kill" any migratory birds except as permitted by regulation (16 U.S.C. 703). The regulations at 50 CFR 21.11 prohibit the take of migratory birds except under a valid permit or as permitted in the implementing regulations. The US Fish and Wildlife Service's Policy on Waterbird Bycatch states:

> *"It is the policy of the U.S. Fish and Wildlife Service that the Migratory Bird Treaty Act of 1918, as amended, legally mandates the protection and conservation of migratory birds. Avian conservation is of significant concern to many in the United States. Substantial numbers of waterbirds (especially seabirds, but also waterfowl, shorebirds, and other related wading species) are killed annually in fisheries, making waterbird bycatch a serious conservation issue and a violation of the underlying tenets of the MBTA. The goal of the U.S. Fish and Wildlife Service is the elimination of waterbird bycatch in fisheries. The Service will actively expand partnerships with regional, national, and international organizations, States, tribes, industry, and environmental groups to meet this goal. The Service, in cooperation with interested parties, will aggressively promote public awareness*

*of waterbird bycatch issues, and gather the scientific information to develop and provide guidelines for management, regulation, and compliance."*

## 7.8 POTENTIAL IMPACTS TO ATLANTIC COASTAL STATE AND INTERSTATE FISHERIES

Regulations developed under the future trawl take reduction plan for pilot whales have the potential to impact trawl fisheries that target Atlantic herring.

## 7.9 IDENTIFICATION OF CURRENT DATA GAPS AND RESEARCH NEEDS

### 7.9.1 Marine Mammal Research Needs

- Abundance estimates capable of distinguishing short-finned from long-finned pilot whales are needed to achieve more accurate status assessments for this species and to improve the ability to monitor them.

### 7.9.2 Sea Turtle Research Needs

- In order to better understand sea turtle populations and the impacts of incidental take in Atlantic herring fisheries, in-water abundance estimates of sea turtles are needed to achieve more accurate status assessments for these species and improve our ability to monitor them.

### 7.9.3 Sea Bird Research Needs

- An analysis of existing bird bycatch data for this fishery should be conducted and summarized for the plan.

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# 9.0 APPENDICES

## Appendix 1: Technical Report on Gonadal-Somatic Index-Based Monitoring System for Atlantic Herring Spawning Closures in US Waters

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Micah Dean (Massachusetts Division of Marine Fisheries)
Dr. Matt Cieri (Maine Department of Marine Resources)

### Introduction

While Atlantic herring reproduce in the same general season each year, the onset, peak and duration of spawning may vary by several weeks annually (Winters and Wheeler, 1996). It is believed that this behavioral plasticity is an evolutionary adaptation that takes advantage of optimal oceanographic conditions (e.g, temperature, plankton availability, etc.) to maximize offspring survival (Sinclair and Tremblay, 1984; Winters and Wheeler, 1996). In an effort to protect the integrity of the spawning stock and allow for increased recruitment, the ASMFC developed a system of seasonal spawning closures in the early 1990s that accounted for this interannual variability in spawning time. Historically, managers have focused on protecting the bulk of spawning during the fall season (August through October), but Atlantic herring are also known to spawn from late July through December. Acknowledging that macroscopic identification of the maturity stage of individual fish is a somewhat subjective process, the closure rule was based on a female gonadal somatic index (GSI), which is assumed to increase linearly as herring approach full maturity (Figures 1 and 2; Equation 1).

1) $GSI = 100 \times [W_{gonad}]/[W_{gonad}-W_{total}]$

At the time of the rule's creation, it was recognized that smaller herring generally have lower GSI values than larger herring (Figure 3). Consequently, separate triggers were established for two size classes: GSI = 15 for 23-27 cm; and GSI = 20 for 28+ cm. According to the closure rule, once two consecutive samples of herring achieve an average female GSI in excess of either trigger, the fishery closes for four weeks. Because all GSI samples are obtained directly from the commercial herring fishery, it is not always possible to collect sufficient data to inform the start of the spawning closure. As such, default closure dates were established for each of three areas that presumed a general north-south progression of spawning (Table 1). Despite the design of the closure system, it is fairly common to find spawning herring in fishery samples after the closure. To counteract this, a closure extension rule was established that mandated a two-week additional closure if fishery-dependent sampling revealed that greater than 25% of a post-closure sample contained fish in spawning condition (Stage V or VI).

When the rules were first established in the early 1990s, limited data were available to derive the critical parameters of the GSI-based spawning closure system (i.e., size categories; GSI triggers; default dates; closure duration). Given recent concerns over the adequacy of the system, which initiated the development of Draft Amendment 3 to the Interstate Atlantic Herring Fishery Management Plan (FMP), the Herring Plan Development Team felt that a re-examination of these parameters was warranted in light of an additional two decades worth of GSI sampling data.

**Factors Affecting GSI**

There is substantial variability in average GSI from one sample to the next, and it is often unclear whether this change is tracking the expected progression of gonad development of the population or is simply a function of the fish size, sample location, gear type, or year. The combined MADMF/MEDMR dataset of fishery-dependent samples includes 8,474 GSI observations (5,435 maturity observations) from 385 samples and covers three inshore spawning areas (Eastern Maine, Western Maine, Massachusetts-New Hampshire); three gear types (purse seine, midwater trawl, and bottom trawl); 15 years (1998-2013); three months (Aug-Oct); and 13 length bins (from 22 to 34 cm). Unfortunately, data are lacking for many factor level combinations (e.g., MWT samples are generally unavailable at the same time/area as other gear types), thereby preventing an analysis of the simultaneous influence of each factor on GSI/maturity using the full dataset. Nonetheless, we can evaluate the influence of several factors by examining a subset of the data. To this end, a generalized linear model (GLM) relating the GSI of female herring to a suite of factors (GSI ~ DAY + YEAR + LENGTH + AREA) was constructed using data from non-midwater trawl trips from the years 2004-2013.

*Size*

The current size-based closure system assumes that smaller herring achieve full maturity at a lower GSI than larger herring. While this has been demonstrated for the closely related Pacific herring (Ware and Tasanichuk, 1989), there is little evidence for such a relationship in our sample data (Figure 4). An alternative explanation for the observed size-GSI relationship (Figure 3) is a size-dependent arrival on the spawning ground (i.e., larger herring spawn earlier). This phenomenon had been documented in several other herring populations (Boyar 1968; Ware and Tanasichuk, 1989; Oskarsson et al., 2002; Slotte et al., 2000), and is believed to be related to a size-dependent maturation process (Ware and Tanasichuck, 1989), or swimming speed (i.e. larger herring arrive earlier to spawning grounds) (Slotte et al, 2000). Regardless, there is clear evidence of a decreasing average fish size as the spawning season progresses (Figure 5). While it is true that smaller GOM herring generally have lower GSI than larger fish (at a given point in time), it is likely that all sizes achieve a similar maximum GSI, just at different times. As expected, the GLM estimated a strong positive relationship between length and GSI (Table 2 - for every 1 cm increase in length, there is a corresponding increase in GSI of 1.84 points). This slope for the LENGTH parameter can be used to standardize GSI observations to a common herring size, thereby removing the influence of length from GSI sample data.

*Year*

The strongly significant year effect indicates that the GSI for a given length/date may shift by six (6) or more points from year to year (Table 3). This suggests that the onset of spawning can vary by five or more weeks, underscoring the need for a GSI-based monitoring system instead of fixed closure dates. Several other studies corroborate this level of interannual variability in spawning time (Boyar 1968; Grimm 1983; Stevenson 1989; Winters and Wheeler 1996).

*Day*

The slope of the DAY parameter (0.19) in the GLM model represents the rate at which GSI increases per day, after controlling for the effects of other factors. Theoretically, this rate could be used to forecast the date when GSI (after adjusting for LENGTH) exceeds a trigger value from a single sample of fish. However, there is likely some interannual variability in this rate,

and it would be more prudent to use samples from within a season to estimate the slope of the DAY parameter to forecast a closure date.

*Area*

The Eastern Maine (EM) spawning area was identified as having a significantly higher GSI than the other two areas, meaning that spawning occurs earlier in EM than elsewhere. Interestingly, the Western Maine (WM) and Massachusetts-New Hampshire (MA-NH) spawning areas do not appear to have significantly different spawning times. This suggests that these two areas should have a similar default date, or could even be combined to increase the number of samples available for informing spawning closures. Several earlier studies describe the timing of herring spawning in the GOM through the use of fishery-dependent maturity data and direct observation of demersal egg beds (Table 3 - Boyar et al., 1973; Cooper et al., 1975; McCarthy et al., 1979; Stevenson 1989). While these investigations confirm an earlier spawning time in EM than in MA-NH, there is no historical evidence to inform the timing of spawning in the WM area.

*Fishing Gear*

An alternative GLM was attempted that included gear type (bottom trawl vs purse seine) as an additional predictor variable (GSI ~ DAY + YEAR + LENGTH + AREA + GEAR); While GEAR was a marginally significant predictor of GSI, this more saturated model did not improve fit to the data, as measured by the Bayesian Information Criterion (BIC). This suggests that it is appropriate to combine samples obtained from these gear types. It should be noted that mid-water trawl samples were excluded from this analysis, as this gear rarely operates at the same time/location as the other gears, preventing an objective determination of whether this gear type influences the GSI of a sample.

**Proposed Changes to the Closure System**

Given that larger herring spawn earlier, it makes sense to standardize GSI observations to a large size class (e.g., 30 cm – 95$^{th}$ percentile of observed lengths), so that the closure period is inclusive of most spawners. Therefore, the observed GSI of each individual fish should be adjusted using the formula (Formula 2), where *a* is the slope of the length parameter from the GLM (*a*=1.84) and *b* is the reference length class (*b*=30 cm):

2) $GSI_{30} = GSI_{obs} + a * (b - TL_{cm})$

Herring are determinate spawners, releasing all of their eggs in a single batch (Kurita and Kjesbu, 2008). Therefore, spawning can be considered imminent at the end of Stage V (i.e., full maturity). However, a range of GSI values has been observed within Stage V that likely represents the final progression of the maturity cycle (Figure 6). Therefore, a point near the high end of the distribution of Stage V GSI values could be considered a reasonable measure of the onset of spawning. Managers could select different points from this distribution as a trigger value, depending on their objectives or risk tolerance. A higher value would shift the fishery closure nearer to the expect onset of spawning, whereas a lower value would shift the closure earlier to provide more protection to pre-spawning fish.

Once the fishery-dependent sampling program has a sufficient number of samples (e.g., a minimum of three) with a significant positive slope to the $GSI_{30}$~DAY relationship ($\alpha$= 0.05), a fishery closure date could be forecasted (i.e., the date when $GSI_{30}$ exceeds $GSI_{trigger}$). This forecast could be updated as additional samples are acquired and an official closure date selected

when the forecast is within a certain number of days (e.g., 5 days). If insufficient samples are available to predict the $GSI_{trigger}$ date prior to the default closure date, the default date would apply.

Using GSI sample data from previous seasons, we can estimate the date at which a $GSI_{trigger}$ would have been reached in each year (Figure 7). The average trigger date provides some representation of what an appropriate default closure date might be (Figure 8). Depending on the trigger value used, the average date for the MA-NH area is 4-24 days later than the most robust literature account for this area, which observed the arrival of herring egg beds on Jeffreys ledge between 1972 and 1978 (Table 3 – McCarthy et al., 1979). Most of the contemporary GSI sampling effort has been focused inshore of Jeffreys Ledge, suggesting spatial and/or interannual variation of spawning time within this area. Unfortunately, there are no literature sources available to inform the default date for Western Maine. The GLM model found no significant difference between the two areas; therefore, it appears reasonable to combine the two areas, increasing the number of samples available to inform a larger Tri-State (WM-MA-NH) spawning area (Table 2). With such few GSI samples available to describe the EM area, the historical information of when herring eggs have been observed on lobster traps is likely more applicable for this area (Table 3 – Stevenson 1989).

Contemporary GSI observations are not particularly useful for describing the duration of the spawning period, because fishery-dependent samples are not available once the closure commences. However, several earlier studies in the GOM concur that the typical duration of herring spawning within a particular area is approximately 40 days (Table 3). Therefore, it appears the current 4-week closure period is inadequate and increasing to a 6-week closure (42 days) would provide a better match for the available information on the duration of GOM herring spawning.

By using the sequence of individual samples obtained in previous years, we can apply the proposed closure rules to simulate the performance of the forecasting algorithm. For example, in 2011 a September 11 closure would have been announced on September 6, assuming a choice was made to select a closure date at five days prior (Figure 9).
There are several benefits to the GSI-based closure system as outlined in this paper:

1) By providing a forecasted closure date once an increase in $GSI_{30}$ is detected, all interested parties (samplers, managers, industry) will have advance notice as to when the spawning closure is likely to occur, allowing them to plan their activities accordingly.
2) Because the forecasting model uses the GSI information from all samples to project a closure date, there isn't pressure to obtain two consecutive samples just prior to spawning, a task that has proven difficult in many years. For this reason, default closure dates due to insufficient samples would occur less often.
3) Aligning the assumptions of the closure system with the current understanding of the reproductive ecology of herring will improve the accuracy of and maximize the effectiveness of spawning closures.
4) By directly taking into account the effect of length on GSI, perceived discrepancies between sampling programs (MADMF, MEDMR) can be reconciled.

Ideally, we would have GSI and maturity samples from before, during, and after the spawning season. This would provide a better idea of maximum GSI (i.e. appropriate trigger value), and how that coincides with the presence of Stage V (full maturity) and Stage VI (spawning) fish. Unfortunately, because the GSI-monitoring program is entirely fishery-dependent, there are essentially no samples available once the spawning closure begins. A directed fishery-independent effort to obtain herring samples during and after the closure could provide this information and be used to further refine the parameters of the closure system in the future.

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**Table 1**. Current default dates for herring spawning closures in the GOM

| Spawning Closure Area | Default Closure Date |
|---|---|
| Eastern Maine (EM) | August 15th |
| Western Maine (WM) | September 1st |
| Massachusetts/New Hampshire (MA-NH) | September 21st |

**Table 2**. Output from GLM (GSI ~ DAY + YEAR + LENGTH + AREA).

ANOVA Table:

| | Df | Deviance | Resid. Df | Resid. Dev | F | Pr(>F) |
|---|---|---|---|---|---|---|
| NULL | | | 4052 | 131631 | | |
| J | 1 | 18802 | 4051 | 112829 | 1032.017 | < 2.2e-16 *** |
| as.factor(YEAR) | 9 | 4554 | 4042 | 108275 | 27.773 | < 2.2e-16 *** |
| LENGTH | 1 | 32700 | 4041 | 75575 | 1794.853 | < 2.2e-16 *** |
| AREA | 2 | 1990 | 4039 | 73585 | 54.627 | < 2.2e-16 *** |

Coefficients:

| | Estimate | Std. Error |
|---|---|---|
| (Intercept) | -83.585212 | 1.949353 |
| J | 0.190262 | 0.005731 |
| as.factor(YEAR)2005 | 1.514119 | 0.595370 |
| as.factor(YEAR)2006 | 2.999203 | 0.673709 |
| as.factor(YEAR)2007 | 1.297457 | 0.551941 |
| as.factor(YEAR)2008 | 1.573861 | 0.630355 |
| as.factor(YEAR)2009 | 1.881865 | 0.572551 |
| as.factor(YEAR)2010 | 0.889922 | 0.591108 |
| as.factor(YEAR)2011 | 6.144499 | 0.572099 |
| as.factor(YEAR)2012 | 5.147404 | 0.576039 |
| as.factor(YEAR)2013 | 5.373736 | 0.572403 |
| LENGTH | 1.838863 | 0.042996 |
| AREAMA-NH | -2.504169 | 0.325561 |
| AREAWME | -2.775418 | 0.265547 |

**Table 3**. Literature accounts of the timing and duration of herring spawning in the GOM.

| Study | Years | Method | Area | Average First Spawning | Average Last Spawning | Average Season Length (days) |
|---|---|---|---|---|---|---|
| Boyar et al., 1973 | 1972 | Maturity | MA-NH | Sep 10 | Oct 20 | 40 |
| Cooper et al., 1975 | 1974 | Eggs (scuba) | MA-NH | Sep 29 | Oct 25 | 26 |
| McCarthy et al., 1979 | 1972-1978 | Eggs (scuba, sub, grab) | MA-NH | Sep 20 | Oct 30 | 40 |
| Stevenson 1989 | 1983-1988 | Eggs (lobster traps) | EM | Aug 28 | Sep 20 | 40 |

**Figure 1.** Observed GSI of female herring by ICNAF maturity stage from 2013 fishery dependent samples from the MA-NH spawning area.

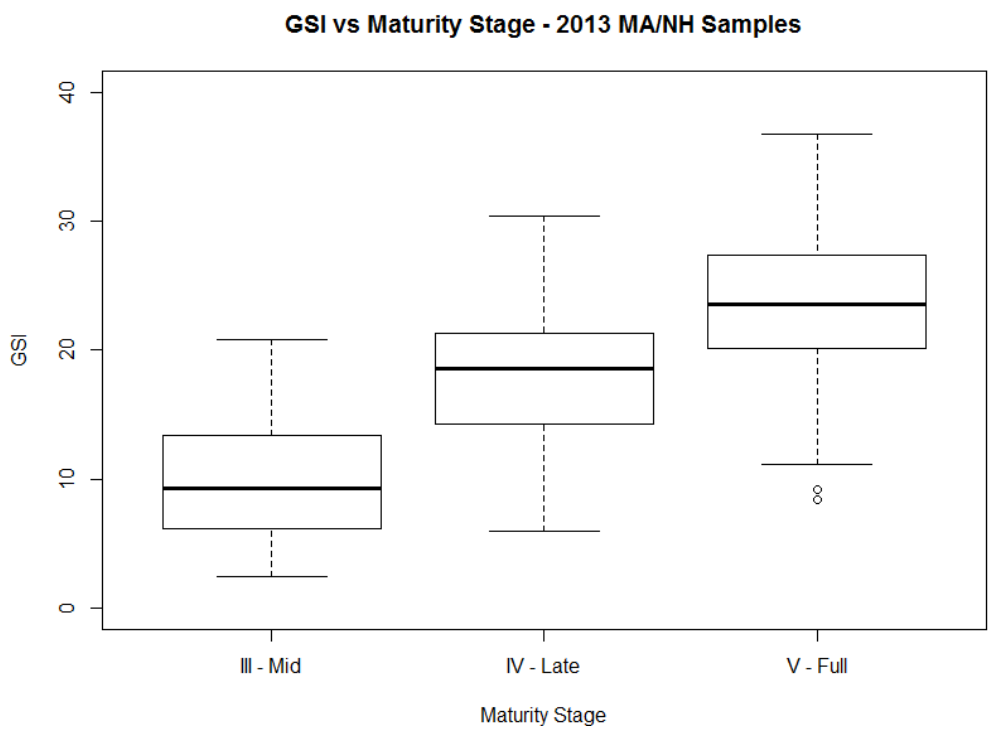

**Figure 2.** Female GSI by date from 2013 MA-NH samples. The red line indicates a significant positive linear relationship between GSI and sample date.

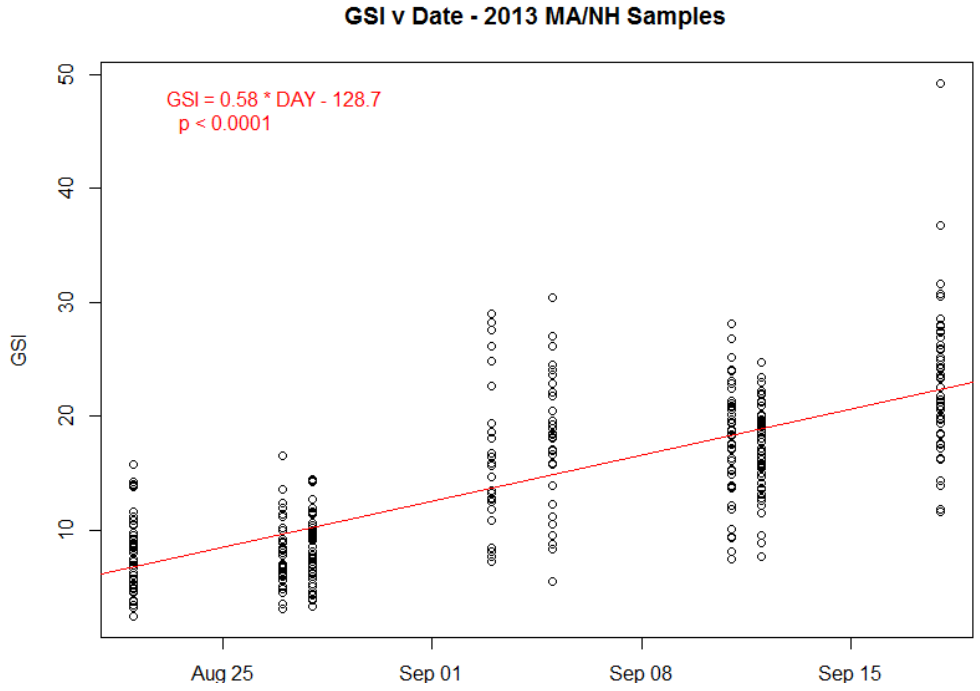


**Figure 3.** Boxplots of GSI by length bin from all sample data (based on total length).

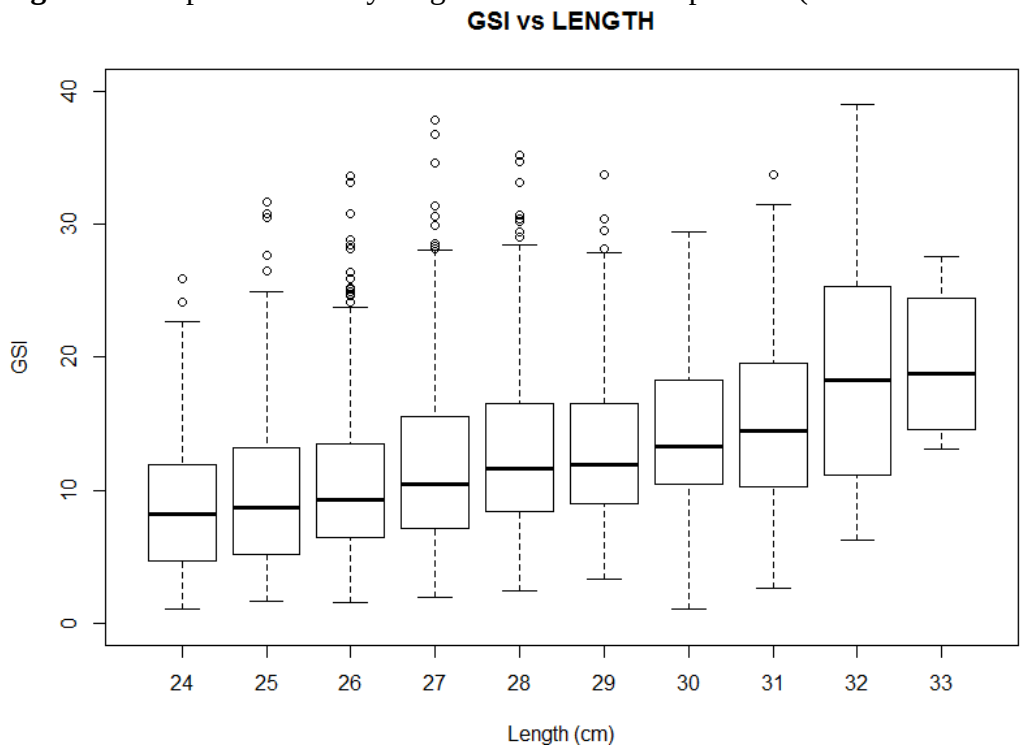

**Figure 4.** Boxplots of GSI at Stage V (full maturity) by length bin. The current size-based GSI triggers are shown in red (GSI = 15 for 24-27 cm; GSI = 20 for 28+ cm).

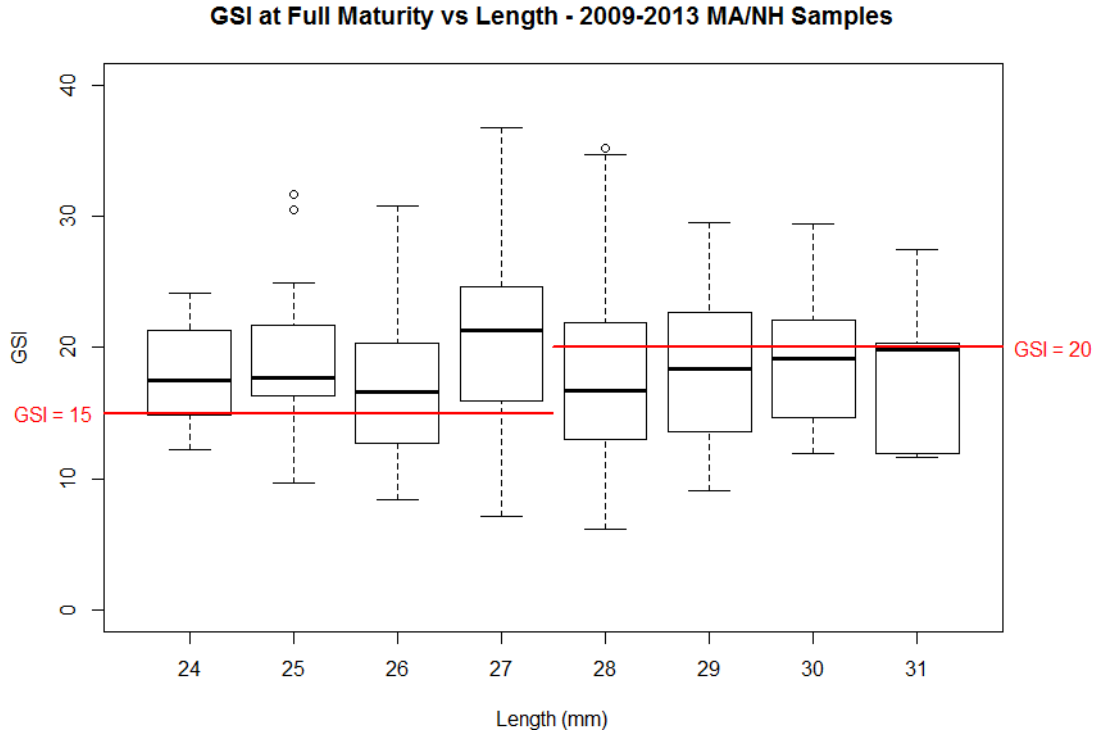


**Figure 5.** Observed fish length from MEDMR sampling of the MA-NH fishery in 2010. Note the significant decrease in observed fish length over the course of the season.

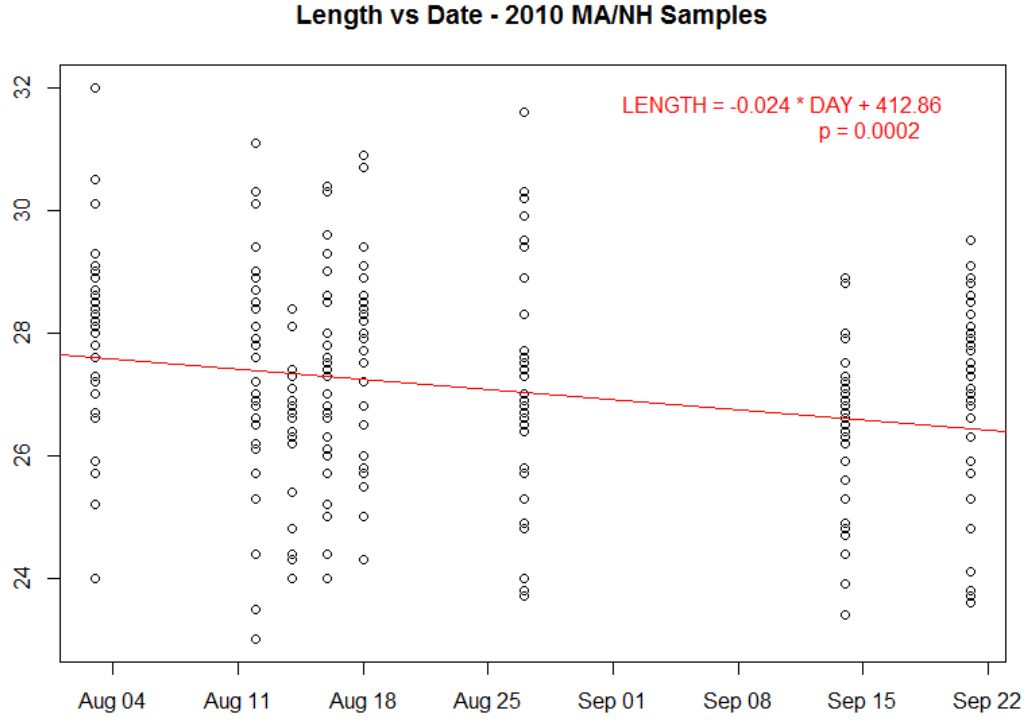

**Figure 6.** Distribution of GSI values for herring classified as Stage V (full maturity). The GSI value at a series of quantiles are shown in red.

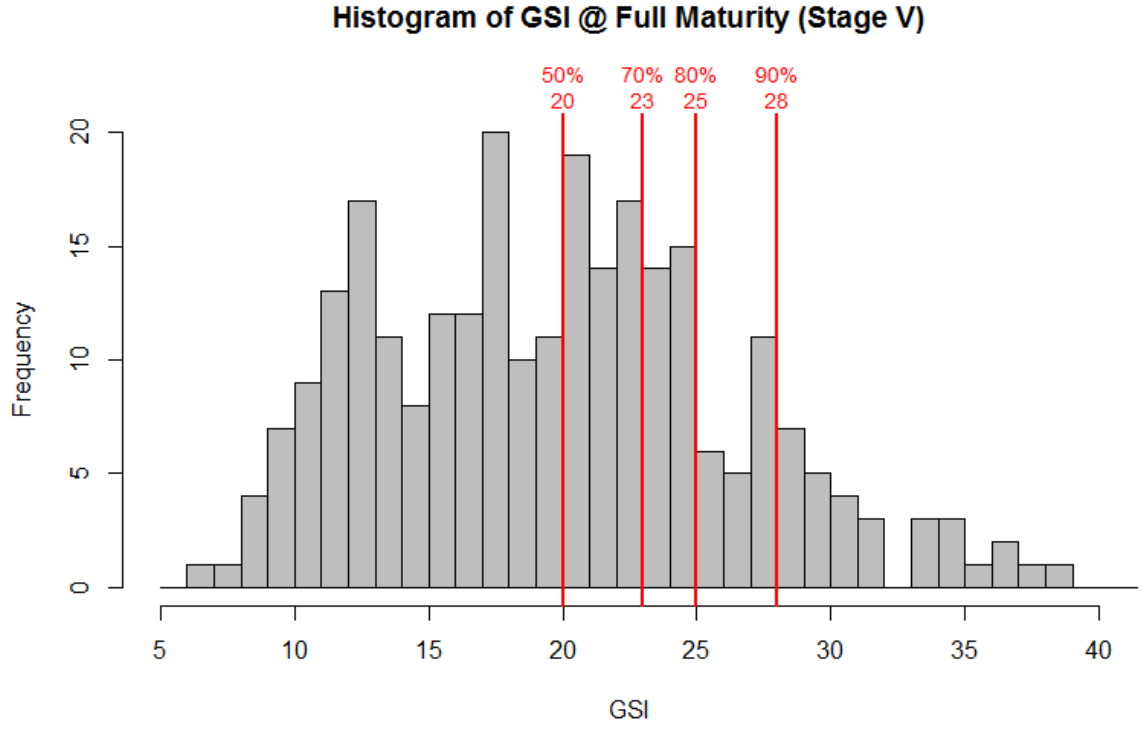

**Figure 7.** Forecasted dates when $GSI_{30}$ exceeded a range of $GSI_{trigger}$ values for sample data from the Western Maine (WM) and Massachusetts-New Hampshire (MA-NH) spawning areas combined. A diagonal line represents a significant linear relationship between $GSI_{30}$ and sample date. Gray points with error bars represent the mean $GSI_{30}$ per sample +/- 2 standard errors.

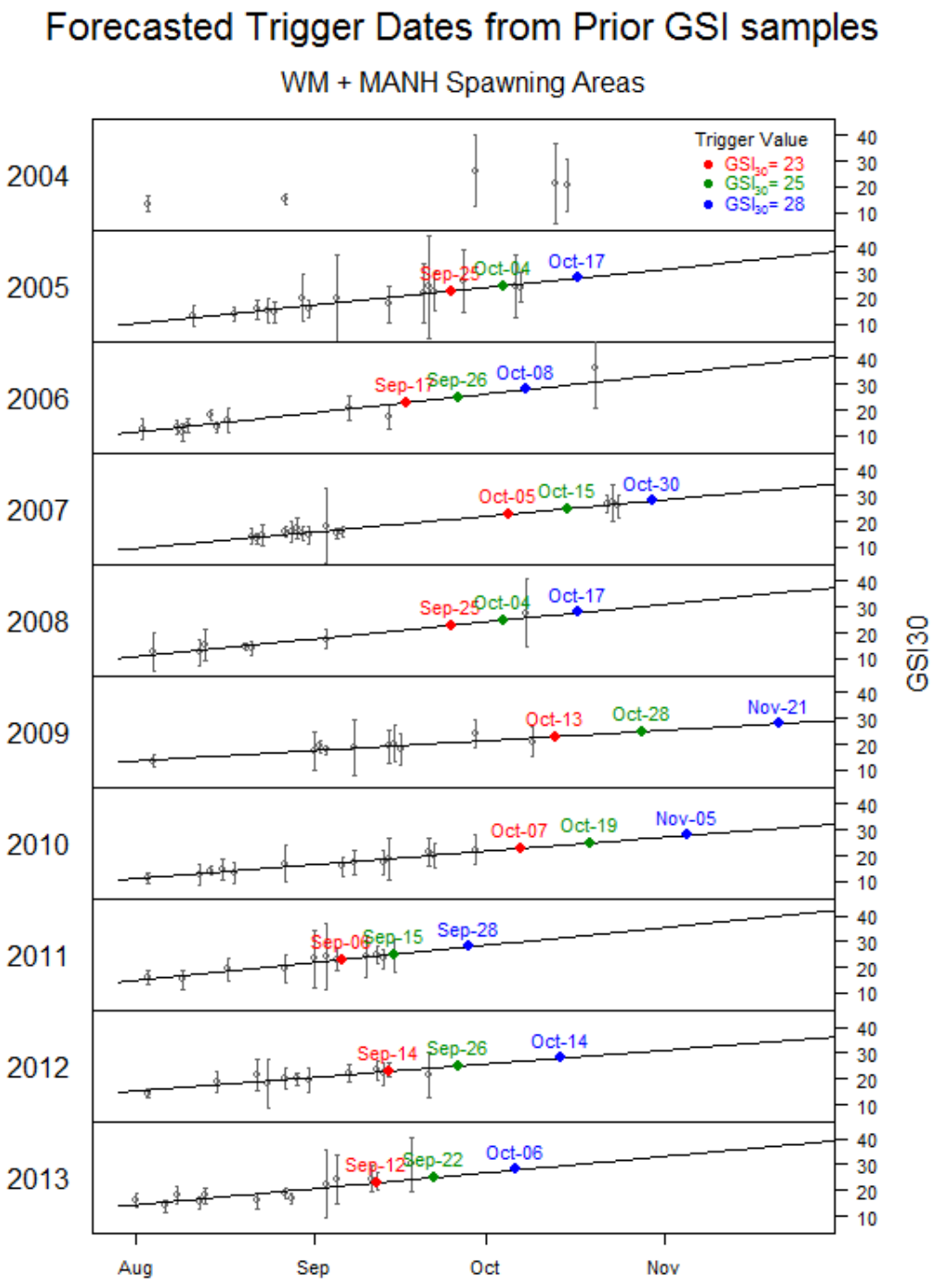

**Figure 8.** Boxplots of forecasted trigger dates for the WM and MA-NH spawning area combined (same data from Figure 7). The median date for each trigger value is labeled and could be used to set a default closure date for when sufficient samples are unavailable to forecast a trigger date.

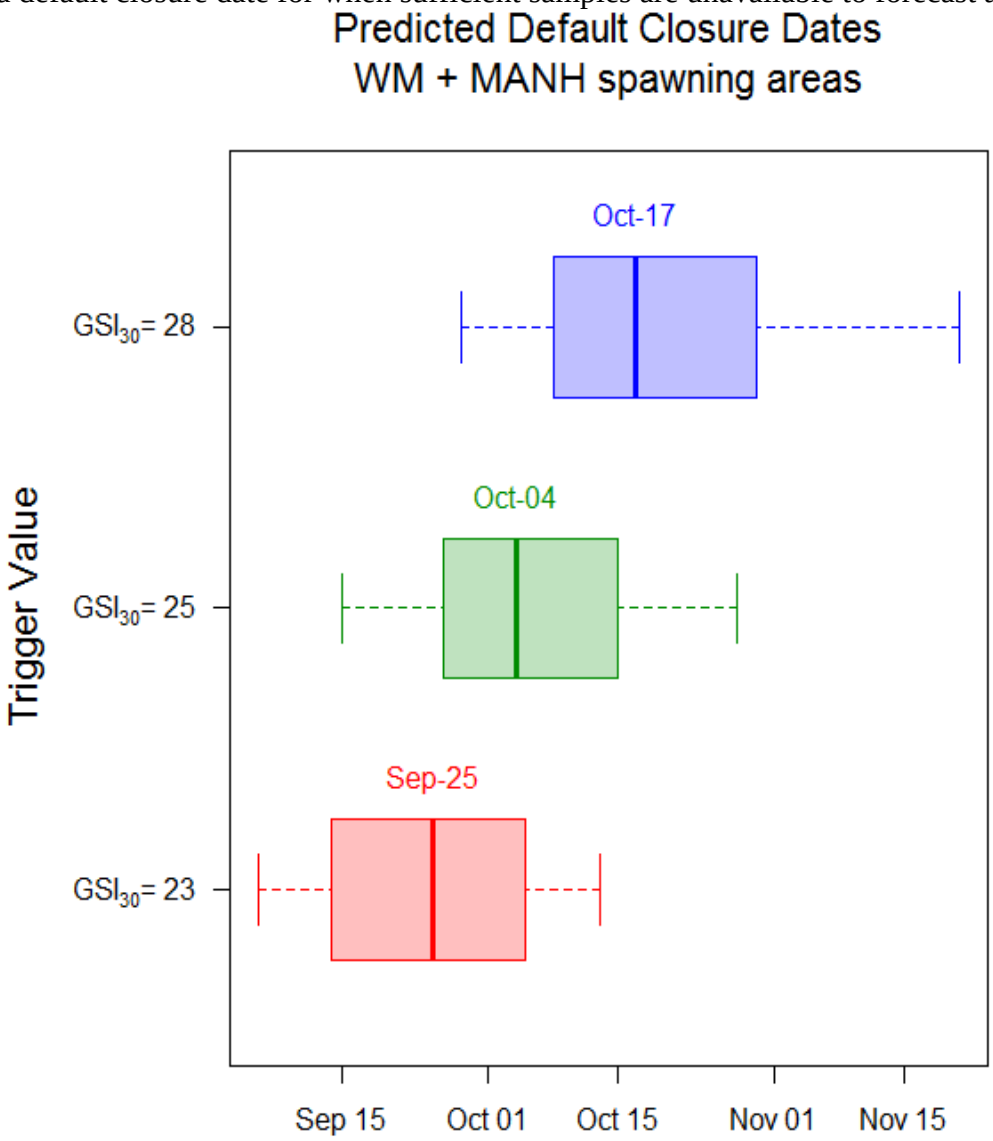

**Figure 9.** An example implementation of a modified GSI-based closure system using 2013 sample data from the MA-NH spawning area. A significant linear increase in $GSI_{30}$ is detected after six samples (Sep-1st). Projecting this relationship forward, a closure date is forecast for Sep-13th. As additional samples are collected, the linear relationship and forecasted closure date are updated. If the choice was made to select a closure date at 5 days prior, a Sep 11th closure would have been announced on Sep 6th. The gray region identifies default t closure period associated with the trigger value used in this example ($GSI_{30}$ = 25).