Fishery Management Report No. 33

of the

Atlantic States Marine Fisheries Commission

Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sea Herring

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Prepared by

Atlantic States Marine Fisheries Commission
Atlantic Herring Plan Development Team

in conjunction with

New England Fishery Management Council
Atlantic Herring Plan Development Team

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This Amendment was prepared in cooperation with the Atlantic States Marine Fisheries Commission s Atlantic Herring Section, Atlantic Herring Technical Committee, the New England Fishery Management Council s Herring Oversight Committee, and the joint Commission/Council Atlantic Herring Advisory Panel.

A report of the Atlantic States Marine Fisheries Commission pursuant to U.S. Department of Commerce, National Oceanic and Atmospheric Administration Award Nos. NA87 FG 0025 and NA97 FGO 0034.

EXECUTIVE SUMMARY

1. Introduction

Atlantic herring (*Clupea harengus*) are distributed in U.S. waters from Maine to Cape Hatteras. Herring undergo extensive seasonal migrations, spending the summer months in the north while overwintering to the south. The U.S. Atlantic herring fishery is currently managed as a single stock complex along the East Coast from Maine to Cape Hatteras although there is evidence to suggest there are at least two separate biological stocks. Generally, the resource has been divided into an inshore Gulf of Maine (GOM) and an offshore Georges Bank (GB) component. Individual spawning aggregations have been identified, but quantitative data on their relative size is lacking. Intermixing among these aggregations outside of the spawning season has led to difficulties in accurately assessing the status of individual stocks.

The most recent peer-reviewed assessment concluded that the abundance of the coastal stock complex is currently 2.9 million metric tons (mt), while the most recent estimate of spawning stock biomass (SSB) is 1.8 million mt (NEFSC 1998b). The current level of abundance has generated interest in new and expanded sectors of the herring fishery. These potentially competing interests have generated different views on how the herring fishery should be managed in the future. Additionally, the interest in rapid expansion of the fishery has raised concerns about potential overharvest, locally or on the entire stock complex. In the late 1960s and the early 1970s, excessive foreign fishing led to the collapse of the Georges Bank stock. There is currently concern from some sectors of the industry and fisheries managers over the condition of the Gulf of Maine (GOM) component of the Atlantic herring population, but existing data are insufficient to separate individual components such as the GOM, into genetically distinct stocks.

Amendment 1 was developed in close coordination with the New England Fishery Management Council as the Council developed a plan for Atlantic herring fisheries in federal waters. When fully implemented, Amendment 1, in conjunction with the Council plan, is designed to minimize the chance of a population collapse due to overfishing, reduce the risk of recruitment failure, promote orderly development in the offshore fishery, reduce impacts to species which are ecologically dependent upon Atlantic herring, and minimize adverse effects on participants in the fishery.

2. Goals, Objectives, Management Unit, Overfishing Definition

Amendment 1 to the Interstate Fishery Management Plan completely replaces all previous Commission management plans for Atlantic herring. The goals of Amendment 1 are:

> To achieve, on a continuing basis, optimum yield (OY) for the United States fishing industry and to prevent overfishing of the Atlantic sea 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.
>
> To provide controlled opportunities for fishermen and vessels in other mid-Atlantic and New England fisheries.

In support of these goals, the following objectives are recommended for Amendment 1:

1) To harvest the U.S. Northwest Atlantic sea herring resource consistent with the definition of overfishing contained in the plan.
2) To prevent the overfishing of discrete spawning stock units consistent with the national standards.
3) To avoid patterns of fishing mortality by age which adversely affect the age structure of the stock.
4) To provide adequate protection for spawning herring and prevent damage to herring egg beds.
5) To promote U.S. and Canadian cooperation in order to establish complementary management practices.
6) To implement management measures in close coordination with other Federal and State FMP s.
7) 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.
8) To achieve full utilization from the catch of herring, including minimizing waste from discards in the fishery.
9) To maximize domestic use and encourage value-added product utilization.
10) 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.
11) To facilitate the development of biologically and environmentally sound aquaculture projects in the EEZ that are compatible with traditional fisheries in the New England region, given that some projects may not occur in federal waters without modifying one or more Council fishery management plans.

Amendment 1 modifies the three management areas contained in the previous fishery management plan by dividing Area 1 (Gulf of Maine) into two subareas. 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. This is based on knowledge of the seasonal distribution and availability of juvenile and adult fish within the management unit area, 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 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 allows for the cooperative management of the resource by different regulatory jurisdictions (the states, the ASMFC and the New England and Mid-Atlantic Fishery Management Councils).

The Commission and Council considered the advice of the 27th Stock Assessment Review Committee, the Atlantic Herring Plan Development Team, and the Overfishing Definition Review Panel before selecting an overfishing definition and biological reference points for Atlantic herring. B_{MSY} is estimated to be 1.1 million mt, and MSY is estimated to be 317,000 mt. The maximum fishing mortality, $F_{threshold}$ is equal to F_{MSY}, estimated as 0.30, when stock biomass is equal to or larger than B_{MSY}. The target fishing mortality when biomass is at or larger than B_{MSY} is 0.28. If biomass declines to less than B_{MSY}, the maximum fishing mortality is the mortality that has a 50% probability to rebuild stock biomass to B_{MSY} in 5 years. The target fishing mortality when biomass is less than B_{MSY} will be determined by applying the previously determined ratio of F_{MSY} to F at the lower level of the 80% confidence interval (0.91) to the maximum fishing mortality. The minimum biomass level, $B_{threshold}$, is 1/2 B_{MSY}, or approximately 500,000 mt.

3. Management Program Elements/Implementation

Recreational Fishery Management Measures (*4.1*)
No recreational fishery management measures are contained in Amendment 1. Recreational landings of Atlantic herring are currently so small as to make regulation of this fishery unnecessary at this time.

Commercial Fishery Management Measures (*4.2*)
The Atlantic herring fishery will be managed primarily through the use of a Total Allowable Catch (TAC). The annual TAC will be based on the optimum yield of the coastal stock complex and partitioned into the different management areas based on the condition of the stock and the fishery. The following management measures are implemented through Amendment 1 or in conjunction with the NEFMC s Atlantic Herring FMP when it is adopted:

Spawning Area Closures/Restrictions (4.2.1) - Amendment 1 adopts a spawning area restriction for all state waters in the Gulf of Maine (Management Area 1A). Restrictions would start on August 1 and continue through October 31. Any vessel may fish for, take, land, or possess spawn herring, herring containing roe or milt from or within a restricted spawning area as long as such herring comprise less than 20% by number of the amount possessed on board at any time. The 20% by number will be determined under sampling procedures specified by the states and enforced dockside as a state landing restriction. Spawn herring are defined as those fish determined to be in ICNAF gonadal stages 4, 5, and 6.

Annual Specifications (4.2.2) - The Regional Administrator, after consulting with the New England Fishery Management Council, determines annual specifications relating to OY, DAH, DAP, JVPt, JVPs, IWP, BT and the reserve. The Council (in consultation with the Commission) and the Regional Administrator will review annually the best available biological data pertaining to the stock. The allowable biological catch (ABC) (based on the target fishing mortality and the estimated biomass) for the Coastal Stock Complex (CSC) will be determined. The fishing mortality rate associated with the ABC will not exceed the overfishing definition. The biomass of Atlantic herring at the end of the fishing year will not be less than the minimum stock size threshold specified in the overfishing definition.

Internal Waters Processing/Joint Venture Processing Allocations (4.2.3) - Recommendations for annual IWP/JVP allocations will be developed in coordination with both the NEFMC s Herring Committee and ASMFC s Herring Section. Recommendations will be forwarded to the Regional Administrator through the Council and implemented as described in 4.2.6. The Section will allocate the amount available for IWP to the individual states. Total allocations in any one area or sub-area will not exceed the TAC set for that area or sub-area. In the event of a closure to a directed herring fishery in any one management area or subarea, BT, JVP_s and IWP operations will cease to receive any herring caught from a closed area or subarea.

General Administrative Provisions (4.2.4) - Vessels fishing for, possessing, or landing herring in or from the EEZ are required to obtain a federal permit. Vessels fishing for herring in state waters only are required to obtain a permit from the appropriate state agency. Operators of vessels federally permitted to harvest herring are required to have an operator permit. Any dealer (as defined by the Regional Administrator) of herring must have a permit issued by the Regional Administrator.

Reporting and Record-keeping Procedures (4.2.5) - States and the National Marine Fisheries Service are encouraged to implement the provisions of the Atlantic Coastal Cooperative Statistics Program when adopted. The operator of any domestic vessel issued a federal permit to fish for herring must maintain on board the vessel, and submit, an accurate daily fishing log report for all fishing trips, regardless of species fished for or taken, on forms supplied by the Regional Administrator. Any dealer issued a federal permit must submit weekly dealer reports as specified in 50 CFR 648.(a)1.

FMP Monitoring (4.2.6) - The NEFMC Herring PDT and ASMFC Herring Technical Committee will meet annually to review the status of the stock and fishery, and based on this review, make recommendations regarding the annual specifications and adjustments to the management measures for the upcoming fishing season.

Catch Control Measures (4.2.7) - Annual Total Allowable Catch (TAC) will be determined for the coastal stock complex and for each management area or sub-area. The total of any assigned TACs will not exceed OY. The directed fishery for herring will be closed in any management area or sub-area when the Regional Administrator projects the catch will exceed 95% of the TAC for that area or sub-area. Up to 5% of each area or sub-areas TAC will set aside for bycatch in other fisheries. Incidental catch of herring in an area closed to directed fishing will be limited to 2,000 pounds per trip per day.

Effort Control Measures (4.2.8) - Effort controls (days out of the fishery) will be used to prevent the annual TAC in each area or sub-area from being exceeded. In the event that the TAC in an area or sub-area is attained, the directed fishery in that area or sub-area will be closed.

Vessel Size Limits (4.2.9) - Amendment 1 adopts vessel size limits for domestic vessels participating in the herring fishery. Domestic vessels catching, taking, or harvesting herring must be less than 165 feet in length, and no more than 750 gross registered tonnage (GRT). Domestic vessels catching, taking, or harvesting herring must have no more than 3,000 shaft horsepower.

Use Restrictions (4.2.10) - Herring may be harvested for roe as long as the carcass is not discarded. The amount available for a roe fishery will be specified annually. Herring roe may also be harvested through a roe-on-kelp fishery. Interested parties are encouraged to contact the appropriate state authority prior to initiating any such activity. The harvest of herring for the primary purpose of reduction to meal or meal-like product is prohibited.

Measures to Reduce/Monitor Bycatch (4.2.11) - In order to monitor bycatch, vessel operators will be required to record any bycatch or incidental catch; the reports will be examined by the PDT and TC on an annual basis to determine if additional management measures are required. NMFS is encouraged to include the Atlantic herring fishery in its observer program. In order to minimize the impact of any discards and to encourage the development of methods to reduce them, TACs will be adjusted to account for discards.

Fixed Gear Fishery (4.2.12) - States will require fixed gear fishermen to obtain a permit and all landings from fixed gear will be counted towards the TAC. Fixed gear fishermen will be required to report daily landings of herring on a weekly basis to the appropriate agency.

Other Management Alternatives (4.2.13) - The NEFMC will require federally permitted vessels to have an operable Vessel Monitoring System (VMS) if it caught or possessed more than 500 mt of herring in the previous year, or if it intends to catch or possess more than 500 mt of herring in the coming year.

IWP Restrictions (4.2.14) - IWP operations are allowed in each management area, subject to an annual review and the specification of IWP allocations by management area. States are required to prohibit the transfer of herring to an IWP operation that were caught from an area or sub-area closed to directed herring fishing.

Please refer to the appropriate section(s) for a complete description of the management measure and accompanying text.

Habitat Measures (*4.3*)

Protection of habitat essential for Atlantic 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 protective measures to egg beds when and if necessary. Monitoring of these locations may

also provide an indication of relative spawning component size. Recommendations and suggested state activities relating to habitat restoration, improvement and enhancement are contained in Amendment 1.

De minimis Fishery Guidelines (*4.4.3*)
The ASMFC Interstate Fisheries Management Program Charter defines *de minimis* as a situation in which, under 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.

States may apply for *de minimis* status if, for the last two years, their combined average commercial landings (by weight) constitute less than one percent (1%) of coastwide commercial landings for the same two-year period. States may petition the 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. *De minimis* states are required to implement management measures to address regulatory requirements 2, 3, and 4 in *Section 5.1.1.1*.

Recommendations to the Secretary (*4.8*)
The Atlantic States Marine Fisheries Commission believes that the measures contained in Amendment 1 are necessary to prevent the overfishing of the Atlantic herring resource, and to allow growth in the fishery. The Atlantic States Marine Fisheries Commission recommends that the federal government promulgate all necessary regulations to implement complementary measures in federal waters that are contained in *Sections 4.1* and *4.2*. In addition, Amendment 1 calls for the Atlantic Herring Section to make additional changes via adaptive management, and as such changes are made, the Section will recommend additional measures to the Secretary. The Commission recognizes that such action may be taken under the Atlantic Coastal Fisheries Cooperative Management Act or the Magnuson-Stevens Fishery Conservation and Management Act.

Specifically, the Atlantic States Marine Fisheries Commission recommends to the Secretary of Commerce, that the Secretary implement the provisions included in the New England Fishery Management Council s Atlantic Herring Fishery Management Plan as proposed.

4. Compliance

Mandatory Compliance Elements for States (*5.1*)
A state will be determined to be out of compliance with the provisions of this fishery management plan, according to the terms of Section 7 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 5.3, 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 without prior approval of the Atlantic Herring Section.

Mandatory Elements of State Programs (*5.1.1*)
To be considered in compliance with this fishery management plan, all state programs must include a regime of restrictions on Atlantic herring fisheries consistent with the requirements of Sections 4.1 and 4.2; except that a state may propose an alternative management program under Section 4.4, 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.

Regulatory Requirements (*5.1.1.1*)
States may begin to implement Amendment 1 after final approval by the Commission. Each state must submit its required Atlantic herring regulatory program to the Commission through the Commission staff for approval by the Section. During the period from submission until the Section makes a decision on a state s program, a state may not adopt a less protective management program than contained in this Amendment or contained in current state law.

1. Each jurisdiction must enact spawning area restrictions that are at least as restrictive or more than those in *Section 4.2.1*.
2. Each jurisdiction shall prohibit the landing of herring from a management area or sub-area when the TAC has been attained in that area or sub-area (*Section 4.2.8.2*);
3. Each jurisdiction shall prohibit directed fishing for herring in state waters when the TAC has been attained in that area or sub-area (*Section 4.2.8.2*);
4. Each jurisdiction shall prohibit the landing of herring to an Internal Waters Processing (IWP) operation, which were harvested from an area or sub-area closed to directed herring fishing (*Section 4.2.15*);
5. Each jurisdiction shall require that (daily) herring landings from fixed gear fisheries be reported on a weekly basis, in order to monitor progress toward attaining the TAC (*Section 4.2.15*); and
6. Each jurisdiction shall annually provide a report on any mealing activity of herring occurring in their state, specifically, the amount in weight of herring processed into meal or like product, biological sampling results, and location of catch by NMFS statistical area or Management Area.

Each state s required Atlantic herring regulations and management program must be approved by the Section. States may not implement any regulatory changes concerning Atlantic herring, nor any management program changes that affect their responsibilities under this Amendment, without first having those changes approved by the Section.

Compliance Schedule (*5.1.2*)
States must implement this Amendment according to the following schedule:

April 1, 1999: States must submit state programs to implement Amendment 1 for approval by the Section. Programs must be implemented upon approval by the Section.
June 1, 1999: States with approved management programs must implement Amendment 1. States may begin implementing management programs prior to this deadline.

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

Compliance Report Content (*5.1.3*)
Each state must submit an annual report concerning its Atlantic herring fisheries and management program for the previous year. The report shall cover:

- the previous calendar year s fishery and management program including activity and results of monitoring, regulations that were in effect and harvest, including estimates of non-harvest losses;
- the planned management program for the current calendar year summarizing regulations that will be in effect and monitoring programs that will be performed, highlighting any changes from the previous year;
- a description of the operation and amount of fish mealed in conjunction with herring processing activities conducted in each jurisdiction; and
- the amount of herring harvested by fixed gear fisheries operating in state waters.

5. Management and Research Needs

Amendment 1 contains a list of management and research needs that should be addressed in the future in

order to improve the current state of knowledge of Atlantic herring biology, stock assessment, population dynamics, habitat issues, and social and economic issues. By no means are these lists of needs all-inclusive and they will be reviewed and updated annually through the Commission s ISFMP Review process.

6. Protected Species

A number of protected species inhabit the management unit addressed in Amendment 1. Eleven are classified as endangered or threatened under ESA; the remainder are protected under provisions of the MMPA.

Entanglements of several species of marine mammals have been documented in fishing gear employed in the Atlantic herring fishery. They include: the northern right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaeangliae*), minke whale (*Balaenoptera acutorostrata*), harbor porpoise (*Phocoena phocoena*), harbor seal (Phoca vitulina) and grey seal (*Halichoerus grypus*).

The Gulf of Maine/U.S. Mid-Atlantic Atlantic herring midwater trawl fishery, including the herring pair trawl fishery (one net towed by two vessels), was recently classified as a Category II fishery under the MMPA due to possible interactions with harbor porpoise and other marine mammal species. The Gulf of Maine purse seine fishery remains a Category III fishery for 1999. This fishery may experience possible interactions with harbor porpoise, and harbor and grey seals.

All sea turtles that occur in U.S. waters are listed as either endangered or threatened under the ESA. 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.

Like marine mammals, seabirds are vulnerable to entanglement in commercial fishing gear. The interaction has not been quantified in the New England and Mid-Atlantic herring fishery, but impacts are not considered to be significant. Human activities such as coastal development, habitat degradation and destruction, and the presence of organochlorine contaminants are considered to be the major threats to some seabird populations. Endangered and threatened bird species, which include the roseate tern and piping plover, are unlikely to be impacted by the gear types employed in the herring fishery.

ACKNOWLEDGMENTS

Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sea Herring was developed under the supervision of the Atlantic States Marine Fisheries Commission s Atlantic Herring Section, chaired by Mr. David V. D. Borden of Rhode Island. This Amendment was developed in conjunction with the development of the New England Fishery Management Council s Atlantic Herring Fishery Management Plan, with guidance provided by its Herring Oversight Committee. Members of the joint Plan Development Team (PDT) included: Dr. Joseph Desfosse (ASMFC staff, co-Chair and principal plan writer), Tom Nies (New England Council staff, co-Chair), Dr. David Stevenson (Maine Dept. of Marine Resources), Dr. Michael Armstrong (Massachusetts Div. of Marine Fisheries), Bruce Smith (New Hampshire Fish & Game), Dr. Kevin Friedland (National Marine Fisheries Service/University of Mass.-Dartmouth), Dr. William Overholtz (NMFS-NEFSC), Dr. Phil Logan (NMFS-NEFSC), Drew Kitts (NMFS-NEFSC), Dr. John Gates (University of Rhode Island), and Dr. Madeleine Hall-Arber (Mass. Institute of Technology). Many thanks also to Tina Berger (ASMFC) and Dianne Stephan (ASMFC) for their contributions to the Protected Species and Habitat sections, respectively.

The Section and Plan Development Team wish to express their thanks and appreciation to Mr. Arthur Odlin, Advisory Panel Chair, and to the other members of the Atlantic Herring Advisory Panel, who provided a wealth of information and discussion during the development of this plan. Appreciation is also extended to the many fishermen, representatives of conservation groups and members of the public who have written letters and attended public hearings to express their opinions and ideas.

Funding for this effort was provided to the Commission by U.S. Department of Commerce, National Oceanic and Atmospheric Administration Award Nos. NA87 FG 0025 and NA97 FGO 0034.

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1.1 BACKGROUND INFORMATION

1.1.1 Statement of the Problem

The U.S. Atlantic herring fishery is currently managed as a single stock complex along the East Coast from Maine to Cape Hatteras although there is evidence to suggest there are at least two separate biological stocks. Generally, the resource has been divided into an inshore Gulf of Maine (GOM) and an offshore Georges Bank (GB) component. Individual spawning aggregations have been identified, but quantitative data on their relative size is lacking. Intermixing among these aggregations outside of the spawning season has led to difficulties in accurately assessing the status of individual stocks.

The most recent peer-reviewed assessment concluded that the abundance of the coastal stock complex is currently 2.9 million metric tons (mt), while the most recent estimate of spawning stock biomass (SSB) is 1.8 million mt (NEFSC 1998b). The current level of abundance has generated competing interests in new and expanded sectors of the herring fishery, including: 1) maintaining traditional use patterns in the fishery; 2) increasing the bait fishery; 3) increasing participation in cooperative ventures with foreign vessels (Internal Water Processing - IWP and Joint Venture Processing - JVP); 4) providing a viable alternative fishery to vessels currently in the groundfish fishery; 5) providing opportunities for increased development of U.S. shore-side processing capacity; 6) interest in participating in the fishery from Pacific Coast fishing operations; 7) interest in maintaining high stock abundance for ecological reasons, i.e. maintaining a forage base for other species; and 8) providing opportunities for modernization and improvement of existing East coast vessels in order to enter the human consumption export markets.

These potentially competing interests have generated different views on how the herring fishery should be managed in the future. Additionally, the interest in rapid expansion of the fishery has raised concerns about potential overharvest, locally or on the entire stock complex. In the late 1960s and the early 1970s, excessive foreign fishing led to the collapse of the Georges Bank stock. Overharvesting has also led to stock collapse in some European and Pacific herring stocks (Murphy 1977). There is currently concern from some sectors of the industry and fisheries managers over the condition of the Gulf of Maine (GOM) component of the Atlantic herring population, but existing data are insufficient to separate individual components such as the GOM, into genetically distinct stocks.

Current interest in expanding the fishery, from many sectors, has raised the issue of 1) appropriate harvest levels overall and by sub-unit; 2) appropriate end uses of herring (food, meal, roe, bait); 3) appropriate expansions in the fishery (IWP, JV, use of factory trawlers and tank boats); and 4) how to best cooperate with Canadian herring interests to improve stock assessments and the establishment of complementary management practices between Canada and the U.S.

1.1.2 Benefits of Implementation

This Amendment, when fully implemented, is designed to minimize the chance of a population collapse due to overfishing, reduce the risk of recruitment failure, promote an orderly

development in the offshore fishery, reduce impacts to species which are ecologically dependent upon Atlantic herring, and minimize adverse effects on participants in the fishery.

1.2 DESCRIPTION OF THE RESOURCE

1.2.1 Species Life History

1.2.1.1 General Information

Atlantic herring (*Clupea harengus*) are distributed along the Atlantic coast from North Carolina to the Canadian Maritime provinces. Schools of adult herring undertake extensive migrations to areas where they feed, spawn and overwinter. Herring are found all along the coast in inshore and offshore waters to the edge of the continental shelf during late winter and early spring. Adult herring move north into the Gulf of Maine in the spring, and in the summer and fall they segregate into more or less discrete spawning aggregations. After spawning, the adults migrate south again. The waters off Cape Cod seemed to constitute a mixing area, with different groups passing at different times of the year (Sindermann 1979). This changing seasonal distribution has given rise to both mobile and fixed gear fisheries which harvest herring of all age groups. The catch supplies domestic and foreign markets for juvenile and adult herring which are used for human consumption, bait and food for zoo animals.

1.2.1.2 Age and Growth

Atlantic herring grow to a maximum length of about 43 centimeters (17 inches) and a weight of 680 grams (1.5 pounds). The maximum age of Atlantic herring is reported to be 18 years and they reach maturity at three or four years of age. Growth rates can vary greatly from stock to stock and from year to year. Some herring will mature by age-3, most will mature by age-5. Growth is highly variable and appears to be influenced by many factors, including temperature, food availability, and population size. In general, there appears to be evidence of overall environmental control of growth (Moores and Winters 1982, Sinclair et al. 1982, Tibbo 1957).

1.2.1.3 Spawning/Reproduction/Early Life History

Atlantic herring are believed to return to natal spawning grounds throughout their lifetime (Ridgeway 1975, Sindermann 1979). 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 and elsewhere. Since fall spawning aggregations of herring in the northwest Atlantic can not be distinguished genetically (Kornfield et al. 1982), the only direct evidence for this homing behavior is provided by a tagging study in Newfoundland which showed that adult Atlantic herring returned to the same spawning grounds year after year (Wheeler and Winters 1984). It could not be demonstrated, however, that these were the same spawning grounds where the fish were spawned.

Spawning occurs from year to year in specific locations in the Gulf of Maine in depths of 10-100 meters (30-300 feet) on coastal banks such as Jeffreys Ledge, along the eastern Maine Coast (and at various other scattered locations along the Maine coast), south of Grand Manan Island (New Brunswick), and off southwest Nova Scotia (Figure 1). 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). Spawning also occurs on Nantucket Shoals and

Georges Bank (Boyar et al. 1973). Spawning concentrations of herring on Georges Bank in 1962 were reported to be as long as 64 to 80 km and as wide as 6 to 13 km. A spawning bed in Miramichi Bay, New Brunswick was examined by divers (Pottle et al. 1981) where most eggs were found attached to bottom vegetation at depths of 0.9-4.3 m, with the greatest concentration of eggs at 1.4-4.0 m. Spawning occurs earlier along the eastern Maine coast and southwest Nova Scotia (August-September), than in the southern Gulf of Maine (early to mid-October in the Jeffreys ledge area and as late as November-December on Georges Bank).

Figure 1. Map of the northeastern U.S. and eastern Canada showing distribution and spawning locations of major Atlantic herring stocks (Iles 1972)

Atlantic herring spawn on the bottom by depositing adhesive eggs of 1.0-1.4 mm in diameter (Messieh 1976), which stick to gravel, sand, or algae, and to each other to form mats or beds. Gravel is the preferred substrate (Drapeau 1973). A single egg bed surveyed on the eastern Maine coast in 1986 was determined to be 0.8 square kilometers (km^2) or 0.3 square miles in area, a continuous carpet up to one inch thick and containing an estimated 2-3 x 10^{12} eggs (Stevenson and Knowles 1988). Egg beds have also been surveyed on Jeffreys Ledge (Cooper et al. 1975) and Georges Bank (Anthony and Waring 1980 Valentine and Lough 1991). One egg bed surveyed on Georges Bank in 1964 covered an area of about 25 square miles (Noskov and Zinkevich 1967). 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 species, including cod, haddock, red hake, spiny dogfish, sculpins, skates and moonsnails. Egg predation and adverse environmental conditions often result in high egg mortalities.

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 larvae remain pelagic through the winter in

nearshore and estuarine waters in the Gulf of Maine (Chenoweth et al. 1980,1989), and have been reported as far south as New Jersey. 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), and more recently, in eastern Maine waters adjacent to Grand Manan (Chenoweth et al. 1989).

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 which survive until the following spring and summer (age-2) are harvested as sardines in the coastal fishery. Larvae which 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).

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 the winter, especially in the 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 Distribution

Atlantic herring are distributed in U.S. waters from Maine to Cape Hatteras. Herring undergo extensive seasonal migrations, spending the summer in the northern portions of their range, while overwintering to the south. Discrete spawning aggregations form in the fall in the Gulf of Maine, and on Georges Bank and Nantucket Shoals. Stock mixing occurs during the winter and spring as fish migrate south.

The location and movement of Atlantic herring which originate from spawning on Georges Bank is not known with any certainty, although surface circulation patterns and the abundance of juveniles in southern New England and Long Island Sound suggests that juveniles move inshore south of Cape Cod or are transported there as larvae. There has always been some speculation that a portion of the juvenile (age-2) herring found along the western Gulf of Maine coast (Massachusetts to New Brunswick) are derived from spawning on Georges Bank, but there is no real evidence so far.

The distribution of Georges Bank fish during the 1960's, at the time when abundance was peaking and the catch was primarily by foreign nations, was described by Zinkevich (1967), using data collected from 1963-65 by Soviet fishing and scouting vessels. He concluded:

> Herring were distributed over the greatest area in winter months. From November to March, herring were fished from 36^{o} N along the continental shelf to the northern extremity of Georges Bank. During that period the herring were active and did not form stable concentrations. In February and March, the bulk of the fish was observed in the areas of Long Island, Hudson Canyon, and farther south. For instance, in March 1964, the bulk (of the fish) was found in the area from 36^{o} to 38^{o} N.
>
> In the spring months, the herring moved from the area of Wilmington and Hudson Canyons to the southern parts of Georges Bank, where they gradually increased in numbers, whereas they decreased in numbers south of 40^{o} N.
>
> From May to October, the bulk of the fish was feeding or spawning on Georges Bank.

1.2.1.5 Stock Structure and Migration

There are three major stocks of Atlantic herring in the Gulf of Maine region that spawn in geographically discrete areas on Georges Bank (GB) and Nantucket Shoals (NS), in coastal waters of the Gulf of Maine (GOM), and off southwest Nova Scotia (Fig. 1). Each of these major spawning areas is composed of a number of smaller spawning grounds. Observations of year to year changes in the abundance of adults on individual spawning grounds, in response to fishing pressure, tend to confirm the view that each of these areas supports a discrete spawning aggregation (or sub-stock) of herring (Stephenson 1998). Some of these discrete spawning grounds are located within 10-15 miles of each other (e.g., Trinity Ledge and Lurcher Shoals, off

the southwest coast of Nova Scotia). 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 (the 4WX stock) for the most part migrate north after spawning and 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). Spawning takes place in the late summer and fall in fairly shallow tidally-mixed shelf waters where larvae are retained for varying periods of time before being dispersed to overwintering areas (Iles and Sinclair 1982).

The evidence for separate stocks in the Gulf of Maine region is derived from discrete 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), meristic and morphometric counts and measurements (Anthony 1981, Safford 1985), and the incidence of parasites (McGladdery and Burt 1985). Some degree of stock differentiation was achieved with early enzyme electrophoresis research (Ridgway et al. 1970, 1971), but more recent attempts to 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 & Bogdanowicz 1987). Evidence for homing is provided by tagging studies (Wheeler and Winters 1984) which showed that the same fish return to the same spawning grounds year after year. Tagging studies conducted on spawning herring in Nova Scotia, on Cultivator Shoals and Jeffreys Ledge, and along the Maine coast during the late 1970's and 1980's demonstrated considerable affinity for home spawning grounds, with some intermixing in the winter, spring and early summer (Stobo 1983, Creaser and Libby 1988).

The most compelling evidence supporting the existence of separate GOM and GB/NS stocks was the collapse of the large GB/NS stock in the early 1970s after several years of heavy exploitation by foreign fishing fleets. This stock remained in a depressed state for about ten years, during which time the smaller GOM stock continued to support a strong coastal fishery. Both of these stocks are transboundary stocks since adult herring occupy both sides of the U.S.-Canada boundary on Georges Bank and because juvenile and adult herring on the New Brunswick shore of the Bay of Fundy are believed to originate from spawning grounds in U.S. and Canadian waters (Stephenson et al. 1998).

1.2.1.6 Mortality

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 the winter, especially in the 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 in part were: 1) larval recruitment is a complex interaction of many processes; 2) two year-old recruitment to the fishery is established in the larval stage in some years and not until the brit stage in others; 3) larval food supply in autumn and winter, along with the quantity and distribution of spawning, are primary factors controlling herring recruitment; 4) when larval survival is above a threshold, density-dependent predation on brit can reduce year-class size; 5) temperature and longshore transport are secondary factors determining survival; 6) in most years, more larvae survive the winter in the coastal areas than in the estuaries and embayments; and 7) the distribution of larvae along the Maine coast in springtime is largely a function of the variable

movement of larvae.

1.2.1.7 Foods/Feeding

Atlantic herring are visual feeders, consuming plankton during daylight hours (Blaxter 1966), filtering out small organisms with long, well-developed gill rakers. Young herring begin to feed on small phytoplankton, eating larger organisms as they grow. Fingerlings or larger-size herring (brit) consume large quantities of copepods. Adult herring feed heavily on the euphausiid crustacean *Meganyctiphanes norvegica*, but may also eat copepods, fish eggs, pteropods, mollusk larvae and the larvae of small fish such as sand lance, silversides, herring and capelin (Scott and Scott 1988). Legare and Maclellan (1960) found copepod genera *Calanus*, *Pseudocalanus*, *Eurytemora*, *Acartia* and *Tortanus*, to be important prey items of herring in the Quoddy region of New Brunswick. They found the most active feeding period to be September to November. Sherman and Perkins (1971) concluded the diet of juvenile herring in Maine coastal waters was varied with copepods the most important prey, especially in summer. Other zooplankton preyed upon included cladocerans, larval cirripeds (barnacles), decapods and pelecypods. Herring in Newfoundland waters were found to eat very little in winter (December to April), apparently living on their accumulated fat (Hodder 1972).

Atlantic herring compete with other species such as Atlantic mackerel and sand lance (*Ammodytes* spp.) for some of the same food sources, e.g., euphausids. In the mid to late 1970's, when mackerel and herring abundance declined, the abundance of sand lance increased explosively, giving rise to speculation that some sort of competitive relationship existed between these three species, especially between sand lance and the mackerel/herring dyad.

1.2.1.8 Predator/Prey Relationships

Herring is an important species in the food web of the northwest Atlantic. Herring eggs or spawn are subject to predation by a variety of bottom creatures, including winter flounder (Pottle et al. 1981, Tibbo et al. 1963), cod, haddock and red hake (Caddy and Iles 1973), and sculpins, skates and smelt. Juvenile herring, especially brit (age-1 juveniles) are preyed upon heavily due to their abundance and small size. Mortality due to predation during the first year of life is believed to be a major factor affecting recruitment to the fishery at age-2 the following spring and summer. Its finfish predators include: cod, pollack, haddock, red hake, white hake, silver hake, squid, spiny dogfish, porbeagle, blue shark, thresher shark, shortfin mako, clearnose skate, little skate, goosefish, hickory shad, Atlantic salmon, bluefin tuna and swordfish. However, according to Grosslein et al. (1980), for many of these predators the information is qualitative only, and the actual significance of herring as prey is unknown.

Nevertheless, some quantitative information is available which indicates the importance of herring as a food source for other species. Overholtz et al. (1991) estimated that silver hake, cod, and dogfish consumed an average of about 1500, 200 and 4300 metric tons respectively each year, of herring from 1988-92 on the northeast U.S. continental shelf.

Overholtz et al. (1991) also calculated that five species of whales, three species of dolphins, harbor porpoises and harbor seals consumed on average, 19,300 mt (42.5 million lbs) of herring a year from 1988-92. Herring was the third most common prey species behind sandeels (55,760 mt) and mackerel (36,260 mt). Finback whales accounted for about 50% of the total quantity of herring consumed by the ten species of marine mammals (10,000 mt). Humpback whales (2,600

mt) and pilot whales (2,800 mt) were also significant consumers. Research on harbor seals off Monomy Island, Cape Cod during 1984-87 indicated that herring increased in their diet from 5% in January and February, to 16% in March and April, although the importance of herring in the diet may have been much higher (Payne and Selzer 1989).

Seabirds also take a share of the herring resource. Estimates were that the northern gannet consumed about 3,000 mt and the shearwater about 250 mt a year during 1988-92 on the U.S. northeast shelf (Overholtz et al. 1991).

These calculations indicate that between piscivorous fish, marine mammals and marine birds, approximately 30,000 mt of herring is consumed each year. This is probably an underestimate since it was based among other things, on a presumed low abundance of herring on Georges Bank and herring, at least during the spawning season, are known to be much more abundant in recent years as the offshore portion of the stock has recovered. However, even using an estimate of 50,000 mt, this only represents 2.5% of the estimated total stock size of Atlantic herring in 1990, and 50% of the annual commercial harvest. The annual natural mortality rate used to estimate stock size, in contrast, is 18%.

1.2.2 Abundance and Present Condition

Section 1.2.1.5. describes the current understanding of the stock structure of Atlantic herring. A complete review of historical assessments and resource surveys can be found in the Source Document for Amendment 1.

For the purpose of this amendment, the U.S. Atlantic herring coastal stock complex is defined to include all herring occupying continental shelf waters over the entire range of the species between the Gulf of Maine and North Carolina, including Canadian waters on Georges Bank and in New Brunswick (Bay of Fundy). The stock complex comprises separate spawning components on Georges Bank, Nantucket Shoals, and in coastal waters and on nearshore banks in the Gulf of Maine. The aggregation of biologically discrete spawning stocks into a single stock complex was first adopted in the fall of 1991 (NEFSC 1992) and has been the convention for U.S. herring assessments ever since then. The decision was based on the fact that there was insufficient data to support independent assessments for individual spawning components and the view that juvenile herring harvested in the New Brunswick fixed gear fishery originated from spawning grounds located in U.S. waters, not from spawning grounds located off southwest Nova Scotia (Stephenson et al. 1995).

All available resource survey and assessment information indicates that the coastal stock complex has grown rapidly in size since the early 1980's. Results from the most recent assessment (Fig. 2) indicate that stock biomass started to increase in the early 1990's, climbing rapidly from 500,000 mt in 1992 to 2.9 million mt at the beginning of 1997 (NEFSC 1998a and b). Spawning stock biomass in 1997 was 1.8 million mt, with an 80% probability that it was between 1.4 and 2.2 million mt. This dramatic increase in abundance in recent years is due largely to the recovery of the Georges Bank/Nantucket Shoals components of the stock complex which supported a large foreign fishery during the 1960's and early 1970's, but collapsed in the mid-70's as a result of over-exploitation. Current stock size estimates are more than double what they were in the late 1960's. Annual fishing mortality rates exceeded 50% for a number of years following the collapse of the Georges Bank stock and have declined rapidly during the last 15 years. The fishing mortality rate in 1996 was only 5%. Currently, the stock complex is large and

underutilized. It may increase in size even further in the near future under current exploitation and recruitment patterns.

Population size and fishing mortality rate estimates for the Atlantic coastal stock complex are based on a virtual population analysis that relies on historical estimates of the number of fish harvested at each age and spring and winter trawl survey abundance indices by age for the time period 1967 to the present (trawl survey data are used to select the terminal fishing mortality rates for the VPA in a process that is called "tuning"). Fall trawl survey can not be used because they are too variable from tow to tow, the result of the aggregation of adults in certain locations during the spawning season. Trawl surveys conducted in the winter and spring, after spawning is over, are not prone to this problem, but at this time of year adult herring belonging to different spawning stocks are mixed (primarily in southern New England and the mid-Atlantic region) and can not be distinguished from each other. For this reason, separate "tuned" VPA's for the two principal spawning stocks can not be performed. Larval survey data collected every year between 1971 and 1994 were used in the past as a second tuning index for the VPA, but are no longer available since NMFS larval herring surveys were discontinued in 1994.

Figure 2. U.S Atlantic herring coastal stock complex biomass (NEFSC 1988a).

The growth of the stock is also evident in the increased abundance of herring caught during fall and spring bottom trawl surveys conducted by the National Marine Fisheries Service along the

Atlantic coast over the past 30-35 years (Fig. 3). Catch rates during the fall spawning season averaged 0.5-1 kg/tow during the 1960's, were negligible throughout the 1970's and early 1980's and then, starting in 1987, increased to values as high as 10 kg/tow. Catch rates in 1996 and 1997 were about 3.5 kg/tow and the five year moving average was easily five times higher than it was during the 1960's at the height of the offshore fishery on Georges Bank. There has been a very similar increase in catch rates in the spring survey from extremely low abundance in the mid 1980's to about 3.5 kg/tow during the last four years, with a high value of 7.5 kg/tow in 1993. Unlike the fall survey data, the catch rates at the beginning of the spring time series (1968-1969) are very similar to catch rates in recent years, suggesting that the stock has recovered, but not beyond the point where it was in the late 1960's.

Figure 3. NMFS spring (above) and fall (below) bottom trawl surveys (NEFSC 1998a).

VPA-derived population size estimates for the stock complex are substantially over-estimated for the most recent years in the time series. To illustrate the nature of the problem, the last time an assessment of this resource was done (in 1995), the 1994 stock size estimate was 3.6 million mt. In 1998, with the addition of three more years (1995-1997) of catch at age and survey data to the analysis, the 1994 biomass estimate dropped by 2/3, to 1.1 million mt. Comparison of stock size estimates from the 1998 VPA with the results of previous assessments (NEFSC 1996) and an examination of catch rates in the spring trawl survey (Fig. 3) and winter larval survey (Fig. 4) also indicate that the increase in stock size started in the mid to late 1980's.

Figure 4. NMFS larval herring abundance indices (Stevenson et al. 1997).

Results of an assessment of the U.S. Atlantic coastal stock complex of herring using a surplus production model (Prager 1994,1995) were presented to the Overfishing Definition Review Panel (ODRP) in the winter of 1997-1998. New overfishing definitions for this stock recommended by the Panel and subsequently adopted by the New England Fishery Management Council were based on this model and the 1995 VPA results (Applegate et al. 1998). Results of the more recent 1998 VPA were not available when the ODRP met to review overfishing definitions for Atlantic herring. The ODRP established a maximum sustainable yield (MSY) of 317,000 mt for the stock complex, biomass (B) at MSY of 1,066,000 mt, a biomass based fishing mortality rate (F) at MSY of 0.30, a target F of 0.28, and a minimum biomass level of 1/4 B_{MSY} (which was subsequently increased by the New England Fishery Management Council to 1/2 B_{MSY}, or 500,000 mt). It also defined a stock rebuilding strategy that would be required if the stock were

to drop below the minimum biomass level. (see Section 2.4 for a more complete explanation of overfishing definitions and MSY control rules for this stock).

The 1998 stock status report (NEFSC 1998b) included projected estimates of stock biomass and fishing mortality under three different scenarios. These scenarios included catch constant at the 1997 level (119,000 mt), catch constant at 200,000 mt (the MSY level estimated by the SARC), and a catch level of 317,000 mt (equal to MSY). Under all three scenarios, spawning stock biomass would increase from 1998 through 2000. It should be noted, however, that these projections are based on the over-estimated 1997 VPA stock size estimate. A total stock size estimate of 1.92 million mt, derived from the surplus production model (Applegate et al. 1998) is probably more accurate.

There is some information on the relative sizes of the two principal spawning stocks that make up the stock complex. Historical assessment information indicates that the western Gulf of Maine stock (herring spawning on Jeffreys Ledge and other locations in Massachusetts Bay) was only 10-15% as large as the Georges Bank/Nantucket Shoals stock during the 1960's and 1970's, prior to stock collapses produced by excessive foreign fishing (Anthony and Waring 1980, ICNAF 1976). The NMFS fall trawl survey provides more up-to-date information on the relative size of each spawning component since it is conducted when adult herring occupy their traditional spawning grounds. An examination of the fall trawl survey data by the 27th SAW (NEFSC 1998a) resulted in estimates of minimum population size (biomass) for each of the three areas for the time periods 1988-97 and 1993-97. Coastal Maine (management area 1) accounted for 27% of the population during 1988-97 and 26% in the more recent time period. Nantucket Shoals (area 2) accounted for 63% of the population from 1988- 97 and declined to 57% during 1993-97. Georges Bank (area 3) accounted for 10% of the biomass in 1988-97 and has increased to 17% in the recent period, a reflection of the increased amount of spawning on Georges Bank during the last five years. These data indicate that the Gulf of Maine spawning stock accounts for about 25% of the total spawning stock biomass and the Georges Bank-Nantucket Shoals stock for the remaining 75%. These estimates are consistent with the historical assessment results when one considers that herring which spawn in the western Gulf of Maine probably represent about half of the total coastal spawning population.

Larval surveys conducted by the National Marine Fisheries Service between 1971 and 1994 clearly document the collapse of the offshore portion of the stock complex in the early 1970's and its recovery over the past ten years. Catch rates of small, recently-hatched herring larvae on Georges Bank and Nantucket Shoals were moderately high in 1973 and 1974, then declined to very low levels until the late 1980's and early 1990's (Fig. 4). Larval catch rates on Nantucket Shoals increased from <100 larvae per 10 m2 in 1987 to 800-1700 per 10 m2 between 1990 and 1994, indicating that considerably more herring were spawning there than on Georges Bank or in Massachusetts Bay. There was no evidence that spawning had resumed on northeast peak of Georges Bank until 1992, when small larvae first appeared in Canadian waters (Melvin et al. 1996). Moderately high larval catch rates in Massachusetts Bay in 1981-1982 (but not in 1973 and 1974) and from 1985 through 1994 indicate that spawning in the western Gulf of Maine proceeded independently of spawning on Nantucket Shoals and Georges Bank.

Catch rates of herring in the spring bottom trawl survey started to increase in the mid-1980's and reached record high levels in 1996 and 1997 (Fig. 5). High catch rates of two year olds in 1996 and three year olds in 1997 in both the winter and spring surveys indicate that the 1994 year class is large and that the stock will continue to increase in size as fish from this year class recruit to

the spawning stock. The 1989 and 1990 year classes also show up as strong ones through ages 5-7 in both surveys.

Figure 5. NMFS spring bottom trawl survey (Stevenson et al. 1997).

Despite the continued growth and large size of the stock complex, the fishery is still primarily conducted as a near shore fishery in the Gulf of Maine, on the smaller Gulf of Maine spawning stock and migrants from the Georges Bank stock which occupy this area to some extent in the spring. Concerns have repeatedly been expressed by the scientific community that current levels of exploitation could threaten smaller localized spawning populations in the Gulf of Maine. The 1998 assessment included an un-tuned exploratory VPA of the coastal Gulf of Maine stock. The results of this VPA indicate that biomass was relatively stable (130-200,000 mt) between 1976 and 1984, tripled between 1984 and 1986, remained relatively stable (300-350,000 mt) through 1995 and then increased again (to 400-450,000 mt). The rapid increase in biomass between 1984 and 1986 corresponded with the decline of the fixed gear juvenile fishery along the Maine coast after 1982 and the sharp reduction in juvenile fishing mortality rates. Population growth was stimulated by the influx of these juveniles into the adult population and by the recruitment of the large 1983 year class. Juvenile and adult fishing mortality rates were high through 1982, then dropped and remained between 0.20 and 0.60 for the next 15 years, indicating that this stock was fully utilized throughout this time period, despite the increase in stock size.

Fishing mortality rates between 0.30 and 0.50 (equivalent to 25-40% annual removal rates) in the Gulf of Maine in recent years indicate that this component of the stock complex may, in fact, be overfished. Without an overfishing reference point or MSY estimate for this stock, it is impossible to be sure. Also, as pointed out by the SAW 27 Stock Assessment Review Committee, it is possible that there is some emigration of adults from the large and growing offshore portion of the stock complex into coastal Gulf of Maine waters. Such an emigration could in part account for the relatively high stock size during a time period when fishing mortality rates are also high, and support the single stock and management approach.

1.3 DESCRIPTION OF THE FISHERY

1.3.1 Commercial Fishery

Herring fisheries have existed in Europe for over 1,000 years and in the Northwest Atlantic for about 450 years. Along the coast, aboriginal fisheries were practiced prior to the arrival of 16th century fishermen. During the colonial period, a sizeable herring fishery developed which supplied bait for the cod fisheries that were expanding off the coasts of the U.S. and Canada. By the end of the 18th century, as the U.S. cod fishery extended its range as far as the Labrador coast, the demand for herring as bait increased and by the early 19th century the U.S. was importing salt and pickled herring for use both as bait and food. During the early years of the twentieth century, the market for bait herring declined as the cod fishery changed from hook and line methods to the otter trawl.

The herring fishery in Maine developed during the late 19th century along the eastern Maine coast. Two events during the latter part of the 19th century led to a resurgence of the herring fisheries. One was the development of the sardine canning industry in eastern Maine in the 1870's, which later spread throughout the Maine coast and into New Brunswick. The other was the expansion and intensification of the lobster fishery after the 1860's. Exploitation of herring from this time until the early 1970's was primarily of young herring of a size suitable for canning as sardines.

The growth of the fishery was stimulated by the development of the canning industry in eastern Maine and New Brunswick during this period and through the first half of the 20th century. There were nearly 50 canneries in operation along the Maine coast during the late 1940's and early 1950's, packing over 3 million cases (100 cans per case) of sardines a year. The establishment of the lobster fishery in the late 19th century also created an additional market for herring as bait. Landings as high as 80,000-90,000 mt were recorded as early as 1898, 1905, 1911, and 1916. Landings of the same magnitude were recorded in the late 1940's and 1950's. Historically, landings have been highly variable due largely to changes in the availability of juveniles along the coast. From 1896 to 1916 the catch averaged around 60,000 tons, then declined to around 25,000 tons from 1917 to 1940, and then in the late 1940's through the 1950's increased again to around 60,000 tons. From 1964 to 1969 the catch was consistently low at about 28,000 tons and from 1970 to 1975 it averaged only 17,400 tons. Landings have been consistently lower during the last 30 years or so, except for a brief period during 1979-1981 (Table 1). Herring landed in Maine in the past have also been used for fertilizer, for smoking and pickling, as fresh herring (whole or fillets), and for reduction purposes (fish meal and oil). Currently, most of the herring landed in Maine are canned and used for lobster bait

Table 1. Total Gulf of Maine (GOM), Southern New England (SNE), Mid-Atlantic (MAT), and New Brunswick, Canada (NB) herring catch, 1960-97 (includes Internal Waters Processing operations and at-sea transfers to Canadian carriers in the GOM) (source: SAW 27, NEFSC 1998a).

YEAR	GB	GOM	SNE	MAT	NB	TOTAL
1960	0	60237	261	152	34304	94954
1961	67655	25548	197	101	8054	101555
1962	152242	69980	131	98	20698	243149
1963	97968	67736	195	78	29366	195343
1964	131438	27226	200	148	29432	188444
1965	42882	34104	303	208	33460	110957
1966	142704	29167	3185	176	35805	211037
1967	218743	35417	247	524	30032	284963
1968	373598	62425	245	122	33145	469535
1969	310758	53420	2104	193	26539	393014
1970	247294	41786	1037	189	15840	306146
1971	267347	52129	1318	1151	12660	334605
1972	174190	61664	2310	409	32699	271272
1973	202335	32492	4249	233	19935	259244
1974	149525	37356	2918	200	20602	210601
1975	146096	37187	4119	117	30819	218338
1976	43502	50808	191	57	29206	123764
1977	2157	50730	301	33	23487	76708
1978	2059	49316	1730	46	38842	91993
1979	1270	63492	1341	31	37828	103962
1980	1700	82244	1200	21	13525	98690
1981	672	64324	749	16	19080	84841
1982	1378	32157	1394	20	25963	60912
1983	53	24824	72	21	11383	36353
1984	58	33958	79	10	8698	42803
1985	316	27157	196	13	27863	55545
1986	586	27942	632	20	27883	57063
1987	11	39970	376	87	27320	67764
1988		39568	1307	365	33421	74661
1989		52774	269	39	44112	97194
1990		54192	2761	48	38778	95779
1991		50984	3947	402	24576	79909
1992		55948	716	4564	31968	93196
1993		53929	1829	1347	31572	88677
1994	474	51413	1935	502	22241	76565
1995	64	64593	10866	612	18248	94383
1996	1758	80925	20177	803	15913	119576
1997	6262	70171	21382	456	20552	118823

Most herring caught along the Maine coast since sardine canning began in 1875 were juveniles of age 2 (about 17 cm, or 6.7 inches, total length) and have ranged from age groups 1 to 3. Until the early 1960's, the capture of adult fish was of minor importance. As the availability of small fish decreased , large herring were used increasingly in canned sardine products; most recently a domestic market for canned specialties, such as steaks and tidbits, has developed. The increased utilization of larger herring by the canning sector was accompanied by an increased use of purse seines in the near shore areas.

An adult herring fishery developed in the western Gulf of Maine (Jeffreys Ledge area) in 1967-1968, with U.S., Canadian and German vessels taking 30-40,000 mt a year between 1968 and 1972. U.S. landings from this fishery reached 20,000 mt during 1970-72 (Anthony and Waring 1980). The fishery in this and other inshore areas was supported by a limited number of U.S. filleting/freezing plants that shipped herring to West Germany. There was also a reduction plant in Gloucester, MA, during the 1970's that provided an additional market for herring. Landings in southern New England (mostly in Rhode Island) and the mid-Atlantic states did not exceed 5,000 mt a year until 1995 (Table 1). In more recent years, herring landed in Massachusetts, southern New England, and the Mid-Atlantic states have either been trucked to canneries in Maine and New Brunswick, or sold as bait, primarily for the lobster fishery. An undetermined amount of herring landed in U.S. ports is also converted into fish meal in Canada and utilized for salmon feed.

A foreign fishery for herring began in the early 1960s on Georges Bank and intensified during the latter part of the decade as the foreign fishing effort increasingly turned to resources other than the traditional groundfish species. During 1961, the Soviet herring fleet on Georges Bank totaled 100 vessels, catching over 67,000 mt (Table 1). By 1965, 200-250 Soviet vessels were fishing for herring, red and silver hake, haddock, and cod on Georges Bank and off southern New England, and over the period 1961-1965, reporting herring catches of 43,000 to 152,000 mt a year. By 1967, the Soviets were joined by vessels from the Federal Republic of Germany (FRG), the German Democratic Republic (GDR), Poland, Japan, Romania, and Canada. The total catch from Georges Bank, Nantucket Shoals and southern New England reached a maximum of 374,000 mt in 1968. From 1965 to 1972, the total number of foreign fishing vessels sighted in waters off the U.S. coast from Georges Bank to Cape Hatteras increased from about 450 to over 1,000, thereafter declining in response to reduced fish stocks and increasing catch restrictions. Much of this distant water fleet activity was directed towards herring. As many as 200 large Soviet stern trawlers were active in the New York Bight winter herring fishery, while more than 100 Soviet side trawlers rigged for purse seining conducted a summer fishery on Georges Bank. Polish stern trawlers fished for herring in conjunction with a winter mackerel fishery and exploited herring on Georges Bank during the summer and fall. GDR vessels followed a similar pattern. It should be noted that historic catch statistics for the foreign fishery on Georges Bank include catches from Nantucket Shoals and the area south of New England.

The intense fishing pressure during the 1960s is believed to have led to the collapse of the George bank stock . Estimated age 3+ stock size dropped from 1.2-1.35 million mt in the late 1960s to about 400,000 mt in the mid 1970s (Anthony and Waring 1980). In 1977, with the U.S. withdrawal from the International Commission for the Northwest Atlantic Fisheries (ICNAF) and the implementation of the Magnuson Fishery Conservation and Management Act, foreign fishing for herring became completely controlled by the U.S. and regulated through the provisions of the Preliminary Fishery Management Plan prepared by the Department of Commerce, and then, in 1978, under the provisions of the NEFMC's FMP for herring. Directed foreign fishing ceased

when approval of this FMP was withdrawn in 1982.

Since 1982, there have been several significant shifts in the coastal fishery. The Maine fixed gear fishery (stop seines and weirs), which harvested over 44,000 mt in 1981, has averaged only 1,600 mt annually since 1984 and has produced less than 1,000 mt since 1994. An increasing portion of the catch has been harvested by purse seines, and, especially in the last five years, by mid-water trawl vessels. Another change has been the increase in herring used for bait. As the lobster fishery has expanded, at least half the herring catch is now sold for lobster bait. Some bait herring is also used in the tuna fishery. These shifts in fishing patterns have been reflected in the catch at age. Estimates of juvenile harvest show a steady decline in numbers during the last ten years (NEFSC 1996). In recent years, a few mid-water trawl vessels have returned to George Bank, though catches from this area have remained relatively low but are increasing (Table 1). Overall, domestic landings of Atlantic herring have increased in recent years, with the largest catch from the Gulf of Maine. In 1996, 81,000 mt of herring were taken from the Gulf of Maine, an increase of almost 20,000 mt over the previous year. Landings in southern New England, particularly in Rhode Island, also increased substantially in 1995, 1996 and 1997 (Table 2).

Table 2. Domestic herring landings (metric tons) by state (does not include IWP, JVP, or transfers to Canadian herring carriers) (Source: NMFS, Fisheries, Statistics and Economics Division, http://remora.ssp.nmfs.gov/commercial/landings).

	State										
Year	**CT**	**DE**	**ME**	**MD**	**MA**	**NH**	**NJ**	**NY**	**RI**	**VA**	**Total**
1976	1		31858	3	18025		54	12	178	0	50130
1977	0		33135		17113	25	33	8	293	0	50607
1978	29		30343	3	18393		43	13	1688	0	50513
1979	2		40540	1	23038		30	58	1281	0	64951
1980	0		48908	1	30322	3010	14	104	1096	6	83462
1981	12		51979	0	12300	48	16	49	688		65092
1982	13	7	23207	2	7123	581	11	18	1363	1	32323
1983	6		18161	1	4057	943	20	20	46		23254
1984			21263		12146	82	10	30	48		33580
1985	1		14570		11128	2	11	46	154	2	25914
1986	3		19797		11543	1	20	49	583		31997
1987	9		20484		18498	0	23	52	311	64	39441
1988	0		16531		22800		23	216	1091	342	41004
1989			15625		24497	284	31	55	214	8	40715
1990	0		22582	1	28085	167	48	3	757	0	51644
1991	4		24327	27	21706	173	367	124	2042	14	48783
1992	0		28049	48	22975	255	3749	9	707	0	55791
1993	2		34750	10	11213	351	1391	8	1821	204	49750
1994	1		35326	4	7306	197	470	27	1910	569	45811
1995	2		43025		14238	148	199	27	10865		68505
1996	55		50357		21882	15	286	47	15999	137	88778
1997	63		55900	0	24224	69	134	37	14921	326	95674

The other significant change in the U.S. herring fishery during the last 10-15 years was the development of Internal Waters Processing (IWP) operations in the Gulf of Maine and southern New England. Operating under provisions in the Magnuson Act, foreign-owned processing ships anchored in U.S. internal waters receive herring caught by U.S. fishermen, subject to annual allocations made by the Atlantic States Marine Fisheries Commission and the states (ASMFC 1994). Total IWP "landings" reached 11,000-12,000 mt in 1989, 1990 and 1996 and averaged 7,850 mt a year between 1989 and 1996. This relatively small harvest has represented an important supplementary market for new vessels trying to break into the fishery, enabling them to also supply shoreside markets. Herring processed aboard IWP vessels is sold overseas.

In addition, a small amount of herring caught in the Gulf of Maine (average 1,858 mt between 1992 and 1997) is transferred at sea to Canadian carriers and landed in New Brunswick. These transfers are part of a larger reciprocal U.S.-Canada trade in which herring move freely by truck across the border between Maine and New Brunswick, supplying canneries and lobster bait in both countries.

1.3.1.1 Description of State Fisheries

Detailed descriptions of Atlantic herring fisheries by state will be included in the Source Document for Amendment 1.

1.3.1.2 Internal Waters Processing

Detailed descriptions of Atlantic herring IWP fisheries will be included in the Source Document for Amendment 1.

1.3.1.3 Vessels and Domestic Harvesting Capacity

Detailed descriptions of Atlantic herring vessels and domestic harvesting capacity will be included in the Source Document for Amendment 1.

1.3.2 Recreational Fishery

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 Fishery Statistics Survey (MRFSS) does not sample during January-February in the north or mid-Atlantic subregions and since herring may be taken during this period, total catch may be underestimated. The herring caught by hook and line anglers are taken as a secondary species in a mixed fishery in conjunction with Atlantic mackerel (*Scomber scombrus*).

A recreational fishery for herring in the northern one third of New Jersey is associated with the Atlantic mackerel and silver hake fisheries. The catch of herring is an incidental catch in these two directed recreational fisheries. The herring are taken on small "teasers" (plastic tubes covering a long shanked hook) used for mackerel, as well as small bucktails and metal jigs. Most of the fish are kept for home consumption, being pickled or smoked, or used as bait, either cut or whole. The great majority of the recreational fishery is conducted from party boats, and to a lesser extent, from charter boats that operate between November and April.

1.3.3 Subsistence Fishery

There is no known subsistence fishery for Atlantic herring along the east coast of the U. S.

1.3.4 Non-consumptive Factors

No information is presently available regarding non-consumptive factors in the Atlantic herring fishery. A social and economic assessment has been prepared for the Council s FMP. Upon further review of these assessments, relative information will be included in the Source Document for Amendment 1.

1.3.5 Interactions with Other Fisheries, Species, and Other Users

Atlantic herring are an important bait for many commercial and recreational fisheries including lobster and tuna. Herring is also used as bait in the recreational tuna fisheries. While bait herring 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 to 90% of the vessels fishing for tuna in New England waters may catch herring for bait.

Atlantic herring are also an important forage species for many marine finfish, marine mammals and birds. For additional information see Section 1.2.1.8 and Section 7.

1.4 HABITAT

This section contains a general description of the physical environment in the region. The NEFMC is in the process of identifying essential fish habitat for those species managed by the Council which will be described in a comprehensive document to be published in October 1998. The NMFS has prepared a draft essential fish habitat document for Atlantic herring and this may be included in the source document for Amendment 1.

1.4.1 Description of Habitat

A detailed description of the physical habitat of the region can be found in the source document of Amendment 1.

1.4.2 Habitat Quality

A detailed description of habitat quality of the region can be found in the source document of Amendment 1.

1.4.3 Environmental Requirements of Atlantic Herring

Atlantic herring adults, larvae, and juveniles tolerate a wide range of temperatures and salinities. Probably the most vulnerable stage in the life history of the species is the egg stage. Eggs do not tolerate salinities below 20 ppt and develop normally in temperatures between 8 and 13 ^{o}C. They are also sensitive to low oxygen concentrations. High egg mortalities have been reported in egg

masses where the underlying layers are not exposed to sufficient oxygen concentrations.

Spawning takes place at known locations in depths 10-100 m in the Gulf of Maine (*see Section 1.2.1.3*) in areas with fairly strong bottom currents (0.25 to 0.5 cm/sec or ½ to 1 knot). The bottom substrate in such areas is generally coarse sand, gravel, shell hash, or small cobble, with or without attached vegetation. In areas where relatively flat expanses of suitable spawning habitat are available, eggs are generally not deposited on large rocks. They are also not laid on soft sediment. Herring eggs have been observed on a variety of macroalgae species (e.g. *Ptiloda serrata*). Eggs are easily dislodged from the substrate as a result of turbulence or mechanical disturbance. Incubation generally lasts from 10 to 15 days, depending on water temperature.

The primary habitat of larval and juvenile Atlantic herring within the management area is the nearshore and estuarine zone of the Atlantic coast between New Jersey and the Bay of Fundy, although larvae are known to also occur offshore. Estuaries and coastal embayments serve as important nursery grounds for juveniles. Adults migrate extensively (*see Section 1.2.1.4*) and therefore are found in coastal as well as more offshore continental shelf pelagic habitats. Possible associations between water or sediment quality throughout the range of the species and survival or population size are unknown, with the possible exception of substrate type or quality and sediment load in the water column, and their effects on spawning behavior or egg survival. Since eggs are demersal and are deposited year after year in the same locations, they are vulnerable to disturbance (storms, bottom trawls or dredges), predation, or possible contamination effects.

1.4.3.1 Temperature

The average incubation period of herring eggs in the Gulf of Maine is 10-15 days when water temperatures are 8-13 ^{o}C (Hildebrand 1963, Bigelow and Schroeder 1953). On Jeffreys Ledge, eggs hatched in 7 days at 13 ^{o}C, and in 12 days at 8 ^{o}C (Boyar et al. 1973). Much of the primary work on temperature effects on egg and larval development was done with European herring. Meyer (1878), as cited by Blaxter and Holliday (1963), reported that egg development was normal at 1 to 22 ^{o}C, but was fatally low at -0.8 ^{o}C. Slightly lower minimum temperatures for development have ranged from -1.2 to 0 ^{o}C for herring stocks off northern Europe (Soleim 1942, Blaxter and Hempel 1961, Blaxter and Holliday 1963). The jaw may develop abnormally at low temperatures and reduce the ability of larvae to capture prey (Alderdice and Velsen 1971).

Two equations were developed for predicting hatching time (days) in relation to water temperature (^{o}C): $D = 4 + 44.7\ e^{-0.1671}$ (Hela and Laevastu 1962); and $D = -2.0 + 165.0/T+1.34$ (Blaxter 1956). Experiments at Grand Manan, New Brunswick, showed that temperatures above 20 ^{o}C and below 5 ^{o}C were lethal to eggs (Bigelow and Schroeder 1953).

Yolk-sac stage duration also varies with temperature. Temperature and duration of the yolk-sac stage were 2.5 days at 14.5 ^{o}C, and 4.5 to 14 days at 8 ^{o}C (Mansueti and Hardy 1967). Lough et al. (1982) reported yolk absorption times of 4.5 days at 10 ^{o}C and 6 days at 8 ^{o}C.

Temperature also affects the availability of plankton for food. If the water temperature is too low, production of plankton of suitable size is inadequate to support an abundance of herring larvae (Lett 1976). Optimal water temperatures induce improved growth and high survival of herring larvae. Furthermore, swimming ability increases and predator avoidance and feeding ability are improved (Lett 1976).

Upper and lower temperature tolerances of newly hatched herring larvae are 22 to 24 °C, and -0.75 to -1.8 °C for fish acclimated to temperatures between 7.5 and 15.5 °C (Blaxter and Holliday 1963). Barker et al. (1981) tested thermal tolerances of herring under conditions associated with passage through condenser cooling systems of electrical generating stations. Larvae were exposed to rapid temperature increases from a base temperature of 8 °C, held for a standard period of time, and then rapidly returned to the original base temperature. The temperature changes ranged from 16 to 25 °C at exposure times of 5, 15, 30, and 60 minutes. Larvae acclimated to 8 °C survived temperature changes of 17 °C for up to 60 mins. and higher temperatures (27 to 29.1 °C) for shorter (<30 min.) periods.

At water temperatures of 19.5 to 21.2 °C, mortality of juvenile herring (11.1 to 21.9 cm TL) was about 50% after 48 hours. Tolerance to high temperatures was greater among small fish (Brawn 1960a). The mean freezing point of herring blood is -0.95 °C, decreasing to -1.01 °C during winter (Blaxter and Holliday 1963). Below these temperatures, herring blood quickly freezes unless supercooling or freezing point depression takes place. The freezing point is 0.75 °C for the fluids of ripe eggs and 0.92 °C for sperm and parental blood (Blaxter and Holliday 1963, Blaxter and Hunter 1982).

The migration and distribution of herring are linked with thermal oceanic fronts between colder, less saline continental shelf water and warmer, more saline continental slope water (Sindermann 1979, Iles and Sinclair 1982). In these fronts, plankton and other food organisms are usually abundant. Intrusions of warmer slope water into spawning areas in the Gulf of Maine influence spawning success and cause annual variations in the commercial catch (Sindermann 1979). Higher water temperatures in September to March seem to favor spawning and recruitment success (Anthony 1972).

1.4.3.2 Salinity

Variations in salinity can affect early development, particularly of newly spawned eggs. Herring eggs are freely permeable immediately after spawning and, therefore, have no protection against osmotic imbalance (Holliday 1965). Because they are isotonic with seawater, the eggs are larger than average in low salinities and smaller in high salinities. The closure of the blastophore after gastrulation -- which occurs in 24 hr at 17 to 24 °C, (Mansueti and Hardy 1967), causes the egg to become more tolerant to changes in salinity. In general, both extremes of salinity are damaging (Blaxter 1965).

Laboratory studies indicate that fertilization, egg development, and hatching can succeed in salinities of 5.9 to 52.5 parts per thousand (ppt) (Holliday and Blaxter 1960). Maximum fertilization is at 25 ppt or more, and hatching success is greatest at 20 to 35 ppt. Egg fertilization reported by Holliday and Blaxter (1961) was 70% at 5 to 12 ppt, and 100% at 25 to 55 ppt.

Atlantic herring larvae tolerate a wide range of salinities under experimental conditions. Blaxter and Hunter (1982) reported a tolerance to salinities of 1.4 to 60 ppt for 24 hr and 2.5 to 52.5 ppt for 7 days. The salinity isosmotic with body fluids was 12 ppt. Yolk-sac larvae, however, survive longer in salinities between 10 and 20 ppt (Holliday 1965). The plasticity that is apparent in salinity tolerance of Atlantic herring eggs and larvae may be indicative of divergent physiological races (Alderdice et al. 1979).

Atlantic herring show an apparent preference for higher salinities as they become older. The lower level of tolerance for juveniles is about 5 ppt (Brawn 1960b). Although herring enter northwest Atlantic bays and estuaries freely, they are rarely observed in salinities less than about 3 ppt (Hildebrand 1963). Atlantic herring in European waters sometimes spawn in shallow inshore waters with salinities of 5 to 35 ppt (Alderdice et al. 1979), herring from the northwest Atlantic are known to spawn only in water of 32 to 33 ppt (Hildebrand 1963).

1.4.3.3 Oxygen

Probably because oxygen is rarely a limiting factor in the marine environment, studies on oxygen-related effects on herring are scarce. DeSilva and Tytler (1973; cited in Blaxter and Hunter 1982) reported that larval 96 hr LD_{50} at 10 °C ranged from about 1.9 to 3.6 mg/l. Braum (1973) reported low hatching success for herring eggs held in water with dissolved oxygen below 20% saturation. Larvae 3 to 4 days old died in 6 hr at 11.6% oxygen saturation (Bishai 1960).

1.4.3.4 Sediments and Turbidity

A proposal to dredge a channel 35 nm long in the Miramichi Bay, New Brunswick, an important herring fishing ground, prompted Messieh et al. (1981) to investigate the effects of suspended silt and clay sediments on early life stages of Atlantic herring. Normal suspended sediment concentrations of less than 20 milligrams per liter (mg/l) were expected to be replaced by concentrations of up to 2,000 mg/l during dredging and dumping. Experiments conducted by Messieh et al. (1981) found 100% mortality in eggs covered by 1 cm of sediment and 85% mortality in eyed eggs covered with only a thin film of sediment. These tests indicate that at least a portion of the egg must be exposed free of sediment if the egg is to survive.

Though hatching success apparently was not affected by suspended sediment concentration or egg density, larvae hatching at low sediment concentrations (0-540 mg/l) tended to be larger. High egg density tends to cause premature hatching and larvae at hatching were smallest when egg densities were high, regardless of sediment concentration. Messieh et al. (1981) noted no deleterious effects of suspended sediments on hatching success at any sediment concentrations up to 7,000 mg/l. Hatched larvae suffered 100% mortality after 48 hr at 19,000 mg/l.

Tests indicated that juvenile Atlantic herring avoided suspended sediment concentrations between 9.5 and 12 mg/l, some juveniles avoided concentrations as low as 2.5 mg/l. In feeding experiments, the number of larval herring feeding at any one time was significantly reduced at suspended sediment concentrations greater than 3.0 mg/l (Messieh et al. 1981).

1.4.3.5 Water Movement

Water currents are important to Atlantic herring in the Gulf of Maine and on Georges Bank because they transport and entrain larvae and plankton into estuaries and coastal areas during autumn and winter. The net alongshore drift carrying larvae in the Gulf of Maine is principally shoreward from east to west (Graham 1970). Larvae migrate vertically in the water column to take advantage of landward tidal currents (Graham 1972).

Adequate water exchange is an important environmental requirement for herring spawning grounds. Sindermann (1979) reported that a current velocity of at least 0.27 to 0.52 m/sec must be present; Caddy and Iles (1973) observed bottom currents of 0.5 to 1.0 m/sec on a Georges

Bank spawning area.

1.4.3.6 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).

1.4.4 Identification and Distribution of Essential Habitat

The NEFMC is in the process of identifying essential fish habitat (EFH) for a range of species, including Atlantic herring, in order to meet the requirements of the M-SFCMA as amended by the Sustainable Fisheries Act of 1996. The ISFMP Policy Board approved a recommendation in June 1998, to adopt Council EFH designations for FMP s or Amendments that are developed jointly or in association with a Council.

Atlantic herring EFH is described as those areas of the coastal and offshore waters (out to the offshore US boundary of the EEZ) that are designated in Figures 6-9 and meet the following conditions:

> 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 (Fig. 6). Eggs adhere to the bottom, forming extensive egg beds which may be many layers deep. Generally, the following conditions exist where Atlantic herring eggs are found: water

temperatures below 15^{o} C, depths from 20-80 m, and a salinity range from 32-33 ppt. Herring eggs are most often found in areas of well-mixed water, with tidal currents between 1.5 and 3.0 knots. Atlantic 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 (Fig. 7). 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 ppt. Atlantic 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 that support the highest densities of juvenile Atlantic herring (Fig. 8). Generally, the following conditions exist where Atlantic herring juveniles are found: water temperatures below 10^{o} C, water depths from 15-135 meters, and a salinity range from 26-32 ppt.

Adults: Pelagic waters and bottom habitats in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Cape Hatteras that support the highest densities of adult Atlantic herring (Fig. 9). Generally, the following conditions exist where Atlantic herring adults are found: water temperatures below 10^{o} C, water depths from 20-130 meters, and salinities above 28 ppt.

Spawning adults: Bottom habitats with a substrate of gravel, sand, cobble and shell fragments, but also on aquatic macrophytes, in the Gulf of Maine, Georges Bank, southern New England and the middle Atlantic south to Delaware Bay that support the highest densities of adult Atlantic herring (Fig. 9). Generally, the following conditions exist where spawning Atlantic herring adults are found: water temperatures below 15^{o} C, depths from 20-80 meters, and a salinity range from 32-33 ppt. Herring eggs are spawned in areas of well-mixed water, with tidal currents between 1.5-3.0 knots. Atlantic herring are most often observed spawning during the months from July through November.

Figure 6. Essential Fish Habitat (EFH) designations for Atlantic herring (*Clupea harengus*) eggs (NEFMC 1998). This represents 100% of the known Atlantic herring egg beds. Egg beds were identified based on a review of all available information on the current and historical herring egg bed locations. All known herring beds were identified for EFH designation to be as inclusive as possible for this critical life history stage, and because all known egg beds may only represent a portion of all herring egg sites.

Figure 7. Essential Fish Habitat (EFH) designations for Atlantic herring (*Clupea harengus*) larvae (NEFMC 1998). This represents 90% of the observed range of herring larvae. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting Atlantic herring larvae at a common or abundant level. This designation was selected to include all areas where herring larvae are found in relatively high concentrations, but not those areas where herring larvae are found in relatively very low concentrations.

Figure 8. Essential Fish Habitat (EFH) designations for Atlantic herring (*Clupea harengus*) juveniles (NEFMC 1998). This represents 50% of the observed range of juvenile herring, plus areas of relatively high concentrations of juvenile herring from the State of Massachusetts inshore trawl survey. This designation also includes those bays and estuaries identified by the NOAA ELMR program as supporting juvenile herring at a common or abundant level. This designation was selected to ensure inclusion of all areas where herring occur in relatively high concentrations.

Figure 9. Essential Fish Habitat (EFH) designations for Atlantic herring (*Clupea harengus*) adults (NEFMC 1998). This represents 50% of the observed range of adult herring, combined with the 50% alternative of the 1997 recorded catch data. This designation also includes information from the fishing industry and those bays and estuaries identified by the NOAA ELMR program as supporting adult Atlantic herring at a common or abundant level. This designation was selected to ensure inclusion of all areas where herring occur in relatively high concentrations.

1.4.5 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. The pelagic environment 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.

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

No information on specific programs to address Atlantic herring habitat could be located prior to submission of this document for approval. Subsequent information may be incorporated in the Source Document for Amendment 1 (ASMFC, in prep.) as it becomes available.

1.4.7 Recommendations for Further Habitat Research

The Council is required to include recommendations, preferably in priority order, for research efforts that the Council and NMFS view as necessary for carrying out their EFH management

mandate. Certain types of research and information are needed to improve the information base upon which EFH has been designated. Additional research may be desired to identify and evaluate actual and potential adverse effects on EFH. The need for additional research on the effects of fishing equipment and EFH and a schedule for obtaining that information should be specified. If an adverse effect on EFH is identified and determined to be an impediment to maintaining a sustainable fishery, and the managed species contribution to a healthy ecosystem, then the research needed to quantify and mitigate that effect should be identified as well.

The research recommendations may include basic life history information that will result in the comprehensive identification of the habitat requirements of the species or species assemblages, including all life history stages, as well as habitat-related information that defines the interrelationship between the species , its environment, and the food web. Research needs should also include adverse impacts from both fishing and non-fishing activities. Fishing activities include both recreational and commercial fishing equipment or practices.

The Council has identified a wide range of needs from short-term (information which already exists) to the long-term (involved research requiring extensive resources and time). Examples of these needs include:

- modeling of water masses and development of predictive capabilities for the movement of water masses;
- high resolution mapping of the sediments and topographic bedforms in areas of the Gulf of Maine, Georges Bank, southern New England, the middle Atlantic, and estuaries and bays;
- high resolution data on fishing effort;
- information on the landings of each species of fish, identified to the ten minute square from which they were harvested;
- effort data on the use of the various fishing gear types, tagged to the ten minute square in which it was used.
- information on species distributions, relative abundance, and habitat associations in inshore waters and habitat related production rates;
- information on the recovery rates of the various habitat types following fishing activity in inshore and offshore waters;
- heavier gears are shown to generally have greater adverse impact on habitat, therefore, the Council will recommend that new, lighter gear types be developed with equal catch efficiency and less adverse impact on the bottom.

1.5 IMPACTS OF THE FISHERY MANAGEMENT PROGRAM

1.5.1 Biological and Environmental Impacts

1.5.1.1 No Action

Under the present combination of management mechanisms there is no direct control on the harvest of herring by domestic vessels. Herring landings have increased rapidly in the last five years and may continue to do so as markets are developed. Without controls on the harvest of herring by domestic vessels, herring could be overfished. Intense fishing pressure from foreign fishing fleets in the 1960's-70's resulted in the collapse of the herring resource on Georges Bank. The resource took over ten years to recover from this collapse. A similar situation in the Gulf of

Maine would result in an extended period with limited herring available for the sardine canneries. In addition, it would force the lobster industry to use a different bait, increasing costs for this critical industry and placing increased pressure on other stocks of baitfish.

In addition, existing management schemes do not provide any protection to individual spawning components. These components could be eliminated, weakening the ability of the resource to survive normal population fluctuations. Almost all of the recent increase in landings is from harvest of herring in the Gulf of Maine. Current landings exceed an estimate of the long term yield of this spawning component. Continued fishing at this level, or increased fishing pressure, could result in collapse of this resource. As a key forage species, overfishing the herring resource could also adversely impact other fisheries in the northeast.

1.5.1.2 Spawning Area Restrictions

One of the goals of this Amendment is to protect individual spawning populations. The desirability of establishing closed or restricted areas to protect aggregations of herring was recognized by the Council in the original FMP. The Council prepared a recommendation for spawning closures for Amendment 4 to the original FMP but was never adopted because the FMP was withdrawn by the NMFS. The concept of a spawning closure was adopted by the Commission in 1994 for the current FMP, and has been implemented through state landings restrictions and closure areas.

There is considerable support for the concept that successful management of herring requires protection of individual spawning stocks to insure successful recruitment in the face of wide stock size fluctuations common to pelagic species (Sinclair et al. 1985, D. Stevenson pers. comm.). Because the recovery of a collapsed spawning population may take a long period of time (Sinclair et al. 1985), its important that the individual populations be protected and monitored. For such an approach to be successful, the individual populations should be monitored so that evidence of overfishing can be readily detected (Pope 1980).

Spawning closures reduce the impact of fishing on aggregations of spawning fish, when the fish are most susceptible to capture. They afford the resource the opportunity to aggregate and spawn with minimum disturbance. Anthony and Waring (1980) theorized that sequential fishing on spawning herring contributed to the collapse of the Georges Bank fishery not only due to excessive mortality but because intense fishing effort reduced the ability of the remaining fish to spawn. The implementation of spawning area restrictions will reduce this danger.

At the same time, removal of fishing pressure will help the assessment of individual spawning populations. It will be easier to accurately evaluate the extent and size of spawning populations if they are not disturbed by fishing activity. Variations in spawning populations from year to year can be monitored and adjustments to the management system can be made to protect individual populations. This will help achieve the Amendment s goal of protecting discrete spawning stock units.

1.5.1.3 Overfishing Definition

The establishment of an overfishing definition is required by the Magnuson-Stevens Fishery Conservation Management Act. Although not constrained by the Act, the Commission, in developing Amendment 1, has adopted the same criteria as the Council in order to cooperatively

manage the herring resource. The term overfishing or overfished means a level or rate of fishing mortality that jeopardizes the capacity of a fishery to produce maximum sustainable yield on a continuing basis. Absent a statement that defines an appropriate level of fishing mortality, it is problematic to determine whether a fishery is overfished and a rebuilding effort is necessary. The lack of an overfishing definition would hinder attainment of the plan s goal to prevent overfishing of the herring resource. An objective, measurable criteria is required to achieve this goal.

1.5.1.4 Specification of OY, DAH, JVPt, and Reserve

This Amendment bases all specifications on the overfishing definition -- specifically, the target fishing mortality. Allowable biological catch (ABC) must be determined before any other specification can be defined. It is specified as Ftarget times the estimated biomass. When the stock size is larger than Bmsy, ABC could be significantly larger than MSY. In the early years of the plan, the ABC is artificially limited to no more than MSY. For example, the stock biomass in 1996 is estimated to have been 1.8 times the biomass necessary to support MSY. Applying the target fishing mortality to this stock size gives an ABC of over 500,000 mt. There is some uncertainty in this estimate, however, based in part on the current low level of fishing mortality. Rather than allow the rapid buildupo to a large harvest in the initial years of the plan because of these stock estimates, the plan takes a precautionary approach and artificially limits the ABC to MSY. This will allow the development of the fishery at a slower pace, reducing the likelihood that high levels of harvest in the early years of the plan will result in a rapidly declining biomass. This conservative approach should reduce the possibility of overfishing in the early years of the plan. The determination of other specifications should have little biological impact since the sum of the various specifications cannot exceed OY.

The OY definition should have a positive impact on other marine resources in the area since it does not provide for a Total Allowable Level of Foreign Fishing (TALFF). Directed foreign fishing mid-water fisheries have a documented impact on marine mammals (Waring et al. 1990). The reasons for these impacts are not clearly understood, but preventing foreign vessels from participating in this fishery removes any impact these vessels may have.

1.5.1.4 General Administrative Provisions

The administrative provisions of this plan should improve management of the resource and prevent overfishing.

The establishment of a permit requirement will identify participants in the herring fishery. This will help managers determine fishing effort and design management measures appropriate to the number of participants.

There is no current reporting requirement for vessels fishing for herring. If a vessel possesses a federal permit for another species, all herring landings must be reported. There are, however, some vessels that may not report all herring landings in a timely fashion. The requirement for vessels and dealers to report catches and purchases will indirectly have a positive biological effect. Developing a comprehensive reporting system will improve information on catches. This, in turn, will lead to better estimates of fishing mortality and assessments of the status of the herring resource. The requirement that vessels or dealers report herring landings on a weekly basis will help managers track progress towards achieving the Tac. By making this requirement

more frequent than standard monthly reporting, the likelihood that the TAC will be exceeded is reduced. As a result, managers will be better able to tailor measures to insure the target fishing mortality is not exceeded.

The establishment of an annual review of the plan reduces the likelihood that any negative impacts of the fishery on the herring or other resources will be undetected for any length of time. The periodic adjustments to the specifications (OY, DAH, etc.), in a similar fashion, will make it easier to achieve the target fishing mortality. The adaptive management measures will make it easier and quicker to implement any adjustments to the management program. The result will be a more rapid response to problems or changes in the fishery.

1.5.1.5 Management Areas

The management areas adopted by the plan are based on knowledge of the various spawning components. This allows development of management measures that specifically target a particular spawning component. It also provides some flexibility, as specific measures can be adopted in an area of concern.

The subdivision of Management Area 1 refines the areas that were initially adopted by the Commission in the 1994 FMP. This subdivision identifies areas of concern for herring in the Gulf of Maine. During the winter and early spring, most of the herring in Management Area 1A are believed to be from the GOM spawning component. In the early summer, some fish from the GB/NS spawning component are also in this area. During the fall, all of the fish in Area 1A are believed to be from the GOM spawning component. Defining these areas facilitates development of TAC s for these areas that will account, in part, for stock mixing. This provides a measure of protection to individual spawning components.

1.5.1.6 TAC/TAC Limitation/TAC Distribution

The establishment of a TAC provides a reference point for controlling fishing effort. The plan prohibits directed fishing for herring when 100% of the TAC is reached in an area during a time period. Some herring, limited to 2,000 pounds per trip, could continue to be taken in other fisheries after an area was closed to directed fishing. when the TAC is reached. This insures that regardless of fishing effort, the fishing mortality of herring will be tightly controlled. As the TAC is approached, effort controls will be imposed which will slow catch rates, extending the fishing season and making it easier to determine when the TAC will be attained.

The distribution of the TAC to different management areas provides a measure of protection to individual spawning components.

1.5.1.7 Mandatory Days Out of the Fishery

Fishing effort will be reduced as the TAC is approached by requiring vessels to take mandatory days out of the fishery. The number of days taken out of the fishery is determined by how close the catch is to approaching the TAC. This regulation should reduce catch rates as the TAC is approached. This will prevent the TAC from being exceeded in an area, which, in turn, will help insure the target fishing mortality is not exceeded.

1.5.1.8 Vessel Size Limits

This plan limits the size of domestic vessels which may fish for, harvest or take Atlantic herring. This restriction will help to prevent exceeding the TAC. If large vessels can harvest herring at a rate too fast for the record keeping system to keep up , there is risk the TAC will be exceeded before effective effort controls can be put into place. A rapid harvest of the TAC may also result in an early closure of the fishery, but this is an economic issue due to its impacts on the market. Large mid-water trawlers may also have more serious impacts on marine mammals and other species; these issues are addressed in Section 7.1.1.

1.5.1.9 Roe Fishery Restrictions

This amendment allows herring to be harvested for roe as long as the carcass is not discarded. The amount of herring that may be used for roe will be determined on an annual basis and specified by the Regional Administrator based upon the recommendation of the Council after consulting with the Commission. This will cap the amount of herring that may be harvested for roe, preventing the unlimited development of a roe fishery that may interfere with other uses of herring.

Herring roe may also be harvested through a roe-on-kelp fishery. This phrase refers to the entrapment of spawning herring until roe is deposited on either artificial or natural kelp. The spawned fish are then released. Because of the experimental nature of this fishery, any person desiring to develop a roe-on-kelp fishery for Atlantic herring is encouraged to contact the appropriate state authority during project development.

Both of these measures will allow the cautious development of a fishery that takes advantage of the high value of herring roe while at the same time protecting the resource.

1.5.1.10 Mealing Restrictions

This amendment prohibits the harvest of herring for the primary purpose of reduction to meal. The harvest of any fish resource for the primary purpose of reduction to fish meal or oil is a concern because of the large volume of fish necessary to support such an operation. The rapid harvest level may make it difficult to track landings and implement effort controls at the appropriate time. This may lead to the TAC 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.

1.5.1.11 Measures to Reduce/Monitor Bycatch

Because of the limited data available on bycatch in the herring fishery, there are no management measures proposed specifically to reduce bycatch. There are several measures that will encourage reduction in bycatch and help to identify the extent of the problem. Bycatch and incidental catch will be considered when developing herring TAC s. Vessels are required to report all herring caught. In this manner, there will be an incentive for the industry to reduce the amount of herring discards as all amounts of herring caught will be applied to the TAC; it will be to the advantage of the industry to develop fishing practices and methods that will maximize the economic value of the herring caught. The plan also encourages the development of an observer program to collect additional data on discards and incidental catch, and acknowledge that such

programs may be developed through industry initiatives.

Provision is also made in this plan to allow the landing of herring in other fisheries. During periods when the directed fishery is closed, vessels in other fisheries will be allowed to land up to 2,000 pounds of herring per trip.

1.5.2 Social Impacts

A complete summary of the social impacts of the management measures can be found in the draft NEFMC Atlantic herring FMP and will be included in the Source Document for Amendment 1.

Appendix 1 to the NEFMC s Atlantic Herring FMP contains an extended discussion of the social issues surrounding the herring fishery and highlights the social impacts of many of the management alternatives considered by the Council. Under the proposed management plan, the current herring fishery will be allowed to nearly double in size. Gross revenues from this fishery could increase by $13 million at current ex-vessel prices, a potential boon to those communities suffering from reduced catches and revenues in other fisheries. The opportunity provided by this fishery is bound to result in some changes in the various fishing communities. It is expected that for the most part, the communities that have been linked to the herring fishery in the past - Rockland, Portland, and other Maine ports, Gloucester, MA and Point Judith, RI - are those ports most likely to benefit from the increased landings. There is a possibility that other fishing communities, such as New Bedford, MA or Cape May, NJ, may also be able to take advantage of the opportunities in this fishery.

In general terms, Amendment 1 and the NEFMC s management plan should benefit the fishing communities of the mid-Atlantic and New England. By providing for a sustainable herring fishery, the plan will both protect the interests of traditional users of the resource and provide an opportunity for others to enter the fishery. There is room for expansion in shoreside processing that will be supported by increased revenues.

1.5.3 Economic Impacts

A complete summary of the economic impacts of the management measures can be found in the draft NEFMC Atlantic herring FMP and will be included in the Source Document for Amendment 1.

Economic assessment requires consideration of the benefits and costs of the proposed action. Because of the lack of an analytical assessment model for herring that links fishing effort, landings, and fishing costs, a quantitative assessment of all expected costs is not possible. There is limited information available on fishing costs for the mid-water trawl and purse seine fishing sectors, the primary gears used to land herring. This makes it difficult, if not impossible, to accurately quantify the impacts on vessel costs that may result from the proposed management measures. Another difficulty with comparing the economic impacts of the alternatives is that in every case, gross revenues of herring are expected to remain constant or increase if the offshore fishery is developed. Because of a lack of information on the cost structure of the industry, a quantitative assessment of the impact of the management measures could not be determined.

1.6 LOCATION OF TECHNICAL DOCUMENTATION FOR AMENDMENT 1

In order to reduce the length of Amendment 1 and restrict its content to major provisions and a minimum amount of explanatory text, supporting documentation will be placed in the Amendment 1 Source Document (ASMFC, in prep.). The Source Document will be available from the ASMFC in early 1999 and will contain extensive materials that will explain the science that supports Atlantic herring management, including: the most recent stock assessment, a state by state description of herring fisheries, social and economic documentation and detailed habitat and protected species information. Additional information may also be found in the Environmental Impact Study for the NEFMC s Atlantic Herring Fishery Management Plan.

1.6.1 Review of Resource Life History and Biological Relationships

A complete review of this species life history and biological relationships can be found in Sindermann (1979) and Kelly and Moring (1986).

2. GOALS AND OBJECTIVES

2.1 HISTORY AND PURPOSE OF THE PLAN

2.1.1 History of Prior Management Actions

Management of USA Northwest Atlantic sea 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 sea 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 sea 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.

2.1.2 Purpose and Need for Action

The Commission and New England Fishery Management Council (Council) have reviewed the status of the Atlantic herring resource and the condition of the industry which utilizes this resource. The Commission and Council have determined that sufficient management problems exist to warrant the development and implementation of a complementary interstate and Federal program for conservation and management.

Absent implementation of this Amendment and a complementary federal plan, there is a distinct risk that increased fishing pressure may harm specific spawning stocks. Catches of herring have increased steadily over the last three years, from about 53,000 mt in 1994 to 98,000 mt in 1997. The bulk of this catch (~80,000 mt in 1997) has been taken from the GOM spawning stock. This exceeds the estimated long term potential yield from the GOM. While this level of fishing pressure can be supported in the short term due to exceptional stock sizes, there is concern that if continued over time it may lead to overfishing of the stock and a possible stock collapse. Recent history provides a pertinent example: overfishing on Georges Bank in the 1970's led to the complete failure of that fishery for over ten years. Because of the critical nature of this fishery for coastal communities that have historically relied upon it, the Commission and Council want to implement controls to ensure its continued viability.

The recovery of herring stocks on Georges Bank presents an opportunity for an expanded fishery. With pressure on other stocks leading to increased regulation, a Georges Bank herring fishery may provide increased economic opportunity for fishermen in the Northeast Multispecies fishery. Either through directed fishing, Joint Ventures, or Internal Waters Processing operations, an expanded herring fishery may ensure the economic survival of these fishermen until multispecies stocks can be rebuilt. It may also provide an opportunity for the further development of shoreside processing capability and development of the ability to enter the human consumption export market.

Management of Atlantic herring is complicated by the limited information available on some herring aggregations, and on the mixing of herring stocks. There is a need for improved scientific information on these issues in order to correctly manage the resource. This Amendment identifies specific resource priorities and urges close cooperation between U.S. and Canadian authorities. In addition, through the adoption of mandatory reporting of catch and landings information by fishermen and dealers, a strong base will be laid for future management efforts.

To address these concerns, the Council s Atlantic Herring FMP will establish a management program for Atlantic herring resources within the Exclusive Economic Zone (EEZ) of the U.S. The Commission s Amendment 1 to its Atlantic Herring FMP continues the implementation of the existing interstate management program for herring within state waters. Each plan has been developed in coordination with both bodies and its member states/constituents in order to ensure consistency throughout the range of the fishery.

2.1 GOALS

The goals of this Amendment are:

> To achieve, on a continuing basis, optimum yield (OY) for the United States fishing industry and to prevent overfishing of the Atlantic sea 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.

To provide controlled opportunities for fishermen and vessels in other mid-Atlantic and New England fisheries .

2.2 OBJECTIVES

In support of these goals, the following objectives are recommended for Amendment 1:

To harvest the U.S. Northwest Atlantic sea herring resource consistent with the definition of overfishing contained in the plan.

To prevent the overfishing of discrete spawning stock units consistent with the national standards.

To avoid patterns of fishing mortality by age which adversely affect the 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 management practices.

To implement management measures in close coordination with other Federal and State FMP s.

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 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.

To facilitate the development of biologically and environmentally sound aquaculture projects in the EEZ that are compatible with traditional fisheries in the New England region, given that some projects may not occur in federal waters without modifying one or more Council fishery management plans.

2.3 SPECIFICATION OF THE MANAGEMENT UNIT

The management unit for this fishery management plan is defined as the Atlantic herring (*Clupea harengus harengus* L.) resource throughout the range of the species within U.S. waters of the northwest Atlantic Ocean from the shoreline to the seaward boundary of the Exclusive Economic Zone (EEZ). Although limiting the management unit to U.S. waters, it is recognized that this is a transboundary resource and that effective assessment and management would be enhanced by cooperative efforts with Canada. Throughout this document, the words herring or Atlantic herring refer to this species.

The management unit does not include the entire range of the Atlantic herring stock complex. The stock complex includes herring which migrate through Canadian waters, beyond the range of management by this FMP. There is a significant fishery in New Brunswick that will complicate management efforts. Atlantic herring are a transboundary resource and effective assessment and management will be enhanced by cooperative efforts with Canada.

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

2.3.1 Management Areas

This Amendment modifies the three management areas contained in the previous FMP. This action is based on knowledge of the seasonal distribution and availability of juvenile and adult fish within the management unit area, 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 allows for the cooperative management of the resource by different regulatory jurisdictions (the states, the ASMFC and the New England and Mid-Atlantic Fishery Management Councils). The management areas are defined as:

Management Area 1 (Gulf of Maine):
All US waters of the Gulf of Maine north of a line extending from the eastern shore of Monomoy Island at 41° 35' N. latitude eastward to a point at 41° 35' N. latitude, 69° 00' W. longitude, thence northeasterly to a point along the Hague Line at 42° 53'14" N. latitude, 67° 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 line subdividing this area is described by the following points:

(1)	70° 00' W	(Cape Cod shoreline at 70° 00'W)
42° 38.4' N	70° 00' W	
42° 53' N	69° 40' W	
43° 12' N	69° 00' W	
43° 40' N	68° 00' W	
43° 58' N	67° 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 of 69° 00' W. longitude and south of 41° 35' N. latitude, 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 69° 00' W. longitude and southeast of the line that runs from a point at 69° 00' W. longitude and 41° 35' N. latitude, northeasterly to the Hague Line at 67° 44' 35" W. longitude and 42° 53' 14" N. latitude.

Figure 10. Atlantic Herring management areas and subareas.

2.4 DEFINITION OF OVERFISHING

The M-SFCMA specifies in section 303(a)(10) that each FMP shall specify objective and measurable criteria for identifying when the fishery regulated by the FMP is overfished. This definition of overfishing must include an analysis of how the criteria were determined, and the relationship of the criteria to the reproductive potential of stocks of fish in that fishery.

NOAA published advisory guidelines for compliance with the National Standards (*Federal Register*, Vol. 63, No. 84). The guidelines for National Standard 1 include definitions for "overfishing" or "to overfish". "Overfishing" occurs when a stock is subject to a rate or level of fishing mortality that jeopardizes the capacity of the stock to produce MSY on a continuing basis. "To overfish" means to fish at a rate or level that jeopardizes the capacity of a stock to produce MSY on a continuing basis. In order to determine if overfishing is occurring, the guidelines state that the FMP should define a maximum fishing mortality threshold. Exceeding this threshold for a period of one year or more constitutes overfishing. In addition, the FMP should have a minimum stock size threshold. Should the actual size of the stock fall below this level, the stock is considered overfished. In both instances, a reasonable proxy can be used to estimate the parameter if necessary.

The Council established an Overfishing Definition Review Panel (ODRP) to conduct a review of existing overfishing definitions and recommend any changes necessary to comply with the provisions of the Sustainable Fisheries Act. The final report (Applegate et al. 1998) recommended overfishing definition reference points and an MSY control rule for Atlantic (sea) herring. A conditioned surplus production model was used to estimate the maximum sustainable yield to be 317,000 mt. The biomass at maximum sustainable yield (B_{MSY}) and the fishing mortality rate at MSY (F_{MSY}) were estimated to be 1.1 million mt and 0.30, with a carrying capacity (K) of 2.13 million mt and an intrinsic rate of population growth (r) of 0.60. The MSY value produced by the surplus production model is reliable and was therefore used. However, the surplus production estimates of annual biomass and B_{MSY} are not as reliable as the annual ratios of starting biomass to B_{MSY} (Prager 1994, 1995). Therefore, in order to calculate B_{MSY} and F_{MSY} the ODRP applied these ratios to biomass estimates from the 1995 virtual population analysis (VPA) for the years 1973 through 1990 (NEFSC 1996) and averaged the result. VPA stock size estimates for the years 1991 through 1994 were not included in this estimate because of the tendency of the VPA to overestimate stock abundance in the most recent years. Similarly, B_{MSY} was not calculated for the years prior to 1973 because the surplus production model may not accurately calculate the biomass ratio for early years in the time series. These calculations are shown in Table 3.

Table 3. Estimates of B_{MSY}, F_{MSY}, K and r for the Atlantic herring coastal stock complex derived from VPA estimates of biomass (000's mt) and surplus production model estimates of biomass relative to B_{MSY} for the years 1973-90.

Year	Biomass (Jan 1)	Ratio of Jan 1 Biomass to B_{MSY}	Calculated B_{MSY}
1973	518.6	0.4326	1,198.9
1974	434.5	0.3513	1,236.9
1975	343.1	0.2996	1,145.3
1976	196.5	0.1833	1,071.9
1977	145.5	0.1444	1,007.6
1978	151.8	0.1612	941.9
1979	135.0	0.1651	817.8
1980	118.7	0.1481	801.6
1981	102.3	0.1226	834.1
1982	97.5	0.09633	1,012.0
1983	129.5	0.09008	1,437.1
1984	216.3	0.1279	1,691.2
1985	291.7	0.1946	1,499.2
1986	401.9	0.302	1,330.8
1987	506.4	0.4909	1,031.5
1988	541.8	0.7601	712.8
1989	700.1	1.077	650.1
1990	1037.8	1.347	770.4
Average			**1,066.2**

$$F_{MSY} = MSY/B_{MSY} = 317,000/1,066,200 = 0.297$$
$$K = 2(B_{MSY}) = 2(1,066,200) = 2.13 \text{ million mt}$$
$$r = 2\ F_{MSY}) = 2(0.297) = 0.60$$

When biomass is equal to or larger than B_{MSY}, the recommended upper limit on fishing mortality - $F_{threshold}$ - is F_{MSY} (0.30). The Panel recommended that herring be harvested such that the target fishing mortality will be F_{target}(0.28) when biomass is equal to or larger than B_{MSY}. The recommended biomass target is B_{MSY}, or 1.1 million mt. The Panel recommended a minimum biomass threshold (B_{limit}), set at a value of 1/4 B_{MSY}, or approximately 250,000 mt. At 1/4 B_{MSY}, the intrinsic rate of population growth indicates Atlantic herring can rebuild to B_{MSY} in five years if F is reduced to 0.15 and held constant during rebuilding. A conditioned surplus production model indicates a maximum five year rebuilding time period if the minimum achievable fishing mortality rate is 0.15. Rebuilding could occur rapidly even from very low biomass levels: from a biomass of one percent of B_{MSY}, the model estimates herring would have a 50% chance of rebuilding to B_{MSY} within ten years if fishing mortality is reduced to near zero. Figure 11 summarizes the overfishing reference points as recommended by the Overfishing Definition Review Panel. Figure 12 summarizes possible rebuilding schedules for Atlantic herring.

Figure 11. Atlantic herring overfishing definition reference points (Applegate et al. 1998).

Figure 12. Rebuilding trajectories for Atlantic herring (Applegate et al. 1998).

In SAW 27, the Pelagic/Coastal Working Group concurred with these reference points, with one exception. The working group report incorporated the recommendation of the Council's herring plan development team (PDT) that the minimum biomass level be established at 1/2 B_{MSY} because of the key role of herring in the ecosystem and uncertainties over the stock structure within the coastal stock complex. The SARC, however, in its review of the working group report, expressed concern over the application of a surplus stock production model (ASPIC) to estimate MSY for multiple stocks of herring. The SARC believed the results of the ASPIC model were unrealistic since the stock complex had only briefly (1968-1971) supported reported landings of this level and higher. As an alternative approach, the SARC applied a yield-per-recruit (YPR) and biomass-per-recruit values at $F_{0.1}$(0.20) to average recruitment levels estimated by the VPA. Based on geometric mean recruitment, the MSY values ranged from 108,000 mt to 290,000 mt depending on the time period used to determine average recruitment. The SARC recommended that it would not be prudent to consider MSY above 200,000 mt or B_{MSY} to be above 1.5 million mt until the sizes of recent year classes were better estimated (NEFSC 1998b).

The herring PDT considered the SARC's recommendation and noted the following:

(1) The SARC approach is highly dependent on the VPA estimates of recruitment (age 1 fish). All of the time periods that the SARC considered in computing average recruitment included 15 years when the stock was in a collapsed condition and therefore the YPR approach underestimates recruitment when the stock is at B_{MSY}.

(2) The YPR analysis used by the SARC was done in 1995 and used a dome-shaped exploitation pattern to estimate yield-per-recruit. The New Brunswick weir fishery targets younger fish and may cause a dome-shaped exploitation pattern when stock biomass on Georges Bank is low. When Georges Bank biomass is near B_{MSY}, however, a flat-topped exploitation pattern may be more appropriate. This inconsistency was not considered by the SARC.

(3) The SARC used recent mean weights at age to estimate YPR at different F values , i.e., mean weights observed during a period of very high biomass levels. Since biomass is estimated to be well above B_{MSY}, the mean weights may be anomalously low compared to what they might be when the stock is near B_{MSY}.

Finally, the $F_{0.1}$ = 0.20 reference point as estimated by the SARC is less than F_{MSY} (0.30) and is more conservative. It will, therefore, produce lower maximum yield estimates for a given stock biomass than an approach based on F_{MSY}. Likewise, the SARC approach produced a higher B_{MSY} than that estimated by the surplus production model.

The surplus production model is a generalized approach that estimates population parameters over the observed range of stock conditions. Implicitly it takes into account changes in mean weights, stock-recruit relationships, and exploitation patterns. While the entire MSY estimate should not be removed from a single stock component, the surplus production estimate appears to be consistent with the past history of the fishery, especially if discards and unreported catches are taken into account. For the reasons given above, the PDT continued to recommend adopting the MSY estimate calculated by the surplus production model.

The PDT also examined the target fishing mortality, F_{target}, when biomass is at or larger than B_{MSY}. The PDT considered the work of Restrepo et al. (1998) in providing technical advice on

the setting of reference points based on the quality of information known about a stock. Restrepo et al. (1998) suggest that target fishing mortality should be selected based on an analysis of uncertainty and risk in estimating fishing mortality in a particular fishery. In the absence of such an analysis, they suggest that the target fishing mortality should be established such that the probability of exceeding the maximum fishing mortality is in the range of 20%-30%. Restrepo et al. (1998) proposed a default target rule that established F_{target} at 75% of F_{MSY}. In addition, they suggested a default policy for establishing F_{target} based on the quality of data available. After considering this information, the PDT expressed concern that an F_{target} of 0.28 was too close to the $F_{threshold}$ of 0.30. Because of incomplete knowledge about the stock structure of the herring complex, the PDT felt the quality of information was "fair" and F_{target} should be set at 75% of F_{MSY}, or 0.23.

The Council considered the advice of the SARC, the PDT, and the ODRP before selecting reference points for Atlantic herring. The Council decided to adopt the F_{target} recommended by the Overfishing Definition Review Panel, F = 0.28. This recommended target is based on the lower limit of the 80% confidence interval around the point estimate of F_{MSY} estimated by the surplus production model. The ratio of F at this lower level to F_{MSY} is 0.91. This ratio is applied to the estimate of F_{MSY} determined by dividing MSY by B_{MSY} to obtain the F_{target} = 0.28. The Council believes that given the current robust condition of the herring resource, this target is sufficiently conservative to protect the resource.

The Council also considered the different minimum biomass threshold recommendations. Because of the key role of herring in the ecosystem and uncertainty over stock structure, the Council established $B_{threshold}$ as ½ B_{MSY}, rather than 1/4 B_{MSY} as recommended by the ODRP. The ODRP recommended 1/4 B_{MSY} because of the high intrinsic growth rate of herring and their recommendation that rebuilding begin as soon as stock biomass is less than B_{MSY}. The Council, however, has adopted ½ B_{MSY} as $B_{threshold}$ for the reasons stated above. Coupled with adoption of the ODRP recommendation to reduce F_{target} when biomass is less than B_{MSY}, this is a more conservative minimum biomass which will provide an early opportunity for the Council to address a declining stock biomass.

B_{MSY} is estimated to be 1.1 million mt, and MSY is estimated to be 317,000 mt. The maximum fishing mortality, $F_{threshold}$ is equal to F_{MSY}, estimated as 0.30, when stock biomass is equal to or larger than B_{MSY}. The target fishing mortality when biomass is at or larger than B_{MSY} is 0.28. If biomass declines to less than B_{MSY}, the maximum fishing mortality is the mortality that has a 50% probability to rebuild stock biomass to B_{MSY} in 5 years. The target fishing mortality when biomass is less than B_{MSY} will be determined by applying the previously determined ratio of F_{MSY} to F at the lower level of the 80% confidence interval (0.91) to the maximum fishing mortality. The minimum biomass level, $B_{threshold}$, is 1/2 B_{MSY}, or approximately 500,000 mt. These reference points are summarized in Table 4 and are illustrated in Figure 13.

Table 4. Summary of overfishing reference points for Atlantic herring.

Parameter	**Estimate**
MSY	317,000 mt
Biomass Target ($B_{target} = B_{MSY}$)	1.1 million mt
F_{MSY}	0.30
Minimum Biomass ($B_{threshold}$)	½ B_{MSY} = 500,000 mt
Maximum fishing mortality ($F_{threshold}$)	0.30
Target Fishing Mortality (F_{target})	0.28
Rebuilding period	5 years

Figure 13. Overfishing threshold and target fishing mortality.

Natural mortality is assumed to be 0.2, and herring are fully recruited to the fishery at age 3. If fishing mortality exceeds $F_{threshold}$ for one year or more, the herring coastal stock complex will be considered overfished. Similarly, if biomass is less than $B_{threshold}$ (½ B_{MSY}), the stock is in an overfished condition. In either situation, the Council must act to stop overfishing and rebuild the biomass to B_{MSY} by reducing fishing mortality.

The MSY estimate for the herring stock complex includes catches taken by Canada in the New Brunswick weir fisheries, as well as on Georges Bank east of the Hague line. These catches are included within the MSY estimate because Canadian catches are included in the VPA data. The stock affinity of the New Brunswick weir catches is being reviewed and, in the future, may result in an assessment that provides separate estimates of MSY on a finer scale. This may lead to the development of separate overfishing definitions for individual stock components.

Stock biomass for 1997 is estimated to be 2.9 million mt, 260% of B_{MSY}. There is considerable uncertainty about current stock size, which could be overestimated. Fishing mortality in 1997 is estimated to be less than 0.1 (there is an 80% probability that fishing mortality for age 3-7 herring is between 0.03 and 0.06). Current fishing mortality is, therefore, below the overfishing threshold.

2.5 STOCK REBUILDING PROGRAM

A rebuilding program is not applicable for the Atlantic herring resource at the present time.

2.6 IMPLEMENTATION SCHEDULE

Amendment 1 is scheduled for adoption by the Commission in October 1998. The Section currently envisions management program implementation to begin by June 1, 1999.

2.7 MAINTENANCE OF STOCK STRUCTURE

All management efforts should promote the maintenance of historical stock structure. Localized fishing mortality should be controlled in order to prevent the overfishing of individual spawning aggregations which could lead to reduced genetic diversity and a decrease in the overall health of the stock complex.

3. MANAGEMENT PROGRAM SPECIFICATIONS/ELEMENTS

Management of this species will be based on scientific advice provided by state and federal biologists, as well as input from public hearings and a joint ASMFC/NEFMC Atlantic Herring Advisory Panel. Management will strive for long-term viable populations supporting sustainable fisheries and dependent fish and wildlife resources. Effective management may require monitoring coupled with controls on fishing mortality and habitat degradation. The measures outlined below are designed to facilitate the management process. As new data become available and new assessments are completed, management measures will be adjusted accordingly.

The Plan Development Team, Plan Review Team, Technical Committee and/or Stock Assessment Committee will meet annually, no later than July, to review the status of the stock and fishery. Based on this review, the PDT will make recommendations concerning future adjustments to the management measures implemented by this plan. Any suggested revisions to the management measures other than changes in the specifications (TAC, OY, DAH, DAP, JVPt, BT and reserve), may be implemented through the Council s framework process or an amendment to the plan.

The PDT/TC will specifically recommend TACs for the following year and an estimated TAC for the year after. In developing their recommendations, the PDT/TC will review the following data: commercial and recreational catch data; current estimates of fishing mortality; stock status; recent estimates of recruitment; virtual population analysis results and other estimates of stock size; sea sampling and trawl survey data or, if sea sampling data are unavailable, length frequency information from the trawl surveys; impacts of other fisheries on the mortality of herring, and any other relevant information.

Based on these recommendations, the NEFMC Herring Committee will recommend to the Council appropriate specifications and any measures necessary to assure that the specifications will not be exceeded. The Council shall review these recommendations and any public comment received, and after consultation with the Commission, will recommend appropriate specifications to the Regional Administrator. Any suggested revisions to federal management measures may be implemented through the framework process or an amendment to the FMP. The Atlantic Herring Section will recommend any changes to management measures in state waters to the Commission, which may make changes through its adaptive management process or an amendment.

Specifications (for OY, DAH, DAP, JVPt, BT and reserve) and TACs will be implemented by the Regional Administrator. Proposed re-specifications and TACs will be published in the Federal Register on or about September 15 for the following fishing year and will provide for a 30 day public comment period. At the close of the comment period, a notice of final specifications will be published in the Federal Register. The previous years specifications will remain effective unless changed by the Regional Administrator. If the specifications will not be changed, this will be announced through a notice action.

The Regional Administrator may adjust the specifications during the fishing year after consulting with the NEFMC. Adjustments will be published in the Federal Register stating the reasons for the action and providing a 30 day comment period.

3.1 ASSESSMENT OF ANNUAL RECRUITMENT

The Technical Committee and 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 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 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 SUMMARY OF MONITORING PROGRAMS

3.4.1 Catch and Landings Information

Fishermen holding a federal permit are required to file reports detailing their catch and landings information. The state of Maine also collects catch and landings data for Atlantic herring. During 1998, Maine initiated a toll-free phone-in system so that fishermen could report their catch while at-sea or during offloading at the dock.

3.4.2 Biological Information

At this time, there is no coordinated effort between the states and the NMFS to collect biological data from the Atlantic herring fishery. The states of Maine and Massachusetts currently collect limited biological samples from the fishery.

3.4.3 Social Information

Currently there are no programs designed specifically to collect social data pertaining to the Atlantic herring fishery. The Atlantic Coastal Cooperative Statistics Program (ACCSP) is currently developing a comprehensive coastwide data collection program that will include social data.

3.4.4 Economic Information

Currently there are no programs designed specifically to collect economic data pertaining to the Atlantic herring fishery. The Atlantic Coastal Cooperative Statistics Program (ACCSP) is currently developing a comprehensive coastwide data collection program that will include economic data.

3.5 STOCKING PROGRAM

There is no stocking program for Atlantic herring at the present time.

3.6 BYCATCH REDUCTION PROGRAM

Available information indicates the Atlantic herring fishery is a clean fishery, with little bycatch of other regulated or protected species, or marine mammals. In order to monitor bycatch, the approach of the Atlantic Coastal Cooperative Statistics Program (ACCSP) will be adopted. Vessel operators will be required to record any bycatch or incidental catch; these reports will be examined by the PDT on an annual basis to determine if additional management measures are required. As pointed out by the ACCSP, the most effective way to monitor bycatch is through independent fisheries observers. The Council and Commission encourage NMFS to include the Atlantic herring fishery in its observer program.

3.7 HABITAT PROGRAM

Currently there is no habitat program designed specifically for Atlantic herring. The Council has identified the Essential Fish Habitat (EFH) for herring and other species it manages. The EFH

provisions (*see Section 1.4.4*) were submitted for all Council plans in one document that amends existing Council management plans, and lists the EFH for Atlantic herring.

4. 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 as to make regulation of this fishery unnecessary at this time.

4.2 COMMERCIAL FISHERIES MANAGEMENT MEASURES

4.2.1 Spawning Area Restrictions

Atlantic herring schools are especially susceptible to fishing when they aggregate for spawning. This is also when herring are most valuable, as fat content is generally at its peak. These economic reasons to allow fishing on spawning herring, however, are countered by conservation concerns. Fishing on spawning herring not only can result in high catch rates, but may interfere with the spawning behavior of those herring not caught. Herring in the latter stages of spawning are not fit for some markets. Therefore, this Amendment defines specific measures designed to reduce the exploitation and disruption of herring spawning aggregations, while providing a limited opportunity to harvest herring during this time of year.

4.2.1.1 Spawning Area Restrictions for Management Area 1 (state waters)

This Amendment adopts a spawning area restriction for all state waters in the Gulf of Maine (Management Area 1A). Restrictions would start on August 1 and continue through October 31. Any vessel may fish for, take, land, or possess spawn herring, herring containing roe or milt from or within a restricted spawning area as long as such herring comprise less than 20% by number of the amount possessed on board at any time. The 20% by number will be determined under sampling procedures specified by the states and enforced dockside as a state landing restriction.

Spawn herring are defined as those fish determined to be in ICNAF gonadal stages 4, 5, and 6.

4.2.1.2 Spawning Area Restrictions for Management Area 1 (Federal waters)

Spawning closures are proposed in the Council s plan for Management Area 1 (in both subareas 1A and 1B) and are included here for reference. The areas are modified from the spawning closures implemented by the Commission in the 1994 FMP. Spawning closure dates are fixed. In an area closed to spawning, fishing for, harvesting, or possessing herring will not be allowed except for the following exception: vessels will be allowed to possess up to 2,000 pounds of herring per trip. The amount of herring landed 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 legally caught herring must have all fishing gear stowed as specified by the Regional Administrator.

The boundaries of the spawning closures, and the dates the areas are closed, may be adjusted through framework action by the Council. Additional area closures may also be adopted through the Council s framework process.

The spawning closure areas (Figure 14) for federal waters in Management Area 1 are defined as:

Eastern Maine

All waters of the EEZ bounded by state waters and the following coordinates:

Maine state waters	68° 20' W
43° 48' N	68° 20' W
44° 04.4' N	67° 48.7' W
44° 06.9' N	67° 52.8' W
44° 31.2' N	67° 02.7' W

North along US/Canada border

Western Maine

All waters of the EEZ bounded by state waters and the following coordinates:

43° 30' N	Intersection with Maine state waters
43° 30' N	68° 54.5' W
43° 48' N	68° 20' W

North to Maine state waters at 68° 20' W

Cashes Ledge

43° 15' N	69° 30' W
43° 15' N	69° 45' W
43° 00' N	69° 45' W
43° 00' N	69° 30' W
42° 40' N	69° 30' W
42° 40' N	68° 50' W
43° 10' N	68° 50' W
43° 10' N	69° 30' W

Jeffreys Ledge

All waters in the EEZ bounded by the following coordinates:

43° 12.7' N	70° 00.0' W
43° 09.5' N	70° 08.0' W
42° 57.0' N	70° 08.0' W
42° 52.0' N	70° 21.0' W
42° 41.5' N	70° 32.5' W
42° 34.0' N	70° 26.2' W
42° 55.2' N	70° 00.0' W

Stellwagen Bank National Marine Sanctuary

All waters in the EEZ bounded by the following coordinates:

42° 34.0' N	70° 23.5' W
42° 28.8' N	70° 39.0' W
42° 18.6' N	70° 22.5' W
42° 05.5' N	70° 23.3' W
42° 11.0' N	70° 04.0' W

The closure dates will be:

Eastern Maine	August 15 - September 11
Western Maine	September 1 - September 28
Jeffreys Ledge/ Stellwagen Bank	September 15 - October 12
Cashes Ledge	August 1 - September 25

Figure 14. Spawning Closure Areas for Management Area 1 (federal waters).

4.2.1.3 Spawning Area Restrictions for Management Areas 2 and 3 (Federal waters)

The following is taken from the Council s proposed herring FMP and included here for reference.

Because of the robust condition of the herring resource, and interest in developing the offshore fishery, spawning closures or restrictions will not be established in these areas when the Council s plan is implemented. Closures may be established in the future as information is obtained on the appropriate times and areas to be closed and the industry develops the ability to harvest herring offshore. Closures may also be adopted if it s determined a developing roe fishery needs to be limited to protect the resource.

4.2.2 Specification of OY, DAH, JVPt, JVPs, IWP, BT, USAP and Reserve

The Regional Administrator, after consulting with the New England Fishery Management Council, determines annual specifications relating to OY, DAH, DAP, JVPt, JVPs, IWP, BT and the reserve. The Council and the Regional Administrator will review annually the best available biological data pertaining to the stock. The allowable biological catch (ABC) (based on the target fishing mortality and the estimated biomass) for the Coastal Stock Complex (CSC) will be determined. The fishing mortality rate associated with the ABC will not exceed the overfishing definition. The biomass of Atlantic herring at the end of the fishing year will not be less than the minimum stock size threshold specified in the overfishing definition.

ABC will be equal to the target fishing mortality (F_{target}) times the estimated biomass.

The current biomass is estimated to be much larger than B_{MSY} and is only lightly exploited. Applying F_{target} to this biomass results in a quantity greater than F_{MSY} times B_{MSY}. Because estimates of current biomass are very uncertain, the wide fluctuations in stock size often experienced by pelagic resources, and the key role of herring in the ecosystem, ABC will be limited to F_{MSY} times B_{MSY} during an initial "fishing up" period. This will allow for a reasonable expansion of the fishery and preserve the option for larger harvests in the future as the quality of data and assessment information improves.

Optimum yield (OY) will be less than or equal to ABC minus the expected Canadian catch (C) from the stock complex. This formula could result in an unrestricted Canadian catch severely limiting the US harvest; therefore the estimate of the Canadian catch deducted from the ABC will not be more than 20,000 mt for the New Brunswick juvenile harvest, and no more than 10,000 mt for the Georges Bank Canadian harvest. The size of the Canadian harvest and its impact on the US fishery will be monitored by the NEFMC Herring Committee and the ASMFC Herring Section. Successful management of this trans-boundary resource will rely on developing an effective means to coordinate US and Canadian management decisions.

$$OY \leq ABC \quad C$$

OY will not exceed MSY.

$$OY \leq MSY$$

This restriction, however, may not preclude the harvest in a specific year from exceeding the harvest associated with MSY. When stock biomass is larger than B_{MSY}, the target fishing mortality may produce a harvest that exceeds the MSY in the short term. This approach will not be taken during the initial period of the plan for the reasons given in the discussion on ABC.

The establishment of OY will include consideration of relevant economic, social, or ecological factors. Management of herring in U.S. waters is complicated by historical variations and fluctuations in abundance, questions concerning the intermixing rates of various spawning components, the importance of herring as a prey resource and uncertainties concerning the Canadian harvest. One of the goals of Amendment 1 is to provide controlled opportunities to U.S. fishers to enter the fishery, providing an economic opportunity to vessels under severe restrictions in other fisheries. Estimates of the available domestic harvesting capacity show that the domestic fleet has the capacity to harvest the entire herring resource should fishers choose to do so. This choice is contingent on expanding existing herring markets or developing new markets. The complexities of predicting world demand for herring products and the opportunities available to the export market argue for a conservative stance when allocating the herring resource. For these reasons, OY may be less than ABC - C, and none of the available OY will be assigned to TALFF. Setting OY equal to DAH (plus a reserve) will help achieve a risk-averse approach to management of the herring stock while it encourages U.S. development of the resource. This will provide the greatest overall benefit to the nation by stimulating further development of an underutilized fishery and diverting effort away from other overfished fisheries.

OY is equal to the expected domestic annual harvest (DAH) plus a reserve.

$$OY = DAH + Reserve$$

Factors to be considered in determining the amount of OY, if any, assigned to the reserve will include:

-uncertainty and variability in the estimates of stock size and ABC;
-uncertainty in the estimates of Canadian harvest from the CSC;
-requirement to insure the availability of herring to provide controlled opportunities for vessels in other fisheries in the mid-Atlantic and New England;
-excess U.S. harvesting capacity available to enter the herring fishery;
-total world export potential by herring producing countries;
-total world import demand by herring consuming countries;
-U.S. export potential based on expected U.S. harvests, expected U.S. consumption, relative prices, exchange rates, and foreign trade barriers;
-increased/decreased revenues to the United States from foreign fees;
-increased/decreased revenues to U.S. harvesters (with/without joint ventures);
-increased/decreased revenues to U.S. processors and exporters;
-increases/decreases in U.S. harvesting productivity due to decreases/increases in foreign harvest;
-increases/decreases in U.S. processing productivity;
-potential impact of increased/decreased TALFF on foreign purchases of U.S. products and services and U.S.-caught fish, changes in trade barriers, technology transfer, and other considerations.

The Regional Administrator, in consultation with the Council and the ASMFC, may transfer any amount from the reserve to the DAH.

DAH is composed of domestic annual processing (DAP), the total amount allocated to processing by foreign ships (JVPt), and the amount of herring taken in US waters and transferred to Canadian herring carriers for transshipment to Canada (BT). When determining JVPt, the Council will consult with the Atlantic States Marine Fisheries Commission (ASMFC) to insure close coordination with the Commission's allocation for Internal Waters Processing (IWP) operations.

$$DAH = DAP + JVPt + BT$$

Part of DAP may be allocated for at-sea processing in the EEZ, by domestic vessels that exceed any vessel size limits adopted by the Council. This allocation will be called the U.S. at-sea processing (USAP) allocation. The term at-sea processing refers to processing activities that occur in the exclusive economic zone outside state waters. When determining this specification, the Council will consider the availability of other processing capacity, development of the fishery, status of the resource, and opportunities for vessels to enter the herring fishery.

4.2.2.1 Initial Specifications

The following specifications have been recommended for the initial year (1999) of the management plan. To simplify accounting and tracking, all catches on or after January 1, 1999, will be applied to the initial specifications and TAC s. These specifications form the basis for the TAC s for the first year of the plan listed in section 4.2.8.4.

Table 5. Initial recommended Atlantic herring specifications.

Specification	Amount (metric tons)
ABC	300,000
OY	224,000
DAH	224,000
DAP	180,000
USAP	0
BT	4,000
JVPt	40,000
JVPs - Total	15,000
JVPs - Area 2	10,000
JVPs - Area 3	5,000
IWP	25,000
Reserve	0

4.2.3 IWP/JVP Allocations

Joint Venture Processing (JVP) and Internal Waters Processing (IWP) operations are essentially the same type of operation from a domestic fishermen s perspective. A foreign processing vessel is contracted to process fish harvested by domestic vessels. The only difference at this time is where the processing vessel is located and under whose authority the JVP or IWP is granted. JVP vessels process fish in federal waters while IWP vessels process fish in state waters. Currently, both receive fish harvested primarily in federal waters.

All herring harvested by domestic vessels is used in some manner. The DAH is comprised of the amount used by domestic processors and the amount used by foreign processing vessels (regardless of whether the processing vessel is located in the EEZ or in state internal waters) and the amount transshipped to Canada on Canadian herring carriers (BT). The amount available for use by foreign processing vessels is the total joint venture allocation - JVP_t.

$$DAH = DAP + JVP_t + BT$$

Once DAH is estimated, the amount expected to be used by domestic processors (DAP) must be estimated and subtracted from the DAH along with herring transported to Canada. If there is any DAH remaining, it is available for joint venture processing operations.

$$JVP_t + BT = DAH - DAP$$

As explained above, JVP_t includes all herring available for foreign processing vessels. This includes both joint venture processing in the EEZ and internal waters processing within state waters. The amount available for processing in the EEZ is called JVP_s; the amount available for state internal waters is IWP.

$$JVP_t = JVP_s + IWP$$

The Council Herring Committee and the Commission Herring Section will consult and recommend the breakdown of the JVP_t allocation into JVP_s and IWP. Factors to be considered include: requests received, demonstrated intent to conduct an operation, and consideration of resource status and potential increases in DAP. Recommendations will be forwarded to the Regional Administrator through the Council and implemented as described in the section on FMP monitoring (*Section 4.2.6*).

The Commission Herring Section will allocate the amount available for IWP to the individual states. These allocations will be established as a compliance criteria for the states and will include reporting criteria for the processing vessels. Reporting criteria will be established based on the recommendations developed through the Atlantic Coastal Cooperative Statistics Program (ACCSP).

The total allocations (DAP, JVP_t, BT and the reserve) in any one management area or subarea will not exceed the TAC set for that area or subarea during that fishing year. In the event of a closure to a directed herring fishery in any one management area or subarea, BT, JVP_s and IWP operations will cease to receive any herring caught from a closed area or subarea.

Nothing in this section will restrict a state from allowing foreign processing vessels to process herring in state internal waters which were caught in federal waters in conjunction with the Magnuson-Stevens Act requirements section 306(c), so long as the area or subarea in which they were caught is open to directed herring fishing.

4.2.4 General Administrative Provisions

4.2.4.1 Permits

Vessel Permits Vessels fishing for, possessing, or landing herring in or from the EEZ are required to obtain a federal permit. Permits will be issued under a vessel's U.S. documentation or state registration number. Vessel owners or operators who apply for a fishing vessel permit under this section must agree, as a condition of the permit, that all the vessel s herring fishing, catch, and gear (without regard to whether such fishing occurs in the EEZ or landward of the EEZ, and without regard to where such herring, or gear are possessed, taken or landed) will be subject to all the requirements of this part. All such fishing, catch, and gear will remain subject to any applicable state or local requirements. If a requirement of this part and a conservation measure required by state or local law differ, any vessel owner or operator permitted to fish in the EEZ must comply with the more restrictive requirement.

Vessels fishing for herring in state waters only are required to obtain a permit from the appropriate state agency. Vessels fishing with fixed gear in state waters will be required to obtain a permit from the appropriate state agency.

Permits are not required for vessels that possess herring for bait (for example, in the lobster and tuna fisheries) and do not have gear capable of harvesting herring.

To receive a federal herring permit, vessels must annually declare their intent (by completing a permit application) to participate in the herring fishery. The application period will be defined by the Regional Administrator. Changes in information supplied for the permit must be reported to the Regional Administrator within 15 calendar days of the change. Permits will be valid for the period May 1 through April 30 the following calendar year, or as designated by the Regional Administrator.

Permit holders will be required to carry their permit aboard the fishing vessel during fishing and offloading operations. It must be available for inspection upon request by an authorized officer. The Regional Administrator may, after publication in the Federal Register, charge a permit fee for administration and enforcement.

For the purposes of this FMP, horsepower is defined as the total maximum continuous shaft horsepower of all the vessel's main propulsion machinery (46 CFR 10.103).

When a vessel is sold or otherwise transferred, the permit is assumed to transfer with the vessel. A written agreement between the buyer and the seller is necessary if the seller wishes to retain the permit.

There are no limits (up to any maximum vessel limits adopted by this FMP) on vessel upgrades or replacements anticipated unless a limited entry system is adopted in the future.

Operator Permits Operators of vessels federally permitted to harvest herring will be required to have an operator permit. No performance or competency tests will be required to obtain a permit. The permit may, however, be revoked for violation of fishing regulations.

Vessel operators may be permitted as follows:

Any operator of a vessel fishing for herring must have an operator's permit issued by the NMFS Regional Administrator.

An operator is defined as the master or other individual on board a vessel who is in charge of the vessel. (Note: This definition is specified in the Code of Federal regulations, 50 CFR 648.5). The operator will be required to submit an application, supplied by the Regional Administrator, for an Operator's Permit. The permit will be issued for up to three years. The applicant will provide his/her name, mailing address, telephone number, date of birth and physical characteristics (height, weight, hair and eye color, etc.) on the application, and will be requested to provide his/her social security number. In addition to this information, the applicant will be required to provide two passport-size color photos.

Permit holders will be required to carry their permit aboard the fishing vessel during fishing and off-loading operations. It must be available for inspection upon request by an authorized officer.

The Regional Administrator may publish notification in the Federal Register and charge a permit fee for administrative costs of issuing permits.

Dealer Permits: Dealer permits will be issued as follows:

Any dealer (as defined by the Regional Administrator) of herring must have a permit issued by the Regional Administrator.

The dealer will be required to submit an application, supplied by the Regional Administrator, for a dealer permit that is valid until it expires, is suspended, or revoked. The applicant will provide the business name, the name of the person signing the application, mailing address, telephone number and principal place of business on the application. The permit cannot be transferred and will expire upon change in ownership of the business. The permit must be maintained at the place of business and be available for inspection by an authorized officer.

The Regional Administrator may publish notification in the Federal Register and charge a permit fee for administrative costs in issuing permits.

4.2.4.2 Observers/Sea Samplers

The Regional Administrator may request any vessel holding a federal permit for herring to carry a NMFS-approved sea sampler/observer. If requested by the Regional Administrator to carry an observer or sea sampler, a vessel may not engage in any fishing operations in the respective fishery unless an observer or sea sampler is on board, or unless the requirement is waived.

If requested by the Regional Administrator to carry an observer or sea sampler, it is the responsibility of the vessel owner to arrange for and facilitate observer or sea sampler placement. Owners of vessels selected for sea sampler/observer coverage must notify the appropriate

Regional or Science and Research Director, as specified by the Regional Administrator, before commencing any fishing trip that may result in the harvest of resources of the respective fishery. Notification procedures will be specified in selection letters to vessel owners.

For foreign processing vessels, the costs of observer coverage will be collected through fees established in accordance with 16 U.S.C. 1821(h). For domestic vessels, observers will normally be funded through the NMFS observer program. In the future, innovative methods of funding observers may include industry sponsored initiatives.

4.2.5 Reporting and Record-keeping Requirements

The reporting requirements for the Atlantic herring fishery are based on the existing requirements for other fisheries in the Northeast Region. The ASMFC, NMFS, US Fish & Wildlife Service, the New England, Mid-Atlantic, and South Atlantic Fishery Management Councils, and all the Atlantic coastal states are currently developing a coastwide fisheries statistics program (Atlantic Coastal Cooperative Statistics Program). A minimum set of reporting requirements based on a trip-level for fishermen and dealers is being developed and once adopted by each state/agency, will become the minimum standard for data collection on the Atlantic coast. Nothing in the proposed program would prohibit a state/agency from requiring more detailed information on a trip basis if so desired. As the ACCSP provisions are adopted in the Northeast Region, they will be incorporated into the reporting requirements for the herring fishery.

4.2.5.1 Domestic Fishermen and Foreign Processing Vessels

The operator of any domestic vessel issued a permit to fish for herring must maintain on board the vessel, and submit, an accurate daily fishing log report for all fishing trips, regardless of species fished for or taken, on forms supplied by or approved by the Regional Administrator. Fishing vessel log reports must include the following information, and any other information specified by the Regional Administrator:

Vessel name; USCG documentation number (or state registration number, if undocumented); permit number; date/time sailed; date/time landed; trip type; trip number; number of crew; number of anglers (if a charter or party boat); gear fished; quantity and size of gear; mesh/ring size; chart area fished; average depth; latitude/longitude (or loran station and bearings); total hauls per area fished; average tow time duration; pounds, by species, of all species landed or discarded; dealer permit number; dealer name; date sold; port and state landed; and vessel operator's name, signature, and operator permit number.

In order to facilitate monitoring of area specific TAC's, vessels will be required to report, on a weekly basis, their catch of herring from each management area. This may be accomplished through submittal of VTR's on a weekly basis until an Interactive Voice Response (IVR) system can be implemented. In an IVR system, the vessel owner or operator will place a telephone call and report required information to a computerized database that will facilitate timely tracking of landings. The IVR system will require operators to submit the information necessary to accurately track landings of herring from management areas. Such information may include vessel identification and all herring landings and discards by trip and management area, and any other information deemed necessary by the Regional Administrator.

If authorized in writing by the Regional Administrator, vessel owners or operators may submit reports electronically, for example by using a VTS or other media.

The operator of any foreign processing vessel issued a permit to fish (as defined in 50 CFR 600.10) for herring must submit the fishing logs and reports specified in 50 CFR 600.502.

4.2.5.2 Dealer Reports

Any dealer issued a federal permit must submit weekly dealer reports as specified in 50 CFR 648.(a)(I). Dealer reports must include the following information, and any other information specified by the Regional Administrator:

Name and mailing address of dealer, dealer number, name and permit number of the vessels from which fish are landed or received, trip number; dates of purchases, pounds by species, price by species, port landed.

4.2.6 FMP Monitoring

The NEFMC Herring PDT will meet with the ASMFC Herring Technical Committee (TC) annually to review status of the stock and the fishery. Based on this review, the PDT will report to the NEFMC Herring Committee and the ASMFC Herring Section, no later than July, any necessary adjustments to the management measures adopted and recommendations for the specifications (for OY, DAH, DAP, JVPt, JVPs, IWP, BT, USAP and reserve) and TAC s. The PDT/TC will specifically recommend TAC s for the following year and an estimated TAC for the year after. In developing this recommendation the PDT/TC will review the following data: commercial and recreational catch data; current estimates of fishing mortality; stock status; recent estimates of recruitment; virtual population analysis results and other estimates of stock size; sea sampling and trawl survey data or, if sea sampling data are unavailable, length frequency information from the trawl surveys; impact of other fisheries on the mortality of herring, and any other relevant information.

Based on these recommendations, the NEFMC Herring Committee will recommend to the Council appropriate specifications and any measures necessary to assure that the specifications will not be exceeded. The Council shall review these recommendations and any public comment received and, after consulting with the Commission, recommend appropriate specifications to the Regional Administrator. Any suggested revisions to federal management measures may be implemented through the framework process or an amendment to the FMP. The Section will recommend any changes to management measures in state waters to the Commission, which may make changes through its adaptive management process or an amendment to the plan.

Specifications (for OY, DAH, DAP, JVPt, JVPs, IWP, BT, USAP and reserve) and TAC s will be implemented by the Regional Administrator. Proposed re-specifications and TAC s will be published in the *Federal Register* on or about September 15 for the following fishing year and will provide for a public comment period. At the close of the comment period, a notice of final specifications will be published in the *Federal Register*. The previous year s specifications will remain effective unless changed by the Regional Administrator. If the specifications will not be changed, this will be announced through a notice action.

The Regional Administrator may adjust any of the specifications (OY, DAH, DAP, JVPt, JVPs, IWP, BT, USAP and reserve) during the fishing year after consulting with the NEFMC, consistent with the plan objectives and other plan provisions. For example, adjustments may be made to correct for errors in estimating any of the specifications, to provide for increased opportunities for U.S. fishermen to use the resource, or to address conservation concerns. Adjustments will be published in the Federal Register stating the reasons for the action and providing a 30 day comment period.

If the Regional Administrator determines that the New Brunswick fixed gear fishery will not harvest 20,000 mt by October 1, the TAC for Management Area 1A may be adjusted by the difference for the remainder of the year. This adjustment will be made if the amount will provide increased opportunities for fishing in Area 1A for the U.S, industry. This adjustment will be accomplished through a notice action, without an opportunity for public comment.

4.2.7 Catch Control Measures

4.2.7.1 Establishment of Total Allowable Catch (TAC)

Total Allowable Catch (TAC) will be determined for the Coastal Stock Complex. The TAC will serve as an analytical device for purposes of evaluating the conditions of the resource and rate of capture. TAC's will also be determined for each management area. TAC s will be recommended on an annual basis by the PDT/TC (*see Section 4.2.2*). The total of any assigned TAC's will not exceed OY.

4.2.7.2 TAC Limitation

In the event that effort controls fail to restrict the catch of herring, the catch in an area will not exceed 100% of the TAC assigned for a particular time period. The directed fishery for herring will be closed in a management area or sub-area when the Regional Administrator projects the catch will exceed 95% of the TAC for that area or sub-area. Up to 5% of each area s or sub-area s TAC will be set aside for bycatch in other fisheries. This level can be adjusted downward (making a larger percentage of the TAC available for the directed fishery) by the Regional Administrator if it appears to overestimate catches of herring in other fisheries. Such an adjustment will be made on an annual basis after providing an opportunity for public comment. Incidental catch of herring in an area closed to directed herring fishing will be limited to 2,000 pounds per trip as described in Section 4.2.8.1.

4.2.7.3 TAC Distribution

The Total Allowable Catch (TAC) will be distributed to Management Areas 1A, 1B, 2 and 3 on an annual (January through December fishing year) basis. The individual area TAC s are designed to allow flexibility in the harvest of herring while protecting individual spawning components. All available information, including tagging studies and the NMFS fall bottom trawl survey, will be used to estimate the proportion of each spawning component (Gulf of Maine, Georges Bank/Nantucket Shoals) that occupies each management area during each season, and the size of each stock, the overall TAC is distributed so that spawning components are not overfished. This amendment includes the flexibility to revise the distribution of the TAC as relative stock sizes change, additional information is learned on stock migration and mixing,

or improved assessment techniques allow a more refined estimate of the size of the individual spawning components.

Using estimates of stock size developed through the assessment of the coastal stock complex of herring, the allowable biological catch (ABC) can be determined. While the assessment is performed on the entire stock complex, it is widely acknowledged that there are separate spawning components of herring that should not be overfished (Iles and Sinclair 1982, Boyar et al. 1973, Haegle and Schweigert 1985). Any distribution of the annual TAC that ignores the existence of these spawning components risks damaging the resource by overfishing a specific component, while remaining within the overall harvest level. For this reason, the overall TAC will be distributed to separate areas. This will allow the setting of these area specific TAC s to reduce the risk of overfishing a specific herring spawning component.

The determination of area specific TAC s is complicated by incomplete information on the migration of herring and the relative sizes of the spawning components. During spawning season, there is believed to be little or no mixing of the separate spawning components. An examination of NEFSC fall trawl survey data (conducted during the spawning season for herring) by the 27th SAW resulted in estimates of minimum population size for each of three areas: the Gulf of Maine, Nantucket Shoals, and Georges Bank. An annual ratio of population size to total population was determined for each of these areas for the time periods: 1988-97 and 1993-97. Coastal Maine accounted for 27% of the population biomass during the ten year period, declining slightly to 25-26% in the shorter, more recent period. Nantucket Shoals accounted for 63% of the biomass in the longer time period, declining to 57% in the 1993-97 period. Georges Bank accounted for 10% of the biomass in the longer period, but has increased to approximately 17-18% in the recent period, reflecting the resurgence of the Georges Bank component (NEFSC 1998a). These relative stock size ratios can be applied to the ABC to estimate how much herring can be taken from each spawning component. These estimates should be viewed as guidelines only rather than absolutes as the accuracy of the percentages has not been determined.

The various spawning components however, are known to intermingle outside of the spawning season. This mixing must be taken into account when distributing the annual TAC s to minimize the risk of overfishing a specific spawning component. Some of the Gulf of Maine component for example, is believed to migrate into Management Area 2 during the winter months. Table 6 summarizes current estimates of the distribution of the various spawning components throughout the year. This percentages are based on current knowledge of herring migration and mixing; as additional information is learned, the estimates of the percent of a spawning component in a management area may be revised. For example, changes in relative size of the various spawning components may result in different percentages of the total stock complex in an area during a specific season. The PDT/TC annual review of the management plan will update the estimates of stock distribution when determining TAC s for the following year.

It is possible to assign seasonal and area TAC s based on this estimated distribution of the various spawning components. Such a system, however, would be difficult to administer and monitor, and would risk frequent interruptions in fishing and the supply of herring as seasonal TAC s are approached and effort controls are implemented. A simpler approach is adopted for Amendment 1 using annual TAC s in each of four areas that consider the seasonal distribution of herring and relative size of spawning components.

Table 6. Distribution of spawning components by season.

Time of Year	Spawning Component	Percent of Component in Management Area		
		1	2	3
Dec-March	GOM	100	20	0
	GB/NS	0	80	0
Apr-July	GOM	50	0	0
	GB/NS	50	100	100
Aug-Nov	GOM	100	0	0
	GB/NS	0	100	100

The maximum size of an individual area TAC is based on the percentage of the ABC that can be harvested from each of the spawning components. Estimates of Canadian catches in the New Brunswick juvenile and Georges Bank fisheries are then subtracted to determine the US harvest available from each spawning component (as described/limited in Section 4.2.2). The amount that can be harvested from each area is determined after considering the migration and mixing of the various components, the pattern of the fishery, and any other relevant factors.

Most herring are currently harvested in the inshore area of Management Area 1. A TAC is established in Area 1A to limit harvest to acceptable levels. Because some Gulf of Maine herring migrate into Management Area 2 in the winter months, the TAC set for Area 1 must consider the impact of the winter fishery in the northern part of Management Area 2. Twenty percent (20%) of the fish caught in this area/time period are believed to be GOM fish. This means the Area 1A TAC will not equal the entire amount that can be removed from the GOM spawning component if there is a winter fishery in Management Area 2. The amount of this impact will change as the fishery develops and if relative spawning component sizes change.

The process to be followed in determining annual TAC s will be as follows:

(1) Estimate the relative abundance of herring in each of three area during spawning season;
(2) Consider existing information on stock distribution and adjust the distribution of spawning components by area (Table 6) as necessary;
(3) Examine seasonal patterns in the fishery to identify changes in the exploitation of various spawning components over time;
(4) Based on ABC, estimate the allowable US harvest from the components of herring that spawn in the Gulf of Maine, Georges Bank, and Nantucket Shoals;
(5) Estimate the expected harvest of Gulf of Maine herring in the winter fishery in Management Area 2;
(6) Estimate the expected harvest of Georges Bank and Nantucket Shoals herring in Management Area 1;
(7) Establish the TAC s for Areas 1A, 1B, 2 and 3;
(8) Determine the amount, if any, of the TAC that will be assigned to a TAC reserve.

The TAC s for each area will be forwarded to the Regional Administrator who may implement them as described in Section 4.2.6 (FMP Monitoring) The Regional Administrator may apportion any or all of the TAC reserve to a Management Area after consulting with the Council.

The Regional Administrator will project whether the New Brunswick juvenile fishery will harvest 20,000 mt by October 1 of each year. If it is determined this fishery will harvest less than 20,000 mt, the TAC for Management Area 1A will be increased by the difference.

4.2.7.4 Initial TAC Distribution

Upon implementation of Amendment 1, the initial TAC distribution will be determined and distributed on the basis of an ABC of 300,000 mt and an OY of 224,000 mt. Relative abundance of herring in each area are estimated as described in Table 6. The winter removals of GOM fish from Area 2 are estimated at 10,000 mt. The relative proportion of the biomass of herring in each area during spawning season is estimated as 25% in the GOM, 55% on Nantucket Shoals, and 20% on Georges Bank.

For Management Area 1A, the initial area TAC is 45,000 mt as calculated below:

(coastal stock complex ABC of 300,000 mt) * 0.25 (relative proportion of GOM spawning component) = 75,000 mt

75,000
-20,000 (removed by the New Brunswick weir fishery)
55,000
-10,000 (removed during Area 2 winter fishery)
45,000
+15,000 (added for GB/NS contribution to historic GOM summer fishery)
60,000
+10,000 (added for GB/NS contribution to offshore GOM)
70,000 Total amount US TAC for Area 1 based on historic fishery

There are believed to be periods of the year when GB/NS spawning component herring are found in offshore areas of the Gulf of Maine (within Management Area 1B). The historic fishery - in particular the coastal fixed gear fishery - did not exploit these fish. An estimate of 10,000 mt of herring can be harvested from this area. The total amount of herring that can be harvested from Management Area 1 is thus 70,000 mt. This amount is divided into 1A and 1B components. The harvest of herring from Management Area 1A will be limited to 45,000 mt, and the harvest in Area 1B will be limited to 25,000 mt.

Landings in Management Areas 2 and 3 will be initially limited to 50,000 mt each. In addition, there will be a 54,000 mt TAC reserve. Because some Gulf of Maine herring are caught in Management Area 2 in the winter, there is a concern that an uncontrolled catch of herring in the winter fishery could damage the Gulf of Maine spawning component. Current estimates are that approximately 20% of the catch in Area 2 in the winter months may be herring from the Gulf of Maine spawning component. With an Area 2 TAC of 50,000 mt, even if this entire TAC were caught in the winter months, the amount of Gulf of Maine herring that is caught would not exceed the amount considered when setting the Management Area 1 (1A and 1B) TACs. The TAC reserve may be released to Area 2 by the Regional Administrator by a notice action, after consulting with the Council. It is expected that this reserve will not be released until Gulf of Maine herring are unlikely to be in this area. As additional information is obtained on the relative sizes of spawning components and on migration patterns, the size of the TAC reserve or the timing of its release to the industry may change.

Table 7. Initial TAC Distribution for 1999.

Area	TAC
Area 1A	45,000 mt
Area 1B	25,000 mt
Area 2	50,000 mt
Area 3	50,000 mt
TAC Reserve (Area 2)	54,000 mt
Total	224,000 mt

4.2.8 Effort Control Measures

Effort controls will be used to prevent the annual TAC in each area or sub-area from being exceeded. In the event that the TAC in an area or sub-area is attained, the directed fishery will be closed.

4.2.8.1 Mandatory days out of the fishery

The NMFS will monitor the herring catch from all areas or sub-areas with an assigned TAC. If catch rates indicate the TAC will be exceeded, mandatory days out of the fishery will be imposed.

When NMFS projects that 50% of the TAC will be exceeded in an area (or sub-area) for a given time period, vessels will be required to take Saturday and Sunday out of the fishery in that area (or sub-area). When NMFS projects that 75% of the TAC will be exceeded in an area (or sub-area) for a given time period, vessels will be required to take Friday, Saturday and Sunday out of the fishery in that area (or sub-area). When NMFS projects that 90% of the TAC will be exceeded in an area (or sub-area) for a given time period, vessels will be required to take Friday, Saturday, Sunday and Monday out of the fishery in that area (or sub-area).

If catch rates are high, the imposition of effort controls may be made with little or no advance notice. Fishermen will be notified through news releases, letters to herring permit holders, and broadcast notice to mariners. NMFS will notify appropriate state marine resource officials to assist in distributing this information.

All vessels will take the same days out (that is, days out will be "no fishing" days) for a particular area.
Fishing will be allowed in other areas, and catch may be landed in an area that is closed to fishing. Any vessel transiting an area closed to fishing with legally caught herring on board must have its fishing gear stowed in accordance with the requirements of the Regional Administrator.

During a closure, vessels participating in other fisheries may retain an incidental catch of herring that does not exceed 2,000 pounds per trip. Vessels may be allowed to possess no more than 2,000 pounds of herring per trip that they caught in an area closed to directed herring fishing. Vessels may not land more than 2,000 pounds of herring per day caught in an area closed to 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 mid-water trawl gear stowed as directed by the Regional Administrator.

This measure will help to control the catch of herring as the TAC is approached. The increasing number of days out of the fishery is designed to steadily reduce the harvest in an area so that the TAC is harvested over a longer period, providing a supply of herring to the industry. The days out are also designed to allow a vessel to fish in an open area when another area is closed, moving effort out of the areas where catches are approaching the TAC. The restrictions on transfers at sea ease the enforcement of this provision by preventing the transfer of large illegal catches to a boat that may have legally caught herring onboard.

4.2.8.2 Transfers at Sea

A vessel may not transfer at sea to other U.S. vessels more than 2,000 pounds of herring per day in an area subject to spawning closures or effort controls. A vessel may not transfer to other US vessels more than 2,000 pounds of herring per day caught in an area subject to a spawning closure or effort controls. A vessel that catches herring in an area subject to a spawning closure or effort controls may not transfer any herring to an IWP or JV processing vessel.

4.2.9 Vessel Size Limits

This Amendment adopts size limits for vessels participating in the herring fishery. Domestic vessels catching, taking or harvesting herring must be less than 165 feet in length, and no more than 750 gross registered tonnage (GRT). Domestic vessels catching, taking or harvesting herring must have no more than 3,000 shaft horsepower.

Large harvesting vessels can have high catch rates, bycatch concerns, and marine mammal interactions. Large vessels entering the herring fishery would also rapidly increase the harvest of herring. The SARC (NEFSC 1998b) recommended that the herring harvest be increased in an incremental manner until the precision of stock estimates can be evaluated.

4.2.10 Use Restrictions

4.2.10.1 Roe Fishery

Herring may be harvested for roe as long as the carcass is not discarded. The amount of herring that may be used for roe will be determined on an annual basis and specified by the Regional Administrator based upon the recommendation of the Council after consulting with the Commission.

This will cap the amount of herring that may be harvested for roe, preventing the unlimited development of a roe fishery that may interfere with other uses of herring.

Herring roe may also be harvested through a roe-on-kelp fishery. This phrase refers to the entrapment of spawning herring until roe is deposited on either artificial or natural kelp. The spawned fish are then released. Because of the experimental nature of this fishery, any person desiring to develop a roe-on-kelp fishery for Atlantic herring is encouraged to contact the appropriate state authority during project development.

Both of these measures will allow the cautious development of a fishery that takes advantage of the high value of herring roe while at the same time protecting the resource.

4.2.10.2 Prohibition on 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, whole herring condemned for human consumption, or waste is permitted.

The harvest of herring for the primary purpose of reduction to fish meal or oil is a concern because of the large volume of fish necessary to support such an operation. The rapid harvest level may make it difficult to track landings and implement effort controls at the appropriate time. This may lead to the TAC 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.

4.2.11 Measures to Reduce/Monitor Bycatch

National Standard 9 of the Magnuson Act requires that conservation and management measures, to the extent possible, minimize bycatch and, to the extent it cannot be avoided, minimize the mortality of bycatch. The term bycatch means fish which are harvested in a fishery, but which are not sold or kept for personal use, and includes economic and regulatory discards.

There is limited information available on the extent of bycatch of regulated or protected species in the herring fishery. Recent observations on a limited number of directed herring trips indicate that there are occasional large discards of herring in the fishery. In the case of some gear types, some of these discards may survive. To minimize the impact of these discards and to encourage development of methods to reduce them, TAC s will be adjusted to account for discards.

Herring vessels also catch a large variety of other species. For marine mammals, the Northeast Fisheries Science Center has advised on a working hypothesis - *that mid-water trawling for pelagic species will result in some marine mammal bycatch.* They further state that based on worldwide information, and the historical distant water herring, mackerel, hake and squid fisheries that operated within the EEZ prior to 1977 had a marine mammal bycatch, although no documentation exists on the magnitude of the bycatch. There may be a need in the future for measures to protect marine mammals.

Available information indicates the herring fishery is a "clean" fishery, with little bycatch of other regulated or protected species. In order to monitor bycatch, the approach of the Atlantic Coastal Cooperative Statistics Program (ACCSP) will be adopted. Vessel operators will be required to record any bycatch or incidental catch; these reports will be examined by the PDT (in conjunction with the TC) on an annual basis to determine if additional management measures are required. As pointed out by the ACCSP, the most effective way to monitor bycatch is through independent fisheries observers. The Commission encourages NMFS to include the Atlantic herring fishery in its observer program.

4.2.12 Fixed Gear Fishery

All landings from fixed gear will be counted as part of the harvested TAC. States will require fixed gear fishermen to obtain a permit. Fixed gear fishermen will be required to report daily landings of herring on a weekly basis to the appropriate state agency.

4.2.13 Other Management Alternatives

4.2.13.1 Vessel Tracking System (VTS)

A VTS or VMS (Vessel Monitoring System) is an electronic device used to monitor the location of a fishing vessel. These devices broadcast the position of the vessel on a periodic basis, enabling enforcement agencies to monitor the vessel's location. These systems can be used to track days at sea, or to assist in the enforcement of fishing area or time restrictions. A VTS requirement would assist enforcement of area closures. It could also be helpful if effort restrictions are established in one management area but not in another. These devices have the ability to support rapid, near real time communications. They may be useful in supplementing the ability to monitor catch and progress in harvesting a TAC, particularly for the catch of vessels that do not land on a daily basis. The use of a VTS may be necessary if a complex TAC distribution system is adopted.

In accordance with the Council s proposed FMP, any vessel with a federal herring permit will be required to have an operable VMS if it caught or possessed more than 500 mt of herring in the previous fishing year, or if it intends to catch or possess more than 500 mt of herring in the coming year. This requirement will not apply to vessels possessing herring with no ability for harvesting - herring carriers, for example. Any vessel that lands more than 500 mt of herring must declare that intention to the Regional Administrator and must have a VMS at the start of the fishing year. If a vessel does not notify the Regional Administrator and obtain a VMS before the beginning of the fishing year, it cannot catch more than 500 mt of herring in that year. Position reports will be required hourly when the vessel is underway in state or federal waters. Position reports are not required when moored, anchored, or manuevering in a port. The system used must be approved by the Regional Administrator. Any attempt or method to determine the time or interval of location polling is prohibited.
weather and environmental conditions.

4.2.14 Internal Waters Processing (IWP) Restrictions

Internal Waters Processing (IWP) operations are permitted in all management areas, subject to an annual review and the specification of IWP allocations by management area. States are required to prohibit the transfer of herring to an IWP operation that were caught from an area or sub-area closed to directed herring fishing, i.e. when the TAC for that area or sub-area is attained. If IWP allocations are specified by area or sub-area, all herring processed must be caught from that area or sub-area. IWP operations may not receive herring caught in areas closed to protect spawning concentrations of herring.

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.

4.4 ALTERNATIVE STATE MANAGEMENT REGIMES

Once approved by the Atlantic Herring Section, a state may not relax its regulatory program without the approval of the Section, except that more restrictive measures can be implemented by states without Section approval. A state can request a change only if that state can show to the Section s satisfaction that the 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.

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

4.4.2 Management Program Equivalency

The Atlantic Herring Technical Committee (or Plan Review Team) will review any alternative state proposals under this section and provide to the 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 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.

States may apply for *de minimis* status if, for the last two years, their combined average commercial landings (by weight) constitute less than one percent (1%) of coastwide commercial landings for the same two-year period. States may petition the 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 (in consultation with the NEFMC and its Herring Committee) 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 Council 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 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 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 Section.

The 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; and shall then decide whether to adopt or revise and 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) Management area boundaries or additional management areas;
(2) Size, timing, or location of a new or existing spawning area closure;
(3) Closed areas other than a spawning closure;
(4) Restrictions in the amount of fishing time;
(5) A days at sea system, including options on transferability or leasing of DAS;
(6) Adjustments to OY, TACs, DAP, DAH, JVP, or the Reserve;
(7) Adjustments to the amount of Canadian catch deducted when determining specifications;
(8) Distribution of the TAC to an area or time period;
(9) Gear restrictions (such as mesh size, etc.) or requirements (such as bycatch reduction devices, etc.);
(10) Vessel size/horsepower restrictions;
(11) Closed seasons;
(12) Minimum fish size;
(13) Trip limits;
(14) Seasonal or area quotas;
(15) Measures to protect essential fish habitat or to facilitate aquaculture;

(16) Measures to facilitate aquaculture, such as:
    a) minimum fish sizes;
    b) gear restrictions;
    c) minimum mesh sizes;
    d) possession limits;
    e) tagging requirements;
    f) monitoring requirements;
    g) reporting requirements;
    h) permit restrictions;
    I) area closures;
    j) special management areas or zones;
(17) Changes to the overfishing definitions;
(18) Vessel tracking system;
(19) Use restrictions, such as prohibitions on mealing or a roe fishery;
(20) quota monitoring tools, such as vessel operator or dealer reporting requirements;
(21) Permit upgrading or splitting limitations, and vessel upgrading restrictions;
(22) Implementation of measures to reduce gear conflicts, such as:
    a) mandatory monitoring of a radio channel by fishing vessels;
    b) gear location reporting by fixed gear fishermen and mandatory plotting by mobile gear fishermen;
    c) standards of operation when gear conflict occurs;
    d) fixed gear marking or setting practices;
    e) gear restrictions for certain areas;
    f) vessel monitoring systems;
    g) restrictions on the maximum number of fishing vessels;
    h) special permitting conditions;
(23) Any other management measures currently included in the FMP.

These are the same measures listed as framework measures in the draft NEFMC Atlantic herring FMP.

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 1. Procedures for implementation are addressed in the ASMFC Interstate Fisheries Management Program Charter, Section 6(c)(10) (ASMFC 1995).

4.7 MANAGEMENT INSTITUTIONS

Where not inconsistent with the following provisions, the management institutions for Atlantic herring are subject to the provisions of the ISFMP Charter (ASMFC 1995).

4.7.1 ASMFC and the ISFMP Policy Board

The ASMFC and the ISFMP are generally responsible for the oversight and management of the Commission s fisheries management activities. The Commission must approve all fishery management plans, and Amendments, including this Amendment 1; and must also make all final determinations concerning state compliance or noncompliance. The ISFMP Policy Board

reviews recommendations of the various Management Boards and 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 Review Team, the Technical Committee and the Stock Assessment Subcommittee; and requests the establishment of the Commission s Atlantic Herring Advisory Panel (jointly with the NEFMC). 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 4.4 and 4.5. The Section reviews the status of state compliance with the FMP or Amendment at least annually, and if it determines that a state is out of compliance, reports that determination to the ISFMP Policy Board under the terms of the ISFMP Charter.

4.7.3 Atlantic Herring Plan Development / Review Team

The Plan Development Team (PDT) and the Plan Review Team (PRT) are composed of a small group of scientists and managers whose responsibility is to provide all of the technical support necessary to carry out and document the decisions of the Section. Both are chaired by an ASMFC FMP Coordinator. 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 1. The Atlantic Herring PDT/PRT is comprised of personnel from state and federal agencies who have scientific and management ability and knowledge of Atlantic herring. The PDT is responsible for preparing all documentation necessary for the development of Amendment 1, using the best scientific information available and the most current stock assessment information. The PDT will either disband or assume inactive status upon completion of Amendment 1. Alternatively, the Section may elect to retain PDT members as members of the PRT.

4.7.4 Atlantic Herring Technical Committee

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

4.7.5 Atlantic Herring Stock Assessment Subcommittee

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

4.7.6 Atlantic Herring Advisory Panel

The Atlantic Herring Advisory Panel is established according to the Commission s Advisory Committee Charter, in conjunction with the New England Fishery Management Council. 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. Normally, the Advisory Panel meetings will be held in conjunction with Section meetings insofar as possible.

4.7.7 Federal Agencies

4.7.7.1 Management in the Exclusive Economic Zone (EEZ)

Management of Atlantic herring in the EEZ is within the jurisdiction of the New England Fishery Management Council. In the absence of a Council FMP, management is the responsibility of the NMFS, as mandated by ACFCMA (16 U.S.C. 5105 et seq.) and the Magnuson-Stevens Act (16 U.S.C. 1801 et seq.). The NEFMC is currently developing an FMP for Atlantic herring which is scheduled to be implemented during 1999.

4.7.7.2 Federal Agency Participation in the Management Process

The Commission has accorded the USFWS and NMFS voting status on the ISFMP Policy Board. Due to the makeup of Sections under the ISFMP Charter, no federal agencies are accorded voting status on the Atlantic Herring Section. The NMFS participates on the Plan Development Team, Plan Review Team, Technical Committee and Stock Assessment Subcommittee.

4.7.7.3 Consultation with Fishery Management Councils

At the time of adoption of Amendment 1, none of the Regional Councils had implemented a management plan for Atlantic herring. However, during development of Amendment 1, the Commission and New England Fishery Management Council, through their respective committees and joint meetings, have worked in concert to develop separate but complementary management plans for their respective jurisdictions.

4.8 RECOMMENDATIONS TO THE SECRETARY FOR COMPLEMENTARY ACTIONS FOR FEDERAL WATERS

The Atlantic States Marine Fisheries Commission believes that the measures contained in Amendment 1 are necessary to prevent the overfishing of the Atlantic herring resource, and to allow growth in the fishery. The Atlantic States Marine Fisheries Commission recommends that the federal government promulgate all necessary regulations to implement complementary measures in federal waters that are contained in Sections 4.1 and 4.2. In addition, Amendment 1 calls for the Atlantic Herring Section to make additional changes to Amendment 1 via adaptive management, and as such changes are made, the Section will recommend additional measures to the Secretary. The Commission recognizes that such action may be taken under the Atlantic Coastal Fisheries Cooperative Management Act or the Magnuson-Stevens Fishery Conservation and Management Act.

Specifically, the Atlantic States Marine Fisheries Commission recommends to the Secretary of Commerce, that the Secretary implement the provisions included in the New England Fishery Management Council s Atlantic Herring Fishery Management Plan as proposed.

4.9 Cooperation with Canada

The PRT, Technical Committee and 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. COMPLIANCE

Full implementation of the provisions of this amendment is necessary for the management program to be equitable, efficient and effective. States are expected to implement these measures faithfully under state laws. Although the Atlantic States Marine Fisheries Commission does not have authority to directly compel state implementation of these measures, it will continually monitor the effectiveness of state implementation and determine whether states are in compliance with the provisions of this fishery management plan. This section sets forth the specific elements that the Commission will consider in determining state 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 1995).

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 7 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 5.3, 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 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 a regime of restrictions on Atlantic herring fisheries consistent with the requirements of Sections 4.1 and 4.2; except that a state may propose an alternative management program under Section 4.4, 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 may begin to implement Amendment 1 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 Section. During the period from submission, until the Section makes a decision on a state s program, a state may not adopt a less protective management program than contained in this Amendment or contained in current state law.

1. Each jurisdiction must enact spawning area restrictions that are at least as restrictive or more than those in Section 4.2.1.

2. Each jurisdiction shall prohibit the landing of herring from a management area or sub-area when the TAC has been attained in that area or sub-area (*Section 4.2.8.2*);

3. Each jurisdiction shall prohibit directed fishing for herring in state waters when the TAC has been attained in that area or sub-area (*Section 4.2.8.2*);

4. Each jurisdiction shall prohibit the landing of herring to an Internal Waters Processing (IWP) operation, which were harvested from an area or sub-area closed to directed herring fishing (*Section 4.2.15*);

5. Each jurisdiction shall require that (daily) herring landings from fixed gear fisheries be reported on a weekly basis, in order to monitor progress toward attaining the TAC (*Section 4.2.15*); and

6. Each jurisdiction shall annually provide a report on any mealing activity of herring occurring in their state, specifically, the amount in weight of herring processed into meal or like product, biological sampling results, and location of catch by NMFS statistical area or Management Area.

Each state s required Atlantic herring regulations and management program must be approved by the Section. States may not implement any regulatory changes concerning Atlantic herring, nor any management program changes that affect their responsibilities under this Amendment, without first having those changes approved by the Section.

5.1.1.2 Monitoring Requirements

The Section will defer action on this measure until the Atlantic Coastal Cooperative Statistics Program comes forward with their recommendation for establishment of a coastwide statistics program. However, it is the sense of the Section that a program to collect accurate and comprehensive statistics not only on the Atlantic herring fishery but for all fisheries, is necessary in order to manage in a timely and proactive manner. The Section will work to ensure that this is accomplished as soon as possible.

States must maintain at least their current reporting and data collection programs and are encouraged to adopt the recommendations forwarded from the ACCSP.

5.1.1.3 Research Requirements

No mandatory research requirements have been identified at this time. However, elements of state plans may be added to address any needs identified during the course of developing Amendment 1.

5.1.1.4 Law Enforcement Requirements

All state programs must include law enforcement capabilities adequate for successfully implementing the jurisdiction s Atlantic herring regulations. The adequacy of a state s enforcement activity will be measured by annual reports to the ASMFC Law Enforcement Committee and the PRT. Such reports will be presented at the regular ASMFC Spring meeting. The first reporting period will cover the period from January 1 to December 31, 1999.

5.1.2 Compliance Schedule

States must implement this Amendment according to the following schedule:

April 1, 1999: States must submit state programs to implement Amendment 1 for approval by the Section. Programs must be implemented upon approval by the Section.

June 1, 1999: States with approved management programs must implement Amendment 1. States may begin implementing management programs prior to this deadline.

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

5.1.3 Compliance Report Content

Each state must submit an annual report concerning its Atlantic herring fisheries and management program for the previous year. The report shall cover:

" the previous calendar year s fishery and management program including activity and results of monitoring, regulations that were in effect and harvest, including estimates of non-harvest losses;

" the planned management program for the current calendar year summarizing regulations that will be in effect and monitoring programs that will be performed, highlighting any changes from the previous year;

" a description of the operation and amount of fish mealed in conjunction with herring processing activities conducted in each jurisdiction; and

" the amount of herring harvested by fixed gear fisheries operating in state waters.

5.2 PROCEDURES FOR DETERMINING COMPLIANCE

Detailed procedures regarding compliance determinations are contained in the ISFMP Charter, Section Seven.

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 1 will be reviewed at least annually. The Section, Policy Board or the ASMFC may request the 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 to be out of compliance, a rationale for the recommended noncompliance finding will be included addressing specifically the required measures of Amendment 1 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 1 requirements.

The Policy Board will review any recommendations of noncompliance from the Atlantic Herring Section within 30 days. If it concurs in the recommendation, it shall recommend at that time to the ASMFC that a state be found out of compliance.

The Commission shall consider any Amendment 1 noncompliance recommendation from the Policy Board within 30 days. Any state which is the subject of a recommendation for a noncompliance 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 1, 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 noncompliance findings, provided the state has revised its Atlantic herring conservation measures.

6. MANAGEMENT AND RESEARCH NEEDS

6.1 STOCK ASSESSMENT AND POPULATION DYNAMICS

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.

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.

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.

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.

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.

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.

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 appropriate.

Investigate the effects of averaging maturity rates over blocks of years to help smooth some of the interannual variability in the calculation of spawning stock biomass.

Consider potential discards if fishing mortality increases in the future.

Organize annual U.S.-Canada workshops to coordinate stock assessment activities and optimize cooperation in management approaches between the two countries.

6.2 RESEARCH AND DATA NEEDS

6.2.1 Biological

Identify known spawning areas where herring deposit eggs.

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.

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.

6.2.2 Social

Develop socio-economic analyses appropriate to the determination of optimum yield.

6.2.3 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.

6.2.4 Habitat

Establish critical spawning habitat areas or special management zones to protect spawning aggregations of herring and/or demersal egg masses.

6.2.5 General

Ensure the monitoring of the IWP landings through the use of trained observers placed aboard IWP processing vessels or through the use of log books.

7. 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 of the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA) in state waters. Historically, these policies have been only minimally implemented and enforced in state waters (0-3 miles). In November 1995, the Commission, through its Interstate Fisheries Management Program (ISFMP) Policy Board, approved amendment of its ISFMP Charter (Section 6(b)(2)) so that protected species/fishery interactions are addressed in the Commission's fisheries management planning process. Specifically, the Commission's fishery management plans 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 which 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

Since its passage in 1972, one of the underlying goals of the MMPA has been to reduce the incidental serious injury and mortality of marine mammals permitted in the course of commercial fishing operations to insignificant levels approaching a zero mortality and serious injury rate. Under 1994 Amendments, the Act requires NMFS to develop and implement a take reduction plan to assist in the recovery or prevent the depletion of each strategic stock that interacts with a Category I or II fishery. Category I and II fisheries are those that have frequent or occasional incidental mortality and serious injury of marine mammals, respectively. A strategic stock is defined as a stock: (1) for which the level of direct human-caused mortality exceeds the potential biological removal (PBR) level; (2) which is declining and is likely to be listed under the Endangered Species Act (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.

7.2 ENDANGERED SPECIES ACT (ESA) REQUIREMENTS

The taking of endangered sea turtles is prohibited under Section 9 of the ESA. There are several mechanisms established in the ESA to avoid the takings prohibition in Section 9. First, the Secretary (of Commerce) may issue Section 4(d) protective regulations necessary and advisable to provide for the conservation of [threatened] species. These implementing regulations provide conservation measures to reduce incidental take and thus allow for the exemption from the taking prohibition. Section 10(a)(1)(B) of the ESA authorizes the Secretary to permit, under such terms and conditions as he or she may prescribe, 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 the Secretary 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 measures to monitor and minimize such take.

7.3 PROTECTED SPECIES WITH POTENTIAL FISHERY INTERACTIONS

A number of protected species inhabit the management unit addressed in Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sea Herring. Eleven are classified as endangered or threatened under ESA; the remainder are protected under provisions of the MMPA. The species found in New England and Mid-Atlantic waters are listed below.

Endangered

Right whale	(*Eubalaena glacialis*)
Humpback whale	(*Megaptera novaeangliae)*
Fin whale	*(Balaenoptera physalus)*
Sperm whale	*(Physeter macrocephalus)*
Blue whale	*(Balaenoptera musculus)*
Sei whale	*(Balaenoptera borealis)*
Kemp s Ridley turtle	*(Lepidochelys kempi)*
Leatherback turtle	*(Dermochelys coriacea)*
Green sea turtle	*(Chelonia mydas)*
Shortnose sturgeon	*(Acipenser brevirostrum)*

Threatened

Loggerhead turtle	*(Caretta caretta)*

Species Proposed for ESA Listing

Harbor porpoise (*Phocoena phocoena*)

In the northeast, protected species utilize marine habitats for purposes of feeding, reproduction, as nursery areas and as migratory corridors. For several stocks of marine mammals, including harbor porpoise, herring are an important prey species. Some species occupy the area year round while others use the region only seasonally or move intermittently inshore and offshore.

For sea turtles, the Atlantic seaboard is considered to provide important developmental habitat for post-pelagic juveniles, as well as foraging and nesting habitat for adults. The distribution and

abundance of sea turtles along the Atlantic coast is related to geographic location and seasonal variations in water temperatures. Water temperatures dictate how early northward migration begins each year and is a useful factor for assessing when turtles will be found in certain areas. Moderate to high abundances of sea turtles have been observed both offshore and nearshore when water temperatures are greater than or equal to 21° C. As water temperatures decline below 11° C, abundance declines markedly and turtles typically move from cold inshore waters in the late fall to move offshore to the warmer waters in the Gulf Stream, generally south of Cape Hatteras, North Carolina. Conversely, in the late spring and early summer, they migrate from the Gulf Stream waters into the sounds and embayments.

7.4 PROTECTED SPECIES INTERACTIONS WITH EXISTING FISHERIES

7.4.1 Marine Mammals

Entanglements of several species of marine mammals have been documented in fishing gear employed in the Atlantic herring fishery. They include: the northern right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaeangliae*), minke whale (*Balaenoptera acutorostrata*), harbor porpoise (*Phocoena phocoena*), harbor seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*).

A description of the major commercial gear types used in the herring fishery is provided in *Section 1.3*. In recent years purse seine and mid-water trawl gear have accounted for the majority of landings, while the use of fixed gear (stop seines and weirs) has declined significantly since 1994. Although poorly documented, herring fishing for the purpose of obtaining bait for the lobster and tuna fisheries has increased along with the expansion and/or value of those fisheries. A large number of bottom trawl vessels appear to engage in the herring fishery on a sporadic basis, but actually account for only a small fraction of the overall landings (Table 8).

Table 8. Landings by major gear type (metric tons), 1986-1997 (source: NMFS, Fisheries Statistics and Economics Division, http://remora.ssp.nmfs.gov/commercial/landings; 1997 data are preliminary).

Gear	Year													
	1984	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Floating Traps (Shallow)	16	8	23	13	21	5	15	0	0	8	3	0	2	.085
Gill Nets, Drift, Other		1	0	0	1		5	1	1	0	3	8	11	9
Gill Nets, Other	5	1	0	3	20	2,629	5	12	3	12	19			
Gill Nets, Sink/Anchor, Other											12	30	3	39
Lines Long Set With Hooks							0		45		0			
Not Coded											1	55		
Otter Trawl Bottom, Fish	491	249	870	1,345	1,389	692	944	1,955	4,836	2,513	2,894	2,003	1,886	1,203
Otter Trawl Bottom, Other										4				
Otter Trawl Bottom, Shrimp	4	3	17	16	19	14	0	5	2	0	0	318		
Otter Trawl Midwater					774				1,939	6,114	7,164	30,644	31,585	41,311
Pots and Traps, Lobster						0			0		51		0	
Pound Nets, Fish	8		4		16	0	2	18	7	2	1	0	3	1
Pound Nets, Other					201				0	1				
Purse Seines, Herring	29,428	21,004	29,012	36,515	36,266	35,846	50,032	44,708	45,118	38,432	34,546	34,608	54,695	51,240
Purse Seines, Mackerel	12										82			
Purse Seines, Other											8			
Stop Seines	70	3,739	1,645	1,225	732	763	216	918	3,443	2,290	293		438	
Trawl Bottom, Paired	8		0					2						
Trawl Midwater, Paired	1,349	2			282		2	1,108		59		839		1,373
Weirs	228	860	382	311	1,202	765	422	50	393	56	168		18	170
Grand Total	31,619	25,867	31,954	39,428	40,925	40,714	51,644	48,778	55,787	49,492	45,247	68,504	88,641	95,348

The impacts of bottom trawling on endangered species of whales, sea turtles, and fish under NMFS jurisdiction, as well as impacts on critical habitat areas designated for the northern right whale were previously addressed pursuant to Section 7 of the ESA for Amendments 5 and 7 to the Northeast Multispecies FMP. According to the NMFS 1998 Final List of Fisheries (*Federal Register*, Vol. 63, No. 23) published pursuant to Section 118 of the MMPA, bottom trawls as well as the other gears used in this fishery are classified as Category III, those with a remote likelihood of causing incidental mortality and serious injury to marine mammals. The list provides species taken by gear type.

The Gulf of Maine/U.S. Mid-Atlantic Atlantic herring midwater trawl fishery, including the herring pair trawl fishery (one net towed by two vessels), was recently classified as a Category II fishery under the MMPA due to possible interactions with harbor porpoise and other marine mammal species. The rationale for this listing is: (1) that this fishery utilizes gear similar to an already classified Category II fishery for Atlantic squid, mackerel and butterfish fishery, which is known to take several species of cetaceans; and (2) the fishery operates at times and in locations of significant densities of marine mammals. For example, based on information provided in association with Framework 18 to the Northeast Multispecies FMP, upwards of 35 vessels may be using mid-water trawls in times and locations where there are high densities of harbor porpoise.

The Gulf of Maine purse seine fishery remains a Category III fishery for 1999. This fishery may experience possible interactions with harbor porpoise, and harbor and grey seals.

7.4.2 Sea Turtles

All sea turtles that occur in U.S. waters are listed as either endangered or threatened under the ESA. Five species occur along the U.S. Atlantic coast, namely, loggerhead (*Caretta caretta*), Kemp s Ridley (*Lepidochelys kempi*), green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbricata*). 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, seabirds are vulnerable to entanglement in commercial fishing gear. The interaction has not been quantified in the New England and Mid-Atlantic herring fishery, but impacts are not considered to be significant. Human activities such as coastal development, habitat degradation and destruction, and the presence of organochlorine contaminants are considered to be the major threats to some seabird populations. Endangered and threatened bird species, which include the roseate tern and piping plover, are unlikely to be impacted by the gear types employed in the herring fishery.

7.5 POPULATION STATUS REVIEW OF RELEVANT PROTECTED SPECIES

7.5.1 Marine Mammals

Three of the six marine mammal species known to become entangled in gear used by the Atlantic herring fishery --namely, northern right whale, humpback whale and harbor porpoise -- are classified as strategic stocks under the MMPA. As strategic stocks, these species are of particular concern because either (1) the level of direct human-caused mortality exceeds the potential biological removal (PBR) level for the stock; (2) the stock is declining and is likely to be listed under the Endangered Species Act (ESA) in the foreseeable future; or (3) the stock is listed as a threatened or endangered species under the ESA or as a depleted species under the MMPA. Above all, the species of greatest concern is the right whale, which is one of the most endangered species in the world, numbering only around 300 animals.

The status of these and other marine mammal populations inhabiting the Northwest Atlantic has been discussed in great detail in the U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments. Initial assessments were presented in Blaylock et al. (1995) and were updated in Waring et al. (1997). The report presents information on stock definition and geographic range, population size and productivity rates and unknown impacts.

More detailed descriptions of these species, including endangered sea turtles and fish, can also be found in the Council's Final Environmental Impacts Statements for Amendments 5 and 7 to the Northeast Multispecies FMP, Amendment 5 to the American Lobster FMP, and Amendment 4 to the Atlantic Sea Scallop FMP. The most recent information on sea turtle status is contained in the 1995 and 1997 status reviews of listed turtles prepared jointly by NMFS and the U.S. Fish and Wildlife Service (NMFS and USFWS 1995, 1997).

7.5.2 Sea Turtles

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7.6 EXISTING AND PROPOSED FEDERAL REGULATIONS/ACTIONS PERTAINING TO THE RELEVANT PROTECTED SPECIES

In 1997, the New England Fishery Management Council approved Framework Adjustment 16 to the Northeast Multispecies FMP to address the potential for harbor porpoise entanglements in the bait fishery, the Council in 1997. The action restricts the use of small mesh pelagic gillnets when the harbor porpoise time/area closures are in effect - parameters that most likely mirror highest porpoise densities in the Gulf of Maine. The intent was to avoid increasing the risk of porpoise entanglements, but still allow a traditional bait fishery to continue by specifying the size of the net (300 feet) and deployment of the gear (the net must be attached to the vessel).

7.7 POTENTIAL IMPACTS TO ATLANTIC COASTAL STATE AND INTERSTATE FISHERIES

As a recently classified Category II fishery, the Gulf of Maine/U.S. Mid-Atlantic Atlantic herring midwater trawl fishery, including the herring pair trawl fishery, will be subject to regulations stemming from the development and subsequent approval of a take reduction plan as specified by the MMPA. Until that time, fishermen participating in this fishery will be required under the MMPA to report all incidental mortalities and injuries of marine mammals during the course of commercial fishing operations to NMFS Headquarters. Additionally, they may be required, upon request, to accommodate an observer aborad their vessels.

7.8 IDENTIFICATION OF CURRENT DATA GAPS AND RESEARCH NEEDS

A lack of sea sampling data in regards to protected species interactions in the domestic Atlantic herring fisheries has been identified during the course of drafting this amendment. Additional observer coverage for this fishery is needed to alleviate this lack of data.

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