2.0 History and Purpose of the FMP

2.1 History of Prior Management Actions

Management of U.S. Northwest Atlantic sea herring stocks beyond territorial waters commenced in 1972 through the International Commission for the Northwest Atlantic Fisheries (ICNAF). The international fishery was regulated by ICNAF until U.S. 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 U.S. waters was regulated through a preliminary management Plan (PMP) prepared by the National Marine Fisheries Service (NMFS).

The international fishery for adult herring in the Gulf of Maine began in 1967, principally by the U.S. and Canada with minor catches by the Federal Republic of Germany and the German Democratic Republic during the period 1969-1975. Catches averaged 38,500 mt from 1969 to 1972 as the accumulated stock was heavily exploited by small side trawlers using otter trawls and by purse seiners. Prior to 1975, the fishery primarily targeted spawning fish on spawning grounds in the Jeffreys Ledge – Cape Ann area. Subsequently, reduced catches ranging from 16-24,000 mt through 1979 were taken exclusively by U.S. vessels, including a newly developed pair-trawling system that exploited overwintering and migrating herring on grounds expanded into Massachusetts Bay and the Cape Cod area.

Under management by ICNAF, total allowable catch (TAC) from the Gulf of Maine stock was steadily reduced from 30,000 mt in 1972 to only 7,000 mt in 1976 and 1977. Consistent catch overages occurred however, throughout the period, reducing spawning stocks to low levels such that the fishery became heavily dependent upon the strength of recruiting year classes.

The Georges Bank herring fishery began in 1961 with the USSR taking 68,000 mt with extensive use of gill nets during the first three years of the fishery. Purse seines were later introduced by the USSR and were used from 1968 until the fishery collapsed in 1977. Subsequently, a number of other foreign distant water fleets entered the fishery, most notably the German Democratic Republic, the Federal Republic of Germany and Poland, with catches building rapidly to 374,000 mt in 1968, averaging 283,000 mt from 1967 to 1971. The dominant gear types used in the fishery were large, bottom tending otter trawls deployed from side and stern trawlers until the German Democratic Republic introduced mid-water trawlers in 1971 (Anthony and Waring, 1980).

The history of Georges Bank herring management under ICNAF was characterized by catch quotas which were influenced more by considerations of social disruptions and short term gains than by conservation (Anthony and Waring, 1978). The Commission typically selected the highest catch options provided by assessment scientists and in some cases specified catch quotas one to three times higher than recommended amounts. The result of this policy was that the Georges Bank and Gulf of Maine spawning stocks were reduced to low levels with the expectation that

recruitment would also remain low with potentially disastrous consequences for the fishery and the resource (Clark and Anderson, 1977). The TAC recommended by assessment scientists to the Commission for Georges Bank never exceeded 150,000 mt with the range of options being as low as 50,000 mt. Despite the advice that catch levels should remain in the range 100,000-150,000 mt, provided that a minimum stock constraint of 225,000 mt was met, the allocations approved by the Commission totaled 150,000 mt from 1972 to 1975 even though stock sizes were plummeting to only 65,000 mt (age 4+) in 1975 (Anthony and Waring, 1980). The concern for the future of the resource was so great that scientific advice in 1977 was a zero quota for the Gulf of Maine and 50,000 mt or less for Georges Bank, with only 8,000 mt being recommended for Georges Bank in 1978.

The Sea Herring FMP developed by the Council and implemented on December 28, 1978 sought to manage the Gulf of Maine and Georges Bank adult herring stocks so as to achieve levels of spawning biomass providing continued and relatively stable recruitment. The second objective of the FMP was to manage the Gulf of Maine juvenile herring resource to stabilize and rebuild the sardine industry.

The FMP accepted the ICNAF recommendation of 60,000 mt as the minimum biomass for the Gulf of Maine spawning stock. In the context of the estimated level of spawning stock at the beginning of 1978 of only 68,000 mt, the assessment scientists recommended a 10-year rebuilding schedule whereby annual catches of adult herring (age 3 and older) would initially be restricted to only 1,000 mt so as to achieve an optimum spawning stock size of 100,000 mt. With regard to the Georges Bank resource, ICNAF had recommended a minimum stock constraint of 225,000 mt and an optimum stock size of 500,000 mt. The assessment had indicated that the spawning stock size of 1978 was at least 200,000 mt and that catch levels in the range of 16-26,000 mt in 1978 would result in a spawning stock slightly above the minimum constraint at the beginning of 1979. With the same level of recruitment, and catches remaining in the same range, the stock could be rebuilt at a rate of about 10% per year.

The Council decided to delay rebuilding the Gulf of Maine adult herring resource until at least 1980, choosing instead a maintenance strategy to minimize adverse impacts on the fishing industry. The initial optimum yield (OY) for the Gulf of Maine stock was set at 8,000 mt for the 1978-1979 fishing year, recognizing recent catch levels of adult fish along the coast of Maine but stipulating that such catches should not exceed 7,000 mt. Optimum yield for the Georges Bank stock (1978-1979 fishing year) was set at 10,000 mt. These OY's were split between a winterspring fishery (December-June) and a summer-fall fishery (July-November) in recognition of information regarding migratory movements of herring recently acquired from tagging studies. Thus, the winter-spring quota in the Georges Bank and South region was only 2,500 mt to minimize impacts on Gulf of Maine fish which overwinter with Georges Bank fish in the Southern New England area. The summer-fall quota in the region was set at 7,500 mt. OY in the Gulf of Maine was evenly split, 4,000 mt in the winter-spring fishery and 4,000 mt in the summer-fall fishery.

The Sea Herring FMP was initially implemented as emergency regulations on December 20, 1978, becoming final regulations effective on March 19, 1979. Amendment #1 to the FMP, published as emergency regulations (reflecting the Council's concern to remain abreast of conditions in the

fishery) on March 28, 1979 (final regulations published on June 26, 1979), was intended to clarify the Council's policy with regard to the quota-setting mechanism for the Georges Bank and South winter-spring fishery. Based on the fact that all of the herring tagging studies had indicated that no Gulf of Maine fish migrate further south and west of the area of Montauk Point, NY, Amendment #1 stipulated that all fish taken west of 71° 50' W. Long. would be counted against the relatively large Georges Bank and South summer-fall quota. Through this action the Council was encouraging fishermen to concentrate fishing pressure on the Gulf of Maine stock wherever found during seasonal migrations.

Amendment #2 to the FMP, implemented under emergency regulation on July 1, 1979 (published under final regulations on September 28, 1979) at the beginning of the 1979-1980 fishing year, extended the OY's and the summer-fall and winter-spring quotas, as established in the FMP. Simultaneously, the Council was engaged in preparation of Amendment #3. Recognizing deficiencies in the scientific basis to the previous stock assessments and the scheme for apportioning seasonal allocation of adult fish by management area, the Council formed a Regional Herring Assessment Working Group to address management of the entire herring resource. The resulting "pooled" assessment of the total herring resource formed the basis for substantial increases in optimum yield and for major changes in the area/period allocation scheme. Perhaps the most significant provision of Amendment #3 was a redefinition of the management unit to include all adult (age 3 and older) herring fisheries from the shoreline of the New England and Mid-Atlantic states out to the limit of the U.S. EEZ. Previously, the adult herring caught in territorial waters of the state of Maine were not explicitly counted against the Gulf of Maine quota. Amendment #3 specified OY's of 30,000 mt for the Gulf of Maine adult fishery and 15,000 mt for Georges Bank and South. Moreover, Amendment #3 subdivided the Gulf of Maine annual quota of adult fish between a traditional "juvenile" fishery (north of Cape Elizabeth) and a traditional "adult" fishery (south of Cape Elizabeth), specifying a 35% - 65% split between the two areas, respectively. Amendment #3, which also specified an area/period allocation system somewhat more complex than that which was modified in Amendment #1, was implemented on August 27, 1980.

Prior to final implementation of Amendment #3, however, the NMFS Regional Director was obliged to close the Gulf of Maine adult fishery on October 1, 1979, when landings reached 17,000 mt (exceeding seasonal quota by 13,000 mt). In retrospect, the original 8,000 mt annual quota (4,000 mt seasonal quota) may have been overly restrictive (in light of the "pooled" assessments which indicated a 30,000 mt OY). Certainly, the assumption that no more than 7,000 mt of adults would be taken in the juvenile fishery along the coast of Maine was tested and found to be wanting. Moreover, the incentives offered by Amendment #1 to shift fishing effort to waters west of 710 50' W. Long. (i.e., away from Gulf of Maine fish) proved to be ineffective for two reasons. The extent of the collapse of the Georges Bank resource was underestimated by ICNAF. By accepting the final assessment advice provided by ICNAF, the Council compounded the error. Secondly, the Council underestimated the resistance by industry to reduce its dependence on the traditional adult fishery in the Jeffrey's Ledge area.

A far more serious concern to the Council, however, was the regulatory ambiguity associated with catches of adult herring in state waters in the Gulf of Maine. The Maine sardine packers have traditionally employed small purse seiners taking mainly three year old fish to make up any shortfall in fixed gear catches of two year olds to achieve the total contracted pack. Thus, availability of two year olds plus the world herring market conditions were major factors driving catches of adult fish in the state waters of Maine. Maine regulatory agencies would be very reluctant to enforce catch limitations promulgated by federal agencies since to do so would involve closing down the operation of packing plants which often represented the sole source of employment in many small communities. Despite considerable effort to arrive at an equitable solution to the problem, the Council was unable to resolve the problem. Moreover, Massachusetts fishermen, experiencing higher fish availability than was suggested by the very restrictive catch quotas, and observing apparent wholesale quota busting in Maine waters, were able to bring sufficient pressure to bear on the Massachusetts regulatory agencies such that the latter declined to enforce the quotas in state waters.

Observing an increasingly chaotic situation, NMFS held hearings in May, 1981, to consider whether the Secretary of Commerce should rescind all or portions of the Sea Herring FMP, implement a Secretarial amendment, preempt state management authority, or take no further action. Subsequently, the NOAA Assistant Administrator for Fisheries (AA) requested that the Council develop an amendment by July 1, 1982, which addressed the major flaws in the FMP. It was clear to most observers that catch restrictions were unenforceable. NMFS also asserted that the FMP violated several of the National Standards. In the event, the Council was unable to meet the AA's request. On September 28, 1982, the Department of Commerce announced its initial determination to withdraw Secretarial approval of the Sea Herring FMP and repeal all implementing regulations. Concomitant to this action, sea herring was placed on the prohibited species list, eliminating directed fisheries for sea herring by foreign nationals within the U. S. EEZ and requiring that any herring by catches by such vessels be discarded.

In the midst of this controversy, fisheries officials from the states of Maine, New Hampshire, Massachusetts, and Rhode Island began a series of meetings on March 12, 1982 to discuss development of an interstate herring management plan. It was recognized that with the fishery occurring predominately in state waters, it was critical that all of the herring-producing states fully embrace an agreed management program. The lack of such a commitment by the states proved to be the most significant flaw in the Sea Herring FMP. The Atlantic States Marine Fisheries Commission (Commission) represented a potential vehicle for production of an interstate herring management plan. However, it was decided that Maine and Massachusetts, with consultation from the other two states, could most expeditiously produce a new plan. That effort was commenced on October 25, 1982 with formation of a Plan Development Team (PDT) tasked with creation of a draft document by April 1983.

The final draft of the "Interstate Sea Herring Management Plan of Maine, New Hampshire, Massachusetts, and Rhode Island" (Plan) was presented by the PDT on November 28, 1983. The Plan was based on one objective and two sub-objectives. These were:

"To acquire information that will allow development and facilitate implementation of management approaches designed to minimize prospects of a collapse of herring stocks on which New England fishermen depend.

- To protect spawning herring.

- To promote complementary management of all components of sea herring fisheries throughout the range of the stocks of interest to U. S. fishermen, including relevant Canadian waters."

The plan deliberately chose not to embrace the conservative management espoused by the Council's FMP through disenchantment with the state of knowledge of quantitative herring stock assessment. Both the states and the industry had observed lost opportunities in the world herring market in 1979 and 1980 when the NMFS Regional Director was obliged to close the fishery as quota overages occurred. Yet, in retrospect, if more accurate resource assessments had been available, the resulting higher allowable harvest levels might not have necessitated fishery closures. The Plan also rejected quota management due to the issues associated with fairness between the adults and juvenile fisheries. The Plan asserted that barring development of fish recruiting to the juvenile fishery, these issues would continue to undermine concerted action by the states which was critical to successful quota management.

The primary management measure implemented by the Interstate Sea Herring Management Plan was a system of spawning closures. The rationale for a prohibition on fishing during the spawning period was based on a widely held concern that unrestrained fishing on spawning aggregations of pelagic species such as sea herring may lead to stock collapse. The dense schooling behavior of herring immediately prior to and during spawning make fish extremely vulnerable, especially to gear such as pair trawls and purse seines, leading to very excessive levels of fishing mortality. Moreover, with disruption of normal behavior patterns, surviving fish may not necessarily spawn successfully. Accordingly, the Interstate Plan specified that spawning closures be instituted, as appropriate, and that such closures be in the form of fixed periods in time, on an annual basis, or could be based on measured biological criteria. If a state opted to take the former route, the most appropriate period of time was judged to be the 3-week period, October 1-31 for the Jeffreys Ledge spawning area; if the latter, a spawning closure would be declared when the weight of the gonad in adult female herring reaches 18% or more of the total weight of the fish.

An additional important provision of the Interstate Plan was that the Plan Development Team would continue to meet on an annual basis after plan implementation to conduct resource assessments and formulate recommendations regarding Plan amendments, as needed, reporting such activity to the states and to the Council. As part of the consultative process, the PDT also would endeavor to promote cooperative arrangements with Canadian management authorities and assessment scientists.

By 1992, the Interstate Herring Management Plan was no longer adequate to manage herring throughout its range. There was a dramatic increase in the numbers of adult spawning herring on historical spawning grounds on Nantucket Shoals and Georges Bank. This resulted in an increased abundance of herring in coastal waters of southern New England and the Mid-Atlantic states. This stimulated interest in Internal Waters Processing (IWP) operations in Rhode Island, Massachusetts, and Maine, and resulted in increased herring bycatches in the mackerel fishery. Increased numbers of adult herring on Georges Bank provoked interest by the Canadian purse seine fleet for an additional source of roe herring for the Japanese market. Concern grew that development of new markets could lead to an uncontrolled exploitation at a time when the

offshore spawning population was still recovering from heavy foreign fishing pressure.

At the same time, the catch of adult herring in the Gulf of Maine increased as well, in part due to a growth in IWP operations in Maine and Massachusetts. There was a significant, continued shift to mobile gear for a much larger percentage of the catch as juvenile fish became scarce in near shore waters. An increased demand for bait in the burgeoning lobster fishery also helped shift the fishery to a predominantly adult fishery. The fishery shifted from one in which the bulk of the catches were made in state waters to the majority of the catch being taken in federal waters.

The Council and the ASFMC began joint efforts to adopt a new FMP to address these concerns. A joint planning effort was begun that focused on improving the IWP allocation procedure, but also identified the necessity for improvements in US/Canadian cooperation in herring management and the need for better scientific information (particularly with respect to individual stock assessments). It was also recognized that as a trans-boundary stock, both the U. S. and Canada would benefit from the development of complementary management measures. Unfortunately, because of more immediate concerns with the management of groundfish in New England, the Council removed itself from the planning process for the FMP.

The Commission, however, adopted a new fishery management plan in March, 1994. The Commission adopted the following goals and objectives:

"The goal of this management plan is to manage Atlantic herring as an inter-jurisdictional resource in U.S. Atlantic coast waters for sustained optimum utilization while conserving the resource through complementary management between the New England and Mid-Atlantic Fishery Management Council, the U.S. Atlantic coast states, and Canada in a manner which will provide the greatest benefit to the nation.

The objectives are:

1) To maintain the U.S. northwest Atlantic sea herring resource at or above 20 percent of its maximum spawning potential for optimum utilization while reducing the risk of stock collapse;

2) To promote U.S. and Canadian cooperation in order to improve herring assessment procedures and to establish complementary management practices.

3) To promote research and improve the collection of information in order to better understand the herring population dynamics, biology, and ecology, and to improve assessment practices;

4) To provide adequate protection for spawning herring and prevent damage to herring egg beds;

5) To avoid patterns of fishing mortality by age which are inconsistent with the goal;

6) To establish complementary management of all components of the fishery throughout

the range of the species in U.S. waters of the northwest Atlantic;

7) To promote the utilization of the resource in a manner which maximizes the social and economic benefits to the nation;

8) To promote recovery of the Atlantic herring resource on Georges Bank and to control development of the fishery.

The Commission FMP established three management areas within the U. S. waters of the northwest Atlantic. A procedure was established to annually assess the coastal stock complex and estimate the total adult surplus biomass available for harvest. This procedure included a recommendation on how much of the surplus to hold in reserve and how much to allocate to IWP's. The FMP continued the practice of closures to protect spawning herring (ASMFC, 1994). Because of the lack of a federal plan, however, there was no opportunity for Joint Venture activities in the EEZ.

In 1995, the NMFS implemented a Preliminary Management Plan to regulate joint venture activities in the EEZ. There were indications that the offshore component of the stock was continuing to grow, coupled with concerns over the fairly intense fishing pressure on inshore stocks. The goal of this PMP was to allocate surplus biomass for joint venture utilization in federal waters without depleting the stock or jeopardizing individual spawning components within the stock, in a manner consistent with the Commission FMP. The PMP adopted the Commission definition for overfishing, adopted the three management areas, and established an allocation procedure. Joint venture processing was prohibited in Area 1. Observer and data reporting requirements were adopted for foreign vessels (NMFS, PMP for Atlantic Herring, 1995).

In 1995, the historic practice of transporting U.S. caught herring to Canada in Canadian flag herring carriers came to the attention of fisheries managers. This practice was used to ease shortages of raw materials for sardine canneries on both sides of the border. Technically, the transport of such herring was a foreign fishing activity regulated by the Magnuson Act and subject to the requirements for a governing international fishery agreement between the two countries. This issue was addressed in a provision of the Sustainable Fisheries Act (P.L. 104-297) passed in October, 1996. NMFS was authorized to issue up to fourteen permits to Canadian vessels that would transport U.S. caught herring from identified areas within 12 nautical miles of the Maine coast. In 1997, fourteen permits were issued, and in 1998 a total of 13 permits were issued for this activity.

The Commission and the Council also began to develop a new management plan for herring in 1996. Evidence of the recovery of the George Bank spawning stock, coupled with increased landings from the Gulf of Maine, increased interest in the controlled development of the fishery. Rather than develop a joint FMP, the Council and the Commission decided that the most flexible way to manage the fishery was for the Council to develop an FMP for federal waters, and the Commission to develop an amendment to its existing Atlantic herring management plan for state waters. Recognizing the importance that the two plans complement each other, the Council and the Commission worked closely in developing these two documents. The Council's Herring Oversight Committee and the Commission's Atlantic Herring section met in joint sessions to

discuss proposed management measures. In addition, both the Council and the Commission adopted the same panel of industry advisors, and the Plan Development Teams (PDT) of both bodies were identical and held all their meetings together. This proposed management plan is the result of the joint process begun in 1996.

In early 1997, the Council and Commission became aware of interest from large factory trawler owners in exploiting the herring resource. This led the Commission to adopt an emergency action to prohibit the landing of herring by vessels over 165 feet in length and/or 3000 horsepower and to prohibit the directed mealing of herring. The Council passed a motion supporting the Commission's action and addressed the issue during development of the management plan. One vessel, the F/V Atlantic Star, obtained a letter of authorization necessary to use a mid-water trawl to fish for herring in the Gulf of Maine or Georges Bank. Congress also addressed this issue in the NMFS appropriations bill for fiscal year 1998, restricting the agency from using its funds to issue permits or other authorization letters to vessels over 165 feet in length, 750 GRT, and 3,00 shaft horsepower. This bill required NMFS to rescind the letter of authorization it had issued to the Atlantic Star, which had not yet begun to fish. The exact impact of the legislation was open to several interpretations. While it clearly prevented NMFS from issuing a permit to large vessels to fish for mackerel, or the required letter of authorization to use a mid-water trawl for herring on Georges Bank and the Gulf of Maine, it was uncertain whether it also prevented the Atlantic Star from fishing for herring in area outside the Gulf of Maine or Georges Bank or from processing herring, since at the time there were no existing permit requirements for either of these activities. In any case, the Commission's emergency action, implemented through state legislation, limited the ability of the Atlantic Star to land herring in the coastal New England and mid-Atlantic states.

The language that restricted NMFS from issuing permits to large domestic vessels to fish for mackerel or Atlantic herring was also included in the appropriations bill for fiscal year 1999 (P. L. 105-277). In addition, Title II of this law adopted the American Fisheries Act which, among other provisions, placed additional restrictions on the ownership and documentation of fishing vessels. This Title includes a revision to documentation laws such that vessels greater than 165 feet in registered length, of more than 750 gross registered tons, or that have more have 3,000 shaft horsepower cannot receive a certificate of documentation and a fishery endorsement except under certain conditions. One of these conditions is that the owner must demonstrate that the regional fishery management measures that allow such a vessel to be used in fisheries under the Council's authority. Another provision allows vessels that received a fishery endorsement prior to September 25, 1997, to retain that endorsement.

2.2 Purpose and Need for Action

The Council has reviewed the status of the Atlantic herring resource and the condition of the industry which utilizes this resource. The Council determined that sufficient management problems exist to warrant the development and implementation of a complementary federal and interstate program for conservation and management. This review and decision were coordinated with the Atlantic States Marine Fisheries Commission (Commission) and the Mid-Atlantic Fishery Management Council (MAFMC).

The U.S. Atlantic herring fishery is currently managed as one 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)/Nantucket Shoals (NS) component. The most recent fully reviewed assessment (NEFSC, 1998) concluded that the abundance of the coastal stock complex in 1997 was 2.9 million (mt) while the estimate of spawning stock biomass (SSB) was 1.8 million mt. The current level of abundance has generated competing interests in new and expanded sectors of the herring fishery.

The herring resource is in an under-exploited state and there is increasing commercial interest in developing this fishery. There are, however, concerns that specific spawning components (notably the Gulf of Maine (GOM) component) may be unable to sustain current or increased fishing pressure over the long term. There is also concern that uncontrolled exploitation of this stock may lead to a stock collapse in the future, similar to the collapse experienced on Georges Bank after intense foreign fishing pressure in the mid-1970's. The primary issue facing this FMP is to manage the herring resource in such a way that development of the fishery continues without damaging any specific spawning components.

Absent implementation of this FMP, there is a distinct risk that increased fishing pressure may harm specific spawning components. Reported catches of herring have increased steadily over the last three years, from 53,000 mt in 1994 to 104,000 mt in 1996. The bulk of this catch (84,000 mt in 1996, 70,171 mt in 1997) has been taken from the Gulf of Maine spawning component. While this level of fishing pressure can be supported in the short term due to exceptional stock sizes, if continued over time it will lead to overfishing of the stock and a possible stock collapse. Recent history provides an 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 resource for coastal communities and as a prey species, the Council wants to implement controls to ensure its continued viability.

At the same time, the recovery of herring stocks on Georges Bank presents an opportunity for an expanded fishery. With pressure on other species leading to increased regulation, a Georges Bank herring fishery may provide increased economic opportunity for fishermen in those fisheries. Either through directed fishing, joint ventures, or internal waters processing operations, an expanded herring fishery may insure the economic survival of these fishermen until other 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 herring export market for food production

Management of sea herring is complicated by the limited information available on some herring aggregations, and on the mixing of herring spawning components. There is a need for improved scientific information on these issues in order to correctly manage the resource. This FMP 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 landing information by fishermen and dealers, a strong base will be laid for future management efforts.

Section 314(c) of the Magnuson-Stevens Act directs the New England Fishery Management Council to develop a fishery management plan for any underutilized species of the northwest Atlantic Ocean. Herring was identified as an underutilized species by the Northeast Fisheries Science Center in 1996 (NEFSC 1996) and again in 1998 (NEFSC 1998b).

To address these concerns, the Council's Atlantic Herring Fishery Management Plan proposed to establish a continuing management program for the herring resources within the Exclusive Economic Zone (EEZ) of the U.S. The Commission's Amendment One to its Atlantic Herring FMP will modify 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.

2.3 Goals and Objectives

The Council proposes the following goals for the Herring FMP:

Goals

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.

Objectives:

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

2) To prevent the overfishing of discrete spawning components 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, and to improve assessment procedures and cooperation with Canada, and to move to real time management of herring.

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 NEFMC fishery management plans.

2.4 Management Unit

The management unit for this FMP is defined as the Atlantic sea herring resource (*Clupea harengus*) 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). 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 in Canadian waters, beyond the range of management by this FMP. There is a significant fixed gear 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.

2.5 Status of the Stocks

Stock status is described in detail in section E.6.3.1.9. To summarize, the last fully reviewed assessment of the Atlantic Herring coastal stock complex was conducted in the spring of 1998. This assessment estimated the 1997 stock biomass as 2.9 million metric tons (mt). The spawning stock biomass was estimated as 1.8 million mt. There is an 80% probability that the SSB is between 1.4 million and 2.2 million mt. Fishing mortality for ages 3-7 herring has an 80% probability of being between 0.03 and 0.06. There is a considerable positive bias in the estimates

of recent year classes; as a result, stock size may be overestimated (NEFSC, 1998a).

The current conditioned surplus production model MSY estimate for the entire herring complex (including New Brunswick fixed gear harvest and Canadian harvest on Georges bank) is 317,000 mt. (Applegate et al. 1998).

In 1996, U.S. catches of herring totaled 104,000 mt, with about 80,000 mt taken from the Gulf of Maine. In 1997, U.S. herring catches totaled 98,271 mt, and about 70,171 mt were taken from the Gulf of Maine. Based on the stock estimates provided above, the overall herring resource is in an under-exploited state. Within the Gulf of Maine, however, current catch levels may exceed the long term potential yield.

2.6 Overfishing Definition

The Council establishes the following overfishing definition reference points for Atlantic herring. If stock biomass is equal or greater than B_{MSY} , overfishing occurs when fishing mortality exceeds F_{MSY} . If stock biomass is below B_{MSY} , overfishing occurs when fishing mortality exceeds the level that has a 50 percent probability to rebuild stock biomass to B_{MSY} in 5 years ($F_{Threshold}$). The stock is in an overfished condition when stock biomass is below $\frac{1}{B}MSY$ and overfishing occurs when fishing mortality exceeds $F_{Threshold}$. These reference points are thresholds and form the basis for the control rule.

The control rule also specifies risk averse fishing mortality targets, accounting for the uncertainty in the estimate of F_{MSY} . If stock biomass is equal to or greater than $1/2B_{MSY}$, the target fishing mortality will be the lower level of the 80 percent confidence interval about F_{MSY} . When biomass is below B_{MSY} , the target fishing mortality will be reduced consistent with the five-year rebuilding schedule used to determine $F_{Threshold}$.

The M-SFCMA states 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 1995) and averaged the result. VPA stock size estimates for the years 1991 through 1994 were not included in this estimate because or the tendency of the VPA to overestimate the 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 2.

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 percent chance of rebuilding to B_{MSY} within ten years if fishing mortality is reduced to near zero. Figure 1 summarizes the overfishing reference points as recommended by the Overfishing Definition Review Panel. Figure 2summarizes possible rebuilding schedules for Atlantic herring.

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 $\frac{1}{2}B_{MSY}$ 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 Council's herring PDT and the Commission's technical committee 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. propose 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 $1/2B_{MSY}$, rather than $1/4B_{MSY}$ 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 ¹/₂ 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 percent 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 $\frac{1}{2}B_{MSY}$, or approximately 500,000 mt. These reference points are summarized in Table 1 and are illustrated in Figure 3.

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 $B_{Threshold}$ (1/2B_{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.

This 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.

Parameter	Current Estimate	
MSY	317,000 mt	
Biomass Target (B _{Target} =B _{MSY})	1.1 million mt	
FMSY	0.30	
Minimum biomass (B _{Threshold})	$1/2B_{MSY} = 500,000 \text{ mt}$	
Maximum fishing mortality (F _{Threshold})	0.30	
Target Fishing Mortality	0.28	
Rebuilding period	5 years	

Table 1 - Summary of overfishing reference points for Atlantic herring

Year	Biomass	B ratio	Calculated
	(January 1)		B _{MSY}
	('000 mt)		('000 mt)
1973	518.6	0.4326	1198.9
1974	434.5	0.3513	1236.9
1975	343.1	0.2996	1145.3
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	1,037.8	1.347	770.4
Average			1,066.2

$$\begin{split} FMSY &= MSY/B_{MSY} = 317,000 \text{ mt}/1,066,200 = 0.297 \\ K &= 2 \text{ (B}_{MSY}) = 2(1,066,200 = 2.13 \text{ million mt} \\ R &= 2(F_{MSY}) = 2)0.297) = 0.60 \end{split}$$

Table 2 – Estimates of B_{MSY} , F_{MSY} , K and r for the Atlantic herring coastal stock complex derived from VPA estimates of biomass (10³ mt) and surplus production model estimates of biomass relative to B_{MSY} for the years 1973 – 1990.



Figure 1 – Recommended herring overfishing definition reference points, from Applegate et al., 1998



Figure 2 – Rebuilding trajectories for Atlantic herring (from Applegate et al., 1998)



Figure 3 – Overfishing threshold and target fishing mortality