

Discussion Paper:
**Summary of Available Information and Management Approaches
to Address
Spawning Atlantic Herring**

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The purpose of this paper is to present available information pertaining to current management measures and the development of additional management measures to address spawning Atlantic herring. The intent of this document is to inform potential decisions that may be made during the development of Amendment 5 to the Atlantic Herring Fishery Management Plan (FMP) or in future Council actions. The following summaries have been put together by the Herring Plan Development Team (PDT) members who have been involved in the development of Amendment 5 to the Herring FMP. This paper summarizes the history of the development of management measures to address spawning fish by both the New England Fishery Management Council and the Atlantic States Marine Fisheries Commission, as well as available information about spawning fish in both inshore and offshore areas.

1.0 BACKGROUND – MANAGEMENT MEASURES TO ADDRESS SPAWNING HERRING

Herring stocks in the Gulf of Maine/Georges Bank region are believed to temporally and spatially isolate themselves during spawning by returning to their natal spawning grounds to spawn in summer and fall. Spawning occurs in 5-90 m of water with eggs laid in “mats” over a variety of possible substrates ranging from boulders to sand to vegetation. Current and historical spawning locations are shown in Figure 1.

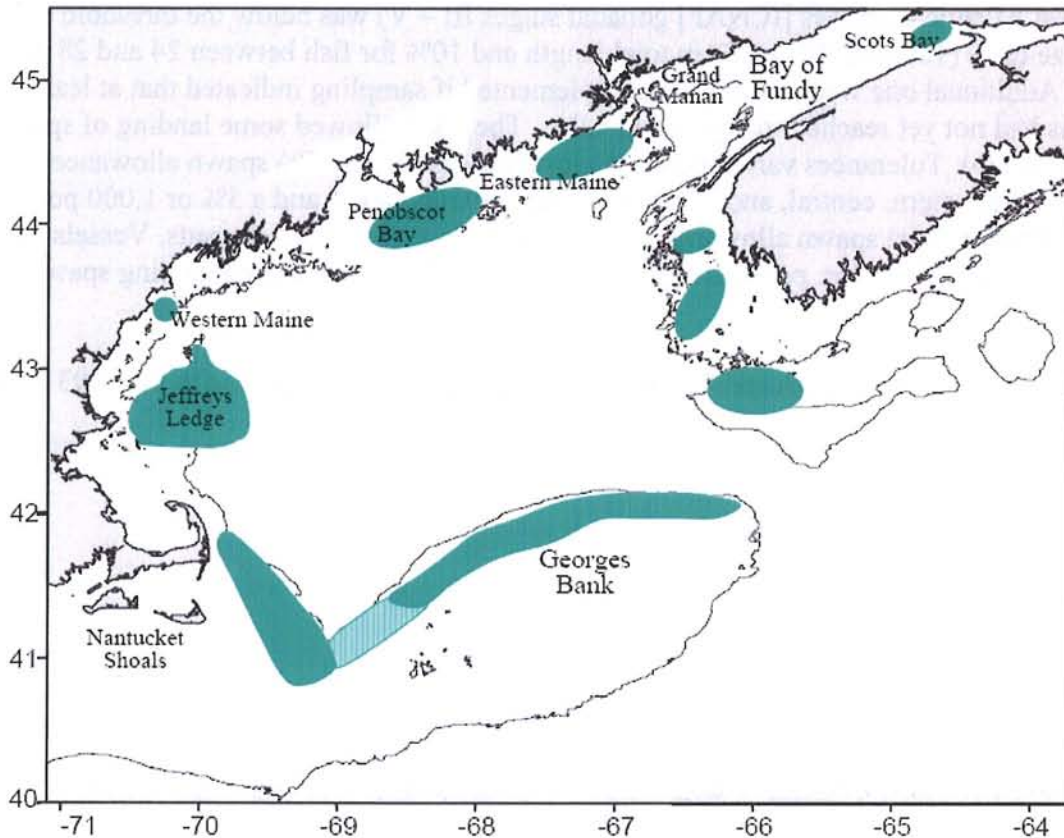


Figure 1. Generalized view of the current major herring spawning areas in the Gulf of Maine and on George Bank (from Overholtz et al. 2004).

Similar to other fish species that form large spawning aggregations, herring can be susceptible to fishing when spawning. The Atlantic States Marine Fisheries Commission (ASMFC) began formal spawning closures in 1994 as part of the 1993 Atlantic Herring Fishery Management Plan (FMP). These spawning closures were a continuation of an agreement among Maine, New Hampshire, Massachusetts, and Rhode Island, who had adopted a series of spawning closures in November 1983 as part of their Interstate Herring Management Plan. The 1993 FMP included spawning protection for the entire range of Atlantic herring, including offshore areas such as Georges Bank. Foreign fishing from the late-1960s to the mid-1970s had depleted the offshore stock. Consequently, there were few spawning females in offshore areas. States sought to protect the new abundance of offshore spawning females when the population rebounded in the late 1980s and included offshore spawning restrictions.

The goals of the ASMFC FMP relating to the spawning closures were “*to maintain the U.S. northwest Atlantic sea herring resource at or above 20% of its maximum spawning potential for optimal utilization while reducing the risk of stock collapse*” and “*to provide adequate protection for spawning herring and prevent damage to herring egg beds*”.

The 1993 ASMFC FMP required states to monitor the spawning closures by sampling commercial catch just prior to the automatic closure dates. Closures were delayed for one week if the average gonad somatic index (GSI) of mature females (International Convention for the Northwest Atlantic Fisheries [ICNAF] gonadal stages III – V) was below the threshold value for either size class (18% for fish ≥ 28 cm total length and 10% for fish between 24 and 28 cm total length). Additional one week delays were implemented if sampling indicated that at least one size class had not yet reached the threshold value. The FMP allowed some landing of spawning fish (tolerances). Tolerances varied between closure areas with a 25% spawn allowance by number in the eastern, central, and western Maine spawning areas and a 5% or 1,000 pound (whichever is greater) spawn allowance in New Hampshire and Massachusetts. Vessels were prohibited from fishing for, possessing, or landing any Atlantic herring containing spawn in all other areas.

Spawning closures boundaries are shown in Figure 2 and language specific to the 1993 ASMFC FMP follows.

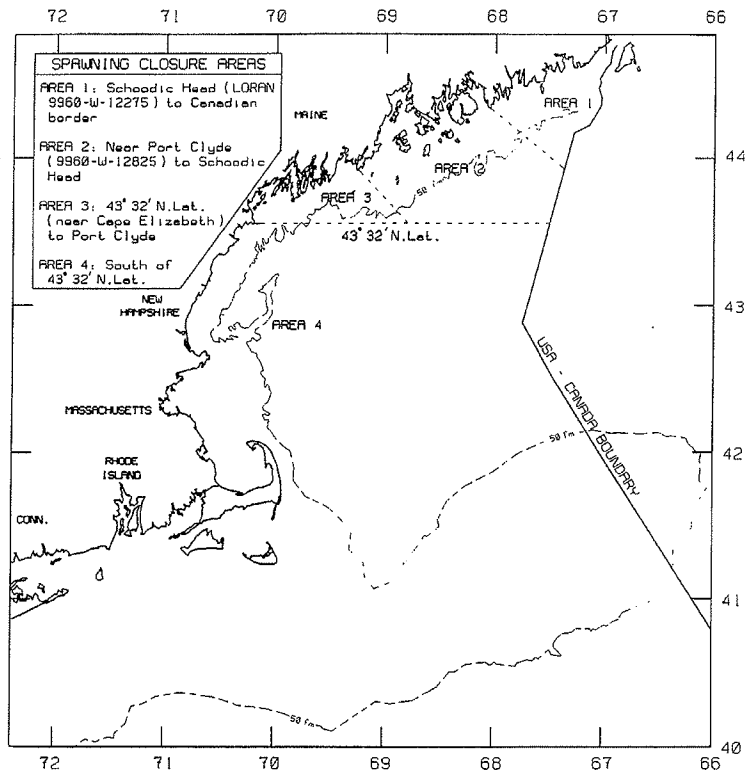


Figure 2. Spawning closure areas from 1993 Atlantic Herring Fishery Management Plan.

From Section 6.2.3 Spawning Closures of 1993 ASMFC FMP:

1. A four week closure in eastern Maine beginning August 15 (unless samples of the commercial catch taken prior to the closure date indicate that females are delayed in reaching full maturity) during which time it is unlawful to fish for or take herring containing spawn (milt or roe) when they make up more than 25% by number of any load.
2. A four week closure in two additional areas in central and western Maine beginning September 1 subject to the same monitoring or maturity and 25% tolerance exceptions.
3. A three week closure beginning October 1 for the area south of 43° 32' N (Cape Elizabeth) that is not subject to any tolerance exceptions. The closure date in this area is subject, however, to successive one week delays if sampling indicates that spawning will be delayed (identical to provisions which apply in the three areas north of 43° 32' N). This closure is enforced jointly by the four states which are party to the Interstate Herring Management Plan.

Area 1 (eastern Maine) : area northeast of Loran C 9960-W-12275 (Schoodic Point) to the U.S.-Canadian border.

Area 2 (central Maine) : area east (or north) of Loran C 9960-W-12825 (Small Point) to Loran C 9960-W-12275 and north of 43° 32' N.

Area 3 (western Maine) : area bounded by 43° 32' N (Cape Elisabeth) on the south and by Loran C 9960-W-12825 on the east (or north).

Area 4 : area south of 43° 32' N, including state and federal waters adjacent to Maine, New Hampshire and Massachusetts and the southern New England area.

The New England Fishery Management Council (NEFMC) first proposed spawning area closures as a part of its Atlantic Herring FMP in 1998. The measures were intended to be adjusted through framework actions which could be initiated when additional information on the timing and locations of spawning became available. Additional closures were also a possibility through a framework action, particularly in the lesser known offshore areas.

The proposed closures in the 1998 NEFMC FMP were considered necessary to ensure adequate protection of the herring resource. Herring fat content is at its peak during spawning, making them more economically valuable for human consumption, while concentrated spawning aggregations make herring susceptible to harvesting. In addition, spawning behavior of the uncaught herring was believed to be influenced by harvesting operations. At the time that the spawning closures were being considered, it was believed that protection of individual spawning populations would ensure successful recruitment across the entire stock complex. It was also believed that removal of fishing pressure during spawning would relieve the aforementioned stresses while also making it easier to accurately assess the extent and size of the spawning populations, as they would not be disturbed by fishing pressure.

The closures proposed by the NEFMC are shown in Figure 3. These areas were modified from the spawning closures implemented by the ASMFC 1993 Atlantic Herring FMP. Language specific to the proposed NEFMC FMP follows. The spawning closure dates in Management Area 1 were defined as:

<i>Eastern Maine</i>	<i>August 15 – September 11</i>
<i>Western Maine</i>	<i>September 1 – September 28</i>
<i>Jeffreys Ledge/Stellwagen Bank</i>	<i>September 15 – October 12</i>
<i>Cashes Ledge</i>	<i>August 1 – September 25</i>

Spawning closure dates are fixed. In an area closed to protect spawning, fishing for, harvesting, or possessing herring will not be allowed except for the following exception: vessels will be allowed to catch and possess up to 2,000 pounds of herring per trip. The amount of herring landed from a closed spawning area by one vessel in a day cannot exceed 2,000 pounds (this prohibits a vessel from making multiple trips in one day to exceed the 2,000 pound trip limit). This limit will be enforced based on calendar days and not on the basis of days-at sea used in any other management plan (for example, a groundfish days at sea running clock cannot be used to land more than 2,000 pounds of herring in one calendar day). Any fishing vessel transiting a closed spawning area and possessing more than 2,000 pounds of herring must have all fishing gear stowed as specified by the Regional Administrator.

Management Areas 2 and 3 were not considered for closures in the proposed measures of the NEFMC FMP because the offshore herring resource was considered robust and there was interest in developing the offshore fishery.

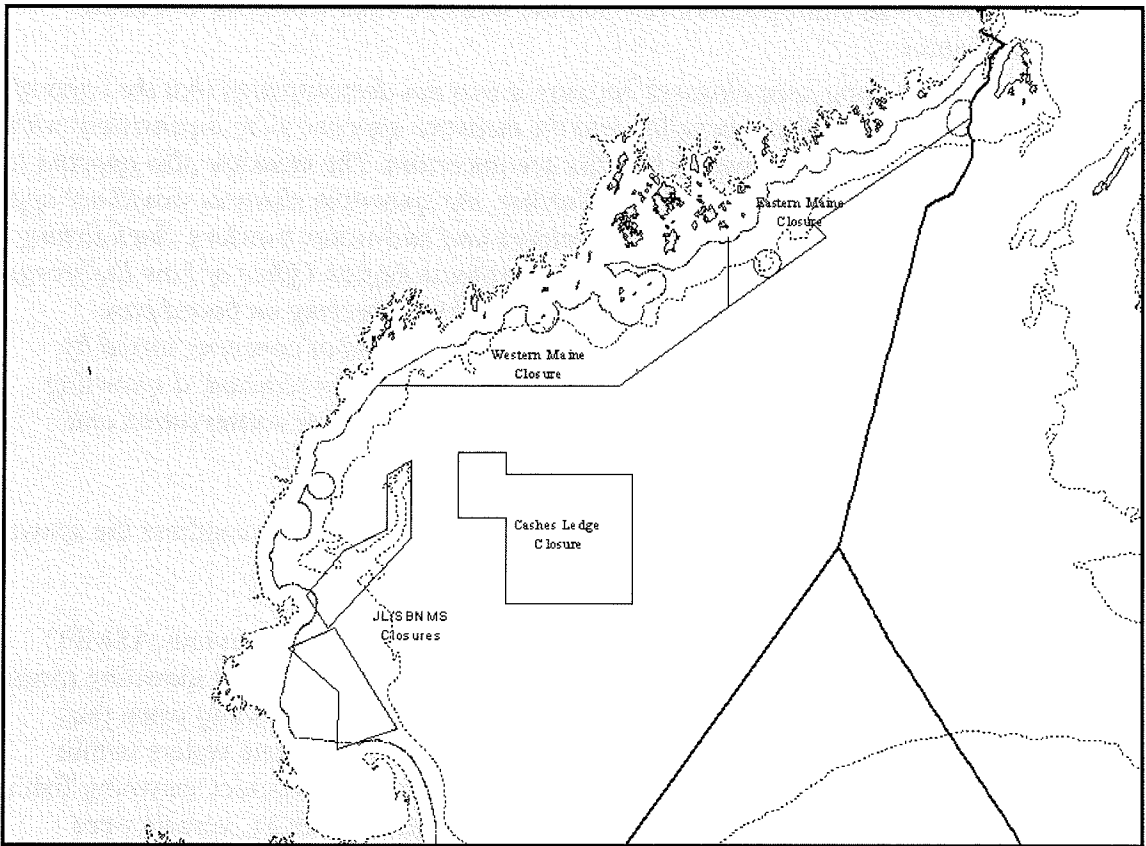


Figure 3. Herring Management Area 1 spawning closures (with approximate territorial sea boundary shown) proposed in the 1998 NEFMC Atlantic Herring FMP.

The proposed NEFMC closures in federal waters were also intended to complement the efforts of the ASMFC Amendment 1 (1999) measures (see below). The tolerance measures enacted by ASMFC allowed for some landing of spawn fish but enforcement was limited to landing regulations implemented by the individual States within ASMFC. The NEFMC developed its proposed measures out of concern that some states did not have the resources to implement and enforce the measures, which would have negated the spawning protection. The NEFMC’s intention was to augment the efforts of the ASMFC by preventing the catch of spawn herring in federal waters.

In the proposed NEFMC FMP, the spawning area closures were predicted to increase cost and decrease revenue for the herring industry. Effort would have been shifted to where and when herring would be less aggregated and contain less fat. It was projected that one-third of the landings of the year prior to the proposed measures (1997) would have been closed to fishing in subsequent years as a result of the proposed action. This analysis was based on only one year of data, however, and may not have represented average fishing. A shift in effort as a result of the measures also was not considered. However, community impacts were projected to be minimal to non-existent because the NEFMC’s proposed closures were smaller than those in the

ASMFC's 1993 plan, and other open areas closer to shore were made available for fishing to the potentially affected boats.

On October 27, 1999, the NEFMC received notification that the National Marine Fisheries Service (NMFS) Regional Administrator rejected the measures that would have created spawning area closures:

"I disapproved the spawning area closures because it was not demonstrated that the costs of imposing the closures outweigh the benefits, and the measure appears to be inconsistent with National Standard 7 in that conservation benefits are uncertain. The measure also appears to contravene the M-SFCMA, Sec. 303 (a)(1)(A). Further, the spawning closures would not apply to mobile, bottom-tending vessels, just to purse seiners and mid-water trawlers. Such fishing gear may also disturb spawning herring. Also, the Northeast Region Office of Law Enforcement stated that spawning area closures that allow the possession of herring on board pose enforcement problems. In consideration of the aforementioned and of concerns raised by commenters, and given the uncertainty of conservation benefits to be realized, a spawning closure at this time does not appear to be a necessary and appropriate conservation and management measure."

The ASMFC developed Addendum I as a result of NMFS disapproval to readdress the spawning measures that had been defined in ASMFC Amendment 1 (see following).

Amendment 1 (1999) to the ASMFC Atlantic Herring FMP replaced all previous ASMFC Atlantic herring measures including spawning closures. The goal of the new spawning measures was to protect distinct spawning units that are especially susceptible to fishing when they aggregate for spawning. The new spawning measures applied only to state waters within Management Area 1A (Figure 4) and did not include any measures to protect spawning fish in offshore areas such as Georges Bank. From August 1 through October 31, vessels were prohibited from taking, landing, or possessing more than 20% (by number) "spawn" herring containing roe or milt from state waters within Management Area 1A. Amendment 1 (1999) defined spawn herring as "ICNAF gonadal stages 4, 5, & 6."

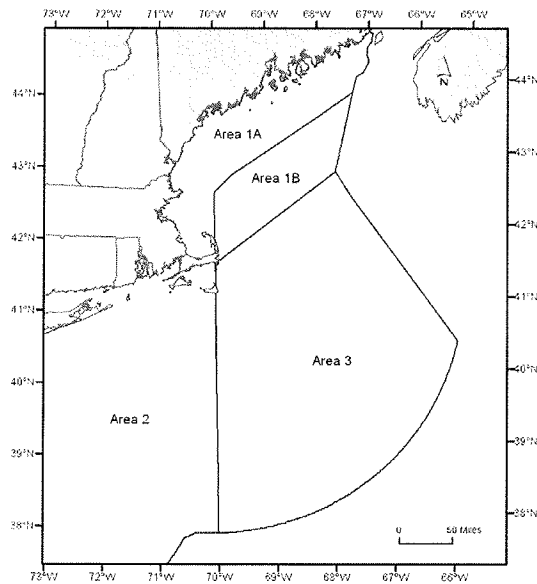


Figure 4. Management areas under Amendment 1.

Addendum I (2000) to Amendment 1 of the ASMFC Atlantic herring FMP was developed to re-address the protection of spawning areas because NMFS rejected the NEFMC's proposed Area 1A spawning closures in federal waters (see above). Under Addendum I, three spawning management areas were created (Figure 5) – Eastern Gulf of Maine (EGOM), Western Gulf of Maine (WGOM), and Massachusetts/New Hampshire (MA/NH), all of which are in Management Area 1A. These spawning areas extended into federal waters and had distinct start dates of August 15 (EGOM), September 1 (WGOM), and September 21 (MA/NH). Closures lasted 4 weeks by default, but would be extended 2 weeks if commercial catch sampling found that 25% or more mature herring, by number, had yet to spawn. Mature or “spawn” herring were defined as Atlantic herring in ICNAF gonadal stages V & VI. The definition remained "ICNAF gonadal stages V & VI" in all subsequent management documents.

In 2000, members of the public, herring fishermen, and Maine Department of Marine Fisheries personnel all noted a significant take of spawn herring from the area just outside the EGOM area during the closure. Consequently, Technical Addendum 1A (2001) was created to expand the EGOM spawning area to protect spawning females inside the eastern tip of Inner Schoodic Ridge (Figure 6).

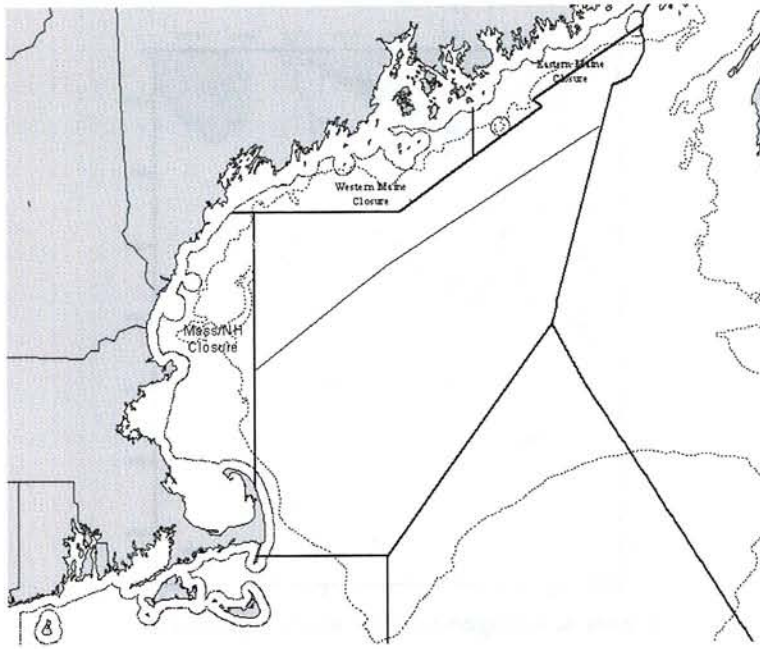


Figure 5. ASMFC spawning closures under Addendum I to Amendment 1.

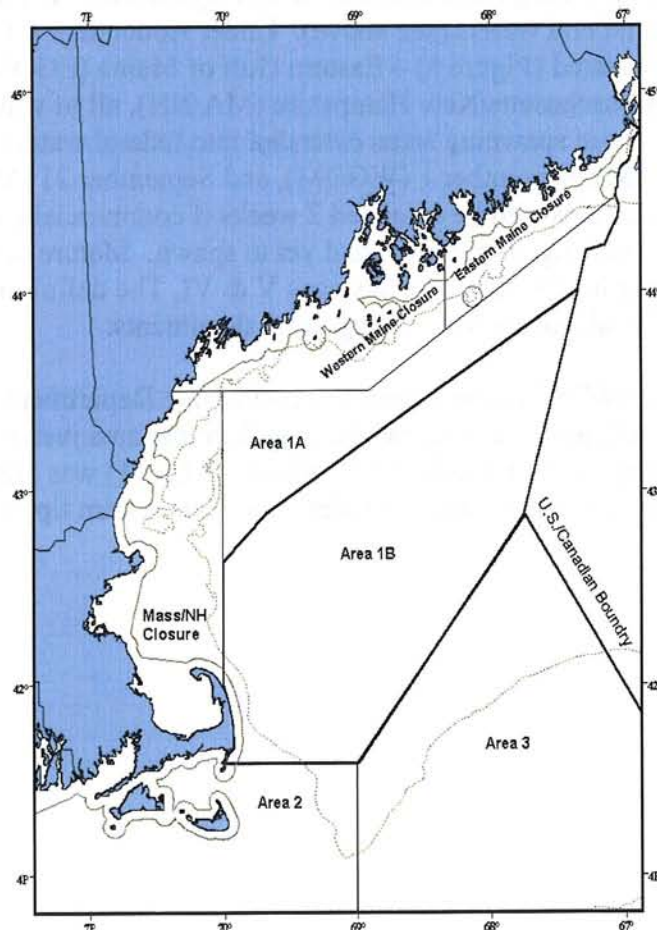


Figure 6. Spawning closure boundaries under Technical Addendum 1A to Amendment 1.

Today, ASMFC spawning regulations are specified through Amendment 2 and Technical Addendum I (2006), which continue with the three spawning areas and default dates established by Addendum 1 and Technical Addendum 1A (Figure 6). Spawning closures begin on the default start date unless commercial catch samples (see Section 2.2 of this document for more information) show significant amounts of spawn herring, defined as 25% or more in ICNAF gonadal stages V & VI. By default, closures last 4 weeks, at which point fishing is allowed. If a significant amount of spawn herring are found in the commercial catch samples after the closure, an additional 2 week closure is triggered. Fishermen are notified of the additional closure by the states, which use a distribution list that includes the ASMFC. The ASFMC will then place notice of the closure on their website.

Amendment 2 contains a “zero tolerance” provision that prohibits vessels from fishing for, taking, landing, or possessing “spawn” herring (ICNAF gonadal stages V & VI) in a spawning area during a closure. Some states interpreted zero tolerance to allow fishing in a closed area as long as no spawn herring are caught. Upon review of the loose interpretation of zero tolerance, and based on input from the Atlantic Herring Law Enforcement Committee (LEC), ASMFC developed Technical Addendum I to Amendment 2 to clarify that vessels are prohibited from fishing for, taking, or possessing herring within a restricted spawning area. The LEC was concerned that tolerances are difficult to enforce while prohibiting fishing in a closed area is easily enforceable.

Vessels on non-directed herring trips are allowed an incidental catch of 2,000 pounds from a restricted spawning area as a bycatch allowance. Any herring vessel that has more than 2,000 pounds of herring onboard that were caught outside an area under a spawning closure must have all of its fishing gear stowed as it travels through the closure area. Fixed gear fishermen east of Cutler, ME, are exempt from spawning closures and are not limited to the 2,000 pound bycatch allowance.

Amendment 2 does not include spawning restrictions for any offshore areas, although enforcement is by possession, not location of fishing. Its measures are designed to protect the inshore component of the stock by moving effort to offshore areas where the total allowable catch was historically not fully harvested. *Section 4.3.2 Spawning Restrictions* states that “protection to the offshore spawning component would come at the expense of putting more pressure on the inshore component of the stock complex.”

2.0 AVAILABLE DATA ON HERRING SPAWNING ACTIVITY IN AREA 3

2.1 NMFS

The NMFS Northeast Fisheries Science Center (NEFSC) acoustic survey of the offshore component of the Atlantic herring population began in earnest in 1999 after about four years of initial pilot work. The survey covers the northern edge of Georges Bank and Great South Channel from the ‘northeast peak’ to Cape Cod and was designed to sample aggregations of herring as they prepared to spawn in the fall (Figure 7). Initially, the index of abundance was near historical highs, but beginning in 2002, the index of abundance from the acoustic survey declined approximately four-fold and remained relatively low through 2008 (Figure 8). This decline and low-level index, however, may not have reflected the true changes in abundance. The fundamental assumption of the acoustic survey is that the herring are congregating to spawn in and during the survey area and period. Atlantic herring spawning times and locations may have changed, but the survey area and timing remained relatively stable among years. If this is the case, the acoustic survey may not be achieving adequate spatial and temporal coverage. For this reason, the acoustic survey was not used in fitting recent Atlantic herring stock assessments (Shepherd et al. 2009).

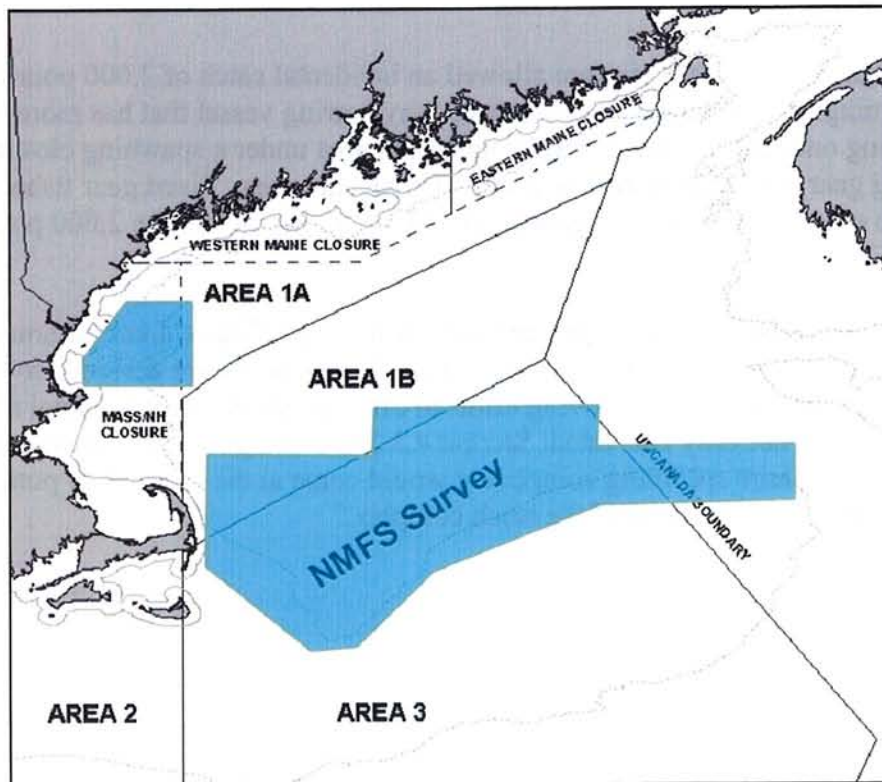


Figure 7. Survey areas of the Atlantic herring acoustic survey. Surveys on Georges Bank and Jeffreys Ledge have been completed every year since 1999.

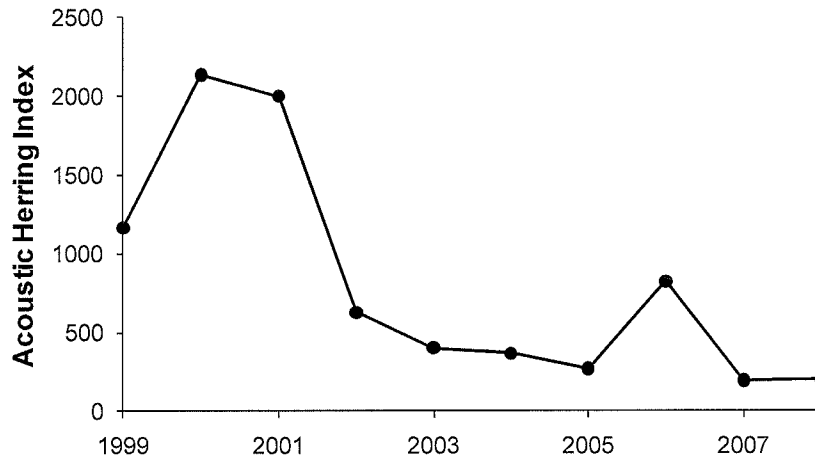


Figure 8. Atlantic herring acoustic index of abundance on George's Bank during 1999-2008.

Several research projects are being conducted to address potential issues with the acoustic survey. Acoustic data have been collected during the annual fall bottom trawl surveys, but these data have never been analyzed to determine if a supplementary acoustic index of herring abundance could be developed. A technician has begun processing the data, but limited funds have prevented the completion of this work. This research will resume as funds become available. Once complete, this project will provide a basis of comparison for the herring acoustic survey, and may serve as an additional index of abundance. Other biological data collected during the annual fall bottom trawl surveys may also be useful for evaluating temporal and spatial shifts in the occurrence of spawning herring. For example, comparing the proportion of herring at different stages of spawning among years and sampling stations may provide insight as to whether systematic changes have occurred in the spatial and temporal distribution of spawning events. This analysis will allow for the determination of whether the herring acoustic survey has adequately sampled over the course of any systematic changes in spawning events. A technician is in the process of conducting this and other analyses of biological data collected during the fall bottom trawl surveys.

A distribution of herring spawning time is calculated during the estimation of the annual NMFS NEFSC larval herring index. Combined with a numerical circulation model that will allow herring larvae to be tracked from sampling location backwards to hatch location, temporal and spatial patterns in herring spawning may be generated. These patterns could then be compared to the time and location of the acoustic survey in each year and a correction factor could be developed to adjust for any mismatches between the spawning patterns as derived from the larval index and the acoustic survey. A proposal based on this research has been submitted to the Fisheries and the Environment program and the project will be conducted by a team of scientists from NMFS NEFSC and Woods Hole Oceanographic Institute.

In addition to the formal research projects described above, NMFS is continually collaborating with other institutes to improve sampling capabilities. On-going collaborative projects include research and development of wide-band echo sounders and sonar systems that span spatial scales of sub-meters to thousands of square kilometers.

In recent years, the herring acoustic survey has been conducted during approximately the same 2-4 week period and the timing and spatial coverage of the survey was not informed by any information about the occurrence of spawning herring. The sampling design of the acoustic herring survey might be improved by using data, such as the biological and acoustic data collected during bottom trawl surveys, to inform the spatial and temporal coverage of the acoustic survey in each year. The details of how such a program might work are yet to be evaluated and will require additional research.

The biggest challenge facing the herring acoustic survey, and the completion of research related to the survey, is finding funds and people to process data and conduct the research. In particular, preparing the acoustic data for use requires a large time commitment, as does conducting much of the research described above. Temporary technicians have been available to conduct some of the analysis, but these positions are often short-term and create a discontinuity in personnel and expertise.

2.2 Maine Department of Marine Resources

Commercial catch samples are taken as part of ME DMR's portside sampling program for the herring fishery. These samples are used to develop the catch-at-age matrix for the Atlantic herring stock assessment and provide other important biological information, including information about the spawning condition of the fish. The portside sampling program randomly samples 50 fish from landed catches of directed herring trips, and both fresh and frozen samples are taken. When trips are being monitored for spawning status, 100 random fish are sampled from each trip, and the focus is on utilizing fresh fish. Once sampled, the fish are transported back to the lab and immediately processed for length, weight, age, sex, gonad weight, maturity stage, gut fullness, and gut weight. Even during the spawning season most fish being transported from Georges Bank are frozen, as the long trip would degrade the quality of the fish. Fish that have been frozen are unlikely to produce accurate results when put through the same sampling process described above, and the GSI and staging results are thought to be compromised. Once recorded this data is entered into the DMR relational database where the record of catch, effort, and sampling for each individual fish can be queried. The database serves two primary functions; for GSI determination of inshore GOM closures and use for catch-at-age models. It is also used for other various purposes such as determining the average ratio of males to females, average growth over seasons, the weight of female, inshore fish, and many others.

The DMR database was queried for reported landings from Management Area 3 (Georges Bank) in September, October, or November between 2000 and 2009. Number of trips that were sampled during these months and years are shown in Table 1. A total of 106 trips are available to examine spawner characteristics on Georges Bank.

Year	Sep	Oct	Nov	Total
2000	9	2		11
2001	17	10	2	29
2002	5	3		8
2003	5	4		9
2004	3			3
2005	4	1	1	6
2006	9	10	1	20
2007			1	1
2008		7		7
2009	8	4		12
Total	60	41	5	106

Table 1. Number of directed herring fishing trips with portside samples collected for examination of herring spawner characteristics in Management Area 3 (Georges Bank).

2.3 Vessel Monitoring System (VMS) Data

Data on the fishing patterns of directed herring trips are available through VMS data. These data, if accessible, would provide highly resolved spatial and temporal data on fishing patterns in Management Area 3 during fall. Such data could be used to evaluate potential lost fishing opportunities or shifts in fishing effort if spawning closure(s) were implemented on Georges Bank.

3.0 REFERENCES

- Overholtz, W.J., L.D. Jacobson, G.D. Melvin, M. Cieri, M. Power, D. Libby, and K. Clark. 2004. Stock assessment of the Gulf of Maine - Georges Bank Atlantic herring complex, 2003. *Northeast Fish. Sci. Cent. Ref. Doc.* 04-06; 290 p. Available from: National Marine Fisheries Service, 166 Water St., Woods Hole, MA 02543.
- Shepherd, G., M. Cieri, and W. Overholtz. 2009. Transboundary Resources Assessment Committee Gulf of Maine/George's Bank Atlantic herring stock assessment update. Transboundary Resources Assessment Committee Reference Document 2009/04.