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# 1.0 DOCUMENT ORGANIZATION.0 DOCUMENT ORGANIZATION

This document is divided into four volumes:

**Volume I** contains the proposed amendment language and other sections required by Section 303 of the FCMA (Magnuson Act) in chapters 2.0 through 7.0. Chapter 8.0, Relationship to Applicable Law, is divided between Volume I and Volume IV. In the first volume, Section 8.1 contains the materials required under NEPA in the form of a Final Supplemental Environmental Impact Statement (FSEIS). This section is contained within Volume I because wherever possible and to avoid duplication of analyses or descriptions the two documents (FMP amendment and FSEIS) are integrated by cross referencing relevant sections. This approach is consistent with the Operational Guidlines issued by NMFS in October, 1992.

**Volume II** contains Appendices for Volume I, including:

Appendix I- Conceptual Basis of the Management Plan
Appendix II- Effects of Mesh vs. Effort Controls on Spawning Stock Biomass of Gulf of Maine and Georges Bank Cod and Georges Bank and Southern New England Yellowtail Flounder
Appendix III- References
Appendix IV- Bioeconomic Evaluations of the Impacts of Amendment #5 Alternatives
Appendix V- Acronyms and Abbreviations.

**Volume III** contains public hearing summaries and written comments submitted during the formal comment period under the NEPA process. The volume also contains a brief summary of the principal comments and the Council's response.

**Volume IV** contains the remaining sections of Chapter 8.0, Relationship to Applicable Law, not contained in the first volume. Each part of this volume contains the materials needed to meet federal regulatory requirements other than the MFCMA and NEPA. These are:

8.2 Executive Order 12291- including the "major rule" determination and the regulatory impact review (RIR);
8.3 Regulatory Flexibility Act (RFA)- including the determination of "significant" impact and the initial regulatory flexibility analysis (IRFA);
8.4 Endangered Species Act (ESA)- including the consultation procedures, record of correspondences and the biological opinion;
8.5 Coastal Zone Management Act (CZMA)- including the determination of consistency with state coastal zone management plans and the record of correspondences;
8.6 Paperwork Reduction Act (PRA) analysis;

8.7 Marine Mammal Protection Act (MMPA).

## 2.0 INTRODUCTION TO AMENDMENT #5.0 INTRODUCTION TO AMENDMENT #5

## 2.1 BRIEF HISTORY OF THE FISHERY MANAGEMENT PLAN.1 BRIEF HISTORY OF THE FISHERY MANAGEMENT PLAN

### Management History

In the spring of 1977, the New England Fishery Management Council implemented its first groundfish fishery management plan and included only cod, haddock and yellowtail flounder. This plan was primarily developed by NMFS and its individual species quotas were a continuation of the ICNAF quota-based management system.

Although the quotas did reduce the catch of these species, the system had a number of serious flaws. Because there was no limit on the number of participants, the number of vessels increased dramatically as the stocks improved between 1977 and 1980. The increasing number of vessels caught the quota in less time causing the fishery to be closed more frequently and for longer periods of time. The quotas forced vessels to catch fish as fast as possible to get the largest possible share before the fishery was closed. In 1977 the Gulf of Maine cod quota was taken within five months. The Georges Bank cod quota was caught in six.

To prevent long closures which disrupted market supplies, the race for fish which caused safety concerns and to give small boats a greater chance to catch their historical share, the Council implemented a system of individual vessel trip limits recommended by some industry groups, notably the Massachusetts Inshore Draggermen's Association. The limits were set for each species and stock area for each of three vessel categories.

The trip limits were eventually abandoned for a number of reasons. Fishermen perceived them as unfair because NMFS could not adequately monitor the daily landings of each vessel. Fish was frequently mislabeled and landed illegally at many ports along the coast. Fishermen also misreported the area where from which they caught fish. When the yellowtail quota from east of 69$^{o}$W was taken, vessels continued to fish in the area and report the landings as coming from outside of the quota area. The mislabeling and misreporting of fish severely damaged the reliability of the data which the Council needed to manage the system.

Because of serious enforcement problems, the trip limits put fishermen who obeyed the regulations at a serious competitive disadvantage to those who did not. As the stocks rebounded, illegal operators earned enormous amounts of revenue which they used to increase their fishing power.

The limits also only roughly corresponded to the amount of landings vessels were capable of catching. Vessels with much higher operating costs were given the same limits as smaller boats which had much lower costs but were in the same category.

**The Interim Groundfish Plan** Because of the problems caused by the trip limit system, the Council eliminated the quota based management system when it adopted the Interim

Groundfish FMP in 1982. The stated objectives of the plan were to restore the reliability of the fisheries data, to give individual fishermen more flexibility and to increase industry support for the management system. This plan replaced the catch quotas with minimum fish size and codend mesh size regulations for Georges Bank and the Gulf of Maine. It also allowed small mesh fishing to continue throughout the Gulf of Maine within the framework of the Optional Settlement Program. The minimum codend mesh size was originally set at 5-1/8 inches and increased to 5-1/2 inches in 1983. For commercial fishing vessels, minimum fish sizes were 17 inches for cod and haddock and 11 inches for yellowtail. For recreational fishermen the minimum sizes were 15 inches for cod and haddock. The closed areas intended to protect spawning haddock were left in place.

**The Hague Line** In October 1984, The International Court of Justice established the boundary line between the U.S. EEZ and Canadian waters. Commonly referred to as the Hague line, it put the most productive haddock grounds on the Northeast Peak of Georges Bank traditionally fished by the largest U.S. vessels on the Canadian side of the line. These vessels, were forced to fish on other parts of Georges Bank and closer to shore, and increase the congestion and fishing pressure on then declining stocks. Many of these vessels eventually were forced out of the groundfish fishery by the lack of fish.

**Northeast Multispecies FMP** The Northeast Multispecies FMP was implemented 1986 after a one-year delay in the review process by NMFS. It was the first plan in the world to set biological targets in terms of maximum spawning potential (%MSP). This framework allows the Council to meet its biological objectives either by increasing the age-at-first capture (size of fish caught) or by controlling fishing mortality. The plan also greatly expanded the number of species included in the management unit.

In its first year, the plan set minimum sizes for witch flounder (12 inches), American plaice (14 inches) and winter flounder (11 inches) and pollock (17 inches). It increased the minimum size for yellowtail to 12 inches. It set both commercial recreational minimum sizes for cod and haddock at 17 inches and established a commercial minimum size for pollock at 17 inches. The plan also enlarged one of the haddock spawning closed areas, Area I, and established a large closed area off of southern New England to protect spawning yellowtail and to help reduce fishing mortality. The Exempted Fisheries Program, which replaced the Optional Settlement Program, substantially reduced the area and time period for small mesh fishing in the Gulf of Maine.

In its second year, 1987, the plan increased the minimum sizes for cod, haddock and pollock to 19 inches and the Council adopted Amendment #1. Amendment #1 decreased the area for the silver hake exempted fishery, increased the large mesh area to include some important yellowtail grounds to the south, and tightened existing mesh size regulations and regulations for the southern New England yellowtail area.

In January 1989, the Council adopted Amendment #2 which eliminated the scheduled increase in codend mesh size to 6 inches, because of compliance and enforcement problems with mesh regulations, and implemented the following measures: 1) trip bycatch limits and stricter non-reporting penalties in the Exempted Fisheries Program; 2) increased the minimum size for yellowtail to 13 inches and American plaice to 14 inches; 3) a established a seasonal large mesh area on Nantucket shoals to protect cod; 4) applied mesh size regulations to the whole of mobile nets rather than only to the codend; 5) set all recreational minimum sizes to be consistent with commercial minimum sizes; and 6) excluded trawlers from Area II during the closure to improve enforcement of the closure.

Amendment #3, implemented in December 1989, established the Flexible Area Action System. Its purpose was to enable the Council and NMFS to respond quickly to protect large concentrations of juvenile, sub-legal (smaller than the minimum legal size) and spawning fish. To date, this system has not been effective.

Amendment #4, implemented in January 1991, added more restrictions to the Exempted Fisheries Program; established a procedure for the Council to make recommendations for modifying northern shrimp gear to reduce the bycatch of groundfish; expanded the management unit to include silver hake, ocean pout and red hake; established management measures for the Cultivator Shoals whiting fishery; further tightened restrictions on the carrying of small mesh while fishing in the Regulated Mesh Area; and established a 5-1/2 inch mesh size in the Southern New England yellowtail area.

In Amendment #4, the Council also stated that it recognized the need to develop and implement rebuilding strategies for the principal stocks of groundfish that were overfished as part of its next amendment.

## 2.2 PURPOSE AND NEED FOR THIS ACTION.2 PURPOSE AND NEED FOR THIS ACTION

### 2.2.1 Multispecies Fishery Management Plan Policy.2.1 Multispecies Fishery Management Plan Policy

The policy for the management of the region's multi-species fisheries that emerged in August of 1983 included the following elements:

1. The Policy is a statement of intent regarding the management of the multi-species fishery; it contains two basic goals for management:

    a. allow the multi-species fishery to operate and evolve with minimum regulatory intervention, and

    b. adopt initial measures to prevent stocks from reaching minimum abundance levels (or stock conditions). (The terms "stock condition" or "condition" have been purposefully inserted into the discussion to relate the reader more directly to the actual criterion used subsequently in the plan to identify species in need of active management action. The reader is referred to Appendix I, "Conceptual Basis for the Management Plan" for a detailed explanation in context.)

2. The Policy identifies what shall be considered in the management program:

a. minimum abundance levels (or stock conditions) based on an unacceptable risk of recruitment failure;

b. minimum disruption of the normal behavior of the multi-species fishery;

c. an emphasis on freedom of choice for participants in the various species fisheries;

d. avoidance of abrupt economic dislocations;

e. acquisition of the best possible data upon which to base fishery management decisions.

3. The Policy defines how the FMP will operate:

a. initial measures will be based on relevant biologic, social and economic factors and will be designed only to limit the risk of reaching minimum abundance levels (or stock conditions); stocks below their minimum abundance levels (or in an unacceptable condition) may be immediately subject to restorative measures that will be applied in the context of the fishery.

b. modifications of initial measures are possible if changes (which unexpectedly contribute to a deterioration in stock condition) are demonstrated in the biologic, social or economic design factors;

c. measures to "restore" a stock which has fallen below its minimum abundance level (or is in an unacceptable condition) will take into consideration impacts on other related fisheries.

The actual ~~policy statement~~ adopted by the New England Council in August, 1983, and subsequently concurred with by the Mid-Atlantic Council in April, 1984 is given below.

**MAJOR POLICY**

1. The Council shall attempt to provide an environment in which the multi-species fishery can operate and evolve with a minimum of regulatory intervention or restriction of fishery options. Initial management measures shall be designed to prevent stocks from reaching minimum abundance levels of individual species within species groups included in the management plan with due consideration for the overall multi-species fishery.

2. Initial management measures will be designed on the basis of biological, social and economic factors operating at the time and may be modified only if significant changes in these factors are demonstrated.

3. Minimum abundance level is defined as that level of abundance below which

there is an unacceptably high risk of recruitment failure (stock collapse). The Council, in establishing minimum abundance levels, shall not consider economic criteria.

4. Minimum regulatory intervention is defined as the use of measures which are only intended to limit the risk of reaching minimum abundance levels.

**OTHER CONSIDERATIONS**

1. The Council will seek the best possible data upon which to base its management decisions in fulfillment of this policy.

2. The Council shall place an emphasis on freedom of choice for fishermen participating in the various species fisheries so long as those species remain above their minimum abundance levels.

3. Consideration will be given to species not explicitly included in an FMP subject to this policy only if the required measures impact a fishery for those species.

4. If a species within a major species group falls below its minimum abundance level, the impact on the fishery for other species within that species group, as well as on other species groups, will be considered in efforts to restore the species to an appropriate abundance level.

5. The Council shall attempt to avoid or minimize abrupt economic dislocations in implementing this policy; however, in no event shall continued access by individual fleet sectors, net economic impacts on individual fishermen, or impacts on the quality of life be considered in framing management measures developed consistent with this policy.

**IMPLICATIONS**

Initial measures would be modified in response to major changes in the biological, social or economic factors operating within a fishery where those changes were judged to be contributory to abundance declining toward minimum abundance levels.

Initial freedom in the fishery might be restricted by adjustments in management measures dictated by a stock decline to the minimum abundance level.

### 2.2.2 Report of the Technical Monitoring Group.2.2 Report of the Technical Monitoring Group

The Technical Monitoring Group (TMG), established by the Multispecies FMP, produced in June, 1988 an assessment of the effectiveness of the Northeast Multispecies FMP with recommendations for plan and management system improvements. Completed 18 months after plan implementation, this evaluation was the first close examination of the operational and technical effectiveness of the management program's measures. The TMG relied on information obtained directly from fishing industry representatives knowledgeable and experienced in the fisheries and from people associated with all the different components of the management system; i.e., those who created, administered, enforced, and been managed by the plan. The TMG concluded that the FMP was making only limited progress towards the achievement of its objectives and that the overall system, including the plan, was inadequate for dealing with many of the resource maintenance and rebuilding needs described in the FMP.

The TMG's reasoning was that plan regulations were difficult to enforce, unlikely to be enforced, or easy to subvert -- three factors combining to undermine the plan's effectiveness. Some of the important premises of the plan were not realistic; i.e., the plan did not take realistic account of the willingness of fishermen to comply with changes in fishing regulations and the ability of NMFS, the states, and Coast Guard to enforce them. Furthermore, most of the incentives for compliance did not exist. The risks and costs of receiving citations were comparatively low, and the economic cost of compliance was significant for individual fishermen. And, finally, the U.S. and Canada had different management approaches manifested in the two countries' management regulations for transboundary groundfish stocks on Georges Bank and in the Gulf of Maine.

For the Council's benefit, the TMG rated the effectiveness of specific plan measures. Those ratings were:

> Working well: minimum fish size regulations
>
> Working marginally, difficult to improve but possible: minimum mesh size regulations; haddock spawning closures; large-mesh area
>
> Not working, difficult to improve but possible: exempted fisheries program; southern New England yellowtail flounder closure area

An important TMG conclusion was: "The marginal effectiveness of the majority of the plan measures is of concern, particularly in view of current resource abundance, current levels of fishing mortality and age-at-entry, and the fact that it was appropriate to increase the FMP's percent maximum spawning potential (%MSP) targets for Georges Bank haddock and yellowtail flounder. For many regulated species, the conditions of low abundance and high fishing mortality rate existed when the FMP was implemented, and these conditions have not measurable changed subsequent to the implementation of the FMP."

The TMG also offered the following critique which helped launch the Council's debate about effort controls in the multispecies fishery:

> "Given the present levels of fishing mortality, it appears that the increase in minimum mesh size necessary to achieve the targets for George's Bank cod and yellowtail flounder would have to be very large. However based on the low level of compliance with existing mesh, it is not likely that a larger minimum mesh size would be effective. If compliance with age-at-entry control measures cannot be achieved, the only alternative management strategy for achieving the %MSP targets would be to reduce

> the amount of mortality due to fishing. The haddock spawning closure areas and the southern New England area closure for yellowtail flounder are the only management measures currently in place that would tend to have this effect. However, these measures do not appear to be restrictive enough in season and area, even if complied with, to effectively reduce fishing mortality. Substantially more extensive closure or other measures that reduce the amount of mortality due to fishing, such as catch limits or effort limits, may be necessary. The merits of these other measures, with particular reference to their effectiveness and enforceability, need to be examined."

The TMG emphasized:

> "...Considering the ineffectiveness of many of the plan measures and the current poor condition of the majority of regulated fish stocks off New England, it is concluded that the management system, in effect, currently allows fishermen to capture short-term benefits at the expense of the long-term conservation of the multispecies fishery resources and the long-term viability of the multispecies fishing industry. Making modifications to the FMP and the supporting management system is necessary to assure that the FMP's objectives will be achieved."

Finally, the TMG offered recommendations for strengthening the FMP and the management system. The Groundfish Committee's Plan Development Team (PDT) subsequently took over for the TMG and followed-up on the TMG's recommendations as part of its larger task of assisting the Groundfish Committee develop a new management approach for the halving fishing mortality on cod, haddock, yellowtail flounder, and the other species covered under the FMP.

### 2.2.3 Definitions of overfishing and the status of the stocks.2.3 Definitions of overfishing and the status of the stocks

**Fishing mortality rate and %MSP** (Definitions of the technical concepts used in this section and throughout this document are given in Appendix I, "Conceptual Basis of the Management Plan".)

National Standard 1-Optimum Yield (50 CFR 602.11) obligates the Fishery Management Councils to define overfishing in a measurable way using the best available scientific information. Overfishing is a level or rate of fishing mortality that jeopardizes the long-term capacity of a stock or stock complex to produce MSY on a continuing basis. The NEFMC has the principal groundfish stocks. The overfishing thresholds for most of the stocks covered by the Multispecies FMP were adopted with the implementation of Amendment #4 in May, 1991 (the overfishing definitions for the remaining stocks are proposed in this amendment).

The most recent cod, haddock, and yellowtail flounder fishing mortality rates and the rates corresponding to the %MSP overfishing definition are given in Table 2.2.1.1. The source of this information is the Northeast Fisheries Science Center 12th and 13th Stock Assessment Workshops (SAWs), held in spring and autumn of 1991. Any stock assessments on these stocks conducted between now and the time of implementation of this amendment will not change the objectives of the amendment or any specific measures, but may be incorporated into the development of any framework actions as defined by this amendment at any time after implementation.

| | | | %MSP | | FISHING MORTALITY | |
|---|---|---|---|---|---|---|
| STOCK | | | CURRENT | TARGET | 1990 | TARGET W/6" MESH |
| GEORGES BANK COD | | | 8.8 | 20 | 0.72 | 0.36 |
| GULF OF MAINE COD | | | 10.3 | 20 | 0.94 | 0.50 |
| GEORGES BANK YELLOWTAIL FLOUNDER | | | 15.7 | 20 | 0.82 | 0.84 |
| SOUTHERN NEW ENGLAND YELLOWTAIL FLOUNDER | | | 7.0 | 20 | 1.61 | 0.70 |
| GEORGES BANK HADDOCK | | | 25.5* | 30 | 0.52 | NOT AVAIL. |

*ESTIMATED

**TABLE 2.2.1.1** Current and target fishing mortality rates and %MSP levels for the three principal groundfish stocks. The status of other stocks in the multispecies plan are discussed in Section E.6.3.2 of the EIS.

Subsequent to the development of the amendment objectives which used data through SAW 13 (1990 catch data), the NEFSC has conducted assessments on Georges Bank and Gulf of Maine cod stocks using 1991 data. The results of SAW 15 indicate that $F_{1991}$= 1.07 and 1.14 for GB cod and GOM cod respectively. In addition to the increase in fishing mortality rates on these stocks, the SAW concluded that abundance levels of both have declined to record-low levels and recruitment (incoming year-class size) is below average or the lowest in the time series.

### 2.2.4 Rationale for a 50% effort reduction.2.4 Rationale for a 50% effort reduction - Managing "multispecies effort"

The current and target fishing mortality levels for individual stocks are given in Section 2.2.3. The target fishing mortality rates are based on the overfishing definitions adopted by the Council in Amendment #4. The reductions in fishing mortality rates needed to eliminate overfishing as defined varies with the individual stocks, and ranges from 27% for Georges Bank yellowtail to 68% for Southern New England yellowtail. Taking a straight arithmetical mean, the reduction required to reach the overfishing level across the four stocks is 50%.

Since fishing mortality is the result of and proportional to fishing effort, the Council is proposing to reduce fishing effort in order to achieve a fishing mortality reduction objective. While individual stocks may be targeted at specific times, generally speaking groundfishing effort impacts the multispecies complex as a unit. The management approach that is being proposed here, therefore, is to achieve an average fishing mortality reduction target by reducing overall, undifferentiated multispecies effort, that is , the time spent fishing for "groundfish".

An across-the-board effort reduction step will have different impacts on different stocks and will likely result in changing the relative impact on fishing mortality per unit of nominal effort. On the other hand, an across-the-board effort reduction is the only practical way to manage the multispecies fishery by effort (as opposed to managing by species-specific effort). There is no way to predict how fishermen will redistribute their effort under a managed reduction program as stocks respond differentially to the reduced fishing mortality. For this reason, the effort reduction percentage is being equated with annual fishing mortality reduction targets for the first five years of the program; a ten percent reduction in effort to achieve a ten percent reduction in fishing mortality across the target stocks. Once the effort reduction program is underway, the impact of the reductions in nominal effort on fishing mortality of individual stocks will be assessed, and effort reduction targets will be adjusted accordingly for the last years of the program.

The target of ~~50% reduction in fishing mortality~~ that coincides with the mean value over the four stocks represents the best estimation of the multispecies fishing mortality objective, considering the imprecision of the estimates and assumptions made in the models, and all the qualitative factors of defining the multispecies fishery. Until the relationship between the proposed reductions in days at sea and actual fishing mortality reductions can be more precisely established, a ~~50% effort reduction program~~ will be initiated to achieve this fishing mortality objective. Unquestionably, the reduction in effort will be large and will drive fishing mortality strongly downward in the direction of the biological objectives set forth in the overfishing definition.

Fishing mortality reduction targets other than fifty percent would probably be more appropriate if the resource could be managed on an individual stock basis, but given the multispecies character of the fishery and the assumptions and uncertainties in relating nominal fishing effort to an imprecise measure of fishing mortality, the Council has adopted this approach. A level less than fifty percent would be insufficient to eliminate overfishing for most stocks. A level greater than fifty percent, say seventy percent which is the level required to eliminate overfishing for southern New England yellowtail, would be excessively restrictive to fishermen fishing on most of the other stocks. When the program is implemented, the Council will have the opportunity to adjust the management measures as appropriate in order to eliminate overfishing for all stocks using updated scientific information and considering the fishing effort patterns of the time (when such adjustments are being considered).

A number of fishermen and industry representatives have suggested that mesh size increases should be the primary mechanism for reducing fishing mortality and increasing spawning per recruit. Increasing the mesh size to 6 inches will not reduce fishing mortality 50% by itself but it will reduce mortality on the smaller fish, thereby contributing in some measure to increasing and stabilizing the spawning stock biomass. The impact of increasing mesh size will vary from species to species. For those stocks for which a 50 percent reduction in fishing mortality is insufficient to eliminate overfishing, such as southern New England yellowtail flounder, increasing the mesh size will be a complementary measure contributing to increased spawning stock biomass per recruit. Increasing the mesh size will also reduce the catching and wasteful discarding of small fish, both regulated and unregulated species.

In addition to mesh size increases, other measures such as closed areas may also contribute to reducing fishing mortality to some degree but these impacts are not predictable. The combined impact of measures other than effort reduction on fishing mortality will be reflected in the assessment of fishing mortality rates once they have been implemented and had an opportunity to have an effect. Future reductions in effort may be adjusted on the basis of the impacts of these other measures.

## 3.0 OBJECTIVES OF THIS AMENDMENT.0 OBJECTIVES OF THIS AMENDMENT

The Council has adopted the following objectives for this amendment:

1. To reduce fishing mortality to a level that will increase the percent maximum spawning potential (%MSP) for cod and yellowtail to 20% in five years and to 30% for haddock in ten years.

2. To rebuild the haddock spawning stock biomass, in addition to reducing the rate at which haddock are fished, by preventing an increase in the fishing effort directed at haddock.

3. To improve and enhance enforcement and administration of management measures.

4. To protect concentrations of fish below the minimum legal size from capture and excessive discard mortality.

5. To reduce the annual take of harbor porpoise in the sink gillnet fishery by the end of year four after implementation to a level not to exceed two percent of the population based on the best available estimates of abundance and bycatch.

## 4.0 PROPOSED MANAGEMENT ACTION SUMMARY.0 PROPOSED MANAGEMENT ACTION SUMMARY

The New England Fishery Management Council has approved a package of measures which it will submit as Amendment #5 to the Northeast Multispecies (Groundfish) Fishery Management Plan. The Multispecies Plan has been in effect since 1983, and has been amended four times. The two main objectives of Amendment #5 are 1) to eliminate the overfished condition of the principal groundfish stocks (cod, haddock and yellowtail flounder) by reducing the rate at which fish are caught by fifty percent over the next five to seven years, and 2) to reduce the bycatch of harbor porpoise in the sink gillnet fishery.

The plan contains management regulations for stocks of cod, haddock, pollock, yellowtail flounder, winter flounder (blackback), witch flounder (grey sole), windowpane flounder, American plaice (dabs), redfish, white hake, red hake, silver hake (whiting), and ocean pout. The first ten species listed are referred to as "large-mesh" groundfish because they are caught with nets that have a specified minimum size. The last three are caught with mesh smaller than the minimum size.

The following summary outlines the Council's proposal as adopted on June 30, 1993:

- a moratorium on the issuance of additional vessel permits during the stock rebuilding period, except that after the third year the Council may recommend on an annual basis the issuance of additional permits;

- **exceptions to the moratorium** for boats fishing exclusively with fewer than 4,500 hooks and boats keeping less than 500 pounds of groundfish at any time;

- **an effort reduction program** in which the days spent fishing for groundfish would be limited; vessels could choose one of two alternatives while fishing for large-mesh groundfish: either 1) required blocks of time out of the fishery to be taken at the vessel's choosing (to be taken in blocks of no less than 20 days each) and layover days proportional to the time spent groundfishing (one day at the dock for each two days of groundfishing); or 2) an individual allocation of days at sea based on the vessel's history of fishing for groundfish which would be reduced in equal annual increments.

  The Council will establish annual harvest targets for the principal groundfish stocks (cod, haddock, and yellowtail flounder) based on fishing mortality objectives. These targets will provide a basis on which to evaluate annually the progress of the plan. In the event adjustments to the effort reduction program are needed, the Council is including a "framework" system by which it may change any of the management measures. In addition to adjustments in groundfishing days, the framework system may be used to adjust other measures including but not limited to the minimum mesh size, minimum fish sizes, area closures, the 500-pound possession limit, and any exceptions to the regulations. The Council may consider these adjustments on a regional, species-specific, or gear-specific basis as needed.

- **an exemption from effort reduction** requirements for boats 45 feet or smaller and all boats groundfishing exclusively with fewer than 4,500 hooks per day;

- **mesh size regulations:** All vessels retaining more than "possession limit" (currently 500 pounds) of the ten large-mesh groundfish species must fish under the appropriate mesh size regulations described below. Vessels fishing with scallop dredges will be prohibited from retaining more than the possession limit.

  1) west of 72°30' the mesh size will be determined by the mesh requirements of the Summer Flounder Fishery Management Plan (currently 5.5-inch diamond or 6-inch square mesh in the codend for at least 75 continuous meshes forward of the terminus of the net, or the terminal one-third portion of the entire net whichever is less);

  2) east of 72°30' and west and south of the line described below vessels will be allowed to fish with 5.5-inch diamond or square mesh in the first year. In the second year and thereafter the minimum mesh size will be 5.5-inch diamond or 6-inch square. The line that delimits the eastern boundary of this area runs south along 70°00' from the Territorial Sea boundary ("three-mile limit") south of Nantucket to 40°50', east to 69°00', and south to the intersection with the current Regulated Mesh Area boundary at 40°30.5', then along the Regulated Mesh Area boundary to the Hague Line;

  3) north and east of the line described above (70°00'-40°50'-69°00') the minimum mesh size will be 6-inches (diamond or square mesh) throughout the net upon implementation of the plan;

  4) north and east of a line that runs south along 70°00' from the Territorial Sea boundary ("three-mile limit") south of Nantucket to 40°50', east to 69°40', the current boundary of the Regulated Mesh Area, then along that boundary to its intersection with the Hague Line, vessels will be prohibited from having on board mesh smaller than the minimum size while in possession of more than 500 pounds of large-mesh groundfish; south and west of the line vessels may have mesh smaller than the minimum size on board, provided the small mesh is stowed in accordance with the regulations whenever the vessel possesses more than the 500-pound limit;

- **exceptions to the mesh size regulations for purse seiners and midwater-trawl vessels fishing for pelagic species;**

- **interim gillnet regulations** to reduce harbor porpoise bycatch using four-day blocks of time when all gear is out of the water. The Council is actively developing an alternative to this program and intends to replace it with a more effective management system as soon as possible. The Council will evaluate the harbor porpoise bycatch reduction measures for their impact on groundfishing effort reduction, and make appropriate adjustments through the framework mechanism to implement effort reduction measures commensurate with the other sectors of the fishery;

- **mandatory reporting** of landings and effort data; effort monitoring will be accomplished by either electronic vessel tracking systems (VTS) (required on vessels taking individual allocation of days at sea) or other types of monitoring systems such as a magnetic-strip card ("mag-card") reporting system;

- **a prohibition on pair-trawling** for groundfish;

- **minimum fish sizes** appropriate to the increased mesh size to reduce discards;

- **seasonal 6-inch square mesh requirement to protect concentrations of juvenile cod** on Stellwagen Bank and Jeffreys Ledge from March through July;

- **closure to protect concentrations of juvenile yellowtail flounder** in the vicinity of Nantucket Lightship for up to one year when there are very large year classes of juvenile yellowtail; the closure will be triggered by the NMFS bottom trawl survey index;

- **expansion of Area II** (the Georges Bank haddock spawning area closure) in size and, in the third year, extension of the closure period to six months (to January through June), and a **suspension of the Area I closure for mobile gear**;

- **a possession limit of 5,000 pounds of haddock**;

- **a finfish excluder device requirement** in the northern shrimp fishery;

- Federal permit holders may elect to fish exclusively for **winter flounder within state waters** under the state regulations provided such regulations conform to the ASMFC Winter Flounder Plan;

- **required permits for all vessel operators and all dealers** with potential suspension or revocation of individual permit for violations of the regulations.

- **The framework adjustment system** will be used by the Council to modify, add or delete regulations in order to meet the plan objectives. Each year, the Council will establish annual harvest targets for cod, haddock and yellowtail flounder stocks based on the fishing mortality reduction target for the year. It will also establish three regional advisory committees comprised of industry and scientific advisors which will annually recommend appropriate adjustments to the management measures. The advisory groups will compare the annual harvest targets to actual catch while considering adjustment options. The Council will consider the advisory committee recommendations and provide for broader public comment before submitting its recommendations to NMFS.

In accordance with federal guidelines, the Council also is proposing measurable definitions of overfishing for those stocks in the plan for which overfishing has not yet been defined. These stocks are: red hake, white hake, ocean pout, windowpane flounder, and pollock.

## 4.1 PROPOSED OVERFISHING DEFINITIONS FOR POLLOCK, RED HAKE, WHITE HAKE, OCEAN POUT AND WINDOWPANE FLOUNDER.1

**PROPOSED OVERFISHING DEFINITIONS FOR POLLOCK, RED HAKE, WHITE HAKE, OCEAN POUT AND WINDOWPANE FLOUNDER**

Pursuant to the Section 602 CFR 11, National Standard 1, the Council must specify the definition of "overfishing" for each stock or stock complex covered by the FMP. Of the thirteen species in the Multispecies FMP, pollock, red hake, white hake, ocean pout and windowpane flounder are currently without approved overfishing definitions. The following definitions of overfishing are proposed:

**Pollock (*Pollachius virens*):** Overfishing is defined as occurring when the target of 20% MSP is not achieved.

**Red hake (*Urophycis chuss*), white hake(*Urophycis tenuis*) , ocean pout (*Macrozoarces americanus*) and windowpane flounder (*Scophthalmus aquosus*):** Overfishing is defined as occurring when the three-year moving average of the (species) abundance index from the Northeast Fisheries Science Center's (species-appropriate) bottom trawl survey falls within the lowest quartile of the time series.

**FIGURE 4.1.1** PLOT OF THREE-YEAR MOVING AVERAGE AND MOVING LOWER QUARTILE OF THE TRAWL SURVEY INDEX FOR WINDOWPANE FLOUNDER, OCEAN POUT, RED HAKE AND WHITE HAKE

**FIGURE 4.1.1 (CONT'D)**

## 4.2 MORATORIUM ON NEW PERMITS.2 MORATORIUM ON NEW PERMITS

A moratorium on vessel permits will be implemented effective as of the control date, February 21, 1991. Exceptions are made for groundfish vessels fishing exclusively with fewer than 4,500 hooks per day which will be issued a "hook gear only" permit, and vessels catching less than the groundfish possession limit which will be issued a "maximum possession limit" permit. The Council will consider annually recommending the issuance of additional permits after year three of the plan.

1. **Qualification -** To be issued a Northeast Multispecies Permit for the moratorium period established by Amendment #5, a vessel must meet one of the following criteria:

   a. Hold a valid Northeast Multispecies Permit as of February 21, 1991, or have renewed a permit in 1991, and show proof of landing multispecies groundfish (cod, haddock, pollock, yellowtail flounder, winter flounder, gray sole, American plaice, windowpane flounder, silver hake, red hake, white hake, ocean pout and redfish) during the time period January 1, 1990 through February 21, 1991;

   b. Show written proof that a vessel was under construction, reconstruction or was under written contract for purchase as of February 21, 1991 and landed the identified fish by February 21, 1992.

2. **Renewal -** After meeting the initial moratorium permit qualification requirements described in paragraph 1a, a Northeast Multispecies Permit may be renewed if the vessel possessed a valid permit throughout the preceding year. The permit does not have to be used to qualify for renewal. If a vessel owner voluntarily relinquishes his or her permit, however, it is not renewable thereafter.

3. **Lost or destroyed vessels -** Any Northeast Multispecies Permit held by a vessel that is lost or destroyed will become invalid. The owner may apply for a permit for a replacement vessel provided the replacement vessel meets the criteria specified in paragraph 10.

4. **Permit transfer, vessel sales and vessel replacement -**

   a. The buyer of a permitted vessel will receive the permit and, if applicable, the allocation based on vessel history. The seller does not qualify for the fishery.

   b. Alternatively, the seller may retain the permit and, if applicable, the allocation based on the vessel history and apply them (permit and allocation) to a replacement vessel. The buyer of the vessel would then be prevented from using that vessel's history to qualify for the fishery. The buyer and seller must explicitly agree to such terms in writing. The replacement vessel to which the seller is applying the retained permit must meet the criteria described in paragraph 10.

c. Splitting of permits: A permit that qualifies under the moratorium and that also qualifies for other fisheries cannot be split into multiple permits for multiple single-fishery vessels.

**5. Appeal of permit denial -**

a. Any applicant denied a permit may appeal the denial. The appeal must be in writing. Any of the following grounds may form the basis for review:

1) The denial was based on mistaken or incorrect information or data;

2) The applicant was prevented by circumstances beyond his/her control from meeting relevant criteria; or

3) The applicant has new or additional information which might change the initial decision.

b. The applicant will have the right to an oral hearing.

c. Boats appealing a no-permit decision will be allowed to fish under applicable rules under the general category in the effort reduction system as though it qualified for a permit. An appeal of a moratorium permit denial shall be filed within one year of the date of implementation of the plan.

**6. Switching gear types -** Vessels may change gear types within the multispecies fishery, or between fisheries, provided all other regulations are observed.

**7. Duration of the moratorium -** The moratorium on new permits will last for the period covered by the management measures of this amendment. The Council may consider on an annual basis with public input adjustments to the moratorium, including the issuance of additional permits which could occur after the third year of implementation.

**8. Exception for vessels catching less than the possession limitException for vessels catching less than the possession limit -** Any vessel may obtain a "maximum possession limit" permit which will enable that vessel to retain up to the maximum allowable limit of groundfish for vessels not fishing for groundfish under the effort control program.

**9. Exception for hook vessels, including party and charter boatsException for hook vessels, including party and charter boats -** An exception to the moratorium is made for vessels fishing with hook gear exclusively throughout the year provided these vessels fish with fewer than 4,500 hooks per day. Vessels fishing under this exception will be issued a "hook gear only" permit.

10. **Limitations on upgrading, refitting or replacing a permitted vessel -** Any vessel with a valid Multispecies Permit will be allowed to refit within the criteria described here. The limitations on replacement vessels or upgrading of vessels are that length, gross registered tonnage, or net tonnage may not be increased by more than 10 percent, and horsepower by more than 20 percent, in any refit or replacement.

    This restriction on upgrading will go into effect upon implementation of the regulation. Upgrading that is in excess of the restrictions described above must be validated by a contract which must be signed before implementation, and the work must be completed within one year of the date of the contract signing.

    During the period covered by the moratorium, each vessel will be limited to one upgrade in vessel horsepower and one upgrade in any or all of the vessel length, gross tonnage or net tonnage. The upgrading of horsepower may be done separately from the upgrading of any one or all of net tonnage, gross tonnage and length.

**Permit Categories**

Any vessel fishing for multispecies finfish, except commercial vessels fishing exclusively within state waters and recreational fishing vessels, must have on board either a multispecies permit, a hook-gear-only permit, or a possession-limit-only permit issued under the provisions of the moratorium described above.

## 4.3 EFFORT REDUCTION.3 EFFORT REDUCTION

### General descriptionGeneral description

All vessels fishing for groundfish may either take the fleet-wide requirement of time out of groundfishing or an individual allocation of days at sea based on historical vessel performance as defined in the NMFS weighout file or as can be demonstrated with logbooks or other records. A vessel may switch between the individual allocation group and the general allocation group one time before the end of year two, provided the switch is made at the beginning of a new year.

Time that a vessel spends landward of the COLREGS demarcation line will not be counted as groundfishing time.

Under the individual allocation option, there is no layover day requirement, but each vessel must declare one 20-day block out of groundfishing between March 1 and May 31 each year. The annual allocation of days at sea will be based on reductions of ten percent per year from the initial baseline. Vessels fishing under an individual allocation must use an electronic vessel tracking device (VTS), and the VTS must be used 365 days per year.

Under the fleet allocation category, all vessels must declare blocks of time out of groundfishing and layover at the dock one day for each two days of groundfishing, based on the actual amount of time (hours) at sea. The time off groundfishing must be in blocks no less than twenty days each, including one block during the period March through May. The layover requirement does not apply to vessels fishing on one-day trips (less than 24 hours) at this time, although the Council may adjust this regulation in the future based on its evaluation of the effort reduction program. Exceptions to the effort reduction requirements are discussed below.

The Council may adjust the effort reduction schedule based on the success of the program and the status of the stocks relative to the amendment objectives. The adjustment procedure is discussed in a separate section.

Under the general effort reduction option, the schedule as currently proposed (pending Council adjustment in future) is as follows: during the first two years, vessels will be required to declare 80 days out of the fishery in addition to taking the layover days. In the third year, vessels must declare 128 days out. In the fourth year, vessels will be required to declare 165 days out of groundfishing. During the fifth year vessels would be required to declare 200 days out of groundfishing.

A further reduction in groundfishing opportunity is scheduled for year six, which will only be implemented if the fifty-percent reduction in fishing mortality is not achieved by the management measures imposed during the first five years. In that situation, vessels might be required to declare 233 days out of the groundfish fishery. Currently, the Council is not proposing any further effort reductions for year seven, although it may adjust the effort reduction schedule up or down as needed through the framework provision.

The schedule of effort reductions is as follows:

| **YEAR** | **LAYOVER RATIO** | **DAYS OUT OF GROUNDFISHING** | **"OPPORTUNITY DAYS"** |
|---|---|---|---|
| 1 | 2:1 | 80 | 190 |
| 2 | 2:1 | 80 | 190 |
| 3 | 2:1 | 128 | 158 |
| 4 | 2:1 | 165 | 133 |
| 5 | 2:1 | 200 | 110 |
| 6 | 2:1 | 233 | 88 |
| 7* | ? | ? | ? |

*The Council has not scheduled any effort reduction time out for year seven, and it may modify any part of this schedule as needed through the framework provision.

When a vessel has declared that it is "out of groundfishing", it must adhere to the possession limit regulation that would currently allow 500 pounds combined weight of the ten large mesh species (cod, haddock, pollock, yellowtail, winter flounder, witch flounder, American plaice, white hake, redfish, and windowpane flounder). A vessel that is fishing under either effort reduction option may not possess more than 500 pounds of groundfish unless the vessel is time is being counted as a groundfish day against its allocation. The Council may, through a framework mechanism, adjust the possession limit in the future.

A vessel must declare seven days in advance that it is leaving the groundfish fishery (taking one of its required blocks of time out of the fishery) and also declare when it is re-entering the fishery. The seven-day notice period could be modified in the future, also through a framework process, depending on the performance of the effort monitoring system (see below). During the blocks of time declared off groundfish, a vessel will be able to participate in other fisheries as long as it retains less than the possession limit for groundfish. When a vessel has not declared itself out of the groundfish fishery, it will be considered to be in the fishery and subject to all the regulations that apply. Time spent assisting the Coast Guard may not be counted against a vessel's allocation of groundfishing time.

**Calculation of individual allocation of days at sea**

To receive a groundfish days at sea allocation, the vessel must first meet the moratorium criteria. The individual vessel allocation will be based on the average number of groundfishing days in the NMFS weighout files for 1988-1990 with the year having the fewest groundfishing days and all years in which there is no record removed from the calculation. Groundfish days are defined as all days absent for a trip where greater than ten percent of the landings were comprised of the ten large-mesh species (cod, haddock, pollock, redfish, white hake, American plaice, winter flounder, witch flounder, windowpane flounder, and yellowtail flounder). No days were counted as groundfish days for those trips where either scallop dredge or gillnets were used.

A vessel that disputes the baseline allocation will be able to appeal that allocation, and continue fishing under the group allocation pending the outcome of the appeal. The appeal must be in writing and review will be based on the following grounds: the allocation was based on incorrect information; the applicant was prevented by circumstances beyond his/her control from meeting relevant criteria; or the applicant has new or additional information which might change the initial decision. The applicant may also request an oral hearing.

**Framework adjustmentsFramework adjustments to the management measures**

Any adjustments to effort reduction measures will be done through a framework system. A framework system allows changes to be made in regulations in a timely manner without going through the plan amendment process.

At any time after the implementation of this amendment, the Council may recommend adjustments to any of the measures proposed in this amendment. These include but are not limited to blocks of time declared off of groundfishing, area or season of closure, possession limit, minimum mesh size, limit on the number of hooks or sink gillnets, the minimum fish size, or, after year three, adjustments to the moratorium. The Council may consider regulating the size or style of hook used in the hook fishery, and it also may consider prohibiting the use of "crucifiers" in that fishery. The Council may elect to implement species-specific, gear-specific (including recreational gear), or regional adjustments provided adequate opportunity is made for public comment, and all other regulatory requirements are observed.

The Council will review annually the progress of the plan relative to the plan objectives. To help in its yearly evaluation of the plan, the Council will utilize annual harvest targets for the principal groundfish stocks: Gulf of Maine cod, Georges Bank cod, Georges Bank yellowtail flounder, Southern New England yellowtail flounder, and Georges Bank haddock. The targets will be based on the fishing mortality objectives for the upcoming year and be set by the Stock Assessment Review Committee (SARC). The fishing mortality targets are determined by the fishing mortality rates for each stock in the most recent SARC report prior to implementation reduced by ten percent each year of the plan. In other words, $F_{target}=F_{baseline}- 0.1(yr)F_{baseline}$, or for the first year the target will be the baseline rate minus ten percent, the second year the baseline rate minus twenty percent, and so on. The Council will also consider other scientific and public input in its annual review of the plan.

The Groundfish Advisory Committee will participate in the annual review of the plan and make recommendations to the Oversight Committee. The Technical Monitoring Group will review all available scientific information and report on the technical status of the plan to the Advisory Committee or the Oversight Committee. The Oversight Committee will recommend appropriate adjustments in the plan to the Council based on the technical and advisory committee input. If the Council adopts the recommended adjustments, it will hold public hearings and make a recommendation to the Regional Director for additional management measures under the framework provisions of this plan.

The Groundfish Advisory Committee may establish regional subcommittees to address local issues for the Advisory Committee. The subcommittees will be based on the three generally distinct fishing areas: the Gulf of Maine, Georges Bank, and Southern New England and South. The Gulf of Maine is considered to be north of 42°20' or west of 70°00' in the Gulf of Maine. The Georges Bank area is defined as being south of that line and east of a line running south from the state waters of Massachusetts along 70°00' to 40°50' then east to 69°00' and south to 40°30.5' (at Loran TD 43450, the current boundary of the Regulated Mesh Area), then along the Regulated Mesh Area boundary to the Hague Line. **(See figure 4.6.1).**

The regional subcommittees may evaluate the effectiveness of management measures in their respective areas and may make recommendations to the Groundfish Advisory Committee. The Advisory Committee will review those comments in the broader regional context and forward its recommendations to the Oversight Committee. The Oversight Committee will develop measures to make the appropriate adjustments for Council consideration. In addition to the scheduled annual review, the Council may request at any time that the advisory committee review and make recommendations on any adjustments to the management measures.

Upon receiving the recommendations of the Oversight Committee, the Council will publish notice of its intent to take action and provide the public with any relevant analysis and opportunity to comment on any possible actions. After receiving public comment, the Council must take action (to forward or not to forward) on the recommendation at the second Council meeting following the meeting at which it received the recommendations. The Council will submit its annual recommendations by November 1 for such recommended adjustments to take effect by January 1. If the Council recommends action to the Regional Director, and the Regional Director approves the Council's recommendation, the Secretary of Commerce will be expected to waive for good cause the requirement for prior notice and comment in the *Federal Register* and publish a "final rule".

This final rule will remain in effect until amended. If the management measure is designated as "routine" by "final rule" under this procedure, specific adjustments can subsequently be announced by publication of a notice in the Federal Register. Examples of "routine" measures include but are not limited to the timing or location of a closure, or an adjustment to the number of nets allowed. Nothing in this proposal prevents the Secretary of Commerce from soliciting additional comment but it is contemplated that the Council process will adequately satisfy that requirement.

The Regional Director may accept, reject or modify the Council's recommendation. If the Regional Director does not approve the Council's specific recommendation, he must provide in writing to the Council the reasons for his action prior to the first Council meeting following publication of his decision.

**Possession limitPossession limit**

Any vessel holding a "possession-limit only" permit, any scallop dredge vessel, and any vessel that holds a valid multispecies permit and which has declared that it is "out" of groundfishing, may not possess more than 500 pounds of combined weight, heads on (except white hake), of the ten large mesh species (cod, haddock, pollock, yellowtail, winter flounder, witch flounder, American plaice, white hake, redfish, and windowpane flounder).

The possession limit will be measured by weight, or by volume of five standard boxes ("totes"), whichever is greater. A standard box designed to hold 100 pounds of fish plus ice has a liquid capacity of 70 liters, or a volume of not more than 4320 cubic inches (2.5 cu. ft.). Alternatively, a vessel may use a standard box designed to hold 125 pounds of fish plus ice, under which circumstances the possession limit will be measured by volume of four such standard boxes. In this case the volume of the box may not exceed 5100 cubic inches. A vessel must have on board one standard box for the purpose of measuring the possession limit. Groundfish must be separated from other species on board the vessel.

The Council will review annually the adequacy of the possession limit. If the Council determines that the amendment objectives are not being met as a consequence of the possession limit, it may adjust the limit under the framework provision.

**Exception to the effort reduction program for vessels engaged in gillnettingException to the effort reduction program for vessels engaged in gillnetting**

The effort reduction system based on either days at sea allocations, or time declared out of groundfishing will not apply to vessels fishing with sink gillnets. Instead, the Council is proposing to use the framework system to incorporate measures being developed by the industry or other technical groups to reduce the take of harbor porpoise provided these measures reduce fishing mortality consistent with the amendment objectives.

The measures to reduce the bycatch of harbor porpoise have not been fully developed at this time so the Council is proposing to exempt gillnet vessels from effort reductions until such time as those regulations can be implemented and evaluated. The Council's intent is to evaluate measures implemented to reduce the take of harbor porpoise for their impact on groundfishing effort and then make whatever adjustments are required such that effort reductions in the sink gillnet sector are commensurate with those taken by the rest of the groundfishing fleet. This approach is intended to minimize duplicative regulations for groundfish effort reductions and harbor porpoise bycatch whenever possible. Vessels fishing under this exception may not have trawl gear on board.

**Measures to reduce harbor porpoise take in the sink gillnet fisheryMeasures to reduce harbor porpoise take in the sink gillnet fishery**

The Gulf of Maine sink gillnet fishery is classified as a Category 3 fishery under the Marine Mammal Protection Act because of the interaction with harbor porpoise. The NEFMC is developing a management system for the gillnet sector and is including an interim measure in this amendment. When an alternative to the interim measure is developed, the Council will hold hearings and consider public comment prior to submitting the measure for implementation under the framework provision. If an alternative measure is adopted by the Council prior to amendment submission, that measure will be substituted for the interim measure.

Under the interim proposal, all sink gillnets must be out of the water during prespecified four-day blocks each month. No other direct effort controls apply (that is, no layover or time out of the fishery requirements). During the first year, the Regional Director will identify with input from the Council, one four-day block in each month and in the second year, two blocks (or one eight-day block) during which all gillnetters would be required to remove their gear from the water. The third year will be a "pause" year, with no additional blocks taken out. During both the fourth and fifth years an additional block will be taken out resulting in a total of 16 days taken out of each month (192 days per year, or 53 percent). A vessel will not be required to stay at the dock while the gillnets are out of the water, but could enter other fisheries or fish for groundfish with other gear under the applicable regulations.

Gillnet fishing is exempt from the effort reduction program in the first year while measures are implemented to reduce the take of harbor porpoise. These measures will be evaluated for their effect on groundfish fishing mortality rates, and future adjustments may be made as needed under the framework provision. The Council is actively developing alternative gillnet management measures to reduce harbor porpoise bycatch which it intends to implement as expeditiously as possible.

In the meantime, the Council proposes an interim system to reduce the take of harbor porpoise based on four-day blocks each month when all sink gillnets must be taken out of the water. By "masking" out periods of time in all months during which all gillnets must be taken out of the water, the time during which harbor porpoise will be exposed to the gear will be proportionally reduced.

Under the framework system described below, the Council will evaluate on a regular basis harbor porpoise data and the effectiveness of the management measures. The Council will use this system to adopt more effective harbor porpoise bycatch mitigation measures when they are developed.

In order to evaluate new data and mitigation proposals, the Council will establish a Harbor Porpoise Review Team (HPRT) comprised of scientific and technical personnel including but not limited to NEFMC, MAFMC, NEFSC, NMFS/RO and appropriate state governments. The HPRT will conduct an annual review of bycatch and abundance data by a specified date, will evaluate the impacts of the mitigation measures in place, and may make recommendations on other mitigation measures. At the first Council meeting following the HPRT annual meeting, the team will, if necessary, make recommendations to the Council. In addition, the Council may request at any time that the HPRT review and make recommendations on any alternative mitigation measures or develop mitigation proposals.

Upon receiving the recommendations of the HPRT, the Council will publish notice of its intent to take action and provide the public with any necessary analysis and opportunity to comment on any possible actions. After receiving public comment, the Council must take action on the recommendation at the second Council meeting following the meeting at which it received the HPRT's recommendations. If the Council recommends action to the Regional Director based on the analysis and recommendation of the HPRT, and the Regional Director approves the Council's recommendation, the Secretary of Commerce will be expected to waive for good cause the requirement for prior notice and comment in the *Federal Register* and publish a "final rule".

The Regional Director may accept, reject or, with Council consensus, modify the Council's recommendation. If the Regional Director does not approve the Council's specific recommendation, he must provide in writing to the Council the reasons for his action prior to the first Council meeting following publication of his decision.

**Exceptions to effort controls for small boats and hook vesselsExceptions to effort controls for small boats and hook vessels**

All permitted vessels 45 feet and under in overall length and all vessels that, while fishing for groundfish, fish with fewer than 4,500 hooks per day exclusively throughout the year will also be exempt from the effort reduction requirements outlined above. Vessels fishing under this exception must bring their gear to port. This exception does not apply to vessels engaged in gillnetting.

Vessels would declare at the beginning of the permit period that they will fish under the hook-gear exception and will be issued a hook-gear-only permit. Vessels fishing under this exception will be prohibited from having trawl gear on board. Vessels fishing under this exception will not be required to comply with the effort monitoring requirements of this plan but must comply with any mandatory data reporting requirements and any other applicable regulations.

The "number of hooks per day" is defined as the number of rigged hooks on board and hooks fishing. "Rigged hooks" are baited hooks or hooks that only need to be baited in order to be fished. For the purpose of establishing whether a hook and gangion is considered fishable, the gear (i.e. hook and gangion) would have to be secured to the ground line of the trawl. Any unsecured hooks and gangions on a board would be considered replacement hooks and not counted as part of the 4,500 limit, however, snap-on hooks must not be baited to be considered as replacement hooks.

For boats 45'0" and under, overall length will be measured along a horizontal line drawn from a perpendicular raised from the outside of the most forward portion of the stem to a perpendicular raised from the after most portion of the stern. Boats built after the implementation of Amendment #5 and wishing to fish under the 45'0" exception must adhere to the following: the product of the overall length divided by the beam will not be less than 2.5. The measurement must be verified in writing by a marine surveyor, the builder, based on the boat's plans, or by a documentation service. A copy of the letter verifying the above must be submitted to NMFS to obtain a permit.

**Exception to the effort reduction program for scallop vesselsException to the effort reduction program for scallop vessels**

Scallop dredge boats may not retain more than the possession limit of groundfish (currently 500 pounds). For the duration of the moratorium or until adjusted by the Council through the framework mechanism, a scallop dredge vessel will be issued a possession-limit-only permit unless that vessel qualifies for an individual allocation of groundfishing days at sea under the effort control system for combination boats. "Combination boats" that historically have switched between the scallop dredge fishery and the otter trawl groundfish fishery would be allocated individual days at sea for groundfish and be required to use the VTS for tracking those days. The baseline individual allocation will be calculated on the vessel's history of otter trawl fishing as defined in the NMFS weighout file or as can be demonstrated with logbooks or other records. Vessels in this program would also be required to identify a 20-day block in March-May when they would not fish for groundfish. Each vessel's allocation of days will be reduced by ten percent per year from the baseline or as adjusted by the Council through the framework system.

**Transfer of groundfish at seaTransfer of groundfish at sea**

Transferring groundfish between vessels or receiving groundfish from another vessel while at sea will be prohibited. In the event that the prohibition on pair trawling for groundfish is lifted or modified, the prohibition on transferring groundfish at sea would not apply to the transfer between the pair of vessels engaged in pair trawling.

**Monitoring of effortMonitoring of effort**

Groundfishing effort will be monitored by either an electronic vessel tracking system (VTS) or a card-based system using magnetic-strip or other data-storage cards. The card system will be required of all groundfishing vessels not exempt from effort controls and not electing to use a VTS. Any vessel fishing under an individual allocation of days at sea will be required to use a VTS. Both systems are described later in the document under "mandatory data reporting".

**Prohibition on pair trawling for groundfishProhibition on pair trawling for groundfish**

Pair trawling for groundfish will be prohibited. This measure may be adjusted by the framework provision or by a future plan amendment dealing with technology issues.

## 4.4 MINIMUM MESH SIZE and MINIMUM FISH SIZE.4 MINIMUM MESH SIZE and MINIMUM FISH SIZE

**Minimum mesh size allowed on boardMinimum mesh size allowed on board**

All vessels retaining more than the "possession limit" of the ten large-mesh groundfish species (currently 500 pounds) must fish under the appropriate mesh size regulations described below. Vessels fishing with scallop dredges will be prohibited from retaining more than the possession limit.

1) west of 72°30' the mesh size will be determined by the mesh requirements of the Summer Flounder Fishery Management Plan (currently 5.5-inch diamond or 6-inch square mesh in the codend for at least 75 continuous meshes forward of the terminus of the net, or the terminal one-third portion of the entire net whichever is less);

2) east of 72°30' and west and south of the line described below vessels will be allowed to fish with 5.5-inch diamond or square mesh in the first year. In the second year and thereafter the minimum mesh size will be 5.5-inch diamond or 6-inch square. The line that delimits the eastern boundary of this area runs south along 70°00' from the Territorial Sea boundary ("three-mile limit") south of Nantucket to 40°50', east to 69°00', and south to the intersection with the current Regulated Mesh Area boundary at 40°30.5', then along the Regulated Mesh Area boundary to the Hague Line;

3) north and east of the line described above (70°00'-40°50'-69°00') the minimum mesh size will be 6-inches (diamond or square mesh) throughout the net upon implementation of the plan;

4) north and east of a line that runs south along 70°00' from the Territorial Sea boundary ("three-mile limit") south of Nantucket to 40°50', east to 69°40', the current boundary of the Regulated Mesh Area, then along that boundary to its intersection with the Hague Line, vessels will be prohibited from having on board mesh smaller than the minimum size while in possession of more than 500 pounds of large-mesh groundfish unless declared out of groundfishing; south and west of the line vessels may have mesh smaller than the minimum size on board, provided the small mesh is stowed in accordance with the regulations whenever the vessel possesses more than the 500-pound limit;

To accommodate those situations when a vessel hauls up mesh smaller than the minimum legal size (for example, a lost or discarded small mesh net), the minimum mesh on board regulation will apply to pieces of mesh larger than three feet square. Vessel captains should take necessary steps to render the mesh unusable (e.g. cutting up large pieces into pieces smaller than three feet square, and otherwise destroying the mesh).

### Minimum fish sizesMinimum fish sizes

The minimum fish sizes for regulated species will be set appropriate to the increased mesh size to minimize the discard of undersized fish. The current minimum fish sizes will not change until year two when all the mesh size increases scheduled by this amendment will have been implemented. The minimum fish sizes would be set at the length at which, on the best available scientific information, 25 percent of the fish (at the minimum size) are retained by the legal minimum mesh size, also known as L25%. The minimum fish sizes for regulated flatfish (yellowtail flounder, winter flounder, witch flounder and American plaice) will be based on the selectivity of 5.5-inch diamond and for the regulated roundfish (cod, haddock, pollock and redfish) on 6-inch diamond.

An exception to the L25% standard is made in the case of winter flounder. The minimum size will be 12 inches beginning in the first year, or, in the case of vessels fishing exclusively for winter flounder within state waters under the state regulations, will be set by state regulations provided such regulations conform to the ASMFC Winter Flounder Plan.

Any fish or part of a fish such as a fillet must meet the minimum size requirements. Fish or parts of fish must have the skin on for the purposes of identification. Minimum fish sizes apply aboard the vessel and ashore; size regulations for fish parts apply only on board the vessel. An exception is made to the fish-part (fillet) size for commercial vessels engaged in groundfishing (i.e. not declared "out" of groundfishing, or fishing under a "possession-limit-only" permit). These vessels may retain 25 pounds per person of fillets from legal sized fish for personal use, (consistent with Massachusetts state regulations). Also recreational, party and charter boats may possess fillets smaller than the legal minimum size, without limit on the weight, as long as those fillets are cut from fish of legal size. Without exception, the fillets must be cut from legal sized fish.

**Small mesh fisheriesSmall mesh fisheries**

Vessels fishing with mesh smaller than the minimum size may not possess more than 500 pounds of groundfish. In addition to the mesh regulations described at the beginning of this section, the following provisions apply to vessels fishing with mesh smaller than the regulated minimum size.

**Finfish excluder device in the northern shrimp fisheryFinfish excluder device in the northern shrimp fishery**

Any vessel catching, harvesting or landing northern shrimp must use a finfish excluder device, such as the Nordmore Grate, with a rigid or semi-rigid bar spacing of not more than one inch throughout the shrimp season.

**Purse seine gear exceptionPurse seine gear exception**

Fishing for Atlantic herring or blueback herring, mackerel, and menhaden may take place throughout the fishing year with mesh sizes less than the regulated size provided that: (a) purse seine gear is used exclusively; and (b) the bycatch of regulated species does not exceed the possession limit of groundfish (currently 500 pounds) for vessels fishing with mesh smaller than the legal minimum.

**Midwater trawl exceptionMidwater trawl exception**

Section 651.20(d)(2) of the Multispecies Plan will be changed to allow midwater trawl fishing for herring and mackerel throughout the year instead of only during December through May. The bycatch limits will be changed to correspond to the large-mesh groundfish possession limit (currently 500 pounds) for vessels fishing with mesh smaller than the legal minimum size.

The Regional Director may require observers on midwater trawl and purse seine vessels to address the bycatch of groundfish.

**Measures to protect concentrations of juvenile fish on Stellwagen Bank and Jeffreys LedgeMeasures to protect concentrations of juvenile fish on Stellwagen Bank and Jeffreys Ledge**

The regulations will require mesh of at least 6 inches (inside stretched measurement) hung on the square (square mesh) in the codend and lengthening piece (defined as 140 bars counted from the end of the net) of mobile net gear and require a minimum mesh of at least 6 inches in sink gillnets from March 1 through July 31 of each year. This measure would apply even if the preferred alternative 6-inch mesh were not adopted.

Fishing for shrimp with approved finfish excluder gear would be allowed; no bycatch of regulated species would be allowed on board shrimp vessels while in the control areas. For purposes of this provision, "on board" is defined as having fish below deck or stored on deck in baskets, totes or other containers.

NMFS would monitor and the Council would annually review the effectiveness of the proposed measures and make appropriate changes in the following year.

The coordinates defining Stellwagen Bank and Jeffreys Ledge are given in the following tables.

**STELLWAGEN BANK**

| Reference Point | Latitude | Longitude | Approximate Loran Coordinates | | Line Description |
|---|---|---|---|---|---|
| S1 | 42°34.0' | 70°23.5' | 13737 | 44295 | |
| | | | | | along 44295 |
| S2 | 42°28.8' | 70°39.0' | 13861 | 44295 | |
| S3 | 42°18.6' | 70°22.5' | 13810 | 44209 | |
| S4 | 42°05.5' | 70°23.3' | 13880 | 44135 | |
| | | | | | along 44135 |
| S5 | 42°11.0' | 70°04.0' | 13737 | 44135 | |
| | | | | | along 13737 to S1. |

**JEFFREYS LEDGE**

| Reference Point | Latitude | Longitude | Approximate Loran Coordinates | | | Line Description |
|---|---|---|---|---|---|---|
| J1 | 43°12.7' | 70°00.0' | 13369 | 44445 | 25826 | |
| | | | | | | along 44445 |
| J2 | 43°09.5' | 70°08.0' | 13437 | 44445 | 25845 | |
| | | | | | | along 70°08.0' |
| J3 | 42°57.0' | 70°08.0' | 13512 | 44384 | 25779 | |
| | | | | | | along 44384 |
| J4 | 42°52.0' | 70°21.0' | 13631 | 44384 | 25805 | |
| | | | | | | 25805 to 25804 |
| J5 | 42°41.5' | 70°32.5' | 13752 | 44352 | 25804 | |
| | | | | | | along 13752 |
| J6 | 42°34.0' | 70°26.2' | 13752 | 44300 | 25720 | |
| | | | | | | along 25720 |
| J7 | 42°55.2' | 70°00.0' | 13474 | 44362 | 25720 | |
| | | | | | | along 70°00' to J1 |

**FIGURE 4.6.1 Multispecies FMP management areas and boundaries****FIGURE 4.6.1 Multispecies FMP management areas and boundaries**

## 4.5 AREA CLOSURES.5 AREA CLOSURES

### Suspension of Haddock Area I closureSuspension of Haddock Area I closure

The haddock spawning area closure in Area I will be suspended for groundfish vessels using mobile gear. The closure will remain for fishing with sink gillnets because of possible interactions with endangered whales. The Council may modify this action under the framework mechanism.

### Expansion of Haddock Area II closureExpansion of Haddock Area II closure

The area of the haddock spawning closure, Area II, will be expanded and, after the third year, the time of the closure will be extended. The boundary lines of Area II (haddock spawning area) would be moved 20' west and 15' south (extended to the intersection with the Regulated Mesh Area boundary) upon implementation of the rule (see map). In the third year and thereafter, the season of the closure will run from January 1 through June. This closure will apply to all gear capable of catching groundfish, excluding scallop dredges. The coordinates for this area are as follows:

| | Latitude | Longitude |
|---|---|---|
| A1 | 42º22' | 67º20' |
| A2 | 41º00' | 67º20' |
| A3 | 41º00' | 66º35.8'* |
| A4 | 41º18.6' | 66º24.8' |

* the intersection of the Regulated Mesh Area boundary at 41º00'.

### Closure to protect juvenile yellowtail flounder in the vicinity of Nantucket LightshipClosure to protect juvenile yellowtail flounder in the vicinity of Nantucket Lightship

When the NEFSC Spring bottom-trawl survey index number of age-2 yellowtail flounder is 12.0 or higher, the area defined below (also see map) would be closed to all vessels with gear capable of catching yellowtail flounder, including scallop dredges. The closure will begin as soon as the Regional Director publishes a notice in the *Federal Register* when the survey results are available, sometime in June, and will remain in effect until the end of the second quarter of the following year. If the minimum legal size of yellowtail flounder is changed (to reflect the increased mesh size), the timing of this closure may be reconsidered and adjusted under the framework provision. Such an adjustment will be made appropriate to the growth rate and mesh selectivity.

The area that would be closed is within a line connecting the following points:

| | |
|---|---|
| 40°50'N | 69°00'W |
| 40°20'N | 69°00'W |
| 40°20'N | 70°20'W |
| 40°50'N | 70°20'W |

## 4.6 HADDOCK POSSESSION LIMIT.6 HADDOCK POSSESSION LIMIT

Vessels will be prohibited from possessing or landing more than 5,000 pounds of haddock.

## 4.7 PERMITTING.7 PERMITTING

**Operator's permitOperator's permit**

An operator of a vessel with a Multispecies Permit must have an "Operator's Permit" issued by NMFS. Any vessel fishing commercially for groundfish under either a moratorium permit or a possession-limit-only permit must have on board at least one operator who holds a permit. That operator may be held accountable for violations of the fishing regulations and may be subject to a permit sanction. During the permit sanction period, the individual operator may not work in any capacity aboard a federally permitted fishing vessel.

The permit program has the following requirements:

a) Any operator of a vessel fishing for multispecies finfish must have an operator's permit issued by the NMFS Regional Director.

b) An operator would be defined as the master or other individual on board a vessel who is in charge of that vessel. (Note: this definition is specified in the Code of Federal Regulations, CFR 50 part 620.2.)

c) The operator would be required to submit an application, supplied by the Regional Director, for an Operator's Permit. The permit would be issued for a period of up to three years.

d) The applicant would 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 would be requested to provide his/her social security number. In addition to this information, the applicant must provide two passport-size color photos.

e) The permit would not be transferable.

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

g) The Regional Director may, after publication in the *Federal Register,* charge a permit fee.

**Dealer's permitDealer's permit**

Any dealer of multispecies finfish must have a permit issued by the Regional Director. A dealer would be defined as the person who first receives fish by way of purchase, barter, or trade. (Note: this definition is specified in CFR 50 part 620.2.) The dealer would be required to submit an application, supplied by the Regional Director, for a Processor / Dealer Permit which would be issued for the period from January 1 to December 31 of each year. The applicant would provide the name, mailing address, telephone number and principal place of business on the application. The permit would not be transferable and would expire upon change in ownership of the business. The permit must be maintained at the place of business and be available for inspection upon request by an authorized officer. The Regional Director may, after publication in the *Federal Register*, charge a permit fee. The Regional Director may require that all permitted dealers, including restaurants buying directly from boats, comply with any data reporting requirements as a provision of dealer permitting.

## 4.8 MANDATORY DATA REPORTING.8 MANDATORY DATA REPORTING

The Council is proposing that effort and landings data be collected under a mandatory reporting system.

**Landings data systemsLandings data systems**

All vessels landing groundfish must report their landings. Logbooks are required of all vessels with a multispecies permit and must be completed for all trips rather than for only trips on which groundfish were landed. The logs would be submitted monthly but must be filled out before the completion of a trip.

The Regional Director has the authority to require observers aboard groundfish vessels. The vessel owner would be responsible for housing and food.

**Effort monitoring systemsEffort monitoring systems**

The Council has identified two alternative effort monitoring systems: the electronic vessel tracking system and a magnetic card system.

A vessel fishing under an individual allocation of days at sea must use an electronic vessel tracking system (VTS) that meets the standards established by the Regional Director in consultation with the Council.  All other vessels landing more than the possession limit of groundfish must use either a VTS or an electronic card effort monitoring system.  A VTS must be capable of providing network message communications between the vessel and shore.  The VTS shall allow NMFS to initiate communications or data transfer at any time.

## 5.0 UPDATED DESCRIPTION OF THE RESOURCE.0 UPDATED DESCRIPTION OF THE RESOURCE

### 5.1 Description of the stocks under the FMP.1 Description of the stocks under the FMP

A description of the stocks under the FMP is contained in the SEIS. See section E.6.3.2.

#### 5.1.1 Life histories and habitat requirements.1.1 Life histories and habitat requirements

See section E.6.3.2.1.

#### 5.1.2 Stock status.1.2 Stock status

See section E.6.3.2.2.

### 5.2 Description of the habitat.2 Description of the habitat

#### 5.2.1 Habitat requirements.2.1 Habitat requirements

A description of the habitat requirements of the stocks under the FMP is contained in the SEIS in section E.6.3.2.1.

#### 5.2.2 Habitat conditions and trends.2.2 Habitat conditions and trends

See section E.6.0, "Affected environment", for a description of the habitat conditions.

#### 5.2.3 Habitat threats.2.3 Habitat threats

See sections E.6.4.4 and E.6.4.5, for a discussion of the impacts of human activity, fishing and other activity respectively, on the environment of the fishery.

#### 5.2.4 Habitat information needs.2.4 Habitat information needs

The sources of information used in developing the SEIS are discussed in section E.6.1.1. In several sections of the SEIS, the concept of ecosystems management is discussed and general information needs are identified.

The Council staff participated in the Northeast Region Fisheries Data Needs Workshop held March 31 - April 1, 1993. Habitat information needs was one of the items discussed in the context of overall data needs. Among the data needs that were identified at this workshop are site-specific information on where and when fishing is taking place, and a reworking of existing databases to make them useable in a geographic information systems, GIS, model. A further point was made at the workshop that "several basic research questions have to be answered on marine habitats." The data monitoring needs are large-scale but only need to be complied over a short time series. The workshop produced a data needs table which included some habitat data needs and which was organized by both collection and application parameters. The workshop also laid out the second phase of the data redesign initiative which will consider appropriate data collection vehicles.

### 5.2.5 Habitat conservation policy and programs.2.5 Habitat conservation policy and programs

#### 5.2.5.1. Federal and state programs

The MFCMA provides for the conservation and management of living marine resources (which by definition includes habitat), principally within the EEZ, although there is concern for management throughout the range of the resource. The MFCMA also requires that a comprehensive program of fishery research be conducted to determine the impact of pollution on marine resources and how wetland and estuarine degradation affects abundance and availability of fish.

The MFCMA established Regional Fishery Management Councils that have the responsibility to prepare fishery management plans which address habitat requirements, describe potential threats to that habitat, and recommend measures to conserve those habitats critical to the survival and continued optimal production of the managed species. The NMFS Habitat Conservation Policy (FR 48(228):53142 - 53147), specifically Implementation Strategy 3, established the basis for a partnership between NMFS and the Councils to assess habitat issues pertaining to individually managed species.

Other NMFS programs relative to habitat conservation are found in the Marine Mammal Protection Act of 1972, the Endangered Species Act of 1973, the Fish and Wildlife Coordination Act, the Federal Power Act, and the Anadromous Fish Conservation Act of 1965. NMFS shares responsibilities with the FWS for conservation programs under these laws.

In addition to the above mentioned NMFS authorities, other laws regulate activities in marine and estuarine waters and their shorelines. Section 10 of the River and Harbor Act of 1899 gives the Army Corps of Engineers (COE) authority to regulate construction in navigable waters of the U.S. Section 404 of the Clean Water Act of 1977 gives the COE and EPA authority to regulate the discharge of dredge and fill material into waters of the U.S., including wetlands. The COE and EPA jointly administer the 404 program. The EPA, in conjunction with the COE, developed the 404(b)(1) Guidelines which govern COE issuance of section 404 permits. The EPA has veto authority over COE permit decisions. Section 401 of the Clean Water Act gives the EPA or States with approved programs, authority to regulate any activity which may result in discharge into navigable waters. The EPA and COE each have regulatory responsibilities under the Marine Protection, Research, and Sanctuaries Act of 1972.

All of the activities affected by these laws have the potential to adversely affect living marine resources and their habitat. NMFS, EPA, FWS, and state fish and wildlife agencies have authority to review these activities, assess the impact of the activities on resources within their jurisdiction, and comment on and make recommendations to ameliorate those impacts to regulatory agencies. Review and comment authority is provided by the Fish and Wildlife Coordination Act of 1934 (as amended 1958) and the National Environmental Policy Act of 1969. Consultative authority extends to all projects which modify waters of the U.S. and require federal permits or licenses, or that are implemented with federal funds.

Other legislation under which NMFS provides comments relative to potential impacts on living marine resources, their associated habitats, and the fisheries they support include, but are not limited to, the Coastal Zone Management Act of 1972; the Marine Protection, Research and Sanctuaries Act of 1972; and the Endangered Species Act of 1973 (Section 7 consultation). A more detailed discussion of the pertinent legislation affecting the protection, conservation, enhancement, and management of living marine resources and habitat can be found in the NMFS Habitat Conservation Policy (FR 48(228):53142-53148).

In addition, NMFS and the other federal resource agencies are involved in other programs with the States (e.g., NMFS Saltonstall-Kennedy and Wallop-Breaux programs) that provide grants to conserve fish habitats and improve fisheries management.

#### 5.2.5.2. Council policy

Recognizing that all species are dependent on the quantity and quality of their essential habitats, it is the policy of the New England Fishery Management Council to:

> Conserve, restore and enhance habitats upon which commercial and recreational marine fisheries depend, to increase their extent and to improve their productive capacity for the benefit of present and future generations. (For purposes of this policy, habitat is defined to include all those things physical, chemical and biological that are necessary to the productivity of the species being managed.)
>
> This policy shall be supported by four policy objectives which are to:

(1) Maintain the current quantity and productive capacity of habitats supporting important commercial and recreational fisheries, including their food base. (This objective will be implemented using a guiding principle of NO NET HABITAT LOSS.)

(2) Restore and rehabilitate the productive capacity of habitats which have already been degraded.

(3) Create and develop productive habitats where increased fishery productivity will benefit society.

(4) Ensure that any fishery management plan which is prepared by the Council with respect to any fishery shall include readily available information regarding the significance of habitat to the fishery and assessment as to the effects which changes to that habitat may have upon the fishery.

The Council shall assume an active role in the protection and enhancement of habitats important to marine and anadromous fish. It shall actively enter federal decision-making processes, to include entering into Memoranda of Understanding with regulatory agencies, where proposed actions may otherwise compromise the productivity of fishery resources of concern to the Council. Participation may be pursued by whatever form appropriate, including but not limited to Memoranda of Understanding.

In support of this policy, the Council proposes several recommendations in Section 5.2.6 of this document to promote habitat conservation for the groundfish resource.

### 5.2.6 Habitat recommendations.2.6 Habitat recommendations

Under the MFCMA, the Regional Fishery Management Councils have the responsibility not only to prepare fishery management plans, but to address habitat requirements, describe potential threats to habitat and recommend measures to conserve those habitats critical to the survival and continued optimal production of managed species. The National Marine Fisheries Service (NMFS) Habitat Conservation Policy (48 CFR 53142-53147), and specifically Implementation Strategy 3, provides the basis for a partnership between NMFS and the Councils to assess habitat issues.

The Magnuson Act, however, limits the Council's role to commenting on proposals that would affect fishery resources and their habitats. Decisions on such projects rest principally with the Army Corps of Engineers (ACOE) and the Environmental Protection Agency (EPA). Other federal agencies, including the U.S. Fish and Wildlife Service and the U.S. Coast Guard are involved in this process as well. In order for the Council to effectively manage fishery resources, more cooperative relationships should be fostered between managers and other habitat protection agencies.

In addition to habitat protection in the EEZ, protection for coastal habitats also is essential because of its role at some point in the life cycle of all inshore and most offshore species. For example, the condition of offshore resources may be compromised when forage species (which may depend on coastal habitats) are reduced as a consequence of degradation of the inshore environment. Because of the link between habitat quantity and quality and fishery production, the Council is concerned about impaired habitat quality and committed to assuming an active role in habitat protection.

Specifically with respect to Northeast groundfish resources, the following recommendations address habitat loss and degradation as mandated under federal law, including the Magnuson Act, Fish and Wildlife Coordination Act, Clean Water Act, Endangered Species Act, Marine Mammal Protection Act, Marine Protection, Research and Sanctuaries Act, Section 10 of the Rivers and Harbors Act, Oil Pollution and Control Act, Comprehensive Environmental Resources Compensation and Liability Act, Coastal Zone Management Act, Federal Power Act and others.

The recommendations are listed in the order in which each issue appears in Section E.6.4, Affected Environment, of the DSEIS.

**1) Impacts of Mobile Fishing Gear**

Despite documentation on the physical disturbances to the environment caused by mobile fishing gear, no systematic studies exist of definitive scale or over a series of bottom types to evaluate their consequences. The Council recommends that any studies undertaken focus on the scale of trawling activities and the potential cumulative impacts on fisheries habitat, especially as it affects the early life stages of groundfish species.

**2) Contaminants**

Contaminants can impact the feeding ecology of groundfish by diminishing food species abundance and availability. Accumulations of some contaminants can also impair groundfish reproductive capability, growth and survival thereby reducing population fitness. The Council requests EPA to consider the impacts of contaminants on groundfish production, both in terms of effects on physiological processes and feeding ecology (e.g. impairments to forage species).

a) The EPA's Water Quality Criteria Series should be used as guidelines for determining concentration levels of toxic substances in wastewater discharges harmful to groundfish stocks prior to permitting or renewing a permit for any potential discharge. Project proponents should be required to address the full range of impacts through the preparation of an Environmental Impact Statement.

b) The Council requests that EPA re-evaluate their water quality criteria to specifically consider impacts to groundfish resources and to the marine ecosystem.

c) The Council strongly urges EPA to evaluate and monitor the effects of the expected accumulation of toxins and sedimentation from the effluent at the Massachusetts Water Resources Authority Boston Harbor outfall project to determine whether there may be impacts to groundfish resources in Massachusetts Bay, Stellwagen Bank and other sites.

d) Because of the numerous discharges in the Gulf of Maine and coastal water bodies, the Council suggests that EPA undertake a study to determine the cumulative impacts of ocean discharges and disposal on groundfish resources. All discharges should meet Clean Water Act criteria.

**3) Effects of Nutrient Over-Enrichment**

a) The Council urges the EPA and the ACOE to evaluate the effluent from the discharge at the MWRA outfall location and the added effects of existing discharges in the Gulf of Maine to determine the potential for causing red tide or other toxic algal blooms.

b) Because the dumping of fish waste can provide enrichment that could trigger the growth of undesirable organisms such as those which cause paralytic shellfish poisoning (PSP), the Council recommends that EPA not allow the disposal of fish waste in any area, including state waters, that are actively fished. In those areas where disposal may be permitted, the proponent should be required to comply with conditions already developed by the EPA, NMFS and through state regulations.

**4) Dredging and Ocean Disposal**

a) The Council recommends that EPA / ACOE review their present management practices of permit by permit review for determining the disposition of dredged material disposal and consider the broader issue of regional dredged material disposal management. This requires an examination of alternatives to open water disposal of contaminated dredged materials which would isolate or neutralize the effects of such materials. The Council recognizes that some of the possible dredged material management alternatives will require considerable studies and finances. Nonetheless, an effort to start airing questions of feasibility and public acceptance should begin immediately.

b) The Council strongly urges that EPA / ACOE utilize the most environmentally productive dredging techniques available and practical. This, at a minimum, should include no barge overflow, closed bucket clamshell (unless a more protective dredging system is used) and consideration of both seasonal and current (tidal) influences to minimize both the extent of the contaminated plume and exposure of the groundfish resources which could be at risk.

c) The Council recommends that EPA / ACOE control the selection of dredge disposal sites to protect vital fish habitats and to ensure both marine and estuarine water quality.

d) The Council recommends that EPA / ACOE impose time of year restrictions on dredging and disposal operations to avoid / minimize impacts to groundfish species. Specifically, restrictions should be imposed in areas utilized for migration, spawning, feeding or other activities critical to the continued survival of groundfish species.

e) The Council recommends allowing ocean disposal only if it is demonstrated that there is no practicable alternative with less impact on the total environment.

**5) Coastal Habitat Loss**

a) The Council recommends that EPA / ACOE aggressively discourage filling of wetlands and shallow water habitats. Mitigation or compensation measures should be employed where filling is unavoidable. In such cases we recommend that EPA / ACOE require that proponents employ sequencing methods to determine the need to fill aquatic habitat. Filling should be permitted only for water dependent projects found to be in the public interest where no feasible alternative is available. Project proponents should be required to address the full range of impacts on groundfish stocks, their habitats, or food sources which may be associated with project implementation. Project proponents also must demonstrate that project implementation will not negatively affect groundfish resources, their habitats or their food sources.

b) The Council recommends that the ACOE establish a compliance program to monitor project construction to ensure that they are completed as specified, and that mitigation is successfully completed or adjusted to prevent the occurrence of net habitat loss and related loss of vital wetland functions.

**6) Research to Support Fishery Habitat Protection**

Research projects will provide the information on natural and altered ecosystems necessary to manage important aquatic habitats and will establish appropriate water quality criteria that considers the viability of groundfish resources. Objectives should be:

a) To develop a basic understanding of the status of groundfish populations and their habitat requirements. In order to establish this, research needs to be conducted to determine which habitats are most important to support groundfish stocks throughout their life history stages and to understand factors essential for sustained fisheries production. In addition, the relationship between offshore groundfish stocks and inshore coastal resources needs to be determined. This would include linking spawning strategies to benthic habitat that support juvenile stages of major groundfish species and identifying food chain connections.

b) To determine the biological and chemical effects of habitat degradation on groundfish populations and associated habitats and provide a sound scientific basis for habitat management and environmental impact assessments, (e.g. what are the effects of physical and chemical modifications of the habitat on groundfish resources?).

c) To investigate the individual and cumulative impact of specific human activities on the viability of groundfish stocks and make recommendations on how to avoid or minimize the impact of these actions.

d) To identify key geographical areas of critical importance in the life cycle of groundfish stocks or their prey for special protection and consideration by regulatory agencies.

## 6.0 UPDATED DESCRIPTION OF THE FISHERY.0 UPDATED DESCRIPTION OF THE FISHERY

### 6.1 The northest multispecies fishery.1 The northest multispecies fishery

Section E.6.0 of the SEIS, "Affected environment", contains a full description of the multispecies fishery. The material is presented in three general sections describing the physical, biological and human aspects of the fishery.

**6.2 The harvesting sector.2 The harvesting sector** - See section E.6.4.1.1.

**6.3 The processing sector.3 The processing sector** - See section E.6.4.2.

**6.4 The recreational sector.4 The recreational sector** - See section E.6.4.1.2.

**6.5 The social and cultural framework of the fisheries.5 The social and cultural framework of the fisheries** - See section E.6.4.3.

**6.6 Safety considerations.6 Safety considerations** - See section E.6.4.3.4.

### 6.7 The existing management framework.7 The existing management framework

#### 6.7.1 Relationship of the FMP to existing federal laws, regulations and policies.

**National Standards..7.1 Relationship of the FMP to existing federal laws, regulations and policies. National Standards.**

The Fishery Conservation and Management Act (FCMA, PL 94-265, 16 USC 1801-1882), also known as the Magnuson Act, claims for the United States sovereign rights and exclusive fishery management authority within the exclusive economic zone (the "200-mile limit"). Title III of the FCMA creates a national fishery management program and establishes the eight Regional Fishery Management Councils, including the New England Council. The Councils are charged with preparing management plans for each fishery within their geographical area of authority that requires conservation and management, and to amend such plans from time to time as necessary. The Northeast Multispecies Fishery Management Plan, which is being amended by this current action, is published in 50 CFR 651.

### 6.7.1.1 Other FMPs

In addition to the Northeast Multispecies FMP, there are currently twenty one management plans for fisheries in the northeast which may directly or indirectly be affected by the measures proposed in this plan. The New England Fishery Management Council (NEFMC), Mid-Atlantic Fishery Management Council (MAFMC), National Marine Fisheries Service (NMFS) and Atlantic States Marine Fisheries Commission (ASMFC) are the management bodies with regulatory authority of these fisheries. In addition to the managed fisheries, a number of unregulated fisheries exist in the region although management plans are in development for some of these. A complete list and status of all commercial fisheries in the region is provided in the Environmental Impact Statement, section E.6.3.3 , "Other Stocks", and a discussion of the impacts in section E.7.1.1.2, "Impacts on other fisheries."

The following management plans are in effect in the northeast:

**NEFMC:**
Atlantic sea scallops
American lobster
Atlantic sea herring
Atlantic salmon

**MAFMC:**
Squid-mackerel-butterfish
Surf clam-ocean quahogs
Bluefish (joint with ASMFC)
Summer flounder (joint with ASMFC)

**ASMFC:**
Striped Bass

Northern Shrimp
Winter flounder (vessels not holding federal permits)
Summer flounder (joint with MAFMC)
Bluefish (joint with MAFMC)
Weakfish
Shad-river herring
Spanish mackerel (joint with SAFMC)

**NMFS:**
Atlantic swordfish
Atlantic billfish
Atlantic sharks
Atlantic bluefin tuna (not an FMP but managed by NMFS under the Atlantic Tunas Convention Act, PL 96-339)

For most of the plans listed above, the relationship to this FMP is indirect and is based on the potential displacement of fishing from groundfish to another fishery. This relationship is discussed in the SEIS under section E.7.1.1. The proposed action also contains measures which directly affect vessels fishing under other FMPs.

The proposed 500-pound possession limit applies to all vessels not fishing under the groundfish effort reduction program or its exemptions. In addition, this amendment includes other measures which have a direct and explicit relationship with four of the plans listed above: ASMFC's winter flounder and northern shrimp plans, the summer flounder FMP and the Atlantic sea scallop FMP. In the first case, the proposed action applies ASMFC regulations to vessels fishing exclusively for winter flounder in state waters. Vessels fishing for northern shrimp will be required to use a finfish excluder device, or grate, to minimize the bycatch of groundfish. In the case of the summer flounder plan, the proposed amendment applies that FMP's mesh regulations on vessels fishing for groundfish west of 72º30'. In the case of scallop vessels, the proposed amendment will prohibit scallop vessels from fishing in an area around Nantucket Shoals when the area is closed to protect large concentrations of juvenile yellowtail flounder. This closure does not occur every year but only when a large year class of yellowtail is indicated by the trawl survey.

#### 6.7.1.2 Federal laws and regulations

##### 6.7.1.2.1 Magnuson Fishery Conservation and Management Act

**Consistency with the National Standards**

Section 301 of the FCMA requires that any regulation promulgated to implement any FMP shall be consistent with the seven national standards listed below.

1) *Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.*

The definitions of overfishing adopted by the Council establish harvest levels consistent with federal guidelines on achieving optimum yield (50 CFR 602.11). Overfishing definitions are based on the minimum spawning stock biomass per recruit needed for the stock to maintain itself at long-term average levels. In other words, the definitions set a minimum threshold below which the risk of recruitment failure is high.

The fishing mortality rate at the level of the overfishing definition is higher than that which will produce the maximum sustainable yield from the stocks. Under this system, optimum yield is not a specific harvest level but a range of acceptable harvest levels between the maximum sustainable yield and the yield generated at the threshold level defined by the overfishing definitions.

Federal guidelines provide that in the case of a mixed fishery, some minor components may be fished at a rate which exceeds the overfishing threshold if the major component is fished at an optimum level. In the case of the northeast multispecies fishery, all the major components, the stocks of cod, haddock and yellowtail flounder, are overfished. The primary purpose of the proposed action is to eliminate the overfished condition of these principal stocks within five years.

2) *Conservation and management measures shall be based upon the best scientific information available.*

In developing this amendment, the NEFMC used information provided by the Stock Assessment Workshops (SAW) as well as analyses conducted by the Council staff and the Groundfish Plan Development Team using data collected by NMFS. See section E.6.1.1, Data Considerations, for a discussion of the databases that were used, and more generally, section E.6.0, Affected Environment, for the actual scientific information that formed the basis of the plan. Wherever appropriate, published scientific literature was referenced. Appendix III contains a complete list of references.

In the time frame of the development of this amendment, the SAW reviewed the following multispecies stocks:

| | | |
|---|---|---|
| SAW 12 | Spring 1991 | Gulf of Maine cod, yellowtail flounder |
| SAW 13 | Fall 1991 | Georges Bank cod, haddock, inshore winter |

| | | |
|---|---|---|
| | | flounder |
| SAW 14 | Spring 1992 | American plaice |
| SAW 15 | Fall 1992 | Georges Bank cod, Gulf of Maine cod, redfish |
| SAW 16 | Spring 1993 | Pollock. |

The SAW reports have generally indicated that all the stocks that have been reviewed are at a low level of abundance and / or are at a high rate of fishing mortality.

During the development of this amendment, one significant limitation of the weighout database became evident. The NEFMC had proposed a system of effort controls that relied on individual vessel histories of groundfishing for all vessels over 60 GRT. The response from the public during the first round of hearings indicated that significant gaps existed in the effort data in the weighout database. This situation has been attributed to the fact that small boats and those fishing from more remote ports are not captured by the data collection system at the same rate as other vessel groups. In response and based on input from the Groundfish Industry Advisory Committee and the Plan Development Team, the Council developed the current proposed system allowing the choice of either an individual history or a fleetwide allocation based on effort data with a greater-than-85-percent interview rate. See section E.5.3.2 for further discussion.

Despite the fact that mesh size has been the primary management measure used by the NEFMC up to this time, no conclusive data analysis exists for the selection characteristics of large mesh (5.5 inches and up) for the stocks covered by this plan. Early in the development of this amendment the PDT conducted a study of the effects of mesh size versus effort controls on the principal stocks covered by the plan. Their report which was reviewed bye the NEFMC's Scientific and Statistical Committee is contained in Appendix II. Subsequently, the 15th SAW held a workshop to review existing mesh studies from around the world. Again, the absence of large mesh data and the significant differences among the various mesh selection studies, proved problematic. The SAW did, however, project selection lengths for 6.0-inch mesh which were not inconsistent with the findings of the PDT. The SAW also concluded that existing databases should be thoroughly analyzed and that future gear selection studies be conducted and reported under a standardized protocol.

The amendment includes the establishment of a mandatory collection system for landings and effort data. This will result in future management decisions being based on universally collected data rather than the current voluntary system and sampling programs. The framework system which is established by this amendment will use this information to make adjustments to the management measures as necessary.

3) *To the extent practicable, an individual stock of fish shall be managed as a unit throughout*

*its range, and interrelated stocks of fish shall be managed as a unit or inclose coordination.*

The regulations proposed in this amendment apply throughout the range of the stocks managed under the FMP. In some cases, however, the NEFMC considered regional differences particularly with regards to mesh sizes used in fisheries other than the multispecies fishery is setting mesh size regulations.

The stocks comprising the northeast multispecies complex are managed as a unit not on an individual species basis with some exceptions. The NEFMC has established separate goals and management measures for haddock due to its prolonged, historically low abundance. The amendment contains measures specifically targeting concentrations of juvenile cod and yellowtail flounder. Otherwise, the measures in this amendment, such as the effort controls, possession limit, and minimum mesh size, apply to vessels catching any of the ten large-mesh species.

For a discussion of the inter-relationship of the stocks in the multispecies complex, see Section E.6.3.1, Geographic Species Assemblages. Some of the stocks managed under this FMP extend into Canadian waters. Canadian management objectives are at least as restrictive as those of this plan and are not expected to have a negative impact on the efforts of the NEFMC to eliminate overfishing.

4) *Conservation and management measures shall not discriminate between residents of different States. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocation shall be (A) fair and equitable to all such fishermen; (B) reasonably calculated to promote conservation; and (C) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.*

The measures in the Multispecies FMP or in this amendment do not explicitly or directly discriminate among residents of different states. Indirectly, however, some measures result in regional allocations of fishing privileges. Furthermore, the amendment results in allocations of fishing privileges to different vessel groups without regard to their geographical distribution.

The NEFMC adopted regional differences in the application of mesh regulations to take into account the regional distribution of impacts that would result if the mesh regulations were to be applied uniformly throughout the range of the stocks. The regional effect results from the diversity of species comprising the overall fishery resource base in the southern part of the range of groundfish stocks and the relative mix of large-mesh species and small-mesh species.

The amendment also allocates fishing privileges among different groups of vessels in ways other than by region. The moratorium allocates fishing privileges to those individuals who currently own qualifying vessels, although it does not prohibit any individual from purchasing a qualifying vessel (and its permit). The effort reduction program allocates fishing time to vessels in one of two ways: either based on the individual history or based on the average fleet history. Those vessels with more groundfishing time during the baseline period used to make the allocation will have a larger individual allocation. The fleet-wide system of time out of groundfishing results in an allocation of fishing opportunity that will impact vessels proportionally to their history of fishing for groundfish. Vessels that have fished more time on groundfish will be restricted more severely.

The possession limit allocates limited groundfish fishing privileges to vessels that do not qualify for a moratorium permit or are engaged in fishing for species other than groundfish. The exceptions to the moratorium and effort reduction also constitute an allocation of fishing privileges to vessels of a certain size or that use a particular gear.

The allocations presented in the previous paragraph are justified on the basis that they will contribute to achieving the FMP objectives. The Council included the possession limit and the other exceptions as a result of its consideration of the impacts of not having these measures (namely the discarding that would result with no possession limit for non-qualifying vessels, or the hardship imposed on the excepted vessels relative to their impact on the resource). The Council also considered a number of alternatives that would have resulted in different allocations, some of which were taken to public hearings in either 1992 or 1993, see Section E.5.2.

5) *Conservation and management measures shall, where practicable, promote efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.*

The overfished condition of the multispecies fishery being addressed by this amendment is to a great extent attributed to an excess of economic inputs into the system. Fleet expansion and technological improvements in the 1980's have enabled the industry to catch fish at a rate that far exceeds the capability of the resource to renew itself over the long term. The management system in place prior to this amendment failed to promote economic efficiency because it allowed the harvesting capacity of the industry to exceed the renewability limits of the resource.

As groundfish catch rates declined, individual vessels became more efficient. Advances in net design, electronics, engine efficiency and vessel construction all contributed to the increased competitiveness of fishing vessels and also raised their level of capitalization. Ironically, overall fleet efficiency has declined as the potential efficiency of individual vessels has increased. The rate of fishing mortality has increased to the point where the catches have declined below optimum levels.

By capping the number of vessels and the aggregated fishing power of the fleet (with a moratorium and restrictions on horsepower and vessel size upgrading), and by incrementally reducing the time vessels can fish for groundfish, the amendment will increase efficiency. Existing fishing businesses will realize the benefits of the measures being imposed as landings from the stocks increase and effort (variable costs) is reduced.

In general two options exist for reducing fishing mortality: controlling the outputs (quota systems) or controlling the inputs (effort and technology controls). In the course of developing this amendment, the NEFMC considered both approaches. These alternatives are discussed and compared in sections E.5.0 and E.7.2.4 of the SEIS. Variations and alternatives within each general category are also discussed.

The amendment also includes several other measures which will enhance the efficiency of the fishery within the context of the overall objectives. For example, the amendment includes measures to reduce discards by protecting concentrations of juvenile fish and by setting the minimum legal size to be appropriate to the mesh size such that fewer undersize fish will be kept by the net. The option allowing vessels to choose an individual days-at-sea allocation under the effort reduction program will enable vessels to choose when they will fish for groundfish and will not tie them to the dock. This way vessels may pursue other fisheries while still achieving a fifty percent reduction in groundfishing time. Perhaps the most significant measure from the point of view of efficiency is the annual review and framework adjustment system. This mechanism will enable the Council to make timely changes to the management program to meet its objectives.

The amendment does re-allocate economic benefits, although this is not its intended purpose. For example, the amendment includes exceptions to the effort control measures and moratorium for certain vessel categories or gear types. The Council adopted this *de facto* allocation on the basis of socio-economic impacts and the costs of imposing the regulations on these groups (hook-gear-only boats and boats under 45 feet) in comparison to their relative impacts on the resource (see section E.6.4). If the justification for these exceptions no longer applies at some point in the future, the Council may use the framework system to make adjustments.

6) *Conservation and management measures shall take into account and allow for variations among, and contingencies in fisheries, fishery resources, and catches.*

The discussions presented under the preceding three sections (management units, allocations and efficiency) reflect the NEFMC's consideration of variations in fisheries, fishery resources and catches. The identification of differences in regional fisheries, gear types and vessel size categories exemplifies the Council's adherence to this standard. Furthermore, the framework adjustment system enables the Council to continually take into account changes in the fishery. The framework system enables the Council to not only respond to changes in the resource but also to changes in the industry. Public and scientific input are both integral elements of this system as established by the amendment.

7) *Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.*

With this amendment the Council attempts to minimize costs to the industry by reducing excessive fishing effort. Instead of forcing vessels to fish more inefficiently, this amendment will reduce the time vessels spend fishing for groundfish. Unlike a fleet quota system, however, the effort reduction program lets vessels choose the days that they may not land groundfish and allows an uninterrupted supply of fish to flow to the market. The administrative costs of the proposed action are identified in section E.7.2.4. The action is expected to reduce enforcement costs of existing management measures such as closed areas and minimum fish and mesh size regulations by increasing the abundance of large fish and by reducing the incentive to catch and discard small fish.

#### 6.7.1.2.2 Other applicable law

A number of federal statues and orders apply to the development of FMPs. Those applicable laws which require explicit attention in the submission of an amendment are addressed individually in Section 8.0 of this document. These include:

APA- Administrative Procedures Act
CZMA- Coastal Zone Management Act
E.O. 12291- determination of "major" rule
ESA- Endangered Species Act
MMPA- Marine Mammal Protection Act
NEPA- National Environmental Policy Act
PRA- Paperwork Reduction Act
RFA- Regulatory Flexibility Act
E.O. 12612- executive order on federalism
E.O. 12630- order on interference with constitutionally protected property rights
E.O 12498- order on regulatory planning process
E.O. 12778- order on civil justice reform.

Federal laws and programs which relate specifically to habitat and environmental issues are discussed in Section 5.2.5, habitat conservation programs.

Commercial fishing vessels must also adhere to regulations promulgated under the Fishing Vessel Safety Act of 1988 .

### 6.7.2 Federal/State relationships. State fishery regulations.7.2 Federal/State relationships. State fishery regulations

Federal fisheries permit holders fishing in state waters must adhere to federal fisheries regulations unless the state regulations are more restrictive or unless they are specifically exempted. The following is a summary of the state regulations relevant to groundfish.

**State Laws for Groundfish and Groundfish Gear**

**MAINE**

Gear restrictions: There is a 5½ inch minimum mesh size for trawls, Scottish seines, bottom tending gillnets and bottom tending seines. Regulations exist regarding the placement of stop seines and fish weirs. Additional gear/season restrictions for specific locations are detailed in Department of Marine Resources regulations.

Area closures: There is a groundfish spawning closure in Booth Bay and Sheepscot Bay from May 1 - June 30.

Seasons: See above.

Licenses: A commercial license is required for the harvest, transport and sale of fish that are not for personal use: $33 for individual, resident operators; $89 for resident operator with crew; and $334 for nonresident operator and crew. No license is required for fish taken with hook and line for personal use. There is no recreational license except for Atlantic salmon.

Other: Nonresidents are required by law to report all groundfish.

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**NEW HAMPSHIRE**

Gear restrictions: The minimum mesh size for gillnets and mobile gear is 5½ inches to take, transport or possess cod, haddock, or yellowtail flounder. No mobile gear may be used to take finfish in Piscataqua River or its tributaries north of the Memorial Bridge in Portsmouth. Mobile gear may be used in state ocean waters from December 15 - April 15.

Area closures: See above.

Seasons: See above.

Licenses: Resident commercial saltwater fishing license ($26) is required. There is no sport fishing license. Residents are not required to have a license to sell fish caught by hook and line but a $200 minimum license fee is required for nonresidents.

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**MASSACHUSETTS**

Gear restrictions: The following minimum mesh sizes apply for mobile gear:
In all state waters north of Loran C line 9960-Y-43940, 5½ inch mesh is required year round. The use of small mesh is allowed for underutilized species (ocean pout and whiting) with no bycatch of regulated species.

For the area south of Cape Cod to the Rhode Island border including waters east of Chatham south of Loran C line 9960-Y-43940, there are no mesh restrictions from April 23 - May 31. From June 1 - October 31 the mesh size must be at least 4½ inches. From November 1 - April 22, the mesh size must be at least 5½ inches. Any vessel possessing mesh less than 5½ inches from April 23 - October 31 must not possess more than 100 pounds of flounders (any species in combination). Possession of mesh less than the minimum size is prohibited if seen fishing.

Gillnets may not exceed 2,400 feet and the mesh used must be greater than 6 inches (stretched measure).

Area closures: All waters closed to night trawling (November 1 - end of February: 6 PM - 6 AM; March 1 - October 31: half hour after sunset to a half hour before sunrise). Buzzards Bay is closed to trawling year round. State waters from Nauset Light to Monomoy west to Succonessett Point, Mashpee are closed to trawling from May 1 - October 31. All waters south of Cape Cod banned to gillnetting April 1 - November 15.

Seasons: See above.

Licenses: Resident Commercial: vessel license ranges from $130 - $260 depending on length; a license for individuals is $65. Nonresident commercial: vessel license ranges from $260 - $520 depending on length; a license for individuals is $130. There is no sport license for fish caught for personal use. A license to sell fish with hook and line is $35 for residents ($100 for nonresidents), and applies to any individual selling fish.

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**RHODE ISLAND**

Gear restrictions: Trawling is prohibited in the upper portion of Narragansett Bay from November 1 - July 1. The minimum cod end mesh size is 5 inches in a portion of central Narragansett Bay from November 1 - February 28. There are numerous specific gillnet regulations by geographic location and season, trap and fyke net regulations regarding leaders, distance from shore, distance between traps, etc.

Area closures: The fishing for or the possession of winter flounder is prohibited north of the a running between Point Judith Light and Sakonnet Point and the south shore coastal ponds including Little Narragansett and the Pawcatuck River. Numerous restrictions on the location of traps off the Island of Rhode Island, the Sakonnet River, and in Narragansett Bay. It is prohibited to set, haul, and/or maintain a seine within 0.5 mile of the seaward entrance of several ponds/rivers. A significant portion of the State is closed to various forms of netting.

Seasons: Fish traps must be out of the water January 1 - end of February.

Licenses: Multipurpose commercial licenses allow for the harvest and sale of fish ($300) with additional fees for specific gear types. There is no sport license to fish for personal use.

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**CONNECTICUT**

Gear restrictions: Cod end minimum mesh size of 4½ inches in trawls for November 15 - May 14, and 3 inches from August 1 - November 14. The minimum mesh size for gillnets is 3 inches. The minimum mesh sizes for pound, fyke and weirs is 2 inches.

Area closures: Fish traps and pound nets may not be set in an area off the mouth of the Connecticut River; pound nets must be set at least one mile apart; trawling is prohibited within an "inshore trawl line"; numerous specific area are closed to trawl and/or other forms of net gear.

Seasons: None except as noted above.

Licenses: A variety of commercial resident and nonresident licenses are available allowing for the harvest and sale of fish. Fees are typically in the $25 - 150 range. Marine angling with hook and line does not require a license if fish are for personal use only. Personal use fishing with trawls and other specific gear will require a commercial license.

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**NEW YORK**

Gear restrictions: No minimum mesh size for trawls at the present time.

Area closures: There are numerous specific locations where trawl and/or other net gear are restricted.

Seasons: Recreational fishing is allowed between May 15 and September 30.

Licenses: A commercial license is required for harvest and sale of fish (Resident: $100, Nonresident: $1000). The nonresident harvest license may only be purchased in January. A nonresident license which allows landing only is $250. There is no sport license for fish caught for personal use.

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**NEW JERSEY**

Gear restrictions: Trawls fishing for groundfish (summer flounder) must have a 4½ inch minimum mesh size in the cod end. Gillnets may not exceed 2,400 feet in length from February 1 - May 15, and may not exceed 1,200 feet from May 15 - December 15.

Area closures: Trawling and purse seining are prohibited within two miles of the coast; gillnetting is limited to the Atlantic Ocean and Delaware Bay.

Seasons: Gillnets cannot be fished from December 16 - February 1.

Licenses: Commercial gears are licensed with fees dependent on the gear type. There is no sport fishing license for hook and line gear and no license is required to sell hook and line caught fish.

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Note: Regulations listed above are as of November 1992. Other regulations may apply and copies of complete regulations should be obtained from the appropriate State.

Source: Mid-Atlantic Fishery Management Council (Amendment 3 to the Fishery Management Plan for the Summer Flounder Fishery)and personal communication with: Perley Sprague (Maine Department of Marine Resources), Bruce Smith (New Hampshire Fish and Game Department), David Pierce (Massachusetts Division of Marine Fisheries), Richard Sisson (Rhode Island Division of Fish and Wildlife), David Simpson (Connecticut Department of Environmental Protection), Chester Zawacki (New York Department of Environmental Protection), and Paul Scarlett (New Jersey Department of Environmental Protection).

MINIMUM FISH SIZES

| SPECIES | EEZ | ME | NH | MA | RI | CT | NY | NJ |
|---|---|---|---|---|---|---|---|---|
| COD | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 12 |
| HADDOCK | 19 | 19 | 19 | 19 | 19 | 19 | - | - |
| POLLOCK | 19 | 19/0 | 19/0 | 19/0 | 19 | 19 | 19 | - |
| REDFISH | 9 | - | 9 | 9 | - | 9 | - | - |
| WHITE HAKE | - | - | - | - | - | - | - | - |
| OCEAN POUT | - | - | - | - | - | - | - | - |
| RED HAKE | - | - | - | - | - | - | - | - |
| SILVER HAKE | - | - | - | - | - | - | - | - |
| AMERICAN PLAICE | 14 | 14 | 14 | 14 | 14 | 14 | - | - |
| WINDOWPANE FLOUNDER | - | - | - | 12 | - | - | - | - |
| WINTER FLOUNDER | 11 | 11 | 11 | 12 | 12 | 12 | 11/10 | 10 |
| WITCH FLOUNDER | 14 | 14 | - | 14 | 14 | 14 | - | - |
| YELLOWTAIL FLOUNDER | 13 | 13 | 13 | 13 | 13 | 13 | 13 | - |

Note: If two minimum sizes are listed, the first is the commercial size and the second is the recreational size.

### 6.7.3 International fisheries treaties, agreements and policies.7.3 International fisheries treaties, agreements and policies

#### 6.7.3.1 Fishery specific agreements and policies

Title II of the FCMA establishes the system for the regulation of foreign fishing within the EEZ. Those regulations are published in 50 CFR 611. The regulations provide for the setting of a TALFF (total allowable level of foreign fishing) for specific species based on the portion of the optimum yield which will not be caught by U.S. vessels. There is currently no TALFF nor are there are any international fishery agreements or treaties which specifically or directly affect species managed under this FMP.

Neither the NEFMC nor the Canadian Department of Fisheries and Oceans has established an explicit policy on cooperative management of transboundary groundfish stocks. As the groundfish stock conditions in Canadian waters deteriorate, however, the government is continuing to restrict the fisheries on Georges Bank (NAFO Area 5Z). The most recent information (9/93) indicates that the Canadian government would like to begin discussions with the United States government on the management of stocks which live on both sides of the Hague Line.

#### 6.7.3.2 Trade policies, agreements and tariffs

##### 6.7.3.2.1 The U.S. - Canada Free Trade Agreement

The U.S. - Canada Free Trade Agreement (FTA) has resulted in the phase-down and /or elimination of all fisheries import tariffs on goods originating in Canada. The import tariff on most seafood products were eliminated entirely and such goods were free of duty on January 1, 1989, the implementation date of the FTA. For certain seafood products, the tariff has been phased down in five or ten equal annual stages commencing on January 1, 1989 and continuing for a maximum of ten years, at which time such goods will be free of import duties. The import tariffs on fresh and frozen groundfish fillets (cod, cusk, haddock, pollock, hake, and Atlantic ocean perch) from Canada are in the five-year phase down categroy and became free if import duties in 1993.

In addition to the phased-in tariff elimination, the FTA specifically excludes certain Canadian provincial government statutes which can be implemented at any time and which essentially prohibit the export of unprocessed Canadian groundfish. The restrictions are designed to bolster the provincial economies by keeping processing jobs in Canada. If Canadian fresh fish processors experience supply shortages due to expanded demand or reduced supply, the provincial governments can invoke these statutes and effectivley eliminate the export of unprocessed groundfish.

#### 6.7.3.2.2 The North American Free Trade Agreement (NAFTA)

The U.S., Canada and Mexico are currently in negotiations over the North American Free Trade Agreement (NAFTA), which will expand free trade provisions to include goods and services originating in Mexico. At this time specific tariff and non-tariff reduction schedules are under negotiation and no details are available.

The measures proposed in this plan amendment are conservation-based, consistent with relevant GATT (General Agreement on Trade and Tariffs) Articles (VII and XX9g)), and their corresponding FTA articles. Neither these measures nor the regulations required to implement them are expected to establish barriers to trade. Similarly, these measures are considered to be consistent with the approaches to environmental laws and regulations envisioned in the North American Agreement on Environmental Cooperation as part of NAFTA.

#### 6.7.3.2.3 Northwest Atlantic Fisheries Organization (NAFO)

In August, 1992, the Department of State (DOS) forwarded to Congress legislation to implement the Convention on Future Multilateral Cooperation in the Northwest Atlantic Fisheries. The Convention was submitted to the U.S. Senate in 1979, and the Senate gave its advice and consent to ratification on July 23, 1983. President Reagan signed the instrument of accession, but the U.S. does not typically accede to a convention until Congress enacts implementing legislation.

Only three or four U.S. vessels have fished in the NAFO Regulatory Area over the past four years. However, the New England fleet has fished off Newfoundland since colonial times. The U.S. had previously been a member of the International Convention for the Northwest Atlantic Fisheries (ICNAF).

At its September 1992 meeting, NAFO adopted several conservation measures. There was agreement on a moratorium on fishing in NAFO Division 3L, which encompasses the fishery for northern cod, already closed inside the Canadian zone under a two-year moratorium imposed by the Canadian government. Other NAFO management measures for groundfish include setting conservativie total allowable catches for the various groundfish stocks under management: minimum fish sizes for cod (41 cm / 16.1 in.), American plaice (25 cm / 9.8 in.), and yellowtail flounder (25 cm / 9.8 in.); minimum mesh sizes of 130 mm / 5.1 in.; and specific requirements for one mesh on board unless a vessel fishes outside the NAFO Regulatory Area and has small mesh gear properly stowed.

### 6.7.3.3 Canadian fisheries management

Canada uses a variety of measures to manage its groundfish fishery. Canada develops catch levels utilizing a fishing mortality rate of $F_{0.1}$. The Canadian Georges Bank fishery (Statistical Area 5Y and 5Z) operates through a combination of quotas and trip limits. The overall quota is broken down by vessel size and gear class. Mobile gear vessels are subject to individual quotas or company quotas (enterprise allocations) depending on vessel size. Once these quotas are achieved, then fishing is no longer allowed in the area by the vessel or company. Fixed gear vessels fish under trip limits and once the fixed gear quota is reached, then the entire fleet is no longer permitted to fish for cod or haddock in this area for the remainder of the year. Larger fixed gear vessels are subject to company quotas.

The 1993 quotas (in metric tons), summarized below, are unchanged from 1992 but are expected to be reduced significantly in 1994:

| | 5Y | | 5Z | |
|---|---|---|---|---|
| | Inshore | Offshore | Inshore | Offshore |
| Cod | 750 | - | 14,325 | 675 |
| fixed gear less than 65' | 750 | - | 9,615 | - |
| mobile gear less than 65' | - | - | 4,430 | - |
| fixed gear 65' - 100' | - | - | 140 | - |
| mobile gear 65' - 100' | - | - | 140 | - |
| vessels over 100' | - | - | - | 675 |
| Haddock | - | - | 3,820 | 1,180 |
| fixed gear less than 65' | - | - | 1,185 | - |
| mobile gear less than 65' | - | - | 2,535 | - |
| fixed gear 65' - 100' | - | - | 50 | - |
| mobile gear 65' - 100' | - | - | 50 | - |
| vessels over 100' | - | - | - | 1,180 |

Vessels subject to the individual quotas are required to land all fish that are caught, which in turn counts against the quota. To aid in monitoring small fish taken in this fishery, Canada uses at-sea observers and will close an area when small fish exceed 15% of the catch. In addition to the quotas there was a minimum mesh size in place of 130 mm (5.1 inches) square mesh or 145 mm (5.7 inches) diamond mesh. There is a spawning closed area for haddock on Georges Bank which is closed from March 1 through May 31.

Other areas of the Canadian fishery are subject to species quotas or individual quotas on vessels. Quotas on cod for several areas were attained during 1992 causing the closure of the fishery in those areas. The closure receiving the greatest attention was the closure of the northern cod fishery off of Labrador and Newfoundland. This closure occurred in July, 1992, and is expected to continue until the spring of 1994. The closure followed a decline in the northern cod stock biomass of one half and the spawning stock biomass of three quarters that had occurred since 1990. While no single factor was identified as the cause for decline, a contributing factor was thought to be a colder winter conditions in 1991. The Canadian government authorized emergency assistance payments ($225 Canadian) to fishermen and plant workers that had exhausted unemployment insurance benefits or failed to qualify for other compensation. Included in this program were options for early retirement, skills training, and aiding processors in the search for new sources of product. The Department of Fisheries and Oceans has recently (9/93) announced that in almost all of eastern groundfish fisheries, the quotas for this year will be reduced immediately and several fisheries will be closed at least for the remainder of the year.

### 6.7.4 Council review and monitoring of the FMP.7.4 Council review and monitoring of the FMP

This amendment provides for annual review of the fishing mortality reduction and harbor porpoise bycatch programs through a framework system. This provision enables the Council to make adjustments to the plan as needed in a timely manner.

## 7.0 CONCEPTUAL BASIS OF THE MANAGEMENT PLAN.0 CONCEPTUAL BASIS OF THE MANAGEMENT PLAN - See Appendix I

## 8.0 RELATIONSHIP TO APPLICABLE LAW.0 RELATIONSHIP TO APPLICABLE LAW

### 8.1 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA).1 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

**DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATMENT (DSEIS)**
**DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATMENT (DSEIS)**

**E.1.0 COVER SHEETE.1.0 COVER SHEET**

**E.2.0 TABLE OF CONTENTSE.2.0 TABLE OF CONTENTS** - see Table of Contents for Volume I, page 2.

**E.3.0 SUMMARYE.3.0 SUMMARY**

**E.3.1 BACKGROUNDE.3.1 BACKGROUND**

The background of this amendment is discussed in Section 2.0 of this document.

**E.3.2 MAJOR CONCLUSIONSE.3.2 MAJOR CONCLUSIONS**

The environmental assessment indicates that the impacts of the proposed measures include both positive and negative impacts on the physical, biological and human environments. In many cases, the availability of appropriate data, analysis techniques or our basic knowledge of the system inter-relationships prohibits conclusive analysis. The majority of physical, biological, and economic impacts relate to the reduction in fishing effort and the subsequent rebuilding of groundfish stocks. In addtion to the consequences of reduced overall effort, the amendment includes measures which specifically address and reduce the fishery`s interaction with protected species.

The fishing industry is expected to experience a short-term reduction in landings and revenues, and a significant increase in long-term economic benefits over taking no action. The breadth and scope of the measures being proposed is expected to cause some element of social change which will be distributed across individuals, families and communities proportional to their dependence on groundfishing. These social impacts are partially linked to the economic impacts, and, as such, could be negative in the short term and positive in the long term, although some fundamental changes will probably occur. One significant element of this amendment is the framework measure which enables the Council to adjust the management measures during the period covered by the amendment in order to achieve its objectives, namely the elimination of overfishing.

**E.3.3 AREAS OF CONTROVERSYE.3.3 AREAS OF CONTROVERSY**

The measures in this amendment address issues of such magnitude and affect such a broad range of interests that controversy is unavoidable. Almost all of the measures contained in this amendment, were opposed by some sector of the industry or public during the development of this plan. The public hearing comments which are summarized in Volume III of this amendment document along with the Council's response reflect the nature of these controversies.

**E.3.4 ISSUES TO BE RESOLVEDE.3.4 ISSUES TO BE RESOLVED**

The Council has identified a number of outstanding issues that are not resolved by this amendment. Specifically, the Council acknowledges that it needs to address a number of questions about the management of technology. Changes in technology and the behavior of fishermen are the two mechanisms by which the effectiveness of controlling nominal effort (fishing days) may be diluted. The Council recognizes the difficulties in trying to manage adaptive behavior but feels that a strategy to manage technology is appropriate and necessary.

The issue of regulating technology requires Council's addressing the fundamental question of whether to manage for economic efficiency or some other objective such as maximization of employment opportunities. Once this strategy is defined, the Council will address specific management approaches such as controls or prohibitions on certain technology as well as incentives for switching to more selective (or, perhaps, less efficient) gear. In this amendment, the Council has already begun the process of addressing the issue with several of the measures being proposed. The technology management measures include increased mesh size and other mesh regulations, a prohibition on pair trawling, a requirement to use a finfish excluder device, exceptions to effort controls and the moratorium for hook-gear boats, and an exception to effort controls for small boats. The Council has stated that it needs to make a clear statement of policy before continuing to address technology in a piece-meal manner.

Other issues that have been identified but are not resolved by this amendment include cooperative management of transboundary stocks, and the ecosystems approach to management of living marine resources which includes consideration of shifts in fishing effort and the concept of an overall regional moratorium on fishing permits. Additionally, the measures proposed in this amendment are primarily intended to eliminate overfishing which is the first objective of the amendment. The Council recognizes that these measures are not being proposed as the permanent management regime. The question that remains, therefore, is how the Council will approach the principal standard of optimum yield from the fishery in a future management system once the overfished condition of the resource has been eliminated.

### E.3.5 MITIGATIONE.3.5 MITIGATION

In order to mitigate the unresolved issues identified in the previous section, the Council has laid the foundation for future deliberation and action, and, wherever appropriate, proposed action in this amendment.

For example, the Council has explicitly identified technology issues as the primary focus of the next amendment. Recognizing that changes in technology could offset the impacts of effort reductions on fishing mortality, the Council is proposing to begin development of Amendment #6 immediately upon implementation of this amendment (#5) to address all relevant technology issues and policies. During the first year, the Council intends to conduct a series of workshops and scoping hearings to identify the relevant issues and begin any necessary data collection. During the second year, the Council will establish a clear policy and develop appropriate alternatives for addressing the technology issues. It will conduct hearings to present those alternatives to the public. Before the end of the third year, the Council intends to complete its review of comments and submit an amendment to the Secretary of Commerce.

This schedule will enable the Council to address technology issues in a timely manner so that their findings can also be available for use in adjusting the Amendment #5 effort reductions under the framework mechanism. The plan development process outlined above will provide the public with more opportunity for input into the framework adjustments as well as any future management plan. This process will enable the Council to monitor technological developments in the context of of the effort reduction program and to respond in a manner consistent with its policy and guidelines before such changes significantly alter the effort/fishing mortality relationship on which the proposed amendment is based.

The Council has stated that its purpose in addressing technology is not to curtail innovation and technological advancement, but to identify ways to incorporate continually increasing efficiency into an industry which is based on a renewable, but finite resource base. The Council proposes to investigate options to create incentives for switching to more selective gear types to reduce wasted mortality. Although gear conflict issues are not the subject of this proposal, the possibility exists that this forum will create an opportunity for the industry and public to resolve some existing and emerging problems with the interaction of different gear types.

On the issue of transboundary stocks, the Council is proposing in this amendment to control fishing mortality rates which is an approach that is more consistent with the Canadian management system. Fishery scientists from both countries currently provide data for and participate in each other's stock assessment workshops, particularly on the assessment of transboundary stocks. The Stock Assessment Workshop Advisory Report has included recommendations for cooperative management of transboundary stocks. And in December of 1991, a treaty went into effect between the two countries for cooperation in enforcement of fishery regulations. The 19th Annual Conference of New England Governors and the Eastern Canadian Premiers, 1993, adopted resolutions to encourage coordinated, integrated, cross-boundary management of fishery resources. These recommendations, if followed by the respective management authorities, may result in a more stock-oriented management approach rather than one which is completely constrained by national boundaries. Furthermore, such an approach is another step to addressing the following issue, ecosystems management. The NEFMC has recently agreed to enter into discussions with the Canadians on the management of transboundary groundfish stocks.

The subject of ecosystems management of marine resources has only recently emerged from the academic arena into the discussions of fishery managers. Scientists in this country and at the international level have been examining this concept for about a decade yet a number of theoretical and practical issues are still unresolved. The Council is, therefore, not prepared to incorporate this approach into the management system in the near term. Nevertheless, The Council's and fishermen's implicit understanding of the interrelationship of species, predator-prey relationships, competition for food and habitat, and habitat quality is evident in the their discussions and decisions. This background of understanding may form the basis for future adoption of a broader systems approach to management than the current single-species approach. The Council is making recommendations in this amendment document with regard to habitat preservation and protection and has identified specific data needs which will enhance its ability to develop an ecosystems approach.

On the issue of limitation of entry to the region's fisheries, the Council has recognized that the pervasiveness of individual permit moratoriums in most of the management plans is creating some degree of confusion in the industry and may have unnecessary negative impacts. A trend has started toward individual species moratoriums advocated by fishermen interested in protecting their interests from increases in fishing effort caused by the displacement effort from other fisheries undergoing restrictions. The near-term impact of this trend is that the number of alternative fisheries for the effort being displaced is declining. The NEFMC has convened an Interspecies Committee which is currently examining the possibilities for addressing this issue.

## E.4.0 PURPOSE AND NEED FOR ACTIONE.4.0 PURPOSE AND NEED FOR ACTION

The purpose and need for action is discussed in detail in Section 2.2 of this document. Briefly, the primary issue to be resolved through this action is the overfished condition of the stocks covered under the Multispecies FMP. The Council is also addressing the decline in abundance of haddock which has taken place over the past three decades. Thirdly, the Council is addressing the issue of extreme, wasteful discarding of large incoming age classes of certain stocks which has taken place periodically and for which the regulatory mechanisms in place are inadequate. The Council is addressing the bycatch of harbor porpoise in the sink gillnet fishery. The Council is also proposing solutions to some of the problems that have been identified with enforcement of the regulations and the issue of non-compliance .

## E.5.0 ALTERNATIVES INCLUDING THE PROPOSED ACTIONE.5.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

### E.5.1 DESCRIPTION OF THE PROPOSED ACTIONE.5.1 DESCRIPTION OF THE PROPOSED ACTION

The proposed action including the preferred and non-preferred alternatives is described in Section 4.0 of this document.

## E.5.2 ALTERNATIVES TO THE PROPOSED ACTIONE.5.2 ALTERNATIVES TO THE PROPOSED ACTION

### E.5.2.1 No ActionE.5.2.1 No Action

The current management system is based on age-at-entry controls (mesh size and minimum fish size) and seasonally closed areas. There are groundfish bycatch limits (percentage of total catch) in the Gulf of Maine small mesh fisheries under rules of the Exempted Fisheries Program. A system was established by Amendment #3 for responding to occasional concentrations of juvenile, sublegal or spawning fish, the FAAS, but this system has not proven to be effective. Under the current system, vessels are permitted but operators are not required to be permitted.

The impacts of taking no action at this time are discussed in Appendix IV, the bioeconomic evaluation of the proposed management action. Projected trends in catch, spawning stock biomass and recruitment are shown primarily for the purpose of comparison to the proposed measures. Taking no action at this time is not an acceptable alternative for the NEFMC due to the explicit overfished condition of cod, haddock and yellowtail flounder and the trend in landings and abundance of the other stocks in the multispecies complex. The fishing mortality rates on the fully recruited age classes is double the level that would achieve the %MSP targets. At the current mesh size, the partially recruited age classes include a large percentage of fish that are below the legal minimum size which must be discarded when caught resulting in wasted mortality and in further reductions in overall %MSP. Based on the current fishing mortality rates of the groundfish stocks and on the recent history of the fishery, the no-action alternative would not eliminate overfishing. Additionally, the no-action alternative would not address the other objectives of this amendment.

### E.5.2.2 Alternative actions that were eliminatedE.5.2.2 Alternative actions that were eliminated

#### E.5.2.2.1 Moratorium

The Council proposed one version of a permit moratorium as part of an amendment document taken to public hearings in May, 1992. At that time the effort control system that was being proposed involved individual allocations of days at sea which meant that individual vessel permits were closely linked to the allocation of effort, and were, therefore, somehow intrinsically valuable independent of a vessel's relative worth. Many of the public's negative comments about the moratorium focused on this aspect of the proposal. A large segment of the public also objected to the proposed moratorium on the perception that individual fishermen (particularly younger individuals working their way up to captain or owner status) would somehow be unable to own a vessel or access the resource.

By revising the effort reduction system and adopting new wording for the moratorium proposed in this document, many of the public's concerns have been addressed. Briefly, the earlier moratorium differed from the current version in the following ways:

- there was a certain amount of ambiguity and uncertainty about the status of vessel permits in the event of a vessel sale or if the vessel was lost or destroyed;
- a vessel that did not possess a permit as of the control date would not qualify even if that vessel held a valid permit during the preceding year and had just not renewed its permit prior to the control date;
- a vessel that held valid permits for more than one fishery was not prohibited from splitting that permit and applying it to more than one vessel in individual fisheries;
- vessels were limited to a ten percent increase in horsepower and fish hold capacity per upgrade and there was no limit to the number of upgrades during the moratorium period;
- there were no exceptions to the preferred version of the moratorium, although a non-preferred version proposed an exception for hook-gear-only boats which was adopted into the current preferred version;
- a special "party and charter boat" permit category was proposed for those boats which took recreational fishing parties during the qualification period, but which may not have held a multispecies permit. Boats fishing under this permit would be prohibited from selling their catch.

In the 1993 round of public hearings the Council's preferred moratorium alternative did not contain a provision for reconsidering the issuance of new permits until the end of the rebuilding program. The public hearing document did contain a non-preferred alternative allowing such consideration, and this is the alternative the Council is proposing for the amendment. Also, under the effort reduction alternative that used quotas, a non-preferred alternative would have eliminated the moratorium, but since the Council is not proposing the quota management system, this alternative was not adopted.

### E.5.2.2.2 Effort reduction alternatives

#### E.5.2.2.2.1 May, 1992 Public Hearings Preferred Alternative

In the first round of public hearings the Council presented the industry with a proposal that would allocate days at sea to all vessels over 61 gross registered tons. Each allocation would be based on the vessel's history of participation in the groundfish fishery. Vessels under 61 GRT would get a group allocation of groundfishing days at sea (in contrast to the proposed measure which requires time declared out of groundfishing).

The alternative was rejected by the Council for several reasons, primarily that the NMFS weighout database was not designed to support this type of management and could not be used to generate individual vessel histories for all vessels over 61 GRT. A number of individuals commented that this system "rewarded" those vessels that created the overfishing problem by fishing harder (more days) for groundfish while "penalizing" vessels that spread their effort across several fisheries or even left groundfishing completely during the time period used to establish groundfishing history. The general concept of a two-tiered effort system incorporating both individual and fleet effort management is, however, the basis for the Council's proposed action.

The effort reduction proposal was as follows:

**1. All vessels - general information pertaining to effort controls**

**a. Definition of a "groundfish day"** - In calculating from the weighout files to determine the baseline number of groundfish days, the days that are counted are those in which the weight of groundfish exceeded 10 percent of the total landings for the trip.

**b. Possession limits** - A vessel is "enrolled" in the groundfish fishery when it is fishing under its allocated days at sea. A vessel that possesses a valid Northeast Multispecies Permit and that is not enrolled in either the groundfish days at sea program or an alternative gear program will be prohibited from possessing more than 1,000 pounds of combined weight of large mesh species if the vessel is 61 GRT or larger, or more than 500 pounds of combined weight of large mesh species if the vessel is under 61 GRT.

**c. Calculation of allocated days** -

i) **Individual allocation:** The individual vessel baseline number of days will be the average number of groundfish days that appear in the NMFS weighout files during 1988-1990 with the year of fewest days and all years in which there is no record removed from the calculation. A vessel that disputes the baseline allocation will be able to appeal that allocation and will be able to continue fishing pending the outcome of the appeal.

**Appeal of allocation:** A vessel with a valid Multispecies Permit taking an individual allocation of days at sea based on vessel history may appeal the allocation. The appeal must be in writing and based on the same criteria listed in the moratorium appeal language.

ii) **Group average allocation:** For vessels less than 61 GRT, the group baseline is the average of all the individual vessels' (in the under 61 GRT group) baseline groundfish days during the 1988-1990 period. In establishing the group average, only vessels that fished for groundfish more than fourteen days per year according to the database were counted. Days at sea are allocated in half-month blocks to facilitate administration of the effort reduction program. The method that was used to calculate the number of half-month blocks recognized and attempted to account for the coverage of effort data of smaller vessels in the weighout file. The calculation also attempted to consider the weather dependency of these vessels and, because of the shorter, more frequent trips, the smaller amount of fishing time represented by a day at sea. Thus each half-month block that was allocated was based on eight days of historical group performance instead of fifteen or sixteen (a half month).

iii) **General measures on allocation of days at sea:**

(a) Days at sea are allocated to each vessel's permit.

(b) The ~~exception~~ to this is in the case of a vessel that is lost, scrapped or sold out of the fishery. In that case, if the owner purchases a vessel that already has a permit and allocation of days at sea, he or she has the choice of either applying the allocation of the original vessel to the replacement vessel or applying the allocation that belonged to the replacement vessel prior to the purchase. The unused allocation, the one not chosen, would be dropped.

(c) The above wording assumes that the owner of the vessel that is lost, scrapped or sold out of the fishery has the option to either build a new boat or to purchase an existing boat that is not in the fishery and apply the allocation of the old boat to the replacement boat (within the bounds of horsepower and fish hold capacity).

**d.** **Annual fishing mortality and effort reduction targets** - The five-year schedule to achieve a fifty percent reduction in fishing mortality will be broken down into five annual targets of ten percent each. This will be manifested in the first three years by annual reductions in effort of ten percent. The progress of the effort reduction program toward achieving the fishing mortality objectives will be reviewed in year three and adjusted accordingly in order to meet the ultimate objective. Fishing mortality on the target stocks will be assessed in the Stock Assessment Workshops held in year three.

**2.** **Mobile Gear** (Otter trawls, Scottish seines, etc.)

a. **Vessels which are 61 GRT or larger** will be allocated a number of days at sea to fish for groundfish based on individual historical performance and the annual fishing mortality reduction target. A vessel would be required to purchase or lease an electronic vessel tracking system (VTS). If the vessel is at sea and has not declared out of the groundfish fishery, the day will be deducted from the allocation. When the vessel is not fishing under its allocated groundfish days there is a maximum possession limit of 1,000 pounds combined weight of groundfish. A vessel appealing its individual days at sea allocation may continue to fish while the appeal is pending.

b. **Vessels less than 61 GRT** may choose one of the following options but would be locked into one program or the other (group or individual allocation) for the duration of the permitting period (year):

i) ~~Individual vessel allocation~~ as described above for large otter trawl vessels.

ii) ~~Blocks of time allocation~~ based on vessel group historical performance. A vessel would initially be allocated seven 1/2-month blocks of time during which it could fish for an unrestricted amount of groundfish (excluding haddock). The blocks of time would be reduced incrementally to 6, 5, 4 and eventually 3 blocks of time in subsequent years.

A vessel would declare in writing to NMFS at least ten days in advance if it intended to fish during the next 1/2-month period. Each period would run from the 1st through the 15th or from the 16th through the last day of each month. A vessel may fish all its 1/2-month blocks consecutively or at any time throughout the year. When a vessel is fishing under an allocated half-month block, there is no limit on the amount of groundfish the vessel can possess. During the rest of the time, the vessel is limited to the possession limit of not more than 500 pounds combined weight of groundfish. Under the block-of-time allocation of days at sea, vessels would not be required to obtain any days at sea monitoring equipment.

**3. Gillnet vessels (sink gillnets):**

a. **Limitation on the number and length of nets:** Limit the number of nets per vessel in the sink gillnet fishery to 100 and the length to 50 fathoms per net.

b. **Tending requirement:** All gillnet vessels will be required to haul through their gear at least once every 48 hours.

c. **Effort reduction:** Gillnet vessels will have the option to take days at sea based on either individual vessel history or the group performance allocation. Days will be allocated, as in the smaller otter trawl vessel category, in half-month blocks. A vessel that elects to fish under an individual allocation based on its historic performance would count each half month block as twelve days against its total allocation. The groundfish possession limit (10 large mesh species) would apply when the gillnet vessel is not enrolled in the groundfish fishery.

d. **Large mesh alternative:** A gillnet vessel may choose to fish with mesh that is at least eight inches (inside stretched measurement) throughout the first year of the rebuilding program as an alternative to fishing a reduced number of days at sea. In subsequent years, the minimum large mesh size may be readjusted if the Council determines a size other than eight inches is more appropriate to achieving the amendment objectives. Since no data exists on the selectivity of large mesh gillnets, the Council will be working in cooperation with NMFS to collect the necessary data to make this determination.

**4. Hook gear vessels**

a. **Effort reduction**: A hook vessel will have the option to take days at sea based on either its individual vessel history or the group performance allocation. Days at sea for groundfish will be allocated in the same manner as for mobile gear vessels. A hook vessel fishing under the days at sea reduction program would not be limited to the amount of gear it could set and would not be limited to the amount of groundfish it could possess while enrolled in the fishery (except 2,500 pounds of haddock). When the vessel is not fishing under its allocation of days at sea or has used up its allocation of days at sea, it would be subject to the same possession limits described in paragraph 1.

b. **Hook limitation alternative:** A hook vessel may choose to not fish under the effort reduction program and instead limit the number of hooks set to 4,500 per day. The vessel would declare at the beginning of the permit period that it is not participating in the days at sea reduction program and will be fishing exclusively with the limited daily number of hooks set.

**E.5.2.2.2.2 Blocks-of-time effort reduction alternatives:**

The Council considered several alternative effort reduction alternatives based on time out of the fishery. For example, the Gloucester Plan would have required three 20-day blocks out of groundfishing, and another proposal considered by the Groundfish Committee was based on vessels declaring two months out of groundfishing. These alernatives were generally rejected on the grounds that they limited or capped the potential time out of the fishery and were not linked in any quantitative way to the effort reduction objectives. The Groundfish Committee also considered that blocks of one month or longer were more restrictive to vessels with monthly financial obligations than blocks of shorter duration.

In the 1993 round of public hearings, the Council's preferred alternative was one which only provided the option for a fleet-wide system (instead of the choice of fleet or individual allocations currently proposed).

#### E.5.2.2.2.3 Effort reduction schedule:

The Groundfish Oversight Committee considered several alternatives for annual fishing mortality reduction targets ranging from large initial reductions (25 percent in the first year) to a "back-loaded" program (smaller initial reductions). An annual percentage reduction schedule of 20-0-20-10-(0) (the last year for adjustments) was taken to public hearings in June, 1992. The committee elected to take equal annual reductions of ten percent in order to balance the various biological, social and economic considerations.

#### E.5.2.2.2.4 Weighting of months under the effort reduction program:

The Groundfish Oversight Committee considered and rejected as insupportable a proposal to assign variable weighted values to different months such that a day fished in one month might count for more against the allocation than a day fished during a different month. This proposal was rejected before going to public hearings.

#### E.5.2.2.2.5 Regional management system based on an aggregate quota, mesh size increases and randomly assigned months out of the fishery

This proposal was taken to public hearings in 1993 as an alternative to the effort reduction measures described above and what was finally adopted by the Council. The provisions for monitoring of effort, possession limit, prohibition on transfer of groundfish at sea, and all other measures were the same as the preferred alternative except the haddock trip possession limit which was proposed to be at 5,000 pounds.

The alternative incorporated a three measure/three area, seven-year approach to the amendment objectives. The system relied on a combination of a quarterly landings quota of an aggregation of the 10 large-mesh species, increases in mesh size, and periods of time out of the fishery based on a modified random selection of months. The northeast region would have been divided into three areas: Gulf of Maine, Georges Bank, and Southern New

England and South. Under one variation, the moratorium as outlined in the preferred alternative applied and under a second variation, there would be no moratorium.

During year one of implementation, the Regional Director, based on recommendations from the Council, would set aggregate (10 large mesh species) quotas for each sub-area. The quota would be based on annual fishing mortality objectives (status quo F minus 10%) and would be divided among the three areas, based on the historical catch recorded for the 1989-1991 period. There would be no individual species quota except a 5,000 pound possession limit for haddock. In the Southern New England Area there would be an additional reduction of ten percent from the allocated quota to compensate for the difference in minimum mesh size regulation during the first year. The mesh sizes that would be required are 6 inches in the Gulf of Maine and Georges Bank areas and 5.5 inches in the Southern New England area. Alternatively, the Council could recommend 6-inch minimum mesh and no additional quota reduction.

In addition to the mesh size and quota during the first two years of the plan all vessels would be required to remain out the groundfish fishery for two one-month periods distributed over two quarters. The months out of groundfishing would be selected at random for every year of plan to ensure that every vessel ties up each month of the year over the life of the plan. The selection process was to be stratified such that no vessel would be assigned two consecutive months of tie-up or more than one month each year that is the first month in a quarter. During the these periods vessels would have been required to turn in their permit and prohibited from retaining more than the groundfish possession limt. Vessels would not be distinguished on the basis of size, gear type or other parameter.

During years three, five and seven of the plan, the Regional Director would have authority to adjust the quota, minimum mesh size or time-out requirement as needed to reduce fishing mortality to achieve plan objectives by year seven. The Regional Director would act after consultation with the Council and upon the recommendation of the Council. The adjustments which the Regional Director could make could vary by sub-area as necessary based on recommendations from the Council. Any adjustments to the conservation measures specified in this alternative were to have originated through a recommendation by the Council to the Regional Director and would be implemented through the framework adjustment mechanism.

The months out of the fishery would be assigned as in the following example. The last digit of the permit would be the "slot number" and determines one month in year one (0=10=October). In year two, add one to original slot number. In year three, add two, etc.

| "Slot number" = Last digit of permit number | Time-out period in year one |
| --- | --- |

| | | |
|---|---|---|
| 1 | 1 | 6 |
| 2 | 2 | 11 |
| 3 | 3 | 12 |
| 4 | 4 | 11 |
| 5 | 5 | 12 |
| 6 | 6 | 1 |
| 7 | 7 | 2 |
| 8 | 8 | 3 |
| 9 | 9 | 4 |
| 0 | 10 | 5 |

This system had the features that no two months out occured in the same quarter, no slot had two months that begin quarters (months 1, 4, 7, 10), during summer (months 7, 8, 9, 10) there is a minimum number of months out, and over the life of plan, every vessel would have been out of the fishery during each month.

A variation to this alternative would have incorporated all the provisions described above, but without the moratorium.

### E.5.2.2.2.6 Aggregate quota based on three-year average landings:

Under the quota/mesh size/time block alternative described above, the Groundfish Committee considered setting the quota on the basis of the combined average landings of the large mesh species (instead of fishing mortality targets). This option was rejected on the basis that the 1988-1991 average would have allowed significant increases in fishing mortality when compared to the status quo or to the objectives of the amendment.

### E.5.2.2.2.7 Individual species and individual vessel quotas (trip limits):

The original groundfish FMP, adopted in 1977, was based on individual species quotas. Under this system, fishermen "raced" to catch as much fish as possible before the quota was reached. The problems associated with the quota/trip limit system included the quota-setting procedure, misreporting and the monitoring of landings, and compliance and enforcement. The elimination of quota management was the primary motivation for development of the Interim Plan in 1982 and the Multispecies Plan which was implemented in 1986. The NEFMC's past experiences with species and trip limit quotas (with the exception of the proposed "possession limit" and trip limit on one species, haddock) are the primary reason why these alternatives were rejected for this amendment as the overall multispecies management strategy. Reaffirming this position, the Council debated trip limits again in the final hours prior to adopting its current proposal.

### E.5.2.2.2.8 Individual Transferable Quotas (ITQs)

The notion of individual ownership of quotas or other fishing rights which are transferable on the open marketplace has been debated by the Council and the fishing industry for several years. The Council has been provided with a number of published academic articles and research documents discussing actual cases where ITQs have been applied in various fisheries around the world. The Council has also been presented with the five-volume National ITQ Study published by NOAA in March, 1992, which examined the potential for ITQs in several fisheries around the United States, including the sea scallop fishery under NEFMC authority and the Pacific groundfish fishery which resembles in some ways the northeast multispecies fishery. Given the amount and level of discussion, that the Council did not formally consider ITQs as an alternative in this amendment is tantamount to tacit rejection of the concept at this time. Some Council members have expressed strong support for the concept and future consideration or debate can be expected.

There are at least five points which have been cited in the Council's deliberations as reasons for not considering ITQs in the groundfish fishery at this time in addition to the widely held philosophical objection to the privatization of a public resource. The practical reasons which have been identified include:

- the potential for a few individuals or business entities to acquire control of a large share of the fishing rights, and the social and economic implications of this fundamental change in the industry;
- the perceived or actual inequity in the financial windfall bestowed upon initial allocation recipients;
- the problems associated with enforcement and administration of an ITQ system;
- the discard problem that occurs under quota management systems, particularly in a multispecies, mixed-trawl fishery;
- the political and social difficulties with establishing a method for the distributing the initial allocation of rights.

The Council and fishing industry discussions also indicate a number of other points of objection to the ITQ system which are not as fully developed as those presented here.

**E.5.2.2.2.9 Reductions in number of gillnets used**

At the first round of public hearings in 1992, and subsequently, proposals have been made by fishermen which rely on controlling the number of nets used by gillnet fishermen as the primary measure for reducing the fishing effort of that sector. This approach is viewed favorably by the Council but several obstacles exist for its adoption at this time.

The primary data obstacle relates to establishing the baseline number of nets in use. Estimates by different sources (industry, sea sampling program, independent surveys) of the mean number of nets in use are not in agreement at this time. Secondly, there is known to be a wide variation in the numbers of nets in use by different gillnetting operations based on the area fished, species targeted and vessel size. The primary analytical difficulty lies in establishing a method that can correlate changes in the numbers of nets in use with some measure of fishing mortality reductions for one sector of the fleet.

A third difficulty with this strategy of controlling gillnetting effort is the enforceability of it. The biggest quesiton is how to establish how many nets are being deployed by any one vessel at any given time.

The Council has instructed its staff to continue to try and resolve these problems so that this industry-proposed strategy could be adopted. The Council will use the framework provisions of this amendment to incorporate any newly developed measures into the plan.

#### E.5.2.2.2.10 Exceptions to effort controls for small boats

In the 1993 round of public hearings, the Council proposed an exception to effort reductions for boats 30 feet and under. Based on comments that very few vessels would be affected by this exception and that it would have only minor benefits, the Council considered several modifications. During the Council's deliberations and review of public hearing comments, it considered exceptions for vessels up to 50 feet before settling on the proposed 45-feet-and-under exception. The number of vessels and the relative fishing power of 50 foot boats were primary considerations in the Council decision.

#### E.5.2.2.2.11 Effort reductions for vessels engaged in pair trawling

In the 1993 public hearings, the Council proposed that the time a vessel spent engaged in pair trawling would be counted at a ratio of four to one in comparison to single vessel trawling. Under this system, the layover-day or time-out-of-groundfishing requirements would have to be adjusted accordingly. In addition, vessels engaged in pair trawling would have been required to use an electronic VTS and obtain a special permit. Based on public comments urging the Council to prohibit pair trawling while it is trying to reduce fishing mortality through effort reductions, the Council adopted the more restrictive measure.

#### E.5.2.2.3 Other measures considered and rejected

#### E.5.2.2.3.1 Mesh size increase implementation schedule

The Council considered phasing in the mesh size increase by requiring the larger mesh only in the codend and lengthening piece during the first year in order to allow fishermen time to use up the smaller mesh. This alternative was rejected based on comments in the June, 1992, public hearings and the thought that a phase-in period would delay the benefits of increasing mesh sizes.  There was also some consideration that a phase-in would compromise the enforceability of the large-mesh regulations.

In the 1993 public hearings, the Council's preferred minimum mesh size alternative was to require the minimum mesh throughout the net, but with a regional implementation schedule. The Council did not adopt either of the two alternatives presented since it developed a third mesh management strategy based on public hearing comments.  The two alternatives were:

> Phase-in Alternative #1 (preferred):  During the first year after implementation of this amendment, the minimum mesh size in southern New England west of 70°W would be 5.5-inch square or diamond.  In the second year and thereafter, 6-inch square or diamond mesh would be required.  East of 70°W, 6-inch mesh would be required from the first year.  Fishing with mesh smaller than the minimum size east of the line would be prohibited except in specific small mesh areas such as the Exempted Fishery Program area or the Cultivator Shoals area.
>
> Phase-in Alternative #2 (non-preferred):  For the first year the minimum mesh size west of the existing Regulated Mesh Area boundary, 69°40', would be 5.75-inch square or diamond.  In the second year and thereafter, the minimum mesh size would be 6.0 inches diamond or square throughout the range of the species, and east of 70°W and north of Loran TD 43400, fishing with mesh smaller than the minimum size east of the line would be prohibited except in specific small mesh areas such as the Exempted Fishery Program area or the Cultivator Shoals area.

**E.5.2.2.3.2 Modifications to the Southern New England Yellowtail Area:**

As an alternative to extending large mesh regulations throughout this area, the Council took to public hearings an proposal that would have extended the period of the existing closure to January through May (instead of the current March through May).  This alternative did not receive technical support and was rejected on the basis that the closure was not effective in controlling yellowtail fishing mortality rates and that the proposed extension of large mesh regulations throughout the range of the groundfish species would provide some protection to sublegal sized fish.

During the development of the proposed action, the Groundfish Committee considered a number of different reconfigurations of the existing area as a way of further protecting large incoming year classes of yellowtail.  The area finally selected encompasses the principal areas where the largest amounts of discarding has occurred within an enforceable and straightforward boundary configuration.  (Other versions of this area that were proposed were multisided irregular polygons deemed too complicated to comply with or enforce.)

### E.5.2.2.3.3 Alternative effort monitoring systems:

The Council considered several alternative effort monitoring systems including a call-in system, which was rejected as burdensome and unworkable, and a time-card system which was taken to public hearings. The time-card system did not receive much support and was deemed to be administratively impractical.

### E.5.2.2.3.4 Transferable vessel permits:

The Council took to public hearings an option that stated that permits are "freely transferable and assignable without attachment to a particular vessel." Transfers would, however, be limited to vessels of similar horsepower. This proposal directly addressed a situation that existed with the proposed moratorium / effort allocation system wherein permit transfers could indirectly take place through a series of "paper transactions" or a vessel sinking and replacement. A number of people who commented at the public hearings opposed the notion that a vessel's intrinsic value would be exceeded by the value of the permit (and its allocation), creating a distorted vessel market. The Groundfish Committee did not adopt this specific language into the proposed moratorium, but did adopt a provision that would allow the vessel permit to be separated from the vessel during a sale, in effect allowing permit transfers.

### E.5.2.2.3.5 Include northern shrimp in the Multispecies FMP:

The Groundfish Committee voted to include northern shrimp in the plan for Amendment #5 but subsequently voted to consider this at a future time.

### E.5.2.2.3.6 Alternatives for managing the recreational, charter and party boat sectors:

The Groundfish Committee considered several alternatives for managing this sector including bag limits, gear restrictions (number or size of hooks), seasonal or areal closures and increasing the minimum size of fish. Much of the discussions focused on the relative impact of this sector on the multispecies complex and the contribution to overall fishing mortality. Socio-economic considerations also factored into the committee's decisions. On the committee's recommendation, the Council took to public hearings a minimum size increase for cod to 21 inches in the recreational sector only and winter flounder minimum size increase to 12 inches in all sectors. (Cod and winter flounder are the primary species of the multispecies group that are caught by anglers; other multispecies fish caught include haddock, pollock and hakes.) The Council also took to public hearings a special party / charter moratorium permit category for historical participants who did not have a multispecies permit, and who would be prohibited from selling their catch. Both proposals were supplanted after the public hearings with the proposals excepting all vessels (commercial and party / charter) fishing with fewer than 4,500 hooks per day from effort controls and the moratorium.

**E.5.2.2.3.7 Permitting of crew members:**

The Groundfish Committee considered and rejected the proposal for practical and administrative reasons.

**E.5.2.2.3.8 Alternative possession limits for haddock:**

The Groundfish Committee considered and rejected a range of alternative possession limits. The discussions centered around striking a balance between the disincentive to target the species and the potential discards resulting from incidental bycatch at different possession limit levels. A lower possession limit (2,500 pounds) was proposed as the preferred alternative in the 1993 public hearings in order to aggressively address Objective #2 of the amendment to rebuild haddock biomass. Based on public comments and concern for potential discards resulting from a lower possession limit, the Council eventually adopted a 5,000-pound limit.

**E.5.2.2.3.9 Prohibition of scallop gear from haddock area closures:**

The Groundfish Committee considered prohibiting scallop dredge gear from fishing in the haddock spawning area closures. This idea was supported by some individuals and opposed by others at the first round of public hearings. The committee rejected this proposal on the grounds that dredges do not catch significant amounts of haddocks and there is no technical evidence to suggest that scallop dredging impacts haddock spawning.

**E.5.2.2.3.10 Closures to protect juvenile fish using sea-sampling data**

In the development of Amendment #4, the Council proposed measures to protect juvenile concentrations of juvenile fish (yellowtail around Nantucket lightship and cod on Stellwagen Bank and Jeffreys Ledge) which would have relied on closures triggered by a discarding problem made evident through fishermen's reports and substantiated by sea sampling. The proposals were rejected by NMFS because the levels of discard chosen to trigger the action were deemed to be inappropriate and there was uncertainty about the adequacy of the agency's ability to determine that a problem was occurring. The agency's comments on the rejection of these measures were primary considerations in the development of the revised proposals.

**E.5.2.2.3.11 Area II closure alternatives (time and area)**

The Groundfish Committee considered four alternative time periods (February-May, January-May, February-June, and January-June) and three area expansion alternatives (10' west and

5' south, 20' west and 5' south, and 20' west and 15' south). Based on the calculated benefits to haddock and other groundfish species, and considering potential net effect of effort displacement to other fishing grounds, the largest area option was selected for implementation in the first year of plan, followed by the widest season expansion in the third year.

#### E.5.2.2.3.12 Haddock biomass objective

The Groundfish Committee discussed, but rejected the concept of establishing a specific haddock biomass objective (minimum stock size). The reasons for their rejection of this idea include the fact that a greater part of the stock lives on the Canadian side of the Hague Line and is subject to Canadian fishing and management, and the fact that stock size fluctuates naturally in response to external factors (environment, predation, competition, etc.). This latter consideration is the primary reason why stock size management targets are not adopted.

#### E.5.2.2.3.13 Minimum mesh size allowed on board

The Council's preferred alternative in the 1993 public hearings was to require only mesh of the minimum legal size on board vessels engaged in groundfishing. The preferred alternative was adopted for vessels fishing on Georges Bank and in the Gulf of Maine, but was not adopted in southern New England as a consideration of the historical and traditional practice of carrying more than one mesh in that region in order to be able to fish for different species on a single trip.

A non-preferred alternative proposed to allow permitted groundfish vessels with a record of historical participation in small mesh fisheries to carry small mesh when fishing for groundfish within certain rules. The vessel would be issued a small-mesh permit and would be restricted to carrying small mesh only in those areas where small mesh is currently allowed. Under a framework provision the activities of the permitted vessels would be monitored by NMFS and permits may be revoked by the Regional Director on an individual basis. The small-mesh permit program could be terminated by Council action if unacceptable numbers of violations occur. Vessels would only be allowed to carry fully rigged codends or three-foot-square panels of small mesh for repair use. While in possession of more than the allowed limit of groundfish (currently 500 pounds), the small mesh must be stowed in accordance with current regulations. Some elements of this alternative were adopted into the Council's proposed amendment but not the permitting or historical participation measures.

#### E.5.2.2.3.14 12-mile zone mobile gear night closure

In response to comments at the 1992 round of public hearings, the Council took to public hearings in 1993 an alternative which would have prohibited fishing with mobile gear capable of catching groundfish (including scallop dredges) within 12 miles from shore at night. The measure was not strongly supported by technical analysis, and it received only limited public support and some opposition and was, therefore, not adopted by the Council.

### E.5.2.2.4 Proposed alternative packages of measures

During the development of Amendment #5 over the past two years, a number of "package proposals" were considered and rejected by the Groundfish Committee or the Council. The industry groups or committee proposing the measures described in this section emphasized that the measures be considered as complete proposal not as the sum of a number of individual, independent measures.

#### E.5.2.2.4.1 Groundfish Advisory Committee Proposed Alternative #1

Prior to the May, 1992, public hearings, the Groundfish Advisory Committee proposed an alternative package of measures that would:

- require 6-inch mesh, or 5 1/2-inch mesh where appropriate;
- require permits for vessel operators (as well as vessels);
- allow immediate permit suspension for willful misconduct, pending a hearing within ten days;
- require dealers' permits;
- keep the closed areas, with modifications to area and closure mechanism as necessary;
- increase the minimum size of cod (to 20 inches) and redfish (to 11 inches).

This position had received broad industry support but was rejected by the Council prior to the June, 1992 public hearings based on the evaluation of 6-inch mesh by the Scientific and Statistical Committee. The Council did not consider the industry-proposed package of measures to be an alternative to the proposed amendment since it does not meet the requirements of eliminating overfishing.

#### E.5.2.2.4.2 Groundfish Advisory Committee Proposed Alternative #2

After the first round of public hearings, the Groundfish Advisory Committee reconvened to develop a second alternative proposal. This was presented to the Oversight Committee as a package of measures that was subsequently rejected as a complete alternative but which formed the basis for the proposed preferred alternative. This package of measures proposed:

- Years 1 & 2: two 30-day or three 20-day blocks declared (in advance) out of groundfishing, including at least 20 days during March through May
- Year 3: an additional 30-day block out of groundfishing or a layover day

system with the same Year 2 blocks

- Alternatively (to the above two), one 20-day block in March-May plus the layover day plan in Years 1 and 2, and additional blocks as needed in Year 3
- A two-area concept divided at Loran line 13800 which extends southeast from Nauset on Cape Cod. North of this line there would be a minimum mesh size of six inches and a finfish excluder device in the shrimp fishery. South of the line, the mesh size would be 5.5 inches and there would be an area closure system based on three 100-microsecond strips being closed for two years and then moved
- Two meshes allowed on board provided the small mesh is stowed while in possession of more than the limit of 1,500 pounds groundfish
- No moratorium
- Permitting of vessel operators and dealers
- Improvements in the FAAS system in order to protect juvenile, undersize or spawning fish including a maximum 5-day response time to effect the closure
- Minimum of seven years to achieve the recovery goals (ten years for haddock)
- Minimum fish sizes remain the same for all species except winter flounder (increase to 12 inches) and redfish (increase to 11 inches)
- "Small boat" exemption from the effort reduction proposal, based on a combination of length, gross tonnage and horsepower
- VTS required only as part of the schedule of penalties
- No quotas or trip limits
- Continuation of Closed Area I and boundaries of Area II, with two-month extension (to January-June) of the closure which would also apply to all gears

#### E.5.2.2.4.3 City of Gloucester Proposal

While the first public hearing proposal was being developed, fishermen from the port of Gloucester, MA, met to develop an alternative package of measures which they presented at the public hearings. Several of the participants in the development of this plan are also members of the Groundfish Advisory Committee and, consequently, some of the elements of this proposal were incorporated into the Advisory Committee's package. Many of the provisions of the "Gloucester Plan" were taken from the Council's first proposal and, after the public hearings, some of the Gloucester proposals were incorporated into the current Council proposal. In summary, this plan included:

- Modifying the annual fishing mortality reduction objectives to a schedule of 5-5-10-15-15 percent (instead of 10-10-10-10-10). The plan also favored a ten-year schedule but recognized that the five years was mandated by the consent decree
- A moratorium that includes a sunset provision, a 25 percent horsepower upgrading allowance, restrictions on the permitting of vessels engaged in pair

trawling for groundfish, and the issuance of new permits (after the moratorium) being limited to participants in the fishery (captains and crewmembers)

- Surrendering the multispecies permit for three 20-day periods, one of which must be between February 15 and April 30, with a review and adjustment in year three and an exception for vessels fishing with 4,500 hooks or less
- Prohibition on night fishing between three and twelve miles from shore
- A possession limit of 750 pounds when fishing with small mesh or during a permit-surrender period
- Gillnet management measures similar to those proposed by the Council
- Six-inch mesh, diamond or square, throughout the range of Council's jurisdiction and one mesh on board except during a phase-in program that would allow fishermen to use up 5.5-inch twine already purchased
- One set of small mesh exempted fishery regulations throughout the Council's jurisdiction with a 750 pound groundfish possession limit
- Reducing minimum fish sizes for all species except redfish by one inch
- A gradual reduction in the haddock possession limit from 10,000 to 7,500 to 5,000 pounds by year three with a review and adjustment at that time
- No change to Area II from the status quo except that all gear be prohibited to allow spawning to take place undisturbed
- Suspension of Area I as proposed by the Council
- On Stellwagen Bank and Jeffreys Ledge, small mesh fishing only would be allowed during May and June and only if the Regional Director determines that there is little or no small cod bycatch
- Support for the Council's proposal to protect concentrations of juvenile yellowtail with the addition of a mechanism to shift the area of the closure if needed
- Opposition to the VTS and the program to permit dealer
- Permitting of vessel operators with permit sanctions to be issued in the event of serious offenses and on the decision of an industry jury
- Exception for purse seiners and for midwater trawl gear; recommend specific definition of midwater trawl gear "neither the net nor the trawl doors...operates in contact with the seabed, and which does not have attached to it protected devices, such as discs bobbins, rollers, or other chafe protection gear attached to the foot rope, but which may have weights attached on the wing tips" and further refinement of this definition in the coming year.

During the second round of public hearings, in May, 1993, the City of Gloucester again presented a unified position on Amendment #5.  Many of the elements of their original plan were included in the revised position, although there were some changes. These changes included:

- support for a 500-pound possession limit
- no exceptions to the moratorium or effort controls (e.g. for hook-gear-only or small-boats)
- incorporation of an industry-proposed gillnet management system using reductions in numbers of nets fished during periods of harbor porpoise migration
- a system that would allow pair trawling under a regulated program
- support for the L25% system for establishing minimum fish sizes
- recommendation for further analysis of the 12-mile night closure before Council consideration
- opposition to the haddock possession limit
- a management system for the recreational, party and charter boat fishery including effort limitation, effort and landings monitoring, a permit moratorium, and a prohibition on filleting at sea
- a tolerance range written into the mesh-size regulations.
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#### E.5.2.2.4.4 New Bedford Preferred Groundfish Management Plan

In New Bedford, MA, as in the city of Gloucester, during the development of the first public hearing document, fishermen organized and developed an alternative to Council's proposal. The outcome of their efforts was substantively different from those proposed by the Gloucester fishermen but disposition of their proposal was similar in many respects. In both cases the Oversight Committee did not specifically address the "package" since several of the participants in the development of this plan are also members of the Groundfish Advisory Committee and elements of this proposal were incorporated into the Advisory Committee's package. The New Bedford plan took the form of an item-by-item commentary of the Council's package of measures and, after the public hearings, some of the specific proposals were incorporated into the current Council version. The New Bedford plan included:

- Opposition to the moratorium
- Offering all vessels a choice of individual allocations or a group allocation, taken in half-month blocks, based on the average individual histories of all vessels in the category
- Support for the Council's proposals for managing the gillnet fishery, the two-tiered possession limit (500 and 1,000 pounds), extending large mesh regulations throughout the range of the species and the development of a southern New England Exempted Fisheries Program, and for setting the minimum fish sizes at L25%
- A minimum mesh size of 5.5 inches throughout the range of regulated species and a one mesh on board rule
- Extension of the boundaries of Area II as proposed by the Council and that the

closure run from January through May (instead of June) subject to periodic review; and suspension of Area I as proposed by the Council

- Support for the Council's proposals to protect juvenile fish on Stellwagen Bank and Jeffreys Ledge extended to cover the period October 1 - December 31
- A modification to the Council's proposal for protecting juvenile yellowtail that would enable the opening and closing of the area to be determined by monthly sampling
- A haddock possession limit of 10,000 pounds (not 2,500) and other groundfish bycatch limits as proposed by the Council
- Support for an effort monitoring system but a stated preference to explore less costly and less intrusive alternatives to the electronic VTS such as the mandatory call-in or time-card system
- Mandatory data reporting, permitting of operators and dealers.

In the 1993 round of public hearings, the New Bedford Seafood Co-op and the Offshore Mariners' Association presented a position on Amendment #5 to the Council. This outline, often referred to as the "New Bedford Plan" was also supported by the Point Judith Fishermen's Cooperative. The Council ultimately adopted many of the elements of the New Bedford plan in its proposed amendment. The 1993 New Bedford plan included:

- opposition ot the moratorium
- using the 13800 Loran line as a management boundary in the New England region
- using a target-quota system that would not result in closure of the fishery but would force adjustments to the management measures in succeeding years through a framework system, target quota to be reduced not more than ten percent per year
- two months out of groundfishing, adjustable up to four months out, and a two-for-one layover day requirement
- 5.5-inch mesh in southern New England with additional restrictions in other measures as needed
- allowing mesh smaller than the minimum size on board
- modified effort controls for pair trawling
- opposition o the night fishing closure in souther New England
- a 5,000-pound haddock trip limit
- support for the suspension of the Area I closure and the expansion in the Area II season but not the Area II closure area
- support for the possession limit of 500 pounds
- opposition to the L25% method of setting the minimum fish size
- general support for the other measures presented in the public hearing document.

#### E.5.2.2.4.5 1991 Council Proposed Package for Amendment #5

In early 1991 the Council approved a package of measures for Amendment #5. The Council subsequently rescinded its decision to go forward with this "fast-track" amendment and develop a more comprehensive amendment package that would address overfishing. This decision preceded the CLF lawsuit and the consent decree. The proposed amendment included four proposals:

- A moratorium on new permits
- An increase in the regulated mesh to six inches and a minimum-mesh-on-board rule while fishing in the Regulated Mesh Area
- Extensions of the boundary lines of the southern New England yellowtail area to the north, east and west
- An unspecified measure to reduce directed fishing for haddock

#### E.5.2.2.4.6 Associated Fisheries of Maine Plan

In the 1993 round of public hearings on Amendment #5, the fishermen's organization Associated Fisheries of Maine presented the Council with an alternative plan. While supporting the primary objectives of the amendment, the plan was not viewed by the Council as being restrictive enough to meet those objectives. Thus, while the Council did not adopt the plan exclusively, it did incorporate some of the plan's proposals. The plan included:

- required use of a finfish excluder device in the northern shrimp fishery
- minimum-mesh-on-board requriement in the Rgulated Mesh Area
- increase the minimum size of cod and redfish
- operator and dealer permits
- plan review after year three with limited adjustments to mesh size, area closures, minimum fish size and possession limit
- regionalization of the fishing mortality reduction targets

### E.5.2.3 Alternatives outside of the Council's jurisdictionE.5.2.3 Alternatives outside of the Council's jurisdiction

#### E.5.2.3.1 Recent legislative action

A number of alternative management measures that are beyond the scope of the Council's jurisdiction have been considered by federal legislators over the past year in several versions of a bill entitled the "New England Groundfish Restoration Act of 1992", also referred to as the "Studds Bill" after its principal sponsor Rep. Gerry Studds (D-MA). One version of the bill, HR 5557, was approved by the House, but the companion Senate version, S. 2489 sponsored by Sen. Kerry (D-MA), was never voted on and the bill died with the ending of the legislative session, although some of the elements of it were signed into law as part of the NOAA reauthorization legislation.

In addition to setting a timetable for Council development of a stock rebuilding program, the various iterations of the Studds Bill contained a number of changes to the Magnuson Act including:

- a vessel repurchase program funded by a vessel fuel tax;

- authorization to enter into enforcement agreements with states and provide funding for state enforcement of federal fisheries regulations;

- legislative establishment of a sea sampling program;

- entering into negotiations with Canada on the conservation and management of transboundary (shared) fishery stocks;

- establishment of a program to promote the development and harvest of underutilized species including the provision of grants from Saltonstall-Kennedy funds;

- allowing the use of capital construction funds set aside under the terms of the Merchant Marine Act of 1936 to be used to defray some specific vessel costs during the rebuilding period;

- establishing a fisheries employment assistance program under the Job Training Partnership Act;

- granting authority to the Secretary of Commerce to suspend fishing upon Council request in areas where there are concentrations of spawning or juvenile fish in less time than is currently possible under the FAAS;

- establishment of a Coast Guard working group for fisheries matters;

- establishment of a New England Fisheries Research program.

The NOAA Reauthorization Act of 1992, which was signed into law on October 29th, 1992, did include two provisions which were taken from Senator Kerry's companion bill to the Studds bill. The two measures deal with enforcement and the development of underutilized species. Title IX of this bill would amend the Magnuson Act to require the Secretary of Commerce, if requested by a New England governor, to enter into cooperative state-federal agreements to enforce the Multispecies FMP. A state participating in such an agreement would be eligible for reimbursement of costs incurred in the detection and prosecution of violations. The Coast Guard's First District would be required to establish an informal fisheries enforcement working group to improve overall compliance with fisheries regulations. The section also requires that fines collected for violations of the groundfish plan be used for enforcement.

The NOAA reauthorization also amends the Magnuson Act to require the Secretary of Commerce to establish a Northwest Atlantic ocean fisheries reinvestment program to assist in the development of economically viable fisheries for underutilized species, to explore new opportunities for processing and use of fish waste and to aid restoration of depleted New England groundfish stocks through aquaculture or hatchery programs. Funding for the reinvestment program could be made available under the Saltonstall-Kennedy fund. Up to $5 million is authorized annually for fiscal years 1993 through 1997.

#### E.5.2.3.2 Other alternatives outside of the Council's jurisdiction

During the development of Amendment #5, fishermen and others involved in the management process have suggested alternative proposals for effort reduction and other broader issues of groundfish management. These proposals are outside of the Council's jurisdiction and, therefore, have not been considered as alternatives for this amendment. These measures generally involve the allocation of federal funds or the tax code, or somehow extracting some form of "resource rent".

Some fishermen have argued that the government should pay them to not fish for groundfish during the rebuilding period especially since it was the government that encouraged the growth in technology and effort and enabled the industry to overcapitalize subsequent to passage of the Magnuson Act. The government's paying farmers to fallow fields has often been cited as a precedent for a similar federal subsidy of the fishing industry. Other forms of subsidy have also been suggested, such as federal purchase of effort-monitoring equipment or other gear required by the regulations, or price subsidies for alternative, underutilized species.

"Resource rent" alternatives that have been suggested include progressive landings taxes and access fees. In the first case, a tax would be levied by species at rates commensurate with management objectives. The marginal profitability of catching a species in excess of the management objective would be a disincentive to continue fishing for that species. Access fees could be either fixed or set at auction; concessionaires at National Parks bid competitively for the privilege of selling on National Park lands, for example, while lumber companies pay a fixed fee for the privilege of harvesting trees on public lands.

Combining these types of alternatives in various ways has also been suggested, such as taxing some landings and using the funds to subsidize the price of other species. Another proposal involved the federal buyback of certain groundfish vessels which would then be used to enhance at-sea enforcement capability. These alternative management schemes have not been deliberated by the Council as they are outside of the Council's authority and involve federal appropriations and tax codes.

## E.5.3 EVALUATION AND COMPARISON OF ALTERNATIVESE.5.3 EVALUATION AND COMPARISON OF ALTERNATIVES

This section contains a qualitative assessment of the principal alternatives (moratorium and effort reduction system) considered by the Council and taken to public hearings in 1993. The specific measures were developed in the context of the same fishing mortality reduction objectives and in that sense have similar results, but they differ considerably in other aspects: ability to be administered; enforceability; public acceptably and expected levels of compliance; and, the distribution of impacts within the industry or among different communities,. The purpose of this section is to illustrate and explain the differences between the alternatives and the Council's rationale for adopting the proposed measures. Section E.5.2 contains a discussion of other alternatives considered and rejected by the Council.

### E.5.3.1 Moratorium

The Council considered two alternatives to the proposed moratorium: 1) having no moratorium (no action), and 2) having a moratorium that would last until the end of the period needed to eliminate overfishing without considering issuing any new permits in the interim. The latter alternative was identified as the Council's preferred alternative in the public hearings. During the development of the moratorium, the Council considered a number of specific issues which it addressed prior to drafting the final proposal, such as the exception for hook-gear-only boats, the provisions for upgrading, and the language on vessel sales.

Since the Council adopted a strategy to reduce fishing mortality by reducing nominal effort (the amount of fishing days generated by the fleet), it felt that allowing an unknown number of new entrants at any time would jeopardize the effectiveness of the overall plan. Even though the Council has the mechanism to adjust the allocation of fishing opportunity to participating vessel, without a cap on the number of participants, its action would be retrospective. Only after total effort had increased by the entry of additional vessels, would the Council know what effort reduction adjustment was warranted. A cap on the number of participants enables the Council to calculate the size of the "slices" of the total effort allocation. Furthermore, many on the Council viewed the moratorium as a way to protect the interests of those fishermen who were being forced to take short-term restrictions in order to achieve some long-term objectives. Thus the "no-action" alternative was not an acceptable one.

The Council did, however, consider and take to public hearings, a "no-moratorium" option in the context of a management alternative which would have used quotas to control fishing mortality (see discussion below). Widespread public opposition to limited entry systems of management added to the attractiveness of this option, but after considerable discussion the Council decided to temporarily suspend issuing new permits rather than adopt a quota-based management system.

The proposed alternative enabling the Council to consider issuing additional permits each year, represents a compromise between the identified concerns but it carries with it some other considerations. For one, the accommodation of new entrants still would come at the expense of currently permitted vessels since the total effort allocation remains independent of the number of vessels. If an upward adjustment in allocated opportunity is warranted, for example, the choice to allocate the additional effort to new vessels will mean that the benefits to current fishermen will be proportionally smaller. With no restrictions on the size, horsepower or fishing power of the new entrants, the potential exists for greater fleet capitalization at a time when overcapitalization is a fundamental part of the problem being addressed with this action. Thirdly, the mechanism for selecting qualifying vessels from the pool of applicants, and accounting for differences in vessel characteristics (tonnage, length, horsepower, etc.) has not been specified. This last point could lead to protracted discussions and controversial allocation decisions when the Council attempts to consider issuing new permits.

One final consideration in the proposed action is the more permanent nature of allowing new entrants in comparison to an annual adjustment in allocated days or other management measures. The issuance of a permit is probably not revocable without cause whereas the Council may adjust the effort reduction through the framework measures. (In other words, the Council can make adjustments in allocated days upward or downward as needed but it is unlikely that the Council can pull someone's permit, once it has qualified under the moratorium, without a violation.) The list of potential applicants is unknown at this time but probably will at least contain all of the currently permitted boats not qualifying for the moratorium (approximately 1,400 boats, although some of those will qualify under the hook-gear exception or through the appeal process).

The moratorium on new permits allows vessel upgrading and vessel replacement (within limitations on "fishing power" increases), purchase and sale of vessels among individuals whether they are currently participating in the fishery or not, and switching among different gear types within the fishery. Given the circumstance that overall effort in the fishery is being reduced by 50 percent, these provisions provide for flexibility, mobility, individual entry into the industry, and modernization of the fleet. Additionally, the exceptions to the moratorium (for hook-gear boats including party/charter boats and vessels retaining less than the possession limit) are included to allow these lower-impact fisheries to continue without diminishing the effectiveness of the effort reduction program.

The moratorium also addresses a concern expressed by many fishermen who are being forced to alter their traditional fishing behavior under the effort reduction program. These fishermen have pointed out that if they must take short-term reductions in catch through the reduced effort allocation, they should be the ones to first benefit from the rebuilding program.

Without a permit moratorium, vessels that have not been forced to make the sacrifices under the effort reduction program could enter the fishery as soon as stocks begin to rebuild.

### E.5.3.2 Effort reduction measures

In the second round of public hearings on Amendment #5, the Council considered three primary alternatives for addressing fishing mortality reductions. Under the Alternative #1 which it had identified as "preferred", all vessels fishing for groundfish with the exception of boats fishing with gillnets or fewer than 4,500 hooks would be given the same opportunity to go groundfishing based on the aggregation of all effort in the fleet (total number of days per boat summed up for all boats in the fishery). Under Alternative #2, which was finally adopted by the Council for submission to the Secretary of Commerce, any vessel that wants to may take an individual allocation of days at sea based on the vessel's history in the fishery and have its effort reductions reduced in annual increments from that baseline, or it may elect to fish under the fleet-wide system proposed under the first alternative. Under Alternative #3 (which included time out of the fishery, regional groundfish quotas and mesh size increases), all vessels would be randomly assigned two one-month periods when they must be out of the fishery, and then, when the quota is reached in a given area, all vessels will simultaneously be out of the directed fishery for groundfish in that area.

Under Alternatives #1 and #2, the success of the effort reduction program is dependant on the degree to which changes occur in the fishery which compensate for the reduction in nominal effort. These changes may be technological such as more efficient gear or more effective fish-locating equipment, or they may be behavioral, such as fishing closer to shore (which reduces steaming time) or fishing more hours during a day at sea (perhaps by increasing crew size). Recognizing the inevitability of these changes, the Council has incorporated annual program reviews and the framework for adjusting effort reductions in order to maintain progress towards the final objective. The issue of technological and behavioral changes are discussed further in sections E.3.4 "Issues to be resolved", and E.3.5, "Mitigation".

Under Alternative #1, all vessels would have the same opportunity to go fishing for groundfish over the course of the year and would be restricted by the same layover-day system. As a result, vessels that historically fished a greater number of days would be restricted proportionally more than vessels that fished fewer days. Vessels that historically fished fewer than the total number of opportunity days could potentially increase their effort. Alternative #2 was proposed to address this perceived unfairness in the allocation of opportunity.

Due to the coverage of effort in the database, the aggregated effort analysis that was used to design Alternative #1 was based on one fleet sector as a paradigm for the entire fleet. Through the first round of public hearings, the Council learned that the data collection system on the whole did not capture a significant enough portion of the effort of some vessel groups that it could be used reliably to design an effort reduction system, particularly one based on individual vessel history or an aggregation of those histories. This deficiency is particularly evident among smaller vessel tonnage classes and in more remote ports not frequented by the port agents who collect the data. For other vessel groups, however, the data system coverage is over 90 percent of the trips with more than three quarters of them being trips in which the operator has been actually interviewed by a port agent.

The largest tonnage category, over 125 gross tons, is one of these groups and is the one which was used for the analysis. The effort distribution pattern in this group is bimodal and representative of the overall groundfish fleet which is comprised of full-time (fishing for groundfish an average of 220 days per year) and part-time or seasonal groundfishing vessels. By adding all the groundfishing days of the vessels in this group and then reducing that total number by ten percent and reallocating the days back to the vessels, a target was established for the first year's effort reduction. The proposed effort reduction system does not, however, allocate a certain number of days to each vessel (190 in the first year, for example) but requires that time be taken off groundfishing in such a way that if a vessel fishes full time, it would have 190 days of opportunity to go groundfishing in the year. A vessel that fishes seasonally would not necessarily have the same allocation to take in a shorter period of time because of the layover-day requirement.

Under the proposed system, all vessels, whether fishing year round or part time for groundfish, would be restricted (exceptions excluded). For vessels not taking the individual allocation, seasonal vessels will initially be restricted only by the layover day requirement. As the total opportunity to go groundfishing is reduced by the greater amount of time required out of groundfishing, a seasonal vessel may be restricted both by the layover requirement and by the requirement to declare time out of groundfishing to the extent that the remaining opportunity is less that the vessel ordinarily fished. Based on available effort data, the restriction is expected to yield an aggregate reduction in nominal effort (groundfishing days) of 10 percent per year. For vessels taking the individual allocation of days at sea, their allocated effort will be reduced by ten percent per year.

Clearly, the layover-day aspect of the fleet-wide option is essential to the overall success of the program if the vessels which tended to contribute proportionally more to the aggregate effort baseline remove themselves from the aggregation by electing to take an individual allocation. The remaining vessels, those not electing the individual allocation option, may not be restricted by a straightforward fleet-wide allocation of fishing days (say, 190 days in each of the first two years) but will most likely be restricted by the requirement to layover at the dock between trips. As the time that boats in this group are required to declare out of the fishery increases, more of these boats will be restricted by this part of the measure.

Secondly, the vessels which fall into the lower range of the effort distribution are more likely to be the ones whose actual effort was not captured in the collection of the data that was used to design the aggregated effort database. This means that the actual impact of the allocation of opportunity may be greater for some vessels which fall below the allocation than is anticipated. In the final analysis, the adjustment of effort allocation during the latter years of the program in combination with the mandatory effort data collection system will enable the overall system to account for these uncertainties.

Alternative #3 proposed to use three principal measures, quotas, mesh size increases and random months out of groundfishing assigned to individual vessels. While the mesh size increase would reduce the mortality on some fish resulting in some short-term reduction in landings, the impact of random months out of the fishery is not predictable. If the mesh size and effort restrictions would result in the desired fishing mortality reductions, then the quota aspect of the measure would not have to take effect. If the mesh increase and time out of groundfishing would not produce the desired result, then the quota would become the operative mechanism for reducing fishing mortality on a quarterly basis. Ultimately, the quota is the mechanism which would ensure that the objectives are met.

The quota proposal called for aggregate catch quotas for 10 of the 'large-mesh' regulated species, subdivided by calendar quarter and management area. Three management areas are defined: Gulf of Maine [GOM], Georges Bank [GBK], and Southern New England and South [SNE]. The alternative specified that the quotas in the first year of plan be set at a level of landings that would be achieved with the status quo fishing mortality rate minus 10%. An additional 10% reduction in the quota allocated to Southern New England and South could be implemented in the first year of the plan, contingent on the adoption of a 6" mesh requirement.

The quota provision of Alternative #3 applied to the aggregate landings of the 10 species of groundfish given above. The intent of this provision was to cease directed groundfishing when the aggregate landings in a quarter, for a sub-area, were reached. Landings of groundfish could have continued on a possession-limit basis using the limit set for other fisheries (currently 500 pounds).

The Council considered an aggregated quota for this alternative because, in the case of the 10 'large mesh' species regulated under the FMP, all stocks are considered overexploited except for white hake (fully-utilized), and the northern stock of the windowpane flounder (fully exploited). Only two stocks have an increasing trend in abundance since 1990, based on Northeast Fisheries Science Center trawl surveys, redfish and white hake, although in recent years single, large year classes of individual stocks have passed through the fishery with a temporary rise in abundance. Without individual stocks experiencing such spikes in abundance, the opportunities for major shifts in effort among the groundfish stocks is limited due to the generally low abundance. Under such a scenario, the aggregated quota system was favored by the Council over a single-species system.

A series of single-species quotas is also impractical in this fishery owing to the highly mixed nature of the groundfish resource, and the large number of species and stocks involved. Likewise, trip quotas (either single or multispecies) would likely encourage wasteful discarding through high-grading, and are also not generally considered appropriate.

The quota provisions of Alternative #3 were intended to ensure that fishing mortality rate goals of the plan are met. In comparison to Alternative #1, the effort reduction adjustment under this proposal will take place within the quarter and area in which the projected target is exceeded, rather than as an adjustment in subsequent years. By establishing an absolute maximum fish removal, consistent with fishing mortality reduction goals of the plan, there is greater assurance that fishing mortality can be reduced. However, a quota based on aggregated landings is not an absolute maximum on fish removals since discarding in other fisheries may still occur, some continued fishing would be allowed under the possession limit, and some high-grading could be expected, especially during the possession-limit only periods when the directed fishery would be closed.

The quota was intended to cap landings at a level equivalent to the fishing mortality rate and the age structure of the stock at the time the quota is set. Since the age structure will change and recruitment of new age classes cannot be predicted, the quota could only be reliably set for one year in the future. The quantity of fish which are discarded, landed under the possession limit or not picked up in the data collection system will proportionally reduce the stock size beyond the level anticipated by the quota. The overall reduction in stock size, combined with new recruitment will be combined to determine future landings quotas. These quota-setting considerations formed the basis for the Council's development of the annual harvest target concept used in the proposed action.

Quota levels under Alternative #3, or harvest targets under the proposed action, for the first and subsequent years of the plan will depend on the stock sizes of the various species, recruitment, and realized fishing mortality rates. In the short term, the harvest targets will necessarily have to be lower than status quo landings, given the rather poor recruitment prospects for the groundfish stocks. If fishing mortality rate goals are met, and as the stocks increase in abundance, total landings targets could increase.

The effort restrictions included in Alternative #3 (random months out of the fishery) were intended to act in combination with the mesh size increases and quotas to ensure that the conservation goals of the plan are met, and that the potential for closures of directed fisheries would be minimized to the greatest extent possible. Similarly, under the harvest target system in the proposed action, additional restrictions would not be indicated if the harvest targets are not exceeded.

The increase in minimum mesh size from 5.5 inches to 6 inches in most of the region will result in some short-term decline in landings under either of the alternatives considered, thereby contributing to the landings staying within the range of the harvest targets or quota in the first years of the plan. The difference is not predictable between two randomly assigned months out of the fishery and a choice of eighty days out combined with required layover days. In either case, some additional reduction in landings is expected. If, however, under Alternative #3, a vessel is "out of groundfishing" for the first month of a quarter by random selection, and if the directed fishery is closed in the preceding quarter and again at some point in the current quarter, that vessel would be significantly restricted in its ability to direct on groundfish. A major difference between the two alternatives, therefore, is one of the amount of choice afforded the individual operator, whether the time out of the fishery would be randomly assigned or would be taken at the time of the vessel's choice.

As with any quota system other than individual vessel quotas, the competition to catch up quota before the fishery is closed raises safety concerns. Smaller vessels, which are more restricted by weather and which generally have lower catch rates, tend to be the ones which take the greatest risks in the race to catch quota. The smaller vessels will also be more restricted in their ability to fish in other areas when the local quota has been reached. The Council also considered this factor in its decision to adopt the proposed action although it recognizes that the resource condition is a greater contributing factor to safety and risk than any inherent characteristic of a management system.

Alternative #3 called for adjustments to the plan to occur in years 3, 5 and 7. These adjustments could occur in any of the three operable measures (quota, months out of groundfishing, or mesh size), alone or in combination. Under the preferred alternative that was taken to public hearings, plan review and adjustment could not occur until year four after implementation. After reviewing public comments, the Council developed the concept of using the annual harvest targets, which would be set in the same manner as an annual quota, to base annual adjustments to any of the measures in the plan. This approach greatly increased the plan's responsiveness to unpredicted or changing circumstances. Perhaps more significant, however, is that the approach provides greater assurance that the actual effect of the management system does not diverge from its intended effect for more than one year before the Council can respond.

The other provisions of Alternative #3 were proposed to be the same as those contained in Alternatives #1 and #2 with the exception of the possession limit for haddock which was increased from 2,500 to 5,000 pounds. The Council actually adopted the latter limit in the proposed action.

## E.6.0 AFFECTED ENVIRONMENTE.6.0 AFFECTED ENVIRONMENT

### E.6.1 INTRODUCTIONE.6.1 INTRODUCTION

This section is intended to provide the background information for assessing the impacts of the proposed action on the physical, biological and human aspects of the environment. In order to perform this assessment, the environmental constraints on the conducting of the fishery are also described. Thus this section includes a description of the habitat of the stocks and the physical environment of the fishery, the life history, habitat requirements and stock assessment of the target stocks, and discussions of other relevant biological elements such as other commercially exploited, non-exploited and endangered species. This descriptive section also includes a discussion of the human component of the ecosystem including the socioeconomic and cultural aspects of the commercial and recreational fisheries and the impacts of other human activities (mining, sewage disposal, pollution, etc.).

This descriptive section, therefore, provides the framework within which the environmental impacts of the proposed action can be assessed and also serves as a reference section for the evaluation and comparison of alternative actions. Much of the information contained herein is a compilation of information that was also used during the development stages of the proposed action, as a basis for making the choices from among a range of alternatives.

**E.6.1.1 Data Considerations****E.6.1.1 Data Considerations**

Data used in the management of fisheries in the northeast is collected under five primary systems: the NMFS permit files, the commercial landings weighout system, the NEFSC research vessel surveys, the sea sampling program, and the NMFS Marine Recreational Fisheries Statistics Survey (MRFSS). Twice a year the NEFSC convenes the Stock Assessment Workshop to review the status of individual stocks and the survey and assessment methods. The status of the stocks that have been assessed is summarized in reports; the status of all stocks in the region are also summarized by the NEFSC in an annual document. Recreational statistics are summarized in irregular reports compiling data over several years.

All vessels (i.e., those craft greater than five gross registered tons) fishing in the exclusive economic zone (EEZ) are required by law to be registered with the U.S. Coast Guard. The registration number must be clearly displayed so that vessels can be identified. In contrast, boats (i.e., those craft less than five gross registered tons) must have either a state registration number or a Coast Guard registration number displayed. In addition, all boats and vessels used to commercially exploit the species managed under federal FMP's in the Northeast Region are required to apply annually for the appropriate fishery specific permits.

In the Northeast, NMFS collects information on landings through a network of 32 federal and state port agents located at the busiest ports. The principal data collection activity in these ports is the collection of weighout sales receipts at the point of first sale. A series of weekly and monthly visits to less busy ports supplements the weighout collections. Another part of the data collection process consists of interviews with the vessel operators conducted by port agents when fish are landed. These "interview records" contain the most reliable trip information on variables such as gear type, fishing location, and effort. The percentage of trips interviewed varies considerably, depending on, among other things, port, size of vessel, and length of trip or trip type. The non-interviewed trip records contain estimates based on those trips that were interviewed. Additional data are collected by conducting a monthly or annual canvas to fill in gaps. All of the landings recorded are associated with the type of gear which produced them. However, the further removed the collection of information is from the date and place of first sale, the more difficult it is to associate those landings with a particular craft and the fishing effort that produced them.

There are eight different "fishery-independent" survey programs used by the NEFSC: the spring and autumn bottom trawl surveys, the sea scallop dredge survey, the clam dredge survey, the summer Gulf of Maine trawl survey, the winter flatfish trawl survey, the marine mammal sighting surveys, fish egg and larval surveys and special experimental surveys. Of these, all are significant to the management of multispecies groundfish except the scallop and clam dredge surveys. The principal and longest time series surveys are the spring and autumn bottom trawl surveys. The method employed in these surveys is a random stratified procedure using standardized gear in order to produce the most unbiased data possible within the scope and scale of the survey program. The marine mammal, winter flatfish, and Gulf of Maine nearshore surveys have been conducted for only one or two years, limiting the usefulness of the data at this time.

The sea sampling program is subcontracted to the Manomet Bird Observatory. From January, 1989, through March, 1992, the program was entitled the Domestic Sea Sampling Program and since April, 1992, under the terms of a new contract is entitle the Fisheries Observer Program. Under the program trained observers take trips on fishing vessels and measure the directed catch and bycatch (quantity, species composition, fish lengths and weights, and discards) as well as collect other data on the vessel, gear, fishing operations, etc.. Data from this program is forwarded to the NEFSC for use in assessments and other purposes

The recreational survey (MRFSS) uses a complementary survey approach using two independent methods: a telephone survey of households and an intercept survey of anglers at fishing access sights. Data from the two surveys are combined to produce estimates of total participation, effort and catch. These data are summarized across several strata including state, catch type (kept and available for measurement, kept but not measurable or discarded dead, and discarded alive), mode (shore, party/charter boat, or private/rental boat), and other parameters.

In addition to these primary sources of information, several other sources were used in the preparation of this document. These include published or unpublished works by individuals with expertise in specific fields. A list of references is provided in Appendix III and a list of preparers and contributors is contained in Section E.9.0.

## E.6.2 PHYSICAL ENVIRONMENTE.6.2 PHYSICAL ENVIRONMENT

### E.6.2.1 Habitat DescriptionE.6.2.1 Habitat Description

This Fishery Management Plan relates to three distinct geographic regions - the Gulf of Maine, Georges Bank and the portions of the continental shelf south of New England. The topographic and oceanographic characteristics of each region are different.

The Gulf of Maine is bordered on the east, north and west by the coasts of Nova Scotia, New Brunswick and the New England States. To the south, the Gulf is open to the North Atlantic Ocean at the surface. Below about 50 m depth, however, Georges Bank forms a southern boundary for the Gulf, making it semi-enclosed. The Gulf is connected to the deep North Atlantic Ocean by only three channels - the major passage being the Northeast Channel between Georges Bank and the Scotian Shelf. The interior of the Gulf is characterized of deep basins (>200 m) which are separated by irregular topography that includes a number of shallow ridges, ledges and banks. The largest and deepest basins are Georges Basin near the mouth of Northeast Channel, Jordan Basin to the northeast and Wilkinson Basin in the southwestern Gulf. Jordan and Wilkinson basins are separated by irregular, shallower topography that extends toward the central Gulf from the Casco Bay - Penobscot Bay coastal region, and includes Jeffreys Bank, Platts Bank and Cashes Ledge. Generalized bathymetry is shown in figure E.6.2.1.1.

The bottom type within the Gulf is quite patchy and generally related to the topography (Schlee, 1973). The deep basins exhibit silty clay or clay sediments, while the irregular topography between basins generally has a higher fraction of sand. The topographic highs within the Gulf are exposed to the winnowing action of the currents and are characterized by sand and gravels. In the near coastal regions (within about 10 miles of the coast) the bottom type south of Casco Bay is largely sand, while to the north and east is generally a finer fraction of silt and clay (Schlee, 1973). However, the bottom type, particularly in coastal and estuarine areas, may exhibit a large degree of small-scale variability (for example see Butman et al., 1992, figure 5). The distributions of benthic species and assemblages of species in the Gulf of Maine are strongly related to the bottom type and the properties of the water overlying the bottom (Watling et al. 1988, Langton and Uzmann, 1989, Langton et al. 1990).

Georges Bank is a large (300 x 150 km) shallow bank that appears to be an eastward extension of the U.S. continental shelf. The bank has a steep slope on its northern edge and a broad, flat, gently sloping southern flank. It is separated from the rest of the continental shelf to the west by Great South Channel. The central region of the Bank is quite shallow, with areas less than 10 m deep, and the bottom there is characterized by large amplitude sand waves (Emery and Uchupi, 1972). The rest of the Bank is sandy and flat, with some regions of gravel on the northern and eastern parts of the Bank (Valentine and Lough, 1991).

The continental shelf south of New England is broad and flat. The bottom is generally sandy, except for an area on the outer shelf southwest of Martha's Vineyard that is silt (Garrison and McMaster, 1966). Southeast of Nantucket is a shoal region (Nantucket Shoals) that has sand waves (similar to those on central Georges Bank) and patches of gravel on the western flank of Great South Channel.

The waters in the region derive from two primary sources - water from the Scotian Shelf (Scotian Shelf Water - SSW) and water from offshore over the continental slope (Slope Water - SLW). The SSW enters the Gulf of Maine around Cape Sable in the near surface layers (Smith, 1983), while the SLW enters at depth through Northeast Channel (Ramp et al., 1985). The two water types mix together as they travel in a general counterclockwise motion around the Gulf. Near the coast the currents also move the waters in a general counterclockwise direction along the coast, except south of Penobscot Bay region where a portion of the coastal flow turns offshore toward Jeffreys Ledge and the shallow topography between Jordan and Wilkinson Basins (Brooks, 1985). From the southwestern Gulf, the surface waters over Wilkinson Basin enter a clockwise gyre on Georges Bank which takes the water eastward to the northeast part of the Bank and then southwestward along the Bank's broad southern flank (Hopkins and Garfield, 1981). From there most of the water flows westward south of New England and through the Middle Atlantic Bight. Some portion of the flow from the southern side of Georges Bank turns northward through the Great South Channel to recirculate around the bank (Butman et al., 1982). The mean residence time for water in (or travel time through) this region is approximately 1.5-2 years.

While this mean circulation of water through the region is characterized by velocities of 5-20 cm / sec, the actual water motion at any time are dominated by tidal currents and by local wind-induced flow and has surface velocities of 20-100 cm / sec. The Gulf of Maine is in near resonance with the M2 tidal component (Garrett, 1972) which results in large tidal currents (80 cm / sec) in the eastern Gulf-Bay of Fundy region, while the western Gulf has tidal currents of 10-20 cm / sec at the surface (Moody et al., 1984). The shoal region of Georges Bank also experiences large tidal currents of 70-100 cm / sec (Moody et al., 1984).

The water properties in the Gulf vary in both time and space. The primary temporal variability is associated with the seasonal cycle (e.g., winter cooling, summer heating). Spatially, the properties vary a) vertically, b) in the east-west direction across the Gulf, c) and between the near coastal regions and the more central portions of the Gulf.

Vertically, the water column in the Gulf of Maine is characterized by three layers. The surface layer (0-50m) is relatively fresh (31-33 PSU). Its temperature changes greatly through the year as a result of seasonal heating and cooling. An intermediate layer is found at mid-depths (50-100m) and is identified by a temperature minimum which results from vertical convection driven by surface cooling and wind mixing during winter (Hopkins and Garfield, 1979). As the surface layers warm through the spring and summer, the intermediate layer remains cool, forming a temperature minimum in the water column that is a remnant of the previous winter's cooling.  The deeper portions of the Gulf contain the Maine Bottom Water, which originates from the Slope Water entering through the Northeast Channel and is warmer and saltier than the intermediate layer above it (Mountain and Jessen, 1987).

The surface layer of the Gulf experiences a large seasonal cycle in temperature due to surface heating and cooling.  The surface temperature ranges from about 4 °C in March across the Gulf to about 18 °C in the western Gulf and 14 °C in the eastern Gulf during August.  The salinity of the surface layer also varies seasonally, with minimum values in the west occurring during summer, from the accumulated spring river inflow, and during winter in the east, from the low salinity of the inflowing Scotian Shelf water. (This low in salinity originates from the peak outflow of the St. Laurence river system at the northern end of Nova Scotia during the previous spring).  The seasonal range in the surface layer salinity is about 0.8 PSU, but can vary between years with the changes in the amount of precipitation and river inflow.  With the seasonal temperature and salinity changes, the density stratification over the upper layer also exhibits a seasonal cycle.  From well mixed, vertically uniform conditions in winter, stratification develops through the spring and reaches a maximum in late summer.  The degree of stratification is greater over the western Gulf than in the eastern half.

The bottom waters of the gulf exhibit a significant east-west difference in water properties that is larger than the seasonal variability (Mountain and Jessen, 1987).  In Georges Basin, near the inflow of Slope Water through Northeast Channel, the bottom water has properties of 6-9 °C and 34 - 35 PSU, while in Wilkinson Basin the values are 4-7 °C and 33-34 PSU. Jordan Basin is intermediate between the other two basins.

Conditions near the coast of the Gulf of Maine are greatly influenced by local river input.  The inflowing fresh waters mix with the coastal waters and form a low salinity, coastally trapped band of water which can extend 20 km or more from the coast. The dissolved and particulate content of the river inflow (e.g., nutrients, sediment, contaminants) is transported by the coastal currents and dispersed along the near coastal region.  The coastally trapped band also transports phytoplankton and can influence the temporal and spatial distribution of toxic phytoplankton blooms in the southwestern Gulf (Franks and Anderson, 1992).

The waters on Georges Bank and on the shelf south of New England are similar in properties to the upper layers of the Gulf of Maine.  The annual range in surface temperature is from about 4 °C in winter to about 15 °C on Georges Bank and about 20 °C on the southern New England shelf during August.  The water column develops thermal and density stratification with the seasonal surface warming.  The bottom temperature on the deeper parts of the bank and the shelf reach a maximum of about 12 °C.  The shallow (<60 m) central portions of the Bank and Nantucket Shoals do not seasonally stratify, but remain vertically uniform year round due to the mixing of the strong tidal currents.

Oceanographically, the southern or offshore boundary of Georges Bank and the continental shelf is marked by a region of sharp gradient in water properties between the bank/shelf waters and the Slope Water further offshore. The gradient region is termed the shelf/slope front and extends downward from the surface to intersect the bottom near the 80-100m isobath.

Larger physical features and oceanographic phenomena, as described above, have dominated the research efforts in the northwest Atlantic but there is a growing awareness of the need to consider different, biological, scales in these research programs. Knowledge of factors controlling events at the level of fishing grounds or groundfish nursery areas is essential for the sustained production of the fishery.

Linking spawning strategies to the benthic habitat that supports the juvenile stages of the major groundfish species is a critical area of research that needs to be addressed. This change in life history represents a shift from control of the fish stocks by large scale, physical and oceanographic, features to a finer scale of resolution represented by fishing grounds and nursery areas. It is at this finer scale that impacts of fishing as well as other human-induced perturbations of the environment may have their most significant impact. This was recognized over one hundred years ago in the introductory remarks by Richard Rathbun to a book that described the fishing grounds of North America. Rathbun (1885) noted: "Many of the data furnished by the ordinary class of hydrographic work are, therefore, entirely unsuited to fishery purposes, and it is of the greatest importance that special surveys be undertaken in the immediate interest of the fisheries, and with the object of ascertaining the full extent and character of all the larger grounds that may be profitably resorted to by our fishermen." Rathbun goes on to point out that fishing grounds seldom conform exactly to the contour lines used on hydrographic charts since fishes are not always influenced by difference in depths as much as by the abundance of food and other physical factors like temperature. A detailed series of charts and descriptions are then given for all known fishing grounds from Greenland to Mexico (Collins and Rathbun, 1885). These and additional data on fishing grounds specifically in the Gulf of Maine were again summarized in a 1929 publication by Rich. Nevertheless, a U.S. research program designed to describe the biological and physical interactions at this scale was not initiated until the late 1980s (Lough et al. 1989, Valentine and Lough, 1991).

Groundfish spawning strategies, spawning areas, and their relation to large scale oceanographic features have been investigated to some degree in the northwest Atlantic for the commercially important groundfish species. Sherman et al. (1984) identified three spawning strategies for 11 continental shelf fish species. The hakes were classified as ubiquitous spawners which describes animals that have a protracted spawning period over a large geographic area. Cod, haddock and redfish, on the other hand, have developed spawning strategies that optimize their chances of survival by being in synchrony with temporal and spatial increases of their zooplankton prey. Cod and haddock, for example, were concentrated on Georges Bank and their maximum abundance was synchronized with the zooplankton within the gyre. Yellowtail flounder larvae have also been found to be retained in a relatively restricted area on the Grand Banks of Newfoundland by the current regime (Walsh, 1992).

Concentrations of 0-group and older juvenile fish are generally considered to be indicative of a nursery for the given species. Coastal areas are often considered to serve in this role and in Europe, in particular, the coastal nurseries for cod, pollock and plaice are well documented (Macer, 1967; Edwards and Steele 1986; Zijlstra, 1972; Lockwood, 1974, 1980a, b, 1984; Thijssen et al. 1974; Kuipers, 1975; Daan, 1978; Burd, 1978; Rauck and Zijlstra, 1978; Veen, 1978; Zijlstra et al. 1982; Basimi and Grove 1985a, b; Hawkins et al. 1985; Veer 1986). Recently fish nurseries have been the focus of much research and the idea that nurseries are restricted to estuaries has to be reconsidered. Coastal areas (Langton et al. 1989, Lenanton, 1982) as well as exposed beaches (Bennett, 1989), the surf zone (Ross et al. 1987), and fjordic environments (Gordon and DeSilva, 1980; Gordon, 1981) have all been documented as important for the production of small and juvenile fishes. Finally, for some of the commercially important northwest Atlantic groundfish, such as cod, haddock, yellowtail flounder, and American plaice offshore banks have been identified as oceanic nurseries (Lough et al. 1989; Walsh, 1991, 1992).

Multidisciplinary surveys to map regions of the sea floor together with identifying the faunal associations in these areas, particularly on eastern Georges Bank, in Sheepscot Bay Gulf of Maine, and the Grand Banks of Newfoundland, have demonstrated the relationship between the physical and biological environment for the juveniles of a number of groundfish species (Valentine and Lough, 1991; Langton et al. 1989 and Langton and Watling, 1990, see also Commercial Fisheries News, December 1992; Walsh, 1992). On eastern Georges Bank, for example, when juvenile cod assumed a demersal life they were found to be widely distributed over a variety of substrates ranging from sand to gravelly sand to gravel. Subsequently they were limited to the gravel and Lough et al. (1989) and Valentine and Lough (1991) suggested that the juvenile coloration mimics the appearance of the gravel thus protecting these fish from predation. Interestingly, the fish were associated with gravel in both trawled and untrawled areas. In Sheepscot Bay juvenile winter flounder, yellowtail flounder, longhorn sculpin and little skate were associated with a gravel and sand substrate, and preyed extensively on an amphipod species that was restricted to the gravelly areas, while American plaice and ocean pout were dominant at the muddy stations (Langton et al. 1989 and unpublished data). On the Grand Banks, yellowtail flounder were also associated with sand to gravelly sand (Walsh, 1992). Bottom type selection by groundfish has previously been described for many of these same species (Scott, 1982, MacDonald et al. 1984) but this should not be interpreted to mean that bottom type is the only factor controlling juvenile fish distribution (eg. Horne and Campana, 1989).

**FIGURE E.6.2.1.1** GENERALIZED BATHYMETRY OF THE NORTHEAST REGION

**E.6.2.2 WeatherE.6.2.2 Weather**

One of the most frequently mentioned physical environmental parameters affecting fishing is weather. High winds, waves and extremely low temperatures create hazardous conditions and place commercial fishing among the most dangerous occupations in the United States. Besides the safety concerns, extreme weather conditions also physically restrict fishing operations to the extent that the total number of days available for fishing is less than a full year. In many cases vessels that are at sea must heave to instead of fishing or heading toward port. Under these circumstances, a day at sea is not proportional to fishing time at the same ratio as under normal conditions.

As stocks decline in abundance and fishermen try to extend their range or fishing time, weather conditions play a greater role in their risk exposure. Management measures which restrict fishermen's behavior or increase the "derby" character of the fishery may exacerbate this situation, but there is no evidence that this effect is any greater that the result of stock decline.

The effect of weather on fishing depends to a large degree on the characteristics of individual vessels (size, hull design, weight distribution, and other parameters) and the location of specific fishing grounds. Generally speaking, larger vessels are less constrained by weather and can, therefore, fish more days during the year and can venture farther from shore. Fishing grounds that are in "shoal water" are more restricted by weather than those in deep water. Similarly, fishing grounds in exposed areas are more restricted than those that are in the lee of some land mass.

Tables E.6.2.2.1, .2 and .3 show relevant weather data from four NOAA buoys (out of eleven between New England and Cape Hatteras). Figure E.6.2.2.1 shows the location of the stations, the period of record and the number of observations. The source of data for these tables is: Climatic Summaries for NDBC Buoys and Stations, Update 1, National Climate Data Center, US Dept. of Commerce, Feb., 1990 As might be expected, the tables indicate that the most severe weather and sea conditions occur in the winter months and, secondarily, in the latter part of hurricane season, during the late summer.

The data in the tables is summarized from observations by the following standards:

| **Measurement** | **Reporting range** | **Sampling interval** | **Averaging period** | **Total system accuracy** |
|---|---|---|---|---|
| Wind speed | 0 to 120 knots | 1 sec. | 8.5 min. | ± 1.9 knots or 10% |
| Wind gust | 0 to 160 knots | 1 sec. | 5 sec. | ± 1.9 knots or 10% |
| Air temperature | -40° to 50° C | 90 sec. | 90 sec. | ± 1° C |
| Significant wave | | | | |

| | | | | |
|---|---|---|---|---|
| height | 0 to 35 meters | 0.39 sec. | 20 min. | ± 0.2 meters or 5% |

Peak wind gust is the highest 5 second window average obtained during the 8.5 minute period. Significant wave height is the average height of the highest one third of waves present during the sampling interval.

**FIGURE E.6.2.2.1 STATION LOCATIONS FOR METEOROLOGICAL DATA**

**AIR TEMPERATURE**

**(º CENTIGRADE)**

| STATION | | MONTH | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
| 44<br>00<br>7 | MEAN | -2.3 | -1.1 | 1.3 | 5.4 | 9.5 | 14.2 | 17.5 | 17.7 | 14.9 | 10.4 | 6.0 | 0.9 |
| | MIN | -20.1 | -17.9 | -13.4 | -7.0 | 2.0 | 6.7 | 10.1 | 9.0 | 6.9 | 0.8 | -8.0 | -15.4 |
| | MAX | 10.7 | 9.0 | 13.9 | 19.6 | 22.4 | 26.8 | 26.8 | 30.4 | 27.5 | 22.2 | 15.0 | 16.5 |
| 44<br>01<br>1 | MEAN | 3.5 | 2.4 | 3.6 | 7.0 | 9.6 | 12.8 | 17.1 | 18.7 | 16.3 | 13.0 | 9.8 | 5.9 |
| | MIN | -8.6 | -4.8 | -4.9 | 1.3 | 3.7 | 7.0 | 10.8 | 13.1 | 10.7 | 6.0 | -1.7 | -5.6 |
| | MAX | 14.3 | 11.7 | 13.3 | 15.0 | 16.0 | 18.8 | 23.6 | 25.1 | 25.3 | 22.6 | 17.0 | 17.2 |
| 44<br>00<br>2 | MEAN | 2.0 | 0.7 | 4.8 | 7.5 | 11.9 | 17.2 | 21.8 | 22.7 | 20.4 | 13.8 | 10.5 | 5.8 |
| | MIN | -10.0 | -12.2 | -10.0 | -1.5 | 3.3 | 10.7 | 14.3 | 15.6 | 11.3 | 4.3 | -2.8 | -6.4 |
| | MAX | 13.7 | 10.2 | 11.0 | 16.4 | 19.0 | 22.8 | 26.7 | 27.0 | 24.5 | 20.2 | 18.0 | 15.5 |
| 44<br>00 | MEAN | 2.9 | 3.0 | 4.4 | 6.8 | 10.4 | 14.2 | 18.0 | 19.4 | 17.1 | 13.5 | 10.3 | 6.1 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **8** | | | | | | | | | | | | | |
| | **MIN** | -11.4 | -9.9 | -7.9 | 0.4 | 3.4 | 7.1 | 9.8 | 12.5 | 10.8 | 5.5 | -5.3 | -10.5 |
| | **MAX** | 14.4 | 13.1 | 12.3 | 13.6 | 18.3 | 20.3 | 25.6 | 25.8 | 23.4 | 21.9 | 20.9 | 16.6 |

**TABLE E.6.2.2.1- Monthly temperature data for four offshore buoys (°C, °F=1.8 °C+32).**

| SURFACE WIND SPEED | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (KNOTS) | | | | | | | | | | | | | |
| STATION | | MONTH | | | | | | | | | | | |
| | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
| 44007 | MEAN | 13.4 | 12.4 | 11.9 | 10.7 | 9.6 | 9.3 | 8.5 | 8.3 | 9.2 | 10.8 | 12.7 | 13.4 |
| | MAX | 41.0 | 41.0 | 33.0 | 35.0 | 29.0 | 29.0 | 29.0 | 31.0 | 45.0 | 43.0 | 37.0 | 35.0 |
| | GUST | 49.0 | 51.0 | 52.0 | 56.0 | 35.0 | 35.0 | 37.0 | 39.0 | 58.0 | 52.0 | 47.0 | 47.0 |
| 44011 | MEAN | 15.7 | 1.52 | 13.9 | 11.7 | 9.5 | 8.9 | 7.2 | 7.6 | 9.1 | 10.5 | 12.9 | 14.4 |
| | MAX | 36.0 | 31.0 | 31.0 | 34.0 | 32.0 | 32.0 | 25.0 | 28.0 | 32.0 | 34.0 | 37.0 | 38.0 |
| | GUST | 54.0 | 41.0 | 43.0 | 49.0 | 45.0 | 41.0 | 33.0 | 37.0 | 44.0 | 43.0 | 51.0 | 53.0 |
| 44002 | MEAN | 17.3 | 14.8 | 13.8 | 11.3 | 9.6 | 9.3 | 9.6 | 9.9 | 10.9 | 13.1 | 14.6 | 16.4 |
| | MAX | 38.0 | 43.0 | 36.0 | 31.0 | 32.0 | 31.0 | 28.0 | 27.0 | 30.0 | 32.0 | 32.0 | 38.0 |
| | GUST | 46.0 | 41.0 | 42.0 | 39.0 | 29.0 | 37.0 | 27.0 | 34.0 | 33.0 | 41.0 | NA | NA |
| 44 00 | MEAN | 14.2 | 15.5 | 14.6 | 13.1 | 11.1 | 10.3 | 8.7 | 8.7 | 9.4 | 11.8 | 14.1 | 14.7 |

| 8 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **MAX** | 45.0 | 47.0 | 43.0 | 38.0 | 35.0 | 33.0 | 27.0 | 41.0 | 35.0 | 37.0 | 52.0 | 42.0 |
| | **GUST** | 58.0 | 58.0 | 56.0 | 59.0 | 47.0 | 41.0 | 39.0 | 52.0 | 49.0 | 52.0 | 67.0 | 58.0 |
| | **NOTE: MEAN & MAX are average of 8.5 minutes; GUST is average of 5 seconds** | | | | | | | | | | | | |

**TABLE E.6.2.2.2- Monthly surface wind speed for four coastal stations**

| SIGNIFICANT WAVE HEIGHT (METERS) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **STATION** | | **MONTH** | | | | | | | | | | | |
| | | **JAN** | **FEB** | **MAR** | **APR** | **MAY** | **JUN** | **JUL** | **AUG** | **SEP** | **OCT** | **NOV** | **DEC** |
| **44007** | **MEAN** | 1.2 | 1.1 | 1.1 | 1.2 | 0.9 | 0.8 | 0.6 | 0.6 | 0.7 | 0.9 | 1.0 | 1.1 |
| | **MAX** | 6.0 | 7.5 | 6.0 | 5.0 | 3.5 | 3.0 | 2.5 | 3.5 | 6.0 | 7.0 | 5.0 | 6.0 |
| **44011** | **MEAN** | 3.1 | 2.6 | 2.5 | 2.2 | 1.6 | 1.5 | 1.3 | 1.2 | 1.4 | 1.9 | 2.4 | 2.6 |
| | **MAX** | 9.0 | 8.0 | 6.5 | 8.0 | 7.0 | 6.0 | 4.0 | 6.0 | 7.5 | 9.0 | 7.5 | 9.0 |
| **4400[illegible]** | **MEAN** | DATA NOT AVAILABLE | | | | | | | | | | | |
| | **MAX** | | | | | | | | | | | | |
| **44008** | **MEAN** | 2.4 | 2.3 | 2.2 | 2.0 | 1.5 | 1.2 | 1.0 | 1.0 | 1.1 | 1.7 | 1.9 | 2.1 |
| | **MAX** | 8.0 | 7.5 | 8.0 | 8.0 | 6.0 | 4.5 | 3.5 | 6.0 | 5.0 | 7.0 | 6.5 | 6.5 |

**TABLE E.6.2.2.3- Monthly significant wave heights for three offshore stations (44002 NA).**

## E.6.3 BIOLOGICAL ENVIRONMENTE.6.3 BIOLOGICAL ENVIRONMENT

### E.6.3.1 Geographic species assemblages and the multispecies complexE.6.3.1 Geographic species assemblages and the multispecies complex

Cluster analysis of NEFSC bottom trawl survey data from 1967-1988 was used to identify persistent spatial boundaries and species membership of groundfish assemblages over the continental shelf between Cape Hatteras and Nova Scotia (Figure E.6.3.1.1) (Gabriel, in press). Six major species groups exhibited strong temporal persistence in their spatial distribution patterns:

**A. Deepwater Gulf of Maine - Georges Bank**: including thorny skate, American plaice, white hake, redfish and witch flounder;
**B. Gulf of Maine - Georges Bank - Transition Zone:** species closely affiliated with Group A, including Atlantic cod, haddock and pollock;
**C. Shallow Water Georges Bank - Southern New England:** typically including winter skate, little skate, windowpane, winter flounder, yellowtail flounder and longhorn sculpin;
**D. Northern Mid-Atlantic Bight:** including spotted hake, fourspot flounder, buttterfish and long-finned squid;
**E. Southern Mid-Atlantic Bight:** including summer flounder, scup, northern sea robin, black sea bass, with a separate inshore warm-water component consisting of Atlantic croaker, spot and weakfish;
**F. Deepwater:** including offshore hake, blackbelly rosefish, longfin hake, armored sea robin, Gulf Stream flounder and fawn cusk-eel.

Other species (silver hake, red hake, American goosefish, short-finned squid, spiny dogfish and cusk), defined as **Group A-B**, were variously associated with groups A, B and C throughout the period of the analysis.

In the Gulf of Maine, species group A appeared susceptible to a relatively low level of fishery perturbation in the 1960s and early-1970s that did not include a significant non-USA fishery, indicating low resistance to perturbation (Figure E.6.3.1.2). Characteristic species groups on Georges Bank (B and C, except for winter skate) declined in response to intense fishery perturbation (1964-74), but these declines were not generally reversed after the perturbation was relaxed in the following years (1975-81), as indexed by standardized fishing effort (Mayo et al., in press). This may be because the duration and/or degree of relaxation was insufficient to allow accumulation of recruitment as persistent stock biomass. Equivalent fishery effort data are not available for evaluation of responses of groups D - F to fishery perturbation. Distribution and abundance of species group D appeared to shift northward and increase during periods of warming temperatures in the mid-1970s, and relative abundance has since remained at relatively high levels. Distribution and abundance of species group E appeared sensitive to temperature patterns as well. Species diversity has declined coastwide in recent years, especially in the Georges Bank region, as relative abundance of spiny dogfish and winter skate has increased.

**FIGURE 6.3.1.1** Species groups and schematic dendrogram based on inverse cluster analysis of 1967-1988 autumn groundfish survey data. Species groups A = Deepwater Gulf of Maine-Georges Bank; B = Gulf of Maine-Georges Bank Transition Zone; C = Shallow Water Georges Bank-Southern New England; D = Northern Mid-Atlantic Bight; E = Southern Mid-Atlantic Bight; F = Deepwater. Second areas in group names represent secondary areas of concentration and/or second stock area for many species.

**FIGURE 6.3.1.2.a. and b.** Species composition by survey summary region and species groups from cluster analysis. (Catch per tow is aggregated over species within each group.) Spiny dogfish (group A-B) is outlined separately, as is winter skate (group C) for Georges Bank. Gulf of Maine includes NEFSC survey strata 24, 26-30, 36-40; Georges Bank includes strata 13, 16, 19-21;

**FIGURE E.6.3.1.2.c and d** Species composition by survey summary region and species groups from cluster analysis. (Catch per tow is aggregated over species within each group.) Spiny dogfish (group A-B) is outlined separately. Northern Mid-Atlantic Bight includes strata 1-2, 5-6, 9-10; Southern Mid-Atlantic Bight includes strata 61-62, 65-66, 69-70, 73-74.

**FIGURE E.6.3.1.2.e** Species composition by survey summary region and species groups from cluster analysis. (Catch per tow is aggregated over species within each group.) Spiny dogfish (group A-B) is outlined separately.

### E.6.3.2 Stocks under the Multispecies FMPE.6.3.2 Stocks under the Multispecies FMP

#### E.6.3.2.1 Life histories and habitat requirements

The distribution of each of the thirteen species discussed below according to the NEFSC bottom trawl survey 1987-1991 is shown in Figures E.6.3.2.1 a-m.

~~Cod~~

Atlantic cod, *Gadus morhua*, are distributed in the Northwest Atlantic from Greenland to Cape Hatteras, North Carolina, and from near-shore areas to depths exceeding 400 m. Off the northeast coast of the United States, the greatest concentrations of cod are commonly found on rough bottoms in waters between 10 and 150 m and at temperatures between 0$^{o}$ and 10$^{o}$C. Cod are omnivorous feeders, eating a wide variety of mollusks, crustaceans, and fishes. Growth is rapid, cod on Georges Bank attain an average size of 26 cm by the end of their first year of life and begin to be routinely captured in commercial and recreational fisheries by age 2 (40-60 cm). Cod commonly attain lengths up to 130 cm and weights up to 25 to 35 kg. Growth parameters, taken from Penttila and Gifford (1976) are listed in Table E.6.3.2.1.1. Maximum age is in excess of 20 years, although young fish (ages 2 to 5) generally comprise the bulk of the catches. The natural mortality rate is 0.20 (U .S. Dept of Commerce 1992). Median age at sexual maturity is between 1.7 and 2.3 years and is attained at average lengths between 32 and 41 cm (O'Brien et al 1992). Spawning occurs during winter and early spring, normally at water temperatures between 5$^{o}$ to 7$^{o}$C. Spawning takes place near the bottom, but the eggs are pelagic and drift for 2-3 weeks before hatching. The transition from pelagic to demersal life occurs when larvae are about 4-6 cm in length or about 3 months old. Cod are highly fecund; a large mature female may produce between 3-9 million eggs.

In New England waters, cod characteristically exhibit seasonal movements into shoal waters in the spring followed by a retreat into deeper water during winter. Little interchange occurs between cod in the Gulf of Maine and those on Georges Bank, but extensive mixing prevails between cod on Georges Bank and in the Southern New England-Middle Atlantic area. A seasonal southwesterly movement of cod from the South Channel area of Georges Bank occurs in the autumn followed by a northeasterly return in the spring.

Cod are assessed as two stocks: Gulf of Maine, and Georges Bank and Southward. Important commercial and recreational fisheries occur in both. The commercial fisheries are conducted year-round with otter trawls and gill nets as primary gear. Recreational fishing also occurs year-round; peak activity occurs during the late summer in the lower Gulf of Maine, and during late autumn to early spring from Massachusetts southward.

~~Haddock~~

Haddock, *Melanogrammus aeglefinus*, are distributed on both sides of the North Atlantic. In the western Atlantic, haddock range from West Greenland to Cape Hatteras. Highest concentrations off the USA coast occur on the northern and eastern section of Georges Bank and in the southwestern Gulf of Maine (Clark et al. 1982). Two stocks occur in USA waters; these are termed the Gulf of Maine stock and the Georges Bank stock. Haddock are most common at depths of 45 to 135 m and temperatures of 2º to 10ºC (Collette and Klein-MacPhee MS 1992). Haddock appear to prefer broken ground, and gravelly, pebbly, and sandy bottom rather than ledges, rocks or kelp (Collette and Klein-MacPhee MS 1992). Adult haddock on Georges Bank appear to be relatively sedentary, but seasonal coastal movements occur in the western Gulf of Maine.

Major spawning concentrations occur on eastern Georges Bank, although some spawning also occurs to the east of Nantucket Shoals and along the Maine coast. Spawning occurs between January and June, with peak activity during late March and early April. Eggs are planktonic, and hatch in approximately two weeks at typical spawning temperatures (Clark et al. 1982). Juvenile haddock remain pelagic for several months before settling to the bottom (Collette and Klein-MacPhee MS 1992).

As planktonic juveniles, haddock mainly consume copepods and euphausiids. After assuming a benthic habit, haddock prey primarily on small invertebrates, but fish are also consumed by adult haddock (Collette and Klein-MacPhee MS 1992). Haddock are moderately long lived (up to approximately 18 years), and have relatively rapid growth (Table E.6.3.2.1.1). The natural mortality rate is 0.20 (U.S. Dept of Commerce 1992). During the early 1960s, nearly all females age 4 and older were fully mature, and approximately 75% of age 3 females were mature. In recent years, the maturation schedule has shifted by about one year; currently nearly all age 3 and 75% of the age 2 female haddock are mature (O'Brien et al. 1993). Individual females may produce up to 3 million eggs, but a 55 cm individual produces approximately 850 thousand eggs (Clark et al. 1982).

~~Pollock~~

Pollock, *Pollachius virens*, occur on both sides of the North Atlantic; in the Northwest Atlantic, they are most abundant on the Scotian Shelf and in the Gulf of Maine. One major spawning area exists in the western Gulf of Maine, and several areas have been identified on the Scotian Shelf. Tagging studies suggest considerable movement between the Scotian Shelf and Georges Bank and, to a lesser extent, between the Scotian Shelf and the Gulf of Maine. Electrophoretic analyses of pollock tissue samples from the Scotian shelf and western Gulf of Maine showed no significant differences between areas, although differences in some morphometric and meristic characteristics were significant (Mayo et al. 1989). Pollock attain lengths up to 110 cm and weights of 16 kg. Maximum ages up to 18 years have been noted in the population, although the major portion of the catch consists of 3-6 year old fish. Von-Bertalanffy growth parameters, taken from Mayo et al. (1989), are listed in Table E.6.3.2.1.1. The natural mortality rate is 0.20 (U.S. Dept of Commerce 1992). Sexual maturation is essentially complete by age 5 although most fish are mature by age 3 (O'Brien et al. 1993).

Adult pollock inhabit depths ranging from 70 to 280 m with associated bottom temperatures between 5º and 8ºC in the Gulf of Maine and along the northern edge of Georges Bank (Leim and Scott 1969). Juvenile "harbor pollock" are common in inshore areas, but move offshore as they grow older. Pollock form spawning aggregations during winter months in the western Gulf of Maine where considerable fishing effort is directed. Juvenile pollock feed primarily on euphausiids and other small crustaceans (Collette and Klein-MacPhee MS 1992). As adults, pollock appear to select larger crustaceans as well as small fish, primarily herring. There appears to be little preference for bottom type as pollock are often found to be semi-pelagic.

~~Redfish~~

Redfish or ocean perch, *Sebastes fasciatus*, are distributed throughout the Northwest Atlantic from the Grand Banks to Georges Bank. Off New England, redfish are most common in deep waters of the Gulf of Maine to depths of 300 m. Ages in excess of 50 years and maximum sizes of 45 to 50 cm have been observed. Von-Bertalanffy growth parameters, taken from Mayo et al. (1990), are listed in Table E.6.3.2.1.1. The natural mortality rate is quite low and a value of 0.05 has been used in evaluating the population dynamics of this stock (U.S. Dept of Commerce 1992). The median age at maturity of Gulf of Maine redfish (5.5 years) is attained at an average length of 20 to 23 cm (O'Brien et al. 1993). Females are viviparous, retaining eggs in the ovary after fertilization until yolk sac absorption. Mating takes place in autumn, with subsequent larval extrusion occurring the following spring and summer. Larvae remain planktonic for 4 to 5 months before descending to the bottom at a length of about 50mm (Kelly and Barker 1961). A strong diel vertical distribution pattern has been observed in adults with considerable movement off bottom at night and a return during daylight.

Redfish are often associated with rocky bottom types in the Gulf of Maine and are most abundant in relatively cold water, usually below 5ºC. Adult redfish feed primarily on small copepods (Bigelow and Schroeder 1953). In the past, redfish were often distributed in numerous dense local aggregations throughout the Gulf of Maine. Because of this, redfish were fished quite heavily during the development phase of the fishery. Because of their low fecundity and low natural mortality rate, the stock is particularly vulnerable to increases in mortality.

~~White hake~~

The white hake, *Urophycis tenuis*, a boreal species that occurs from Newfoundland to Southern New England, is found on muddy bottom throughout the Gulf of Maine. Stock boundaries are uncertain, although research vessel survey data indicate that the Gulf of Maine population is more or less discrete from populations further north and east. White hake in the Gulf of Maine appear to be recruited from an early spring spawning population located on the continental slope south of Georges Bank and Southern New England (Fahay and Able 1989). White hake attain a maximum length of 135 cm and weights of up to 21 kg, with females being larger. Ages of over 20 years have been documented. Von-Bertalanffy growth parameters, taken from Hunt (1982), are listed in Table E.6.3.2.1.1. The median age at maturity occurs at about 1.5 years at sizes between 32 and 35 cm (O'Brien et al. 1993).

Depth distribution varies by age and season; juveniles typically occupy shallower areas than adults, but individuals of all ages tend to move inshore or shoalward in spring and summer, dispersing to deeper areas in autumn. White hake are found within a relatively broad temperature range. Juveniles may be found in shallow water as high as 15°C in summer or as low as 2°C in winter, and adults occur in regions of the inner Gulf of Maine at temperatures as low as 5°C. Juveniles feed primarily upon shrimp and other crustaceans, but adults feed almost exclusively on fish, including juveniles of their own species. Most trawl catches are taken at depths of 110 m or more, although hake are taken as shallow as 27 m during gillnetting operations in summer.

~~Red hake~~

Red hake, *Urophycis chuss*, are distributed from the Gulf of St. Lawrence to North Carolina, but are most abundant between Georges Bank and New Jersey. The stock structure of this species is not clearly defined. It appears that there are possibly two stocks, divided north and south in the central Georges Bank region. Red hake have a broad geographic and depth distribution throughout the year, undergoing extensive seasonal migrations. Red hake over-winter in the deep waters of the Gulf of Maine and along the outer continental shelf and slope south and southwest of Georges Bank. They are most common in relatively deep water, and appear to prefer sandy or muddy bottoms (Collette and Klein-MacPhee MS 1992). Adult fish prefer water temperatures of 5 to 12° C.

Spawning occurs from May through November, with major spawning areas located on the southwest part of Georges Bank and in the Southern New England area south of Montauk Point, Long Island. Spawning generally occurs at temperatures between 5 and 10° C. The eggs are small, buoyant and pelagic, with hatching occurring within 3 days to approximately 1 week at typical spawning temperatures (Collette and Klein-MacPhee MS 1992). Young red hake remain pelagic for the first few months of life, becoming demersal after reaching approximately 30 mm. After settling, juvenile red hake are commonly found within the mantle cavities of sea scallops (*Placopecten magellanicus*), maintaining this association until roughly 100 mm (Collette and Klein-MacPhee MS 1992).

As planktonic larvae and juveniles, red hake feed largely on copepods and other small crustaceans. Demersal red hake also feed primarily on crustaceans (e.g. decapod shrimp, euphausiids, amphipods and crabs), but adult red hake also feed extensively on fish (Collette and Klein-MacPhee MS 1992). Red hake are relatively short-lived, reaching a maximum age of about 12 years; few fish survive beyond 8 years of age, however. Red hake growth is initially rapid, but they do not reach a large size. Von-Bertalanffy growth parameters, calculated from Penttila et al. (1989), are listed in Table E.6.3.2.1.1. The natural mortality rate is 0.40 (U.S. Dept of Commerce 1992). Maturity is reached at an age of 1.7 to 1.8 years (25 to 27 cm) for females, and 1.4 to 1.8 years (22-24 cm) for males (O'Brien et al. 1993).

~~Silver hake~~

Silver hake or whiting, *Merluccius bilinearis*, are widely distributed, ranging from Newfoundland to South Carolina. The center of abundance is from Maine to New Jersey. Two stocks have been identified based on morphological differences; one extends from the Gulf of Maine to northern Georges Bank, and the second occurs from southern Georges Bank to the mid-Atlantic area. Migration is extensive, with overwintering in the deeper waters of the Gulf of Maine for the northern stock and along the outer continental shelf and slope for the southern stock. Silver hake are found at a variety of depths, from the shoreline to depths as great as 900 m, but their preferred temperature range is between 6 and 18° C (Collette and Klein-MacPhee MS 1992). Although silver hake show seasonal migrations, movements within these broad depth and temperature ranges appears to be related to the distribution of food organisms.

Major spawning areas include the coastal region of the Gulf of Maine from Cape Cod to Grand Manan Island, southern and southeastern Georges Bank, and the Southern New England area south of Marthas Vineyard. Silver hake are a summer spawner, with peak egg production occurring during July and August (Collette and Klein-MacPhee MS 1992). The eggs are buoyant, and hatch within 2 to 3 days of fertilization (Collette and Klein-MacPhee MS 1992). Larval silver hake appear to be passive planktors until reaching a size of approximately 20 mm when they become able to migrate vertically within the water column in search of preferred water temperatures and prey (Collette and Klein-MacPhee MS 1992).

As juveniles, silver hake feed primarily on small crustaceans such as copepods, amphipods and euphausiids (Bowman 1981). After reaching approximately 20 cm in length, their diet shifts to primarily fish, squid and decapod shrimp (Bowman 1984). Feeding occurs mainly at night (Bowman and Bowman 1980, Bowman 1984). Growth of silver hake is initially rapid, but after reaching 25 cm, there is a divergence in growth between males and females, with females growing more rapidly and achieving a larger maximum size (Hunt 1980). Von-Bertalanffy growth parameters, calculated from Penttila et al. (1989), are listed in Table E.6.3.2.1.1. Ages up to 15 years have been reported, but few fish beyond age 6 have been observed in recent years. The natural mortality rate is 0.40 (U.S. Dept of Commerce 1992). More than 50% of age 2 fish (20-30 cm), and nearly all age 3 fish (25-35 cm) are sexually mature (O'Brien et al. 1993).

~~Ocean pout~~

The ocean pout, *Macrozoarces americanus*, is a demersal eel-like species ranging from Labrador to Delaware that attains lengths of up to 98 cm and weights of 5.3 kg. Ocean pout prefer depths of 15 to 80 m (Grosslein and Azarovitz 1982) and temperatures of 6° to 9°C (Collette and Klein-MacPhee MS 1992). Tagging studies and NEFSC bottom trawl survey data indicate that ocean pout do not undertake extensive migrations, but rather move seasonally to different substrates. During winter and spring, ocean pout feed over sand or sand-gravel bottom and are vulnerable to otter trawl fisheries (Olsen and Merriman 1946). In summer, ocean pout cease feeding and move to rocky areas, where spawning occurs in September and October. The demersal eggs are guarded by both parents until hatching. During this nesting time ocean pout are not available to commercial fishing operations. Catches typically increase again when adults return to their feeding grounds in late autumn and winter. The egg development period is longer than one year and fecundity is relatively low. The diet consists primarily of invertebrates, with fish being only a minor component.

Stock identification studies suggest the existence of two stocks: one occupying the Bay of Fundy - northern Gulf of Maine region east of Cape Elizabeth, and a second stock ranging from Cape Cod Bay south to Delaware (Olsen and Merriman 1946). The southern stock is characterized by faster growth rates, and to date has supported the commercial fishery. The median length at which maturation occurs in the northern stock is 30.3 cm for males and 26.2 cm for females; and from the southern stock, 31.9 cm and 31.3 cm for males and females, respectively (O'Brien et al. 1993).

~~Yellowtail flounder~~

The yellowtail flounder, *Pleuronectes ferruginea*, ranges from Labrador to Chesapeake Bay. Off the USA coast, commercially important concentrations are found on Georges Bank, off Cape Cod, and in Southern New England, generally at depths between 10 and 100 m, on sandy or sandy-mud substrates (Collette and Klein-MacPhee MS 1992). Fishing for yellowtail by the USA fleet also occurs in the northern Gulf of Maine, in the Mid-Atlantic Bight, and on the Grand Banks of Newfoundland outside the Canadian 200-mile limit (the Tail of the Bank).

This flatfish can be classified as medium sized with average lengths of 40 cm for males and 46 cm for females. Maturity is attained roughly at ages 2-3 for all stocks, with median length at maturity ($L_{50}$) occurring at 24.9 cm and 25.6 cm for the Georges Bank stock and 27.6 cm and 29.0 cm for the Southern New England stock, for females and males respectively (O'Brien et al. 1993). Von-Bertalanffy growth parameters, taken from Moseley 1986, are listed in Table E.6.3.2.1.1. The $L_{inf}$ in the tables is lower than might be expected because of the modelling technique and the lack of older age samples in the available data. Historical data provides evidence of significant numbers of fish reaching 50 cm.. The natural mortality rate is 0.20 (U.S. Dept of Commerce 1992. Fecundity ranges between 350,000 to 570,000 eggs per spawner. Spawning occurs during spring and summer, peaking in April to June at temperatures between 4.5-8.1° C (Collette and Klein-MacPhee MS 1992). Larvae drift for a month or more, then assume adult characteristics and become demersal. Food habits data suggest that diets are comprised almost entirely of small invertebrates such as mysids, amphipods, and polychaetes (Collette and Klein-MacPhee MS 1992).

Although relatively sedentary, some seasonal movements have been documented. Tagging studies and other information indicate that Southern New England, Georges Bank, and Cape Cod yellowtail flounder form relatively discrete groups, although some intermingling of fish among these groups occurs (Lux 1963).

~~Winter flounder~~

The winter flounder, blackback, or lemon sole, *Pleuronectes americanus*, is distributed in the Northwest Atlantic from Labrador to Georgia. Abundance is highest from the Gulf of St. Lawrence to Chesapeake Bay. Tagging and meristic studies indicate discrete groups of winter flounder north (Gulf of Maine) and south of Cape Cod (Southern New England-Middle Atlantic) and on Georges Bank. Winter flounder may attain sizes up to 58 cm (23 in.) total length and ages in excess of 15 years. Von Bertalanffy growth parameters for Georges Bank winter flounder, taken from Lux (1973) and Witherell and Burnett (1992), are listed in Table E.6.3.2.1.1. The median age at maturity for male and female winter flounder north of Cape Cod is 3.3 and 3.5 years, respectively (28 and 30 cm); age at maturity for winter flounder south of Cape Cod is 3.3 and 3.0 years for male and female (29 and 27 cm); and age at maturity of winter flounder on Georges Bank is 1.9 for males and females (26 and 25 cm) (O'Brien et al. 1993). Spawning commences in early winter in the southern extent of the range and may extend into April and May on Georges Bank. The height of the spawning season for most areas is between January and March. Spawning among coastal winter flounder occurs in estuaries, embayments, and saltwater ponds. There is evidence that winter flounder tend to migrate to the same spawning locations in consecutive years. Movement patterns are generally localized. Restricted movement patterns and differences in growth, meristic, and morphometric characteristics suggest that relatively discrete local groups exist.

The diet consists primarily of small benthic invertebrates, such as shrimps, amphipods, small crabs, annelid worms, molluscs, hydrozoans and anthozoans (summarized in Klein-MacPhee 1978). The habitat preferences of winter flounder range from gravel to sand, or muddy sand. The populations on the offshore banks are generally on some type of hard bottom. The normal distribution of winter flounder covers a wide range of temperature, from the freezing point of salt water in the northern edge of the range, to a maximum of 19º-20º C at the southern limit. Preferred temperatures appear to be between 3º and 15º C. Peak spawning activity occurs when water temperatures range from 3.3º to 5.6º C.

~~American plaice~~

The American plaice or dab, *Hippoglossoides platessoides*, is distributed along the Northwest Atlantic continental shelf from southern Labrador to Rhode Island in relatively deep waters. Primary concentrations of the Gulf of Maine - Georges Bank stock occur in inshore waters along coastal Maine and Massachusetts from Casco Bay to Cape Cod Bay including Jeffreys Basin and Stellwagen Bank and in the offshore waters from central Gulf of Maine to Great South Channel. The maximum age attained is between 24-30 years and the maximum size is 70-80 cm (Bigelow and Schroeder 1953). Growth rates are similar between sexes until age 4 when females grow faster than males. Von-Bertalanffy growth parameters, taken from Sullivan (1982) are listed in Table E.6.3.2.1.1. The natural mortality rate is 0.20 (U.S. Dept of Commerce 1992). The median age at maturity for females (3.6 yrs) and males (3.0) is attained at an average 26.8 and 22.1 cm, respectively (O'Brien et al. 1993). Spawning occurs from February to June in the coastal areas of western Gulf of Maine from Cape Elizabeth to Cape Cod, including Stellwagen Bank and Cape Cod Bay, and central and western Georges Bank in depths no greater than 90 m (Smith 1985; Collette and Klein-MacPhee MS 1992).

American plaice inhabit areas with a fine but gritty mixture of sand and mud or soft oozy mud, primarily in depths ranging from 27-108 m. The preferred food of adults are echinoderms, amphipods, and polychaetes, however, they are opportunistic and will feed on most any bottom dwelling animals small enough to devour. Juvenile plaice prefer small shrimp, other crustaceans, and polychaete worms. The optimum temperature range for plaice is from 1.7 - 7.7 °C., however, they can survive in -1.5 to 13 °C water. Spawning occurs in a narrower range of 2.7 - 4.4 °C (Collette and Klein-MacPhee MS 1992).

~~Witch flounder~~

The witch flounder or gray sole, *Glyptocephalus cynoglossus*, is common throughout the Gulf of Maine and also occurs in deeper areas on and adjacent to Georges Bank and along the shelf edge as far south as Cape Hatteras. Research vessel survey data suggest that the Gulf of Maine population may be relatively discrete from populations in other areas. Witch flounder appear to be sedentary, preferring moderately deep areas; few fish are taken shallower than 27 m and most are caught between 110 and 275 m.

Witch flounder attain lengths up to 60 cm and weights of approximately 2 kg. Von-Bertalanffy growth parameters, taken from Burnett et al. (1992), are listed in Table E.6.3.2.1.1. The natural mortality rate is 0.15 (U.S. Dept of Commerce 1992). The median age at maturity of witch flounder (3.6 years for males and 4.4 years for females) is attained at an average length of 25.3 cm for males and 30.4 cm for females (O'Brien et al. 1993). Spawning occurs in late spring and summer, with peak spawning occurring in July and August. Witch flounder are frequently caught on smooth bottom, where muddy sand, clay or mud occur. Witch flounder occupy temperatures ranging from about 1.7 - 14.5 $^{o}$. The diet of witch flounder consists primarily of polychaete worms, however, their diet also includes echinoderms, amphipods and other small crustaceans, squid and small molluscs (Collette and Klein-MacPhee MS 1992).

~~Windowpane flounder~~

Windowpane or sand flounder, *Scophthalmus aquosus*, is a thin-bodied, left-handed flounder distributed along the Northwest Atlantic continental shelf from the Gulf of St. Lawrence to Florida. The greatest commercial concentrations exist in waters less than 46 m from Georges Bank and Southern New England. Sexual maturity occurs between ages 3 and 4; about 50% of fish 22 cm long are sexually mature (O'Brien et al. 1993). Spawning occurs from late spring to autumn, peaking in July-August on Georges Bank and September in Southern New England. Windowpane spawn at temperatures between 6 -17$^{o}$ C, at depths less than 40 m. (Collette and Klein-MacPhee MS 1992) Windowpane commonly attain lengths up to 41 cm. Von Bertalanffy growth parameters, taken from Thorpe (1991), are listed in Table E.6.3.2.1.1.

The windowpane primarily inhabits waters between the tide mark and 36-45 m, where bottom sediments are sandy or muddy. Young fish settle in shallow water inshore and move offshore and deeper as they grow. Adults can tolerate a wide temperature range, between 0 - 26.8$^{o}$C, but in summer occur primarily in waters where surface temperatures are 13$^{o}$ C or higher. Windowpane feed intensively on mysid shrimp as juveniles and adults; adults over 20 cm also take small or young fish as prey (Collette and Klein-MacPhee MS 1992).

**Table E.6.3.2.1.1. Von-Bertalanffy growth parameters for 13 species in the Northeast Multispecies Fishery Management Plan.**

| Species/ Stock | L(inf) | K | to |
|---|---|---|---|
| Cod | | | |
| Gulf of Maine | 146.5 | 0.116 | 0.285 |
| Georges Bank | 148.1 | 0.120 | -0.616 |
| Haddock | | | |
| Gulf of Maine | 72.91 | 0.352 | 0.295 |
| Georges Bank | 73.80 | 0.376 | 0.165 |
| Pollock | | | |
| Gulf of Maine- Georges Bank | 107.4 | 0.1664 | -0.3214 |
| Redfish | | | |
| Gulf of Maine- Georges Bank | | | |
| Male | 32.8 | 0.1693 | -0.3546 |
| Female | 38.9 | 0.1452 | -0.1200 |
| White Hake | | | |
| Gulf of Maine | | | |
| Male | 110.6 | 0.11 | 1.17 |
| Female | 135.3 | 0.09 | -0.89 |
| Red Hake | | | |
| Gulf of Maine to Mid-Atlantic | 60.19 | 0.191 | -0.836 |
| Silver Hake | | | |
| Gulf of Maine- N. Georges Bank | 65.5 | 0.181 | -0.275 |
| S. Georges Bank- Mid-Atlantic | 46.1 | 0.416 | 0.274 |
| Ocean Pout | | | |
| Southern New England | Not Available | | |

**Table E.6.3.2.1.1. (Continued)**

| Species/ Stock | L(inf) | K | to |
|---|---|---|---|
| Yellowtail Flounder | | | |
| Georges Bank | | | |
| Male | 41.0 | 0.748 | 0.671 |
| Female | 46.0 | 0.629 | 0.676 |
| Southern New England | | | |
| Male | 39.0 | 0.637 | 0.572 |
| Female | 41.0 | 0.662 | 0.706 |
| Cape Cod | | | |
| Male | 70.0 | 0.157 | -0.678 |
| Female | 53.0 | 0.360 | -0.356 |
| Winter Flounder | | | |
| Gulf of Maine | | | |
| Male | 39.8 | 0.41 | 0.38 |
| Female | 49.0 | 0.27 | 0.07 |
| Georges Bank | | | |
| Male | 55.0 | 0.37 | 0.05 |
| Female | 63.0 | 0.31 | 0.05 |
| Southern New England | | | |
| Male | 45.9 | 0.31 | 0.18 |
| Female | 49.0 | 0.31 | 0.25 |
| American Plaice | | | |
| Gulf of Maine- | | | |
| Georges Bank | | | |
| Male | 59.83 | 0.17 | -0.04 |
| Female | 64.17 | 0.17 | 0.12 |
| Witch Flounder | | | |
| Gulf of Maine- | | | |
| Georges Bank | | | |
| Male | 58.05 | 0.1533 | -0.0120 |
| Female | 61.99 | 0.1482 | 0.0542 |
| Windowpane Flounder | | | |
| Georges Bank | 37.2 | 0.39 | 0.1 |
| Southern New England | 35.2 | 0.27 | -1.0 |

Sources: Cod: Penttila and Gifford (1976); Haddock: Clark et al. (1982); Pollock: Mayo et al. (1989); Redfish: Mayo et al. (1990); White hake: Hunt (1982) ; From Gulf of St. Lawrence; Red hake: Calculated from Penttila et al. (1989); Silver hake: Calculated from

Penttila et al. (1989); Yellowtail flounder: Moseley (1986); however Lux (1969) reported L(inf) of 47 cm for males from Cape Cod grounds; Winter flounder: Georges Bank - Lux (1973); Gulf of Maine and Southern New England - Witherell and Burnett (1992); American plaice: Sullivan (1982); Witch flounder: Burnett et al. (1992); Windowpane flounder: Thorpe (1991)

### E.6.3.2.2 Stock Assessment

NOTE: in the following section, the terms "over-exploited" , "fully exploited" and "under-exploited" are used to discuss the stock condition relative to historical patterns and fishing effort. These terms are distinct from the "overfished" condition referred to in the definitions of overfishing. Secondly, for stocks which cross international boundaries, the Canadian landings are used in the assessments and the trawl surveys are conducted on both sides of the boundary line.

**Cod**

~~Gulf of Maine Stock~~

During the past 30 years, USA commercial catches have ranged between 2,600 and 17,800 mt. Between 1960 and 1975 annual landings never exceeded 9,000 mt and averaged 5,500 mt per year, while during 1976-1985 annual landings were never less than 10,000 mt and averaged 12,200 mt per year. USA catches declined below 10,000 mt during 1986-1988 but subsequently increased, doubling between 1987 and 1990 (7,500 to 15,200 mt), and were a record-high 17,800 mt in 1991 (Table E.6.3.2.2.1). In 1992 landings fell to around 11,000 mt, reflecting the high rate of mortality and poor recruitment.

NEFSC autumn survey biomass indices were high during the mid-1960s and early-1970s (12-23 kg/tow), declined to low levels during 1973-1976 (7-9 kg/tow), but increased to moderate levels during 1977-1982 (9-16 kg/tow) (U.S. Dept. of Commerce 1992). Subsequently, survey indices have again declined reaching record-low levels during 1989-1991. Fishing mortality has been very high (F=0.80-1.00) since 1983 and well in excess of $F_{max}$ (0.27) and $F_{20\%}$ (0.40) (NEFSC 1991). In 1991 the fishing mortality rate reached its highest level on record, F=1.14. As such, the stock is significantly overfished. Spawning stock biomass declined by 50% between 1982 and 1986 but markedly increased during 1989-1991 due to excellent recruitment of the 1987 year class, reaching a record high in 1990 of 27,500 mt. However, recruitment since 1988 has been much poorer and, as a consequence of record high fishing mortality rates, SSB in 1992 was a record-low 13,600 mt, and is expected to decline further in 1993 according to the 15th SAW. To halt the declining trend in SSB, fishing mortality needs to be markedly reduced (NEFSC 1991).

~~Georges Bank and South Stock~~

Since 1960, total commercial catches of Georges Bank cod have ranged between 11,000 (1960) and 57,000 mt (1982). USA landings increased four-fold between 1960 and 1980 (10,800 to 40,000 mt) but declined to 17,500 mt in 1986. Since 1988, USA catches have varied between 24,000 and 28,000 mt. The 1991 USA catch (24,200 mt) was the lowest since 1987, and below the 1977-1990 annual average of 29,000 mt (Table E.6.3.2.2.1). The catch declined further in 1992 to approximately 17,000 mt.

Spawning stock biomass increased from 55,000 to 75,000 mt between 1985-1990 due to the strong 1983, 1985 and 1988 year classes entering the spawning stock. Subsequently, however, SSB has declined to a record-low level of 41,000 mt in 1992. Fishing mortality doubled between 1979 and 1985 (0.34 to 0.74, or an exploitation rate of 28% to 46% per ye ar), declined to 0.49 in 1986-1987, but increased to 0.81 in 1988, and reached a record high in 1991 of 1.07 (a 61% annual exploitation rate). The current fishing mortality is more than twice as large as $F_{max}$ (F=0.30) and well in excess of the F needed to attain 20% maximum spawning potential ($F_{20\%}$ = 0.36) (NEFSC 1992a), the management target established for this stock. In this context, the stock remains significantly overfished.

**Haddock**

~~Gulf of Maine Stock~~

USA landings of Gulf of Maine haddock declined from about 5,000 mt annually in the early 1960s to less than 1,000 mt in 1972. Landings increased sharply between 1974 and 1980, reaching 7,300 mt in 1980. Subsequently, catches have declined to record-low levels (300 mt in 1989; 400 mt in 1990 and 1991) (Table E.6.3.2.2.1).

Spring and autumn NEFSC survey abundance indices have shown a similar pattern to landings. Relatively high survey indices were observed during the early 1960s and again in the late 1970s (U.S. Dept. of Commerce 1992). During the 1980s and 1990s, survey indices have steadily declined to record low levels. The 95% decline in landings observed from 1983 to 1991 (7,600 mt to 400 mt) and 98% decline in the fall research index (5.22 kg/tow to 0.12 kg/tow) are indicative of the status of this stock. This stock is severely depleted and is at an all time low in abundance. Recruitment has been insufficient to support the current level of landings, resulting in further stock depletion. Preliminary estimates of fishing mortality on this stock are greater than $F_{20\%}$ (Hayes and Buxton 1991), the biological reference point for this stock.

~~Georges Bank Stock~~

Prior to 1960, USA landings of Georges Bank haddock averaged nearly 50,000 mt annually. During the early 1960s distant water fleet exploitation on this stock expanded. In 1965 and 1966, combined USA and distant water fleets landings exceeded 100,000 mt. Subsequent to this, USA landings declined through 1976, reaching a low of 2,900 mt. Catches increased sharply between 1977 and 1981, reaching 19,200 mt, but have since declined, reaching record lows of 1,400 mt in 1989 and 1991 (Table E.6.3.2.2.1).

The NEFSC spring and autumn bottom trawl surveys have also indicated a marked decline in the abundance of haddock since the mid to late 1970s, with the 1991 autumn survey index the lowest in the time series (U.S. Dept. of Commerce 1992). Population estimates derived from virtual population analysis (VPA) show that this stock is in a severely depleted state; abundance and biomass are at all-time lows, approximately 17 million fish with a biomass of 22,500 mt (Hayes and Buxton 1991). This is in contrast to abundance during 1979 (for example) when there was an estimated 132 million haddock with a biomass of 113,600 mt. From 1980 to the present, fishing mortality has averaged 0.40, a value at or above $F_{30\%}$ (the biological reference point for this stock); the 1990 F was estimated at 0.52 (NEFSC 1992a). Population projections suggest that if recruitment and fishing mortality remain at current levels the abundance and biomass of this stock will continue to decline (Hayes and Buxton 1991). The combination of continued poor recruitment and low abundance suggests that this stock remains in an overfished condition.

**Pollock**

Traditionally, pollock were mainly taken as bycatch in the USA demersal otter trawl fishery but during the 1980s directed effort increased substantially. Much of this increase in effort has occurred in the winter gillnet fishery. USA catches increased from an average of 9,700 mt during 1973-1977 to more than 18,000 mt annually between 1984 and 1987, peaking at 24,500 mt in 1986. Since then, annual catches have steadily declined totalling 7,500 mt in 1991 (Table E.6.3.2.2.1), a 70% decrease compared to the 1986 level. Estimated annual recreational catches have fluctuated between 100 and 1,300 mt since 1979. USA catches have generally accounted for between 20 and 30% of the total harvest from this stock, and since 1984, the USA fishery has been restricted only to that fraction of the stock occurring in areas of the Gulf of Maine and Georges Bank west of the line delimiting the USA and Canadian fishery zones. The total nominal catch from the stock, including recreational, after declining for four consecutive years, remained relatively stable at 47,400 mt in 1991 (U.S. Dept. of Commerce 1992). Most of the decline since 1986 was due to sharp reductions in USA landings in 1987, 1988, and 1989 followed by a substantial decline in Canadian landings in 1990.

Virtual population analyses have indicated a gradual increase in age 2+ stock biomass during the 1970s followed by a 45% decrease between 1984 and 1988. The increases in stock biomass during the 1970s resulted from recruitment and growth of several relatively strong year classes, notably those of 1971, 1975 and 1979. Recruitment conditions were favorable throughout the 1970s and early 1980s, with moderate to strong year classes appearing regularly every three to four years. The most recent strong year class which contributed to this earlier increase in stock biomass was produced in 1982 and recruited to the fishery at age 2 in 1984. By 1989 and 1990, however, the catch composition of the USA fishery was dominated by the 1985 and 1986 year classes, which are considered to be only moderate in size (U.S. Dept. of Commerce 1992).

Under the favorable recruitment conditions which prevailed during the 1970s and early 1980s, fishing at $F_{0.1}$ would provide a long-term catch of 53,600 mt, while fishing at $F_{max}$ would provide a catch of 58,100 mt. Although potential yield is approximately 8% greater at the $F_{max}$ level, fishing at $F_{0.1}$ provides for a 55% increase in total stock and a 74% increase in spawning stock biomass over those achieved under $F_{max}$, thereby providing for greater stability in reproductive potential and resilience to environmental perturbations. Continued fishing at or above $F_{max}$ will likely result in a long-term decline in spawning stock, since this strategy does not account for fluctuating recruitment. Increases in total landings during the mid-1980s (in excess of 63,000 tons per year between 1985 and 1987) resulted in relatively high fishing mortality rates ranging from 0.5 to 0.7 during the latter part of the decade. Although total landings have declined by about 30% since the 1986 peak, these reduced catch levels may still generate high fishing mortality rates because stock biomass has also decreased. Overall, the stock continues to be over exploited.

**Redfish**

During the development phase of the Gulf of Maine redfish fishery, USA catches rapidly rose to a peak level of about 60,000 mt in 1942 followed by a gradual decline to less than 10,000 mt during the mid-1960s. USA catches ranged from 10,000-16,000 mt during the 1970s but have declined continuously throughout the 1980s, reaching historic low levels of between 500 and 600 mt per year during 1989-1991 (Table E.6.3.2.2.1).

The NEFSC autumn survey biomass index declined from 40.4 kg/tow in 1968 to an average of 3.8 kg/tow during 1982-84. Although the autumn index increased in 1986, estimates for 1987-89 have been only slightly above the record low 1982-1984 average. The 1990 and 1991 autumn biomass indices were the highest since the early 1980s, but are still well below the average of the 1960s and early 1970s (U.S. Dept. of Commerce 1992). In the past 20 years, only two strong year classes, those produced in 1971 and 1978, have recruited to the fishery. Estimates of exploitable biomass (ages 5 and older) from virtual population analysis declined from over 130,000 mt during the early 1970s to 34,000 mt in 1984 (NEFC 1986). Average fishing mortality during the 1970s was slightly greater than $F_{max}$ (0.14) and twice the $F_{0.1}$ (0.07) level. In addition, the combination of declining overall stock size and increased fishing effort on the 1971 year class produced fishing mortality rates that were 50% above $F_{max}$ and three times $F_{0.1}$ in the late 1970s. Fishing mortality has likely declined in recent years to a point less than or equal to $F_{0.1}$ and well below $F_{max}$ but, given the low current population biomass and unique life history characteristics of *Sebastes*, even low to moderate fishing mortality rates can inhibit rebuilding of this stock (Mayo 1987). The stock remains in an overfished condition.

**White hake**

The USA catch of white hake has been taken primarily in the western Gulf of Maine both incidentally to directed operations for other demersal species and as an intended component in mixed species fisheries. A substantial portion of the annual catch is taken by the Gulf of Maine gillnet fishery, primarily during summer months. Since 1968, the US has accounted for approximately 94% of the Gulf of Maine-Georges Bank white hake catch. USA catches increased steadily from less than 1,000 mt during the late 1960s to a peak level of 6,500 mt in 1984, declined to 5,000 mt by 1990, but increased to 5,600 mt in 1991 (Table E.6.3.2.2.1). The increases evident throughout the 1970s and early 1980s likely reflects both a general increase in incidental catches associated with the greater fishing power of the expanded New England otter trawl fleet and an increase in directed fishing effort toward white hake.

The NEFSC autumn survey biomass indices have fluctuated without any consistent long-term trends since the early 1970s, although total landings tended to follow inter-annual fluctuations until the early 1980s. Except for an extremely low index in 1982, indices for 1981 to 1991 have been quite stable at a level 30-40% below the 1970-1980 average (U.S. Dept. of Commerce 1992). Catches have generally declined since 1984 but still remain high relative to pre-1981 levels. Given the stability in stock biomass since 1981, the mean 1981-1990 catch of may be an appropriate estimate of the long-term potential catch. Since recent catches have been close to this level, the population is considered to be fully exploited.

**Red hake**

~~Gulf of Maine - Northern Georges Bank Stock~~

Trends in landings from this stock have shown three distinct periods. The first period, from the early 1960s through 1971, was characterized by landings of less than 5,000 mt. The second period, from 1972 to 1976, showed a sharp increase in total landings up to 15,300 mt. During this period approximately 93% of the total annual landings were taken by the distant water fleets on northern Georges Bank. Following implementation of the Magnuson Fisheries Conservation and Management Act in 1977, both total landings and the proportion of landings by the distant water fleets dropped sharply. From 1977 to the present, annual landings from this stock have averaged roughly 1,000 mt (Table E.6.3.2.2.1), taken exclusively by the United States.

Trends in survey indices have shown two general levels of stock abundance. From 1964 to 1976, abundance was relatively low, with survey indices ranging from 0.2 to 1.8 kg/tow. Following 1976, survey indices increased and have remained at relatively high levels (1.3 to 7.9 kg/tow) since that time. The survey index has declined during 1990 and 1991, but remains above the long-term average (U.S. Dept. of Commerce 1992). The combination of low landings and relatively good year classes has allowed the stock to maintain itself at above relatively high levels of biomass. This stock is underexploited and could support substantially higher catches.

~~Southern Georges Bank-Mid-Atlantic Stock~~

USA commercial landings increased from 4,300 mt in 1960 to a high of 32,600 mt in 1964, but declined sharply to 4,000 mt in 1966. During this time period, catches by the distant water fleets were much greater than domestic landings, with maximum combined landings of 108,000 mt in 1966. Between 1967 and 1979, USA landings remained at about 4,000 mt per year, and distant water fleet landings likewise declined. During the 1980s, landings have been nearly exclusively domestic, and have ranged between approximately 800 and 1,000 mt/year (Table E.6.3.2.2.1).

The NEFSC autumn bottom trawl survey index declined from its highest levels in the early 1960s to a relatively constant level between 1968 and 1982. During 1983, the survey index reached its second highest value in the time series. Following 1983, the index declined to the time series' minimum in 1987 and 1988. Since 1988, the survey index has increased substantially to above average levels. Survey data indicate that most year classes produced during the 1980s were low to moderate in strength (U.S. Dept. of Commerce 1992).

The decline of the autumn index from 1982-1988 does not appear to be due to the fishery. Total landings during the 1980s were low (less than 5,000 mt/year) compared to the late 1960s and early 1970s (over 20,000 mt most years) when the survey index was stable. The increase in abundance is likely due in part to the relatively strong year classes that have been produced during the past four to five years. This stock is underexploited and could support substantially higher catches.

**Silver hake**

~~Gulf of Maine-Northern Georges Bank Stock~~

Domestic landings from this stock have shown three major periods since 1955. From 1955 through 1968, landings were high (averaging 41,500 mt annually), but showed a declining trend. Landings dropped sharply in 1969 to 15,900 mt, and remained at approximately that level (averaging 12,100 mt) until 1978. From 1979 to the present, annual landings have been low, averaging 5,900 mt. From 1962 to 1975, distant water fleet landings contributed strongly to total landings, averaging 49% during this time period. No foreign landings have been recorded for this stock since 1977.

The NEFSC autumn bottom trawl survey biomass index declined throughout the 1960's, reaching a minimum in 1968-69. With the appearance of the strong 1973 and 1974 year classes, biomass indices increased during the mid-1970's, declined thereafter through 1981, and have generally increased (with fluctuation) over the past decade. Although bottom trawl survey indices suggest silver hake biomass over the past 15 years has remained at or above levels observed prior to 1975, results from the VPA show a significant decline (through 1986) in stock biomass levels compared to the pre-1975 period, despite the rather low level of landings. Because of this inconsistency, estimates of fishing mortality on this stock are suspect.

~~Southern Georges Bank - Middle Atlantic Stock~~

From 1955 to 1965, domestic landings from this stock averaged 15,200 mt per year. During this time, foreign landings greatly exceeded domestic landings, with over 280,000 mt being taken in 1965. From 1966 to 1971, both USA landings (averaging 7,900 mt) and foreign landings (averaging 80,200 mt) declined. After 1971, domestic landings steadily increased from a low of 5,200 mt to 11,400 mt in 1978; a level which has been maintained since that time. High distant water catches were observed from 1971 to 1977 (greater than 40,000 mt annually), but since 1982 have diminished to negligible amounts.

After dropping sharply throughout the 1960's, the NEFSC autumn trawl survey index fluctuated without major trend until 1985. After reaching a minor peak in 1985, the index declined, reaching a record low in 1991. While bottom trawl survey indices suggest that silver hake biomass remained fairly constant from the late 1960's through the mid-1980's, VPA estimates of spawning stock biomass have decreased steadily since 1973, and in the late 1980's were only about 10% of the biomass estimates for the mid-1970's. Because of this inconsistency, estimates of fishing mortality on this stock are suspect.

**Ocean pout**

Commercial interest in ocean pout has fluctuated widely. Ocean pout were marketed as a food fish during World War II, and landings peaked at 4,500 mt in 1943. However, an outbreak of a protozoan parasite that caused lesions to ocean pout virtually eliminated consumer demand for this species as a food item. From 1964 to 1974, an industrial fishery developed, and nominal catches by the USA averaged 4,700 mt during these years. Distant water fleets began harvesting ocean pout in large quantities in 1966 and total nominal catches peaked at 27,000 mt in 1969. Catches by distant water fleets declined substantially afterwards, and none have been reported since 1974. USA catches also declined to an average of 600 mt annually during 1975 to 1983. Catches increased in 1984 and 1985 to 1,300 mt and 1,500 mt respectively, due to the development of a directed fishery supplying the fresh fillet market. Landings have since remained relatively constant, averaging about 1,450 mt annually (Table E.6.3.2.2.1).

From 1968 to 1975 (encompassing peak levels of distant water fleet activity and the domestic industrial fishery), commercial landings and NEFSC spring survey indices followed similar trends; both declined from historic high values in 1968-1969 to record low levels in 1975.

Between 1975 and 1985, survey indices increased to record high levels, peaking in 1981 and 1985. Survey catch per tow indices have subsequently fluctuated about the long-term average (U.S. Dept. of Commerce 1992). The population appears to be fully exploited, and catches at the present level appear sustainable.

**Yellowtail flounder**

~~Georges Bank~~

Total landings of yellowtail flounder from Georges Bank averaged 16,300 mt during 1962-1976 but declined to an average of 5,800 mt between 1978 and 1981. Landings increased to over 11,000 mt in 1982 and 1983 due to strong recruitment from the 1979 and 1980 year classes. Since then landings have generally declined, reaching a record low of 1,100 mt in 1989, increasing slightly to 2,740 mt in 1990, and declining again to 1,784 mt in 1991 (Table E.6.3.2.2.1).

NEFSC autumn survey biomass indices for Georges Bank yellowtail declined between 1963 and 1976, stabilized at relatively low levels during 1977-1983 (with the exception of the elevated 1980 index), and subsequently fell to record low levels during 1984 and 1988. After increasing slightly in 1989, due to above average recruitment from the 1987 year class, the survey index declined again in 1990, and remained stable in 1991 (U.S. Dept. of Commerce 1992).

Although abundance of the Georges Bank stock increased modestly in 1989 due to the above average 1987 year class, the stock is still at a very low level and is comprised of few age groups. Recent recruitment following the 1987 cohort appears to be poor. Fishing mortality rates ranged between 0.5 and 0.8 between 1969 and 1973, but increased to well over 1.0 during 1974-1988. An apparent drop in F in 1989 was followed by an increase to 0.82 in 1990, a level considerably above the estimates of $F_{max}$ (0.63) and $F_{20\%}$ (0.58) (NEFSC 1991). As such, this stock remains overfished.

~~Southern New England~~

Total landings of yellowtail flounder from the Southern New England stock averaged 28,000 mt during 1963-1970 but declined rapidly afterward, reaching a low of 1,700 mt in 1976. Landings increased during 1977-1983, peaking at 18,500 mt in 1983, but subsequently declined to a record low of only 900 mt in 1988 (Table E.6.3.2.2.1). In 1989 and 1990, landings increased to 2,500 mt and 8,008 mt respectively, due to recruitment from the strong 1987 year class, but declined in 1991 to 3,910 mt.

NEFSC autumn survey abundance and biomass indices were at historically high levels between 1963 and 1972, but declined markedly in 1973 and remained very low until 1982 when both abundance and biomass values increased due to strong recruitment from the 1980 and 1981 cohorts. These increases, however, were short-lived; survey indices during 1985-1988 were the lowest on record. The 1989 indices increased to their highest levels since 1983 due to strong recruitment from the 1987 year class. However, this increase was again short-lived, as the 1990 index dropped precipitously, and declined further in 1991 (U.S. Dept. of Commerce 1992).

As for the Georges Bank stock, abundance of the Southern New England stock improved in 1989 and 1990 due to the strong 1987 year class. This cohort was relatively stronger in Southern New England than on Georges Bank, and essentially comprises the entirety (97%) of the Southern New England stock. Significant quantities of this cohort were discarded in 1989 since, as two year old fish, virtually all fish were less than minimum legal landing size of 13 in. Significant discarding continued on this year class in 1990, especially early in the year. Fishing mortality rates (on the fully recruited ages) fluctuated between 0.6 and 1.0. during 1973 to 1979. After 1979 fishing mortality rates were generally well in excess of 1.0, with a peak of 1.9 in 1984 and a recent high of 1.6 in 1990, levels considerable in excess of the estimates of $F_{max}$ (0.48) and $F_{20\%}$ (0.49) (NEFSC 1991).

~~Cape Cod~~

Total landings of yellowtail flounder from the Cape Cod stock generally fluctuated between 1,500 and 2,000 mt in the 1960s, increased during the 1970s to approximately 5,000 mt in 1980, and then declined reaching record low levels during the 1980s (Table E.6.3.2.2.1). Landings in 1990 were 2,979 mt, dropping to 1,466 mt in 1991.

NEFSC autumn survey indices have been highly variable, but have reflected the general pattern of landings. The 1989 value was the highest since 1980, due to the strong 1987 year class, but the index declined again in 1990, and dropped even lower in 1991 (U.S. Dept. of Commerce 1992). Recent declines in landings and the corresponding general downward trends in the survey indices suggest that stock biomass has been reduced by the high catches of the late 1970s and early 1980s.

**Winter flounder**

~~Gulf of Maine~~

Commercial catches from the Gulf of Maine increased from a steady 1,000 mt for the period 1961 to 1977 to nearly 3,000 mt in 1982. Commercial catches in 1983 dropped nearly 25% and since then landings have fluctuated, but continued to trend downwards. Catches of 1,000 mt in 1991 (Table E.6.3.2.2.1) were the lowest since 1969.

Bottom trawl survey abundance indices from the Massachusetts Division of Marine Fisheries spring survey for the Massachusetts Bay-Cape Cod Bay areas decreased after 1983, and have trended downward to the lowest values in the series in 1988-1991. Commercial catch per unit effort indices (tonnage class 2 otter trawlers) peaked in the late 1960s to early 1970s, averaging 3.0 mt/days fished between 1968 and 1971. The index has declined steadily since then, to remain at record low levels, averaging 0.9 mt/day fished in 1986-1991 (U.S. Dept. of Commerce 1992). Although the 1991 value (1.0 mt/day fished) is the highest in the last six years, it is the sixth lowest in the 28-year time series.

~~Georges Bank~~

Commercial catches from the Georges Bank region increased from 1,900 mt in 1976 to near record high levels during 1980-1984 (average of 3,800 mt/yr). Between 1985 and 1988, landings averaged 2,400 mt per year; and in recent years (1989-1991) averaged 1,900 mt per year (Table E.6.3.2.2.1). Landings in 1991 (1,800 mt) remained near the lowest on record. Commercial CPUE indices in 1991 were also among the lowest ever observed. The NEFSC autumn survey stock biomass index has generally trended downward since 1977. The survey index declined again in 1991 to the lowest value in the 27-year survey time series (U.S. Dept. of Commerce 1992).

~~Southern New England-Middle Atlantic~~

Commercial catches from the southern New England-Mid-Atlantic area increased from roughly 4,000 mt in the mid-1970s to nearly 12,000 mt in 1981. Commercial catches declined steadily from their level of the early 1980s to 3,600 mt in 1990, but increased to 4,700 mt in 1991 (Table E.6.3.2.2.1). NEFSC spring survey indices have shown similar trends as commercial catches since about 1975, increasing through 1981 and generally declining, with the exception of 1985, to near record low levels between 1989-1991 (U.S. Dept. of Commerce 1992). Commercial catch per unit effort indices (tonnage class 3 otter trawlers) showed a continuous decline from the 1964-1983 average of 2.7 mt/day fished to a record low of 0.8 mt/day fished in 1989, and have remained low since then (0.8 mt/day fished in 1991).

## American plaice

Since 1960, catches of American plaice have ranged from 1,300 mt (1960) to 15,000 mt (1982). The fishery shifted from a bait fishery to a food fishery in the early 1970s (Sullivan 1982), and landings increased from an average 2,300 mt during 1972-1976 to more than 10,000 mt during 1979-1984 (O'Brien et al. 1992). Subsequently, annual landings declined and are now at levels similar to those of the late 1960s (4,300 mt in 1991) (Table E.6.3.2.2.1). The 1986 and 1987 year classes accounted for the majority (69% by numbers; 57% by weight) of the landings in 1991. Between 1960 and 1974, 67% of USA landings were from deepwater areas on Georges Bank. Since then, Gulf of Maine landings have greatly exceeded those from Georges Bank (O'Brien et al. 1992).

Discarding of American plaice is highest for age 2 and 3 fish in the shrimp fishery and for age 3 and 4 fish in the large mesh fishery (Mayo et. al 1992). Direct estimates of discarded plaice in the northern shrimp fishery using sea sampling data indicated that by 1991, 40% of the total cumulative catch (in numbers) of the 1987 year class had been discarded. Similarly, in the large mesh fishery, indirect estimates of discarding of plaice indicated that 41% of the total cumulative catch of the 1987 year class had been discarded by 1991 (O'Brien et al. 1992). Abundance and biomass indices from NEFSC autumn surveys reached record-low values in 1987 but increased until 1990, due to recruitment of the 1987 year class, and remained stable in 1991 (U.S. Dept. of Commerce 1992). Survey abundance indices indicate the strongest year classes occurred in 1978, 1979, and 1987 and above average year classes occurred in 1986 and 1989.

Fishing mortality (F) rates more than doubled from 1981 (F=.36) to 1987 (F=.87). The current F (0.58) in 1991 is twice as high as $F_{max}$ (0.29) (O'Brien et al. 1992), and greater than $F_{20\%}$ (0.49) (NEFSC 1992b). Stock sizes declined 72% from 1980 (204 million) to 1986 (58 million). In 1990, stock size increased 81% (105 million) as the outstanding 1987 year class recruited into the fishery and subsequently declined 13% in 1991 (91 million). Spawning stock biomass declined from 41,400 mt in 1980-1982 to 10,333 mt in 1989-1991. In 1991, the spawning stock biomass increased to 13,400 mt as the 1987 year class began to recruit to the spawning stock (O'Brien et al. 1992).

**Witch flounder**

Since 1960, the USA catch has been distributed almost evenly between Georges Bank and the Gulf of Maine, although in recent years most of the USA catch has come from the latter area. Distant-water fleet catches on Georges Bank averaged 2,600 mt in 1971-1972, but subsequently declined sharply and have been negligible since 1977. After averaging 2,700 mt during 1972-1981, USA catches increased sharply during the early 1980s and peaked at 6,500 mt in 1984. Since 1984, the catch has steadily declined, with 1991 representing the second lowest annual catch in 27 years (Table E.6.3.2.2.1).

NEFSC autumn survey indices reflect trends in biomass. Heavy exploitation by distant water fleets in 1971-1972 was followed by a 50% decline in the autumn index between 1966-1970 and 1975. The biomass index increased in 1977-1978 but subsequent indices have declined steadily to the lowest levels on record in 1990 and 1991 (U.S. Dept. of Commerce 1992).

The low level of landings since 1988 reflects a declining biomass, as reflected in low survey indices and in low catch per unit effort indices (1991 CPUE indices were among the lowest in the time series). These declines suggest that this resource is being adversely affected by current levels of exploitation. Additionally, high discard rates of juvenile witch flounder are associated with the small mesh Northern shrimp fishery in the Gulf of Maine. It appears that harvests of 3,000 mt or more cannot be sustained over the long term. The population is overexploited.

**Windowpane flounder**

Windowpane were first exploited as a commercial species in 1943-1945 during the end of World War II. Between then and 1975, these fish were exploited (and reported) only as an industrial species. Separate commercial landings data for this species were first available in 1975. Commercial landings declined from 1975-1976 to a low of 900 mt in 1980. Subsequently, annual landings increased to a peak of 4,200 mt in 1985 and are now at 87% of this record level, at 3,700 mt.

Because no stock structure information is presently available, a provisional summary of information is given for two areas corresponding to survey strata, based on suggested differences in growth, maturity and abundance trends between fish from Georges Bank and Southern New England. Because the proportion of landings contributed by the Gulf of Maine and Mid-Atlantic areas is low (less than 7%), information from these two areas is combined with that from Georges Bank and Southern New England areas, respectively.

~~Gulf of Maine-Georges Bank~~

Commercial landings from the Gulf of Maine-Georges Bank area have fluctuated between 400 and 2,100 mt through 1990, and have averaged 1,100 mt since 1975. Landings in 1991 (2,900 mt) show a 165% increase from 1990 levels (Table E.6.3.2.2.1). No recreational catches have been reported from this area.

Increased landings in 1991, largely due to record landings in areas 561 and 562, probably reflect an expansion of the fishery offshore, as well as the targeting of windowpane flounder as an alternative to other depleted flatfish stocks. NEFSC autumn offshore indices have been highly variable, but appear to have been declining since 1984 (U.S. Dept. of Commerce 1992). Preliminary indices of commercial catch per unit effort show a declining trend since 1975. It is thus likely that this stock is overexploited.

~~Southern New England-Middle Atlantic~~

Commercial landings from the Southern New England-Mid-Atlantic area averaged 700 mt in the first decade of the fishery. Landings between 1986 and 1990 averaged 1,200 mt and have generally declined since 1985 peak levels of 2,100 mt. No recreational catches have been reported from this area. Landings in 1991 (800 mt) declined 9% from 1990 and approach the low levels observed prior to 1985 (Table E.6.3.2.2.1).

Both NEFSC autumn offshore survey indices and preliminary indices of commercial catch per unit effort have declined since the early 1980s to record-low levels in recent years (U.S. Dept. of Commerce 1992). This would indicate that this stock is overexploited.

**TABLE E.6.3.2.2.1. USA commercial landings (1000 metric tons, live) of 13 species in the Northeast Multi-species Fishery Management Plan.** (Preliminary landings for 1992 indicate Gulf of Maine and Georges Bank cod at 11,000 and 17,000 mt, respectively, GOM and GB haddock at 312 and 2,000 mt, and total yellowtail at 5,473 mt.

| Species/ Stock | Average 1972-1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cod | | | | | | | | | | | |
| Gulf of Maine | 10.2 | 13.6 | 14.0 | 10.8 | 10.7 | 9.7 | 7.5 | 8.0 | 10.4 | 15.2 | 17.8 |
| Georges Bank | 23.3 | 39.4 | 36.8 | 32.9 | 26.8 | 17.5 | 19.0 | 26.3 | 25.1 | 28.2 | 24.2 |
| Haddock | | | | | | | | | | | |
| Gulf of Maine | 3.1 | 5.6 | 5.6 | 2.8 | 2.2 | 1.6 | 0.8 | 0.4 | 0.3 | 0.4 | 0.4 |
| Georges Bank | 8.7 | 12.6 | 8.7 | 8.8 | 4.3 | 3.3 | 2.2 | 2.5 | 1.4 | 2.0 | 1.4 |
| Pollock | | | | | | | | | | | |
| Gulf of Maine-Georges Bank | 12.4 | 14.4 | 14.0 | 17.8 | 19.5 | 24.5 | 20.4 | 14.9 | 10.5 | 9.5 | 7.9 |
| Redfish | | | | | | | | | | | |
| Gulf of Maine-Georges Bank | 11.3 | 6.6 | 5.2 | 4.7 | 4.2 | 2.9 | 1.9 | 1.1 | 0.6 | 0.6 | 0.5 |
| White Hake | | | | | | | | | | | |
| Gulf of Maine | 4.6 | 6.0 | 6.2 | 6.5 | 6.4 | 5.3 | 5.5 | 5.4 | 5.0 | 5.0 | 5.6 |
| Red Hake | | | | | | | | | | | |
| Northern stock | 0.8 | 1.2 | 0.9 | 1.1 | 1.0 | 1.5 | 1.0 | 0.9 | 0.8 | 0.8 | 0.7 |
| Southern stock | 3.2 | 3.0 | 1.3 | 1.2 | 0.8 | 0.6 | 0.9 | 0.9 | 0.8 | 0.8 | 0.9 |
| Silver Hake | | | | | | | | | | | |
| Gulf of Maine-N. Georges Bank | 9.1 | 4.7 | 5.3 | 8.3 | 8.3 | 8.5 | 5.7 | 6.8 | 4.6 | 6.4 | 6.1 |
| S. Georges Bank-Mid-Atlantic | 9.4 | 11.9 | 11.5 | 12.7 | 11.8 | 9.4 | 9.8 | 9.2 | 13.2 | 13.8 | 10.5 |
| Ocean Pout | 1.3 | 0.3 | 0.4 | 1.3 | 1.5 | 0.8 | 2.2 | 1.8 | 1.3 | 1.3 | 1.4 |
| Yellowtail Flounder | | | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Georges Bank | 10.9 | 10.7 | 11.4 | 5.8 | 2.5 | 3.0 | 2.7 | 1.9 | 1.1 | 2.7 | 1.8 |
| Southern New England | 5.4 | 10.3 | 17.0 | 7.9 | 2.7 | 3.3 | 1.6 | 0.9 | 2.5 | 8.0 | 3.9 |
| Cape Cod | 3.3 | 3.2 | 1.9 | 1.1 | 1.0 | 1.0 | 1.2 | 1.1 | 0.9 | 3.0 | 1.5 |

**Table E.6.3.2.2.1. (Continued)**

| **Species/ Stock** | **Average 1972-1981** | **1982** | **1983** | **1984** | **1985** | **1986** | **1987** | **1988** | **1989** | **1990** | **1991** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Winter Flounder | | | | | | | | | | | |
| Gulf of Maine | 1.7 | 2.8 | 2.1 | 1.7 | 1.6 | 1.3 | 1.2 | 1.3 | 1.2 | 1.1 | 1.0 |
| Georges Bank | 2.9 | 3.0 | 3.9 | 3.9 | 2.2 | 1.8 | 2.6 | 2.8 | 1.9 | 1.9 | 1.8 |
| Southern New England | 6.3 | 9.4 | 8.7 | 8.9 | 6.6 | 4.9 | 5.2 | 4.5 | 3.7 | 3.6 | 4.7 |
| American Plaice | | | | | | | | | | | |
| Gulf of Maine- Georges Bank | 6.6 | 15.1 | 13.2 | 10.1 | 7.0 | 4.1 | 3.8 | 3.3 | 2.3 | 2.5 | 4.3 |
| Witch Flounder | | | | | | | | | | | |
| Gulf of Maine- Georges Bank | 2.7 | 4.8 | 5.8 | 6.5 | 6.0 | 4.5 | 3.4 | 3.2 | 2.1 | 1.4 | 1.8 |
| Windowpane Flounder | | | | | | | | | | | |
| Georges Bank | 0.9 | 0.4 | 0.5 | 0.7 | 2.1 | 1.8 | 1.4 | 0.5 | 1.6 | 1.1 | 2.9 |
| Southern New England | 0.7 | 0.7 | 0.8 | 1.1 | 2.1 | 1.4 | 0.9 | 1.8 | 1.1 | 0.9 | 0.8 |

Notes:

Windowpane flounder: 1975-1981 average used.

### E.6.3.3 Other StocksE.6.3.3 Other Stocks

In addition to the stocks covered under the Multispecies FMP, there are a number of other commercially valuable species in the region, some of which are managed by plans developed by the NEFMC, MAFMC or the ASMFC, or are regulated by individual states, and others which are not regulated at this time even though they are fished commercially. In some cases the species are caught with the same or similar gear and vessel types as those used to catch multispecies groundfish (summer flounder, goosefish, and dogfish, for example). In other cases the gear, and frequently the vessel type, used is characteristically different (such as in the pot fisheries or pelagic longlines). The geographical distribution, life histories and habitat requirements of these stocks cover the range of possibilities as can be inferred from the diversity of species listed below (Table E.6.3.3.1). The relative size and value of the fisheries for these species also covers a wide range (Table E.6.3.3.2, from the ~~Status of the Fishery Resources of the Northeastern United States for 1992~~ ).

The multispecies fishery interaction with these other fisheries may be direct (through the gear or as a bycatch fishery, for example) or indirect (through some ecosystem interaction or as they represent alternative, perhaps seasonal fisheries). This relationship between the multispecies fishery and the other fisheries is not static as changes occur in abundances, geographical distribution, market conditions and technology. In many cases, what was once discarded as unmarketable are now high-value, directed fisheries. A detailed description of these stocks is beyond the scope of this document, although the impacts of this proposed action are discussed in Section E.7.1.

**TABLE E.6.3.3.1**- Commercially exploited species in the Northeast other than those included in the Multispecies FMP. Also noted are the management agency and the status of the stock where known.

| **MANAGEMENT AUTHORITY** | **STATUS** |
|---|---|
| NEFMC- New England Fishery Mgmt Council | U-Underexploited |
| MAFMC- Mid-Atlantic Fishery MGMT Council | F-Fully exploited |
| ASMFC- Atlantic States Marine Fisheries Commission | O-Overexploited |
| state- individual state regulation | NK-not known |
| NM- not managed | |
| DOC- Dept. of Commerce ("Secretarial Plan") | |

| SPECIES | MGMT | STATUS | SPECIES | MGMT | STATUS |
|---|---|---|---|---|---|
| Summer flounder | MAFMC / ASMFC | O | Spiny Dogfish | NM | U |
| Atlantic Mackerel | MAFMC | U | Black Sea Bass | MAFMC / ASMFC | O |
| Scup | MAFMC / ASMFC | O | Squid (Ilex) | MAFMC | U |
| Atlantic Herring | NEFMC | U | Squid (loligo) | MAFMC | U |
| Butterfish | MAFMC | U[1] | Sea Scallop | NEFMC | O |
| Goosefish (Monkfish) | 2/ | O | Ocean Quahog | MAFMC | F |
| Tilefish | NM | O | Surf clam | MAFMC | F |
| Northern Shrimp | ASMFC | F | American Lobster | NEFMC / ASMFC | F 3/ |
| Bluefin tuna | DOC | O | Yellowfin tuna | NM | NK |
| Swordfish | DOC | O | Bigeye tuna | NM | U |
| Hard clam | state | F | Soft clam | state | F / O |
| Blue crab | state | F / O | Oyster | state | F / O |

| SPECIES | MGMT | STATUS | SPECIES | MGMT | STATUS |
|---|---|---|---|---|---|
| Mussel | NM | NK | Whelks | state | F/O |
| Bay Scallop | state | NK | Sea urchin | state | NK |
| Weakfish | ASMFC | O | Tautog | state | NK |
| Striped bass | state | 4/ | Bluefish | MAFMC/ ASMFC | F |
| Atlantic Salmon | NEFMC/ state | O | River Herrings | ASMFC | varies by area |
| Shad | ASMFC | varies | Menhaden | ASMFC | F/O 5/ |
| Atlantic Sturgeon 6/ | ASMFC | O | Atlantic Wolffish | NM | O |
| Pelagic Sharks | DOC | O | Atlantic Halibut | NM | O |
| Red crab | NM | NK | Skates | NM | U |
| Bay scallop | state | F | Sea worms | state | NK |
| Cusk | NM | O | | | |

Notes:

1/ MAFMC feels that current discard rates and the age structure of the population make achievement of MSY (on which the "underexploited" status is based) unlikely.

2/ Management of monkfish is under development through a joint effort by the MAFMC and NEFMC.

3/ Offshore stock only. The status of other lobster stocks(s) is under review but is at least fully exploited and may be overexploited.

4/ Striped bass have been under protection since 1984 because of severe decline in stock abundance during the 1970's attributed to overfishing and pollution of spawning habitat. Positive trends in abundance indices and recruitment in some areas have resulted in the relaxation of some restrictions on exploitation.

5/ Atlantic Menhaden are considered to be fully exploited from the point of view of recruitment overfishing and growth overfished (pers. comm., Douglas Vaughan, Beaufort Laboratory).

6/ Shortnose sturgeon is listed as an endangered species under the ESA.

SOURCES:

a) Status of the Fishery Resources off the Northeastern United States for 1992,NOAA Technical Memo, NMFS-F/NEC-95;

b) Our Living Oceans, NOAA Technical Memo, NMFS-F/SPO-1;

c) and personal communications with staff of MAFMC, ASMFC, NEFSC, and Beaufort Laboratory.

**TABLE E.6.3.3.2** Northeast landings (L) (1,000mt), values ($ million) and prices ($/lb) of important species, 1986-1991 (preliminary data, 1991). Some aquaculture species are included.

### E.6.3.4 Endangered species and marine mammalsE.6.3.4 Endangered species and marine mammals

A number of protected species inhabit the management unit addressed in the FMP. Eleven are classified as endangered or threatened under the Endangered Species Act of 1973; the remainder are protected under the Marine Mammal Protection Act of 1972. Protected species utilize marine habitats for feeding, reproduction, nursing and migration. Some species occupy the area year round while others use the region only seasonally or move intermittently inshore and offshore.

**Endangered and Threatened Species Likely to Occur in the Area Covered by the Amendment/Management Plan**

**Endangered**

Right whale: *Eubalaena glacialis* - With a population of 350 animals, this species is the rarest of the world's great whales. It inhabits the Cape Cod area from December to June and the Lower Bay of Fundy from July to November. It migrates along the entire continental shelf to Florida from November to June.

Humpback whale: *Megaptera novaeangliae* - Humpbacks can be found along the southern edge of the Gulf of Maine, Georges Bank and off southern New England from April to December. Concentrations of animals feed during the early spring months in the Great South Channel area of Georges Bank.

Fin whale; *Balaenoptera physalus* - The most commonly sighted large whale in the management area, it inhabits all continental shelf waters in all seasons.

Sperm whale: *Physeter macrocephalus* - Sperm whales are distributed along the shelf edge in all seasons, but in summer and fall can range inshore of the 1000 meter contour.

Blue whale: *Balaenoptera musculus* - Only occasionally seen in New England, the blue whale is usually found in open seas and in colder subarctic waters.

Sei whale: *Balaenoptera borealis* - Considered uncommon, sei whales are found along the eastern and southern edges of Georges Bank.

Kemp's ridley: *Lepidochelys kempi* - Although their offshore distribution has not been determined, ridleys are most often found in bays and coastal waters from Cape Cod to Cape Hatteras from summer through fall.

Leatherback turtle: *Dermochelys coriacea* - In the Northeast, they are found in open water throughout the summer. The southern migration occurs in nearshore waters from August to November.

Green sea turtle: *Chelonia mydas* - Generally an inhabitant of the Gulf of Mexico and southeast regions, green turtles are only occasionally seen in nearshore waters from Massachusetts to Virginia between July to November.

Shortnose sturgeon: *Acipenser brevirostrum* - While it does not occur in the offshore marine environment, the species spawns in the major river systems in the Northeast. Because population levels are considered stable north of the Delaware River, NMFS has recommended downgrading their status to threatened under the ESA.

**Threatened**

Loggerhead turtle: *Caretta caretta* - The most common turtle in the management area, loggerheads range from Cape Cod to Cape Hatteras from spring through fall.

**Species Proposed for ESA Listing**

Harbor porpoise: *Phocoena phocoena* - The smallest of the cetaceans found in the Northeast, these animals occur in the Gulf of Maine year round and east and southeast of Cape Cod in spring and summer. The southern limits of their range may extend south to Cape Hatteras.

Bottlenose dolphin: *Tursiops truncatus* (coastal population only) - The Mid-Atlantic coastal migratory stock ranges from Florida to New Jersey in spring and fall. (Maybe we don't need this groundfish plan since only a few sightings occur on Stellwagen Bank and in the GOM annually.)

**Other Protected Species**

Other species of marine mammals likely to occur in the groundfish management unit include the minke whale (*Balaenoptera acutorostrata*) white-sided dolphin (*Lagenorhynchus acutus*), white-beaked dolphin (*Lagenorhynchus albirostris*), pilot whale (*Globicephala melaena*), Risso's dolphin (*Grampus griseus*), common dolphin (*Delphinis delphis*), spotted dolphin (*Stenella* spp.), striped dolphin (*Stenella coeruleoalba*), killer whale (*Orcinus orca*), beluga whale (*Delphinapterus leucas*), Northern bottlenose whale (*Hyperoodon ampullatus*), goosebeaked whale (*Ziphius cavirostris*) and beaked whale (*Mesoplodon* spp.) (CeTAP, 1982). Pinnipeds species include harbor (*Phoca vitulina*) and gray seals (*Halichoerus grypus*) and less commonly, hooded (*Cystophora cristata*) harp (*Pagophilus groenlandicus*) and ringed (*Phoca hispida*) seals.

**E.6.3.5 Other biota** **E.6.3.5 Other biota**

**The Biotic Assemblage**

Zoogeographically, the Gulf of Maine region is boreal, and the fauna is typically Acadian. South of Cape Cod to Cape Hatteras is warm temperate, and the fauna is Virginian. Although Cape Cod is the general dividing line, many species are found throughout the region from the Gulf of Maine to Cape Hatteras. Gulf of Maine fauna may include subtropical, tropical, temperate, and arctic immigrants at various times of the year.

~~The Plankton~~ The plankton are microscopic plants (phytoplankton) and animals (zooplankton) that drift in the water column. The annual cycle of the plankton community is typical of the temperate zone. In winter, nutrients are abundant in the water but phytoplankton abundance is low because productivity is suppressed by low levels of solar radiation and temperature. The level of solar radiation increases as spring approaches, and causes an intense phytoplankton bloom which is comprised primarily of diatoms. This level of productivity results in a decrease of inorganic nutrients, and as summer approaches, phytoplankton abundance begins declining.

Zooplankton feed predominantly on phytoplankton, but fish larvae commonly feed on zooplankton (often copepods). During summer, zooplankton reach maximum abundance, while the phytoplankton decline to near winter levels. Dinoflagellates and other phytoplankters, apparently more suited to warm, nutrient-poor waters, become abundant during summer. Although bacteria in the sediments actively remineralize nutrients from organic debris (detritus), summer stratification of the water column may prevent nutrients from being returned to the near surface (euphotic zone) where they may contribute to primary productivity through photosynthesis. On Georges Bank and the eastern and northeastern edge of the Gulf of Maine, vertical mixing of the water column occurs during the summer, thereby recirculating nutrients and maintaining high plankton productivity. Water column stability may be affected by severe storms, and anomalies in temperature may disturb the timing between annual cycles of interacting species. In the autumn, decreasing water temperatures result in a breakdown of the vertical temperature gradient, and nutrients are again circulated up into the euphotic zone. Another phytoplankton bloom results, and lasts until low solar radiation levels inhibit photosyntheses. Phytoplankton and zooplankton levels then decline to the winter minimum, and nutrient levels increase to their winter maximum.

~~The Nekton~~ The nekton are animals that swim in the water column. They are predominantly fish, but also include other animals such as squid, whales and porpoises. The ability to swim allows nektonic organisms to migrate between locations or to maintain a specific breeding location with some consistency year after year.

The feeding habits of nekton vary by species, by the size of the individual, and probably by season and food availability. Adults of many commercially important species of the region feed on either fish or invertebrates, but small fish, including the young of some large species, often feed on plankton. Adults of some large species, such as various whales, basking sharks and ocean sunfish, are plankton eaters throughout life.

~~The Benthos~~ The benthos are animals that live on or within the bottom sediments. They are predominantly invertebrates (e.g., tube worms, starfish), although strongly bottom-oriented fishes are considered benthic. Benthic organisms are extremely diversified, and include species from several phyla. They can be classified by size (meiobenthos, macrobenthos), by their location on or in the sediments (epifauna, infauna), by the type of bottom in which they live (sand, mud, gravel, rock, etc.), by feeding type (deposit feeders, suspension feeders, herbivores, carnivores), and by the type of community with which they are associated.

The extent to which the commercial fishery for groundfish interacts with other commercial or protected species, both nektonic and benthic, and how the gear impacts the other non-specific flora and fauna of the seafloor are discussed in other sections.

#### E.6.3.6 Stellwagen Bank Marine SanctuaryE.6.3.6 Stellwagen Bank Marine Sanctuary

On October 7, 1992, Congress reauthorized Title III of the Marine Protection, Research and Sanctuaries Act and passed an amendment which designated Stellwagen Bank as a National Marine Sanctuary. The area, located between Cape Cod and Cape Ann, Massachusetts, is known to support a rich and diverse population of marine life at different times of the year, including several species of endangered whales, groundfish stocks and bluefin tuna. Commercial fishing is not a regulated sanctuary activity, and will continue to be the responsibility of the NEFMC.

The Sanctuary designation places a prohibition on the "exploration for, and mining of, sand and gravel and other minerals" and requires a consultation process of agencies proposing actions which are likely to destroy, cause the loss of, or injure any Sanctuary resource. To the extent that certain activities with deleterious effects on fish stocks (see, for example, Section E.6.4.5) may be affected, the designation may have positive impacts on commercial stocks.

### E.6.4 HUMAN ENVIRONMENTE.6.4 HUMAN ENVIRONMENT

#### E.6.4.1 The commercial and recreational multispecies fishery E.6.4.1 The commercial and recreational multispecies fishery

The species assemblages described in Section E.6.3.1 "Geographic Species Assemblages" occur primarily as a result of overlapping temperature and depth preferences of the various groundfish species (Overholtz and Tyler 1985; Murawski and Finn 1988). The interaction of co-occurring species with fishing technologies that cannot separate them results in mixed-species catches observed in the groundfish complex. Groundfish resources in the northeast region are highly mixed (Murawski et al. 1983) when compared to groundfish systems elsewhere. Patterns of the mixtures of groundfish landings vary by season and sub-area, but are generally persistent from year to year (Overholtz and Tyler 1985).

In the Gulf of Maine, a series of mixed-species groundfish fisheries is defined based on the varying species dominance patterns, and the gear types and regulations that determine fishing patterns (Murawski et al. 1991). Large mesh fisheries for groundfish are partitioned into trawling that occurs east and west of the 'large mesh only' line. Large mesh trawling inshore of the line generated cod, mixed flounders pollock and goosefish. Large mesh trawling east of the line is in deeper water, and has a characteristic species mix of pollock, cod and white hake, and various other species. The differences in species composition is indicative of changes in the resident species composition with depth in the Gulf of Maine.

Other mixed fisheries in the Gulf of Maine include gill net (primarily directed at pollock, cod, white hake and dogfish), shrimp trawling (catching shrimp, cod and mixed flounders), and small mesh fisheries for whiting and various species including red hake and ocean pout. Interactions among these fisheries are important since small mesh fisheries may generate discards of species that are targeted by large mesh fisheries (Murawski et al. 1991).

Mixed-species fisheries on Georges Bank are almost exclusively large mesh trawl fisheries. The shallow-water assemblage yields primarily winter flounder, yellowtail, skates and cod. Deeper water fisheries along the northern edge of the Bank catch a higher proportion of haddock, American plaice, and cod. A summer fishery occurs in the Cultivator Shoals area using small mesh, directed to spawning concentrations of silver hake.

Groundfish fishing in the Southern New England region is distinctly seasonal, reflecting the movement and aggregation patterns of the principal species: silver hake, cod, yellowtail flounder, and winter flounder.

The persistence of mixed-species groundfish fisheries in the various sub-regions is important when considering potential management regulations pertaining to the complex of species present. Depending on the mix available in any particular region, measures such as mesh restrictions or bycatch limits will differentially influence fishery yields in the various areas.

#### E.6.4.1.1 The commercial fishery

The northeast multispecies fishery, the groundfish fishery, is the predominant fishery in the northeast region in terms of landed pounds and number of vessels, and currently ranks third in terms of revenue (behind lobsters and sea scallops). Table E.6.3.3.2 (preceding section) shows the relative size of the fisheries in the region in terms of landings and value.

The groundfish fishery is characterized by a diversity of fishing operations, gear types, vessel sizes, business structures, and target species or species mix. A significant percentage of participants, possibly more than half, are seasonal or part-time, while the predominance of landings is attributable to full-time otter trawl vessels. Not all otter trawl vessels are dedicated to fishing for multispecies groundfish, however. Geographically, the fishery is centered in New England, although approximately one quarter of the identified otter trawl vessels land in the mid-Atlantic. Those mid-Atlantic otter trawl vessels are predominantly used for catching species other than those covered by this plan although many of them regularly catch some multispecies groundfish species. To further complicate any descriptive analysis of the "groundfish fishery" some gear types (such as scallop dredges) catch groundfish incidentally while fishing for other species, as a bycatch, or to supplement the landings of the target species.

### E.6.4.1.1.1 The vessels and fleets

The following description of the fishery, adapted from the text of the Status of the Fishery Resources, 1992 (NMFS-F/NEC-95), will provide background information for assessing the impacts of the proposed management action. Section E.6.1.1 "Data Considerations" explains the data that is used to make the following characterizations. The collection of weighout receipts coupled with the ability to identify the particular vessel involved allows landings to be associated with vessel and gear characteristics for federally documented vessels over five gross tons, the "tonnage vessels". "Undertonnage vessels", those vessels under 5 gross tons and all state registered vessels (which may be larger than 5 grt) are not individually identified in the weighout system and are, therefore, not individually associated with gear or landings data.

Table E.6.4.1.1.1 examines these identified vessels and lists their landings and revenue by gear type as recorded in the weighout database in 1991. These are all identified vessels in the region (not only those landing groundfish.) As this table indicates, one can associate only a portion of total landings with the specific vessels that made those landings. These landings are about 64 percent of all landings for all fisheries in all waters of the region.

**TABLE E.6.4.1.1.1** Identified vessels' landings (1,000mt) and ex-vessel revenues ($million) in the Northeast by gear used, 1991.

While the preceding table shows the aggregated performance of all gear types for vessels identified in the weighout files, Table E.6.4.1.1.2, based on data in the NMFS Permit Files, shows the number of vessels holding Multispecies Permits by gear type and by state. The table shows the number of permits as of September 18th, 1992 (that date is when the table was generated and is insignificant except to illustrate the change that has taken place since the control date) and those qualifying under the moratorium as proposed. Increases by gear category were 16 percent (otter trawl), 9 percent (dredge), 14 percent (gillnet), 65 percent (handline / rod & reel), 45 percent (longline), and 35 percent (other). The dramatic increase in the longline and handline/rod&reel categories is attributed, in part, to a growing awareness of the requirements of the permitting process, as well as a concern about potential moratoriums and management options. The number of vessels that are permitted greatly exceeds the number that actually use a specific gear or fish for groundfish in any given year.

**TABLE E.6.4.1.1.2** Status of Northeast Multispecies Fishery Permits as of September 18, 1992, and qualifying under the proposed moratorium rules.

The tables which follow contain condensed pictures of the activity of known vessels captured by the port data collection system for the principal groundfish gear types. All information about an individual vessel's activity has been aggregated into an annual picture. This information was then aggregated across vessels into groups or fleets on the basis of gear use, area fished, and tonnage class. Tonnage class two vessels range from five to 50 gross registered tons (GRT), class three are 51-150 GRT, and class four are greater than 150 GRT.

Several caveats are in order concerning how vessels were categorized by fleet. In general, if a vessel landed at least once in a port in the region, its total activity (all trips regardless of gear used) was ascribed to that region, defined as either New England, Mid-Atlantic, and Chesapeake, or the entire Northeast. Hence, several vessels and their activity may be represented in more than table. The same multiple representation exists for use of a gear. If a vessel uses a gill net, for example, and in the same year, a longline, its total activity will be represented in the total activity section of two tables, but its "primary gear activity" in only one- that describing gill net use or that describing longline use. For some gears this distinction between primary gear activity and total activity is not displayed because a gear's use constitutes an overwhelming majority of the activity of the fleet in question.

The total number of vessels participating in the ~~New England Otter Trawl~~ fishery, Table E.6.4.1.1.3a, continues to decline, now at 822 vessels, a pre-1980 level. Total landings increased for the second year, recovering slightly from their steady decline through the 1980s, partially attributed to a couple of strong year classes of key stocks. Average revenue-per-vessel increased for each tonnage class in 1991, because total revenue was up and vessel participation was down. The average number of days-at-sea has increased slightly for all tonnage classes in the aggregate.

~~Mid-Atlantic Otter Trawl~~ vessels, Table E.6.4.1.1.3b, primarily land summer flounder, scup and black sea bass, but at times catch multispecies groundfish such as yellowtail and winter flounder. The number of vessels engaged in this fishery dropped further in 1991, to 240 vessels, 34 less than in the previous year. A significant increase in the average number of days absent from port occurred among all tonnage classes, attributable to the increase in total days absent and the decline in vessel numbers. On average, vessels experienced an increase in per-day-absent revenue and landings. Each vessel in this fishery, on average, continues to make a greater number of trips each year. In 1991, total revenue increased by 8 percent, and total landings reached another new high of 63,000 mt, a 13 percent increase. Receipts-per-vessel rose approximately 23 percent over 1990 as landings increased and vessel participation declined.

Although New England or Mid-Atlantic otter trawlers did not do a significant amount of fishing with other gears, there was great variability among them in the number of days absent. This reflects, to some extent, the frequency of encounters of some vessels with data collection (port agents) as much as it reflects actual vessel behavior. For 1990, the latest year for which these data are available, total annual days absent most frequently ranged from less than 10 to 75 days for tonnage class 2, 75 to 200 days for tonnage class 3, and from 150 to 250 days for tonnage class 4. Standardized otter trawl effort almost doubled in the decade ending 1985, declined about 10 percent between 1986 and 1989, and increased in 1990 and 1991. The 1991 multispecies landings by species for otter trawl vessels (and other gears) are shown in Table E.6.4.1.1.4.

Although not shown in these tables, 14 vessels participated in pair trawling activities in the Northeast Region in 1991. These pair trawling vessels had significantly higher revenue-per-day absent and landings-per-day-absent than otter trawl vessels fishing singly. Pair trawling activity is summarized in Tables E.5.3.3.1, .2, and .3, earlier in this document under the discussion of management alternatives.

The ~~Northern Shrimp Fishery~~,Table E.6.4.1.1.3c, is a seasonal fishery operating in federal waters under the Exempted Fisheries Program of the Multispecies FMP due to the bycatch of groundfish in the small mesh shrimp nets. Beginning in 1992, shrimp vessels are being required to use a finfish excluder device which is also being proposed as part of this action to be incorporated into the Multispecies regulations. Since the excluder device virtually eliminates the bycatch of groundfish, this fishery represents an alternative for vessels during their time off groundfish under the proposed action. More than 80 percent of the fleet is composed of small, tonnage class 2 vessels. The principal gears used by these vessels in the off-season are otter trawls, gillnets and lobster traps.

The ~~Northeast Gillnet~~ category shown in Table E.6.4.1.1.3d, is a broad category of gear, but it excludes the large-mesh drift net used for large pelagics. Sink gillnets and small-mesh drift gillnets capture a substantial amount of cod and pollock, and smaller amounts of other groundfish species as well as bluefish. Table E.6.4.1.1.4 shows the 1991 landings by species for gillnet vessels on a region-wide basis. When examined at different temporal and geographical scales, the percentage of the total landings of a given species attributable to gillnets varies significantly due to the regional nature of the fishery. Thus, according to the most recent assessment (SAW 15) of the Gulf of Maine cod stock, gillnet catches comprised about 40% of the total landings from that stock during 1987-1989 but only about 23% in 1991.

The majority of gillnet vessels are small, tonnage class 2 vessels or undertonnage vessels that employ other gear for approximately 20 percent of the year on average, usually otter trawls and shrimp trawls. The number of vessels in this fishery increased steadily between 1986 and 1989, decreased in 1990, but increased again to 253 vessels in 1991. Since gillnet vessels tend to be in the smaller size classes and are less centralized in distribution (fish out of rural areas or small harbors), they are not captured by the weighout system as completely as other vessel groups and their landings are more often aggregated making analysis of this sector problematic.

An independent survey of gillnet fishermen conducted by Lazar and DeAlteris of the University of Rhode Island in 1992 suggests that the gillnet fleet is comprised primarily of seasonal (78 percent part time, 22 percent full time), small boats (80 percent under 46 feet in length) employing two or three fishermen. This survey suggests that lobstering and tuna fishing (rather than shrimping and otter trawling) are the principal other activities of these vessels. (pers. comm) These fishing activities are more commensurate with small boats than otter trawling. The amount of gear deployed by these fishermen also varies with target species, operational characteristics of the vessel, and the season and area being fished. Nets are deployed in strings of ten to fifteen nets per string; individual vessels may deploy up to 15 strings. The "average" number of nets in use on a typical vessel is currently a matter of some debate among fishermen, fishery scientists and managers but is somewhere between 70 and 100. The difficulty in establishing the baseline characteristics of this fishery provides an element of uncertainty in the development and assessment of management proposals.

**TABLE E.6.4.1.1.3a & b**

**TABLE E.6.4.1.1.3 c & d**

**TABLE E.6.4.1.1.4** 1991 Landings (metric tons) of multispecies by principal gear types

| | OTTER TRAWL | | GILLNET | | OTHER GEAR | | TOTAL | |
|---|---|---|---|---|---|---|---|---|
| **SPECIES** | **SUM** | **PCT** | **SUM** | **PCT** | **SUM** | **PCT** | **SUM** | **PCT** |
| COD | 31373.5 | 75.1 | 7234.2 | 17.3 | 3189.9 | 7.6 | 41797.5 | 100 |
| HADDOCK | 1709.4 | 93.0 | 81.5 | 4.4 | 47.1 | 2.6 | 1838.0 | 100 |
| POLLOCK | 4786.9 | 61.3 | 2919.2 | 37.4 | 97.3 | 1.2 | 7803.3 | 100 |
| Y'TAIL FL. | 6815.5 | 89.2 | 123.3 | 1.6 | 701.1 | 9.2 | 7639.9 | 100 |
| WINT. FL. | 6519.1 | 92.0 | 110.8 | 1.6 | 458.7 | 6.5 | 7088.6 | 100 |
| WITCH FL. | 1697.6 | 95.6 | 18.3 | 1.0 | 60.7 | 3.4 | 1776.6 | 100 |
| AM. PLAICE | 4093.7 | 96.0 | 39.3 | 0.9 | 132.2 | 3.1 | 4265.2 | 100 |
| REDFISH | 478.6 | 89.7 | 53.8 | 10.1 | 1.2 | 0.2 | 533.6 | 100 |
| W. HAKE | 3547.8 | 63.3 | 1614.3 | 28.8 | 438.4 | 7.8 | 5600.4 | 100 |
| WINDOWPANE | 3429.2 | 93.7 | 0.9 | 0.0 | 227.9 | 6.2 | 3658.0 | 100 |
| SIL. HAKE | 16009.5 | 99.2 | 55.4 | 0.3 | 78.5 | 0.5 | 16143.4 | 100 |
| RED HAKE | 1516.6 | 94.3 | 30.2 | 1.9 | 61.2 | 3.8 | 1607.9 | 100 |
| OCEAN POUT | 1381.5 | 97.5 | 0.6 | 0.0 | 35.1 | 2.5 | 1417.2 | 100 |
| R & W HAKE | 68.4 | 40.5 | 98.9 | 58.6 | 1.4 | 0.8 | 168.8 | 100 |
| **TOTAL** | 83427.4 | 82.3 | 12380.5 | 12.2 | 5530.7 | 5.5 | 101339 | 100 |

**UNDERTONNAGE AND SMALL BOATS**

The number of permitted boats in the undertonnage category is compared with the numbers in the tonnage category by gear type, according to the NMFS permit file, in Table E.6.4.1.1.2. Since these boats are not individually identified in the weighout system, the percentage of these boats that are actually fishing cannot be determined. Small boats, in general, are not covered as thoroughly by the weighout data collection system since many of them operate out of remote ports where port agent activity is limited. Table E.6.4.1.1.5 shows the number of boats at or below specific lengths according to the permit files. Some of these boats may be "tonnage vessels" while others would fall into the "undertonnage vessel" category.

Table E.6.4.1.1.6 shows the landings of the large mesh species by the tonnage and undertonnage classes. This table illustrates how the small boats tend to catch a higher proportion of certain species than others (namely, cod, pollock, winter flounder, and white hake) which is probably due to the fact that these boats use certain gear types (gillnets and hook gear) proportionally more than the overall fleet and are more restricted to fishing nearshore than larger vessels.

Figure E.6.4.1.1.1 illustrates the length distribution and cumulative groundfish landings at length for tonnage vessels in 1991as percentages of the total tonnage fleet. For example, 36 percent of tonnage vessels are 50 feet or less and they accounted for 16 percent of the total groundfish landings by tonnage vessels. This figure does not show either the landings or numbers of undertonnage boats. Although there is a general linear relationship between gross tonnage and length, not all vessels in the undertonnage category are also the shortest in length. This implies that there are vessels and groundfish landings at the lower end of this figure that are not reflected in the graphs.

The "small boat fleet" is perhaps the most diverse of all the vessel groups in the region in terms of the types of gears used, species targeted, and seasonality and level of individual effort. The collection of boats comprising this group is also the most difficult to characterize using established databases and conventional sources of information. This region-wide diversity combined with the lack of systematically collected data makes assessing the impacts of proposed management measures on this segment of the industry tenuous and problematic. In section E.6.4.1.1.2 is a summary of the distribution of undertonnage multispecies vessel permits by port, including per-capita numbers by community which illustrates somewhat the importance of this segment of the fleet at the community level.

**TABLE E.6.4.1.1.5** Number and percentage of vessels at or below specific lengths that qualify for a moratorium permit under the proposed rule, and that are currently (as of 9/92) permitted to fish for multispecies.

| | QUALIFYING | | CURRENT | |
|---|---|---|---|---|
| LENGTH (ft) | NUMBER | PERCENT | NUMBER | PERCENT |
| 20 | 202 | 5.1 | 283 | 5.3 |
| 25 | 670 | 16.8 | 1043 | 19.4 |
| 30 | 993 | 24.9 | 1543 | 28.7 |
| 35 | 1594 | 40.0 | 2427 | 45.1 |
| 40 | 2166 | 54.3 | 3205 | 59.6 |
| 45 | 2547 | 63.9 | 3715 | 69.0 |
| 50 | 2738 | 68.6 | 3948 | 73.4 |
| 55 | 2859 | 71.7 | 4108 | 76.3 |
| 55 | 2859 | 75.1 | 4267 | 79.3 |
| TOTAL | 3989 | | 5381 | |

**TABLE E.6.4.1.1.6** Groundfish landings by undertonnage and tonnage vessels 1991 (metric tons)

| | UNDERTONNAGE | | TONNAGE | | TOTAL |
|---|---|---|---|---|---|
| SPECIES | SUM | PCT | SUM | PCT | SUM |
| COD | 4090.1 | 9.8 | 37707.4 | 90.2 | 41797.5 |
| HADDOCK | 31.4 | 1.7 | 1806.7 | 98.3 | 1838.0 |
| POLLOCK | 492.6 | 6.3 | 7310.8 | 93.6 | 7803.3 |
| YELLOWTAIL | 266.7 | 3.5 | 7373.2 | 96.5 | 7639.9 |
| WINTER FL. | 319.5 | 4.5 | 6769.1 | 95.5 | 7088.6 |
| WITCH FL. | 38.7 | 2.2 | 1737.9 | 97.8 | 1776.6 |
| AM. PLAICE | 137.9 | 3.2 | 4127.3 | 96.8 | 4265.2 |
| REDFISH | 11.5 | 2.2 | 522.1 | 97.8 | 533.6 |
| WHITE HAKE | 268.1 | 4.8 | 5332.3 | 95.2 | 5600.4 |
| WINDOWPANE | 6.7 | 0.2 | 3651.3 | 99.8 | 3658.0 |
| TOTAL | 5663.3 | 6.9 | 76338.0 | 93.1 | 82001.3 |

**FIGURE E.6.4.1.1.1** Cumulative percent of groundfish landings at vessel length and cumulative percent of numbers of vessels at length for tonnage vessels in 1991.

### E.6.4.1.1.2 The ports

If one word were to be used to characterize the fishing industry in the northeast, it might be "diverse". Within the region, numerous fisheries have evolved which exploit a wide variety of species (at least sixty, see section E.6.3.3, for example), using all sorts of gear types (discussed earlier in this section) on vessels ranging in size from under thirty feet to well over one hundred feet. Many vessels switch among fisheries. There are also ethnic, cultural and philosophical differences among fishermen which are more difficult to describe systematically, but which become evident when fishermen are interviewed or have the opportunity to make public statements (see section E.6.4.3).

The diversity which is characteristic of the fisheries of the northeast is most evident in the differences among ports of the regions. These differences are the product of geography, economics and, in part, tradition. The proximity to fishing grounds abundant in specific species, or the capability of a port to accommodate large vessels, for example, contribute to the evolution of a port's character. The marketing and processing facilities, such as the presence of an auction, a processor / freezer, or long-standing fishermen / dealer relationships will contribute to a fisherman's choice of where to land the catch, even if the port is not the closest to his home.

Some ports are merely in a sheltered cove with a dock at the end of a road where a few boats unload their catch to be trucked to a market center. Other ports are hubs of activity offering the full range of services and supplies and also safe haven for a large number of large vessels. Each port has its unique character, marked by gear types used and species landed, which will affect the degree to which the proposed action impacts it.

The following description of the ports of the region is based on the data in the NMFS weighout database, the NMFS Multispecies FMP permit file, the 1990 U.S. Census, and the Department of Commerce publication, ~~Fisheries of the United States, 1991~~. The NMFS weighout database is used to describe the gear types used and the revenues per vessel in some of the principal ports; as noted earlier, only tonnage vessels are individually identified in the database, although practically all landings are captured. For this discussion, smaller ports, and those with a higher proportion of aggregated undertonnage vessels have been grouped into "other Maine", "other Massachusetts", etc.. Landings that are not captured in the federal weighout system include "state landings", which are collected by individual states and which generally include the inshore fisheries, such as lobster.

The permit files include all vessels which have indicated on the permit application the desire to be permitted; there is no charge nor any performance requirements and, therefore, the number of permitted vessels greatly exceeds the number of active groundfish vessels. (There are vessels with Multispecies permits in Puerto Rico and California, well beyond the range of the species). The information is useful, nevertheless, in indicating the overall distribution of vessels, and, since they are divided into tonnage and undertonnage categories, the concentrations of large- and small-vessel fleets. The permit files also include recreational, i.e. party and charter, boats which are required to have permits.

The U.S. Census data for 1990 provides information about the populations of the communities where vessels are permitted and groundfish is landed. The census data is aggregated by township or city name, and, therefore, individual census towns may include several ports which are locally identified by separate names (for example, Barnstable, MA, locally known as Hyannisport, or Hyannis, also includes Marstons Mills, Centerville, Cotuit, and Osterville which are named on the permit files). Conversely, some ports which are referred to by a single name actually incorporate several individual towns identified in the census files (for example, the "port of New Bedford" is the center of activity for vessels registered in Fairhaven, Mattapoisett, Marion, Dartmouth, and also serves as a major port for vessels from more distant places).

The revenue data presented in the ~~Fisheries of the United States~~ includes all state-recorded and federal-recorded landings. Only the prinicipal ports are identified, and they are aggregated by local name (e.g. New Bedford landings reflect the port of New Bedford, not just the city as identified in the census files). All of the differences and similarities among the various databases must be considered in the following review of the ports of the groundfish fishery.

The port of Portland, Maine, depends on groundfish landings for about half of its total revenues from fishing, $20.6 million out of a total of $44.1 million (Table E.6.4.1.1.2.1). The landings other than groundfish include lobster, shrimp, whiting, and a variety of other species. Portland ranks second in total revenues of the ports in the region, and third in total groundfish revenues. Portland ranks sixth in total number of vessels permitted, 119 (Table E.6.4.1.1.2.2). Nearly that many tonnage vessels, 112, landed in Portland during 1991, indicating that a number of vessels that are not homeported there land there, presumably to sell at the fish exchange. Of the identified vessels in the weighout system, about one-third of the vessels are otter trawl vessels catching primarily large-mesh groundfish species, one-third are otter trawl vessels whose revenues include at least half from other species such as shrimp and whiting, about one-fourth are gillnet vessels relying primarily on groundfish, and the remaining vessels land a mix of species using a mix of gear types. While Portland ranks high in comparison to the revenues of other ports, the per capita dependence on groundfishing is relatively low, with only 1.85 permitted vessels per 1000 residents (Table E.6.4.1.1.2.3).

In 1991, Gloucester, Massachusetts, landed about $25.5 million worth of groundfish (Table E.6.4.1.1.2.1) which placed it second of all ports in its reliance on groundfish. Total revenues from fishing were $40.0 million, fourth in the region. Gloucester is one of the busiest ports, with 204 identified vessels landing, and it has more vessels permitted in Multispecies than any other with 322. Like in Portland, about one-third of the identified vessels are otter trawlers landing primarily groundfish, one-third are otter trawlers with at least half of their revenues from shrimp, whiting or other species, twenty percent are gillnetters landing groundfish, and the remaining are mixed gear and species vessels. Gloucester ranks twenty third in the per capita number of multispecies permits, with 11.2 per thousand, and twenty fifth in per capita tonnage vessel permits, with 7.6 per thousand (Tables E.6.4.1.1.2.3 and .4, respectively). Of the twenty five ports with the highest per capita number of permits, Gloucester has the largest total population at 28,716.

Boston, Massachusetts, can be described as a groundfishing port, with about 80 percent of its total fishing revenues coming from groundfish, $10 million out of $13 million (Table E.6.4.1.1.2.1). With only 33 identified vessels landing in Boston, the port has the highest per vessel groundfish revenues of all ports in the region, and it ranks fourth in total groundfish revenues. Nearly all identified vessels are large mesh otter trawl vessels landing predominantly groundfish. Boston's total fishing revenues of $13 million place it seventh in the region. Boston is homeport to 106 multispecies-permitted vessels, but with a city (i.e. not metropolitan area) population of over 570,000, the per capita number of permitted vessels is among the lowest in the region at 0.18 per thousand.

Provincetown, Massachusetts, at the tip of Cape Cod, landed about $2.0 million worth of groundfish, out of $3.4 million in total (federally-recorded) fishing revenues. As indicated on Table E.6.4.1.1.2.1, the ~~Fisheries of the United States~~ has aggregated Cape Cod landings into Provincetown/Chatham, producing about $14.3 million in fishing revenues; further analysis is needed to correlate the different revenue databases. Provincetown's vessels are primarily otter trawlers which depend on groundfish for one-half to two-thirds of their revenues, with the remaining revenues coming from small mesh species. Additionally, Provincetown lands a significant amount of bluefin tuna and a mix of other species. With a population of around 3,600, and a total of 67 permitted vessels, Provincetown ranks 13th in per capita total number of permits with 18.8 per thousand, 13th in per capita tonnage permits with 11.2 per thousand, and 10th in per capita under tonnage permits with 7.7 per thousand (Tables E.6.4.1.1.2.3, .4, and .5, respectively).

Chatham, Massachusetts, whose total revenues are aggregated with Provincetown's in the ~~Fisheries of the United States~~, is probably more dependent on groundfishing than Provincetown. With 209 total multispecies permits, Chatham ranks fifth in the region, and with a population of about 6,600, has 31.8 permits per thousand, placing it 4th in per capita multispecies permits (Tables E.6.4.1.1.2.2 and .3). Chatham's geography (narrow inlet, distance from major markets) makes the port less attractive to larger vessels, hence the number of undertonnage permits is nearly double the number of tonnage permits; Chatham ranks second in the region in the per capita number of undertonnage boats with 21.1 per thousand (Table E.6.4.1.1..2.5).

New Bedford, Massachusetts, ranked first in the nation in total revenues from fishing in 1991, with $157.7 million. Despite the fact that more than two-thirds of that revenue was from species other than groundfish (primarily sea scallops), New Bedford also ranked first in the region in revenues from groundfish with $48.9 million. Of the 326 vessels identified in the weighout system landing in New Bedford in 1991, about half are otter trawlers landing primarily large-mesh groundfish with ten to twenty percent of their revenues from other species. Only about 35 percent of the vessels landing were scallopers, despite the much greater revenues from scallops, reflecting the value of that species. The remaining vessels catch a wide variety of species, such as swordfish, lobsters, and conch (whelks).

While the city of New Bedford ranks second in total multispecies permits with 307, the per capita number of multispecies is relatively low with only three per thousand. As mentioned earlier, the port of New Bedford incorporates several surrounding towns and also serves as the port of landing for a number of vessels whose principal port of landing is elsewhere. The port area offers one of the widest range of services (shipyards, fuel, ice, dealers and processors) of any of the ports in the region. The per-capita statistics are based on the census data for the city, and does not include the population of the metropolitan area; likewise, the permit files may identify homeports as one of the surrounding communities even though the boats' activities are based in New Bedford. Further investigation would reveal more details about the economic geography of this port area.

The port of Point Judith, in the town of Narragansett, Rhode Island, ranks fifth in the region both in total fishing revenues, $37.5 million, and groundfish revenues, $6.7 million (Table E.6.4.1.1.2.1). With less than 20 percent of its revenues coming from groundfish, Point Judith is one of the most diversified fishing ports in the region. This diversity has been a long-standing characteristic of the port, and reflects its geographical location near the southern limits of the range of many groundfish species, at the northern edge of many more southern species, in close proximity to the continental shelf, and equidistant between the mid-Atlantic Bight and Nantucket Shoals and the Great South Channel, all rich fishing grounds.

About three-fourths of the identified vessels landing in Point Judith in 1991 were otter trawl vessels catching a diverse range of species including groundfish, squid, butterfish, whiting and more. For most of these vessels, the revenues from groundfish species are greatly exceeded by the revenues of the other species. About 15 percent of the identified vessels landing in Point Judith derive their primary income from lobsters. The town of Narragansett ranks third in total multispecies permits with 249, and 15th in per capita permits with 16.6 per thousand (Tables E.6.4.1.1.2.2 and .3). With 189 of the total permits being tonnage vessels and a population of 15,000, Narragansett ranks 12th in per capita tonnage multispecies permits, 12.6 per thousand (Table E.6.4.1.1.2.4).

Proceeding southward along the coast, the importance of groundfish landings to the major ports generally decreases, as the distance to the groundfishing grounds increases. The vessels that fish out of these southern ports may make trips into the region and land their groundfish catch in other ports, such as New Bedford.  These ports along Long Island, New York, and in New Jersey, also may catch one or two species of the multispecies group (namely winter flounder and yellowtail) but not the entire range caught in the New England mixed-trawl fisheries.  These ports are generally smaller communities with a heavy dependence on fishing, and as such many of them rank among the top in per capita multispecies permits (Barnegat Light, New Jersey is first).

Besides the principal ports, producing the greatest proportion of the groundfish revenues, there are throughout the region, medium and small ports that depend on groundfishing as a significant part of their fishing revenues.  Many of these ports have a significant number of permits even in comparison to the larger ports (Table E.6.4.1.1.2.2), and, because of their generally smaller population, have a far greater number of per capita permits (Tables E.6.4.1.1.2.3, .4, and .5).  Nevertheless, when aggregated by state, the combined revenues of these smaller ports is far less than the revenues of the larger ports (see "other Maine", "other Massachusetts", etc. in Table E.6.4.1.1.2.1).  This may in part be due to the fact that these boats will use the market and other services available in the centralized ports, while being based in their home communities.

The per capita distribution of permits (recognizing the shortcomings of that database)  should be considered in assessing potential impacts of the proposed action on communities. Unfortunately, these communities are far-less completely covered in the weighout system, and the quality of individual vessel revenue and effort data makes such an analysis impossible at this time.

**TABLE E.6.4.1.1.2.1** Fishing revenues and tonnage vessels in principal northeast ports in 1991.

**TABLE E.6.4.1.1.2.2** The twenty five ports with the most number of multispecies permits in 1991, and their per capita permit count.

**TABLE E.6.4.1.1.2.3** The twenty five ports with the highest total number of multispecies permits per capita in 1991.

**TABLE E.6.4.1.1.2.4** The twenty five ports with the highest number of tonnage vessel multispecies permits per capita in 1991.

**TABLE E.6.4.1.1.2.5** The twenty five ports with the highest number of undertonnage vessels multispecies permits per capita in 1991.

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## E.6.4.1.2 THE RECREATIONAL FISHERY

Of the most commonly sought and caught species in the recreational fishery in the North Atlantic Subregion, Atlantic cod and winter flounder are the only species that are also in the Multispecies FMP. (Table E.6.4.1.2.1) Pollock, other flounder and hakes are also caught to a lesser degree. Cod, pollock and hakes are caught predominantly outside of three miles from shore, while the flounder species are caught almost exclusively within three miles within bays and estuaries. (Table E.6.4.1.2.2)

The catches of the principal recreational species in the multispecies fishery have been declining in recent years although the 1987 year class of cod is evident in the catch of that species. (Table E.6.4.1.2.3)

As a percentage of total landings of groundfish, the impact of the recreational sector is minor but in some years may exceed ten percent on an individual species basis for cod or winter flounder. (Table E.6.4.1.2.4)

The three modes of recreational fishing are shore, party/charter and private/rental boat (where there is no hired captain). The estimated total weight of fish caught (catch type A) for 1991 is shown in Table E.6.4.1.2.5. Fishing from shore and on private or rental boats is predominantly conducted by coastal residents while slightly more party/charter trips are taken by non-coastal residents and out of state residents. (Table E.6.4.1.2.6). Most marine recreational anglers are male and between the ages of 25 and 44 years old (Table E.6.4.1.2.7).

The demand for and value of fishing by anglers in the Northeast Region remains poorly understood in quantitative terms, and the economics of charter and party boat fishing has not been examined either. For example, anglers as a group are known to fish for fun, food and, in some cases, income, but the relative importance of these motives among anglers remains unknown in fisheries throughout the region. Similarly, income and employment in the commercial sector which services anglers, including charter boat or party boat fishing, is unknown.

The complex and poorly understood relationships among stock size, harvest, anglers' motives, and industry performance undermine economic (and social) evaluations of proposed regulations. Existing data on expenditures by anglers are necessary to begin to understand the relationships, but expenditures are not indicative of angler satisfaction or income (Edwards, 1990).

| NORTH ATLANTIC SUBREGION | | | | |
|---|---|---|---|---|
| SPECIES SOUGHT | 1990 | | 1991 | |
| | COUNT | PCT | COUNT | PCT |
| BLUEFISH | 4399 | 31.93 | 4701 | 34.13 |
| NONE | 1944 | 14.11 | 1905 | 13.83 |
| ATLANTIC COD | 1599 | 11.61 | 1295 | 9.40 |
| WINTER FLOUNDER | 1567 | 11.37 | 998 | 7.25 |
| STRIPED BASS | 1368 | 9.93 | 1544 | 11.21 |
| TAUTOG | 891 | 6.47 | 677 | 4.92 |
| SCUP | 528 | 3.83 | 998 | 7.25 |
| ATL. MACKEREL | 420 | 3.05 | 434 | 3.15 |
| SUMMER FLOUNDER | 354 | 2.57 | 352 | 2.56 |
| BLUEFIN TUNA | 117 | 0.85 | 148 | 1.07 |

**TABLE E.6.4.1.2.1:** Primary species group sought as reported by anglers in the intercept survey.

Source: Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1990-1991, US Dept. of Commerce, NOAA / NMFS, Current Fisheries Statistics #9204.

| ALL SUBREGIONS COMBINED | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SPECIES GROUP | OCEAN <3 mi. | | OCEAN >3 mi. | | INLAND | | ALL AREAS | |
| | 1990 | 1991 | 1990 | 1991 | 1990 | 1991 | 1990 | 1991 |
| ATLANTIC COD | 399 | 244 | 2151 | 1485 | 86 | 148 | 2635 | 1877 |
| POLLOCK | 170 | 74 | 183 | 336 | 51 | 47 | 403 | 457 |
| RED HAKE | 445 | 131 | 1294 | 258 | 31 | - | 1769 | 395 |
| OTHER HAKES | - | 62 | 82 | 127 | 39 | - | 145 | 200 |
| WINTER FLOUNDER | 1062 | 568 | 86 | 54 | 3306 | 3740 | 4454 | 4362 |
| OTHER FLOUNDER* | 439 | 421 | 41 | 34 | 298 | 698 | 890 | 1254 |

*Excluding summer, gulf, and southern flounders

**TABLE E.6.4.1.2.2:** Estimated numbers (THOUSANDS) of fish caught (all catch types) by marine recreational anglers by species group and primary area of fishing.

Source: Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1990-1991, US Dept. of Commerce, NOAA / NMFS, Current Fisheries Statistics #9204.

| SPECIES | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|
| ATLANTIC COD | 1.6 | 2.0 | 3.0 | 2.5 | 2.7 | 1.9 |
| POLLOCK | 0.5 | 0.7 | 1.4 | 0.7 | 0.4 | 0.5 |
| WINTER FLOUNDER | 10.4 | 13.0 | 14.0 | 8.5 | 4.1 | 4.4 |

**TABLE E.6.4.1.2.3:** Estimated numbers (MILLIONS) of fish of three principal species of multispecies groundfish caught (all catch types) by marine recreational anglers by

Sources: Status of the Fishery Resources off the Northeastern United States for 1991, NOAA Technical Memo. NMFS-F / NEC-86;
Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1990-1991, US Dept. of Commerce, NOAA / NMFS, Current Fisheries Statistics #9204.

| SPECIES | 1989 | | 1990 | | 1991 | |
|---|---|---|---|---|---|---|
| | C | R | C | R | C | R |
| ATLANTIC COD | 35.5 | 6.8 | 43.4 | 5.5 | 42.0 | 3.8 |
| HADDOCK | 1.7 | <0.1 | 2.5 | <0.1 | 1.8 | <0.1 |
| REDFISH | 0.6 | 0.0 | 0.6 | 0.0 | 0.5 | 0.0 |
| SILVER HAKE | 17.8 | <0.1 | 20.2 | <0.1 | 16.6 | <0.1 |
| RED HAKE | 1.6 | <0.1 | 1.6 | 0.0 | 1.6 | 0.2 |
| POLLOCK | 10.5 | 0.4 | 9.5 | 0.1 | 7.9 | 0.1 |
| YELLOWTAIL FL. | 5.0 | 0.0 | 14.1 | 0.0 | 7.5 | 0.0 |
| AMERICAN PLAICE | 2.3 | 0.0 | 2.5 | 0.0 | 4.3 | -- |
| WITCH FLOUNDER | 2.1 | 0.0 | 1.4 | 0.0 | 1.8 | 0.0 |
| WINTER FLOUNDER | 6.8 | 2.9 | 2.6 | 0.4 | 7.5 | 1.1 |
| WINDOWPANE FL. | 2.7 | 0.0 | 1.9 | 3.7 | 0.0 | |
| WHITE HAKE | 5.0 | <0.1 | 5.0 | <0.1 | 5.6 | <0.1 |
| OCEAN POUT | 1.3 | 0.0 | 1.3 | 0.0 | 1.4 | 0.0 |

**TABLE E.6.4.1.2.4:** 1989-1991 Comparison of U.S. Commercial (**C**) and Recreational (**R**) Landings of Species covered by the Multispecies FMP (**THOUSAND METRIC TONS**).

Sources: Status of the Fishery Resources off the Northeastern United States for 1991, NOAA Technical Memo. NMFS-F/NEC-86;
Status of the Fishery Resources off the Northeastern United States for 1992, NOAA Technical Memo. NMFS-F/NEC-95;

| MODE | OCEAN <3 mi. | OCEAN >3 mi. | INLAND | ALL AREAS |
|---|---|---|---|---|
| SHORE | 704 | NA | 989 | 1692 |
| PARTY/CHARTER | 138 | 239 | 326 | 702 |
| PRIVATE/RENTAL | 1153 | 1529 | 3441 | 6123 |

**TABLE E.6.4.1.2.5:** Estimated total weight (**THOUSAND KILOGRAMS**) of fish caught (Catch type A- available in whole form for identification and measurement by interviewer) by marine recreational anglers in the North Atlantic subregion by mode of fishing in 1991.

Source: Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1990-1991, US Dept. of Commerce, NOAA/NMFS, Current Fisheries Statistics #9204.

| MODE | COASTAL RESIDENTS | NON-COASTAL RESIDENTS | OUT OF STATE RESIDENTS | ALL TRIPS |
|---|---|---|---|---|
| SHORE | 2417 | 135 | 923 | 3475 |
| PARTY/CHARTER | 106 | 18 | 125 | 250 |
| PRIVATE/RENTAL | 2951 | 163 | 675 | 3788 |
| TOTALS | 5475 | 316 | 1722 | 7513 |

**TABLE E.6.4.1.2.6:** Estimated number of fishing trips (**THOUSANDS**) by marine recreational anglers by mode and area of residence, 1991.

Source: Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1990-1991, US Dept. of Commerce, NOAA/NMFS, Current Fisheries Statistics #9204.

| | | AGE | | | | | | | | SEX | | TOTALS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **5-13** | **14-17** | **18-24** | **25-34** | **35-44** | **45-54** | **55-64** | **>65** | **M** | **F** | |
| **NUMBER** | | 916 | 442 | 1266 | 3521 | 3155 | 2030 | 1308 | 1136 | 12491 | 1283 | 13774 |
| **PERCENT** | | 6.7 | 3.2 | 9.2 | 25.6 | 22.9 | 14.7 | 9.5 | 8.2 | 90.7 | 9.3 | |

**TABLE E.6.4.1.2.7;** Age and sex frequency distribution of intercepted anglers, 1991.

Source: Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1990-1991, US Dept. of Commerce, NOAA / NMFS, Current Fisheries Statistics #9204.

### E.6.4.2 Description of the Atlantic groundfish processing sectorE.6.4.2 Description of the Atlantic groundfish processing sector

Since the prices for fresh fillets are much higher than those for frozen product, almost all domestic landings of Atlantic groundfish are processed into fresh fillets and sold into the domestic market. Groundfish processing plants almost always specialize in groundfish production; few process other species and even fewer produce both fresh and frozen product. Local landings, whole fish trucked in from other domestic ports, and whole fish trucked in from Canada provide their supply of unprocessed fish. Almost all groundfish processing plants are located in the major ports of Massachusetts, Gloucester, Boston, and New Bedford, with a few plants in Rhode Island and a growing number in Portland Maine.

The groundfish processing industry boomed with the sharp increase in landings following the FCMA in 1976 (Georgianna and Ibara, 1983). The recent sharp decrease in domestic landings, however, have caused it to become an industry in decline.

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**Figure 6.4.2.1** Processing Employment in Massachusetts

The industry's decline is reflected in the trend in employment. Figure E.6.4.2.1 shows processing employment in Massachusetts using data from Fisheries of the United States and from the Massachusetts Division of Employment and Training (DET). Both data series include all fishery products, but interviews and observation indicate that most of these plants in Massachusetts process groundfish (Georgianna, 1992). Data from ~~Fisheries of the United States~~ (US DOC Current Fishery Statistics, No. 9100) show a sharp increase in employment from 1976 until 1980 and a steady decline of 5 to 7 percent per year since then. DET data, which is not available before 1982 in the same form, shows a similar steady decline. The difference in the number of employees shown by the two series is due to the inclusion of wholesalers and dealers in the ~~Fisheries of the United States~~ series.

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**Figure 6.4.2.2** Number of Processing Plants in Massachusetts

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**Figure 6.4.2.3** Wholesale Employment in Massachusetts

Figure E.6.4.2.2 shows the number of processing plants in Massachusetts from 1970 through 1990. The recent trend is not clear from the figure, since ~~Fisheries of the United States~~ shows a slight increase, while the DET data show a slight decline. Once again, the much higher number of plants in ~~Fisheries of the United States~~ is caused by the inclusion of many plants whose primary activity is wholesaling. From 1988 to 1990, the DET data show a sharp decline from 47 to 41 plants. Interviews with port agents and managers of processing plants confirm this trend of a decline in the number of processing plants. Since 1990, according to our interviews, several more firms left the industry in New Bedford, Boston, and Portland.

Figures E.6.4.2.3 and .4 show wholesaling employment and the number of firms respectively. There are two problems with these data. Firstly, the data cover all products and species, and fresh Atlantic groundfish has only a small share of the wholesale fish market. Secondly, wholesaling is an ambiguous term; it could mean selling processed product to retail operations or selling processed or unprocessed product between intermediate firms.

Figure E.6.4.2.3 shows an increase in employment in the wholesale sector in the ~~Fisheries of~~

~~the United States~~ series, and roughly constant level according to the DET data. These results roughly conform with the rising trend in consumption of seafood. The DET data include distributors as well as wholesalers, which accounts for DET's higher numbers of employees. Figure E.6.4.2.4 shows a sharp increase in the number of wholesaling firms from both data sources. This is a surprise since it does not conform to the drop in landings; however, our interviews have confirmed that many former processors have moved into wholesaling, most often moving whole fish from one firm to another, either within the same port or trucking the product to a different port.

Interviews showed the same trends as the data shows. Several firms reported that they have drastically reduced employment due to the shortage of landings. The shortage of landings and subsequent rise in ex-vessel prices has drastically reduced processors' and wholesalers' ability to maintain long-term relationships with their customers. Previously, processors could make up losses from cyclical or periodic shortages of landings and high ex-vessel prices during periods of increased supply. Now, they can no longer supply constant quality within an acceptable price range, and their customers are resisting high prices, since only a few restaurants will dare to reflect wholesale invoice costs of fish in the entree prices.

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**Figure 6.4.2.4** Wholesalers in Massachusetts

Processors are also shifting to other species, both domestic and imported. Processors and wholesalers are shifting from Atlantic groundfish to Alaska pollock, Pacific cod, orange roughy, and other species. However, larger firms can make this shift more easily than smaller firms, which often rely on a few suppliers and a few customers who supply and demand the same few species of groundfish. Most processors are continually looking elsewhere for supply. More fish is trucked whole between New England ports and from Canada. This pattern is complicated by boats shifting to Portland, preferring to sell at the auction there rather than in New Bedford and other Massachusetts ports.

The declining trend in groundfish landings and the growing consumer demand for quality fresh fish is contributing to the character of this sector described above. This is an industry in transition, caught between suppliers and consumers, both of which are experiencing significant change.

A recently completed study (Georgianna, et al., 1993) of the New England groundfish and scallop processing sectors produced the following facts about the 1979-1991 period:

> 1) the domestic landings of groundfish declined from 300 million pounds in 1982-1983 to 150 million pounds in 1990, a reduction of 50%;
>
> 2) processing employment decreased from 6500 in 1982-1983 to 5500 in 1990, a reduction of 18%;
>
> 3) the number of processing plants actually increased from 225 in 1982-1983 to about 250 in 1990, although there has been a continuous but slight decline since 1987;
>
> 4) in contrast to the trend in processing employment, wholesale employment increased from about 1600 in 1982-1983 to about 2800 in 1990, an increase of about 75%.
>
> 5) the number of wholesale plants more than doubled from about 300 in 1982-1983 to 650 in 1990.

The upward trend in wholesaling that occured while domestic landings were declining was the result of several factors:

> 1) some processors eliminated their processing activities and became wholesalers; however, about twenty five processing firms that went out of business in recent years while the increase in the number of wholesalers was about 350;
>
> 2) the processors have extended their product range and switched to species other than groundfish; processed monkfish, dogfish and skate wings are mostly exported through the wholesalers;
>
> 3) some wholesalers and large processors are handling product that is caught or raised in other parts of the world, especially Alaska, Australia and the Far East.

The expansion in domestic and foriegn sources of substitutes for Atlantic groundfish, and the expansion in the spectrum of fish that consumers will accept has provided opportunities for new firms to enter at the wholesale level.

Furthermore, the Georgianna study found that:

> 1) Processing activity has become more concentrated around the Boston area, although landings have been redistributed somewhat, mainly due to the Portland auction. Processing will continue to move toward greater Boston and away from landing ports because Boston is the regional center of the food processing network;

2)  Processor and wholesale prices have become more volatile, and profit margins have become narrower; this has hurt smaller and less well-financed firms;

3)  Processing has become more concentrated in larger firms with the drop in landings and reduction in whole imports;

4)  Since 1987, imports of haddock have almost completely replaced New England haddock as a source of supply to processors.

### E.6.4.3 Social and cultural aspectsE.6.4.3 Social and cultural aspects

Included in this descriptive section are an anthropologist's profiles of three ports (New Bedford, Gloucester, and Stonington, Maine) which characterize the importance of fishing and of the fishing industry to the individual, family and communities. (Available statistical information from the U.S. Census Bureau and NMFS presented in section E.6.4.1.1.2 is also referred to in this section.) In addition to the cultural aspect of the fishing industry and the port statistics, this section describes native American and subsistence fishing, to the extent that they exist in the area covered by this action, as well as issues of public health and safety. This background information forms the basis for the social impact assessment later in this document.

#### E.6.4.3.1 Description of the cultural aspects of the New England groundfish fishery

##### E.6.4.3.1.1 Introduction

One need only look at the geography of the New England region to make some educated guesses about the fishing industry and the differences that have developed among the various ports. The convoluted coastline of Maine with its hundreds of islands, rocky land and the wealth of the sea life makes it obvious why fishing was a fitting and natural industry to promote since the days of the first settlers.

The richness of sea life is not unique to Maine, of course. The Gulf of Maine, and the Massachusetts, Cape Cod and Narragansett Bays have always been noted for their great abundance of fish, whales and other sea life. Fishing has been a historically important and traditional occupation along the entire New England coast.

Take a step away from the shoreline, however, and consider why and where population centers have developed, how the transportation networks connect the population centers, what the migration patterns of people and fish have been; even consider the weather, technological development and the ascendancy of other occupations, to gain a better picture of what the New England fishing industry looks like in all its variety.

Management has also affected the way the industry has developed. Before the Magnuson Act extended federal jurisdiction to 200 miles, management in the prime fishing grounds off New England was the responsibility of the International Commission for the Northwest Atlantic Fisheries (ICNAF). The perceived lack of control over foreign fishing led the United States government to establish various programs to aid domestic fishermen (Peterson and Smith:1981).

Among these were programs to supplement vessel construction, loan and marketing programs, development and small business grants, underutilized species development programs, gear research programs and representation on international fishery delegations (Peterson and Smith:1981). Some observers suggest that these aid programs continued too long, causing an inflation of the domestic fleet, and are ultimately responsible for the diminishment of stocks.

**Urban vs rural**

Many of the differences among fishing ports can be attributed to differences associated with urban centers and rural areas. This difference is discussed further in section E.6.4.1.1.2, the ports.

*Vessel size and gear shifting:*
The urban centers tend to attract large (over 60 feet long) fishing vessels that take 5- to 10-day trips out to fishing grounds on Georges Bank, return to port for 2 or 3 day layovers, load up on fuel and provisions, visit families, perform maintenance work on engines, and return to the fishing grounds. These large vessels tend to maintain one type of gear and concentrate on a few species. As fish has become scarce, some report that trips have lengthened by two to four days and layovers are briefer. Ownership varies. Many are owner-operated, but fleets of two or three large vessels operated by hired captains are not uncommon, and in some ports, fleets of several boats are found.

The rural areas, in contrast, have multitudes of relatively small (under 55 or 60 feet), owner-operated fishing vessels. In the northern part of the region, the small vessels usually take long, but single day trips, leaving in the early hours before dawn and returning in the late afternoon or early evening. These boats fish as close to shore as they productively can, traditionally within 20 miles of shore though the declines in desirable stocks are forcing them farther and farther out. (Peterson and Smith, 1981). The small vessels are often opportunistic, frequently shifting gear and fishing grounds to try to capitalize on availability and price changes. Dewar (1983) points out than weather, prices and fish behavior make gear switching a necessity on inshore boats, whereas offshore boats rarely switch gear because of the expense of the conversion.

In some areas, the shifting is seasonal. For example, in Maine, a number of small boats gillnet in the summer and longline in the winter. Other small vessels go lobstering in the summer, while longlining or scalloping, urchining or shrimping in the winter. The choices are very personal, everyone seems to have developed an affinity for one or another type of fishing. Start-up costs and experience also affect the choices. Fishermen may be limited to particular species by their knowledge and/or by compatibility with their gear.

In other areas, the shifting occurs within the same trip. Point Judith boats often seek yellowtail flounder, but if they hear of a school of whiting, they may switch nets to "top off" their trip. The versatility of the fishermen contributes to their self-esteem as well as to the benefit of their "bottom-line."

Differences in gear can play havoc with equitable management and contributes to some conflict among users of different gear making consensus difficult to achieve. Gillnetters, for example, claim to be victims, draggers purposefully go through their gear; while draggers complain that the gillnet users usurp bottom that was traditionally available to draggers. Everyone claims that theirs is a "better gear." Gillnetters point out that they don't require bait, they are size selective, use less fuel and don't tear up the bottom. Longliners say their gear does not affect bottom and is selective. Both deride draggers for pounding the bottom with their heavy doors leaving nowhere for fish to hide. Draggers complain about ghost nets fishing and lost lines and hooks fouling the bottom.

*Marketing:*
Market arrangements vary in both urban and rural areas. Urban centers are of course are more apt to have a wider variety of options for marketing. Notably, the most active auctions are held in Portland (Maine), Boston and New Bedford (Massachusetts). In other areas there are a variety of dealers and trucking options. In some cases there are fishermen's cooperatives and labor unions that affect how fish is handled. Each place has a reputation and associated pros and cons for individual fishermen.

For example, the Portland display auction appeals to fishermen who want to emphasize quality. The auction also has a reputation for honesty (fair scales and no stealing by employees), but since the catch must be physically present, there are extra handling costs and a broker is needed if the fisherman does not want to spend the time actually selling the fish. New Bedford, on the other hand, has a reputation for a lot of wheeling and dealing and diverting of fish. Moreover, a few processors are said to control the waterfront.

Where there is a publicly-owned pier, the fishermen are more apt to be free to select a dealer based on price and/or fair-dealing. Where the waterfront is privately-owned, a fishermen is likely to be forced to sell to a particular dealer who in turn provides ice, fuel, bait, and/or credit, in addition to a place to tie-up to unload and/or work on the boat.

Long term relationships with a particular dealer can work to the fishermen's advantage, making their catch the first bought and sold in a soft market, when others without such a relationship have to scramble for buyers and a decent price. Wilson (1980) confirms that failure to establish long-term relationships to dealers can be detrimental to fishermen. Nevertheless, it is clear that fishermen everywhere face constraints imposed by the harvest of a highly perishable product with wide daily fluctuations in supply and demand, a circumstance that seems to give dealers a wider range of options than it does fishermen.

Marketing naturally affects decisions about the species being sought. Price, availability of the species (to be caught) and proximity to an appropriate market all figure in the decision-making.

In rural areas, the distances to market can be great so prices often reflect the higher transportation costs. Some of the vessels attempt to develop local markets, selling to fish markets and restaurants, particularly in tourist areas, to avoid the problem.

**Demographic issues**

*Education:*

Many fishermen started going out in summers with their fathers or other relatives while still in high school. In the generations now at middle-age or nearing retirement, it was not uncommon to quit school as soon as legally possible to go fishing full-time. As fishermen became more sophisticated, that is, as the boats became more capital-intensive and fishing more technically complex, more fishermen completed high school before going full-time. Now most ports have at least a few college-educated captain/owners.

Nevertheless, the majority of active fishermen do not have extensive formal educations, but rather are educated "in the school of hard knocks," as one man put it. Consequently, fishermen would generally be at a disadvantage in competition for many alternative occupations. When Peterson and Smith (1981) did their research, they found no correlation between education and income from fishing. In other words, lack of formal education did not interfere with making a good living from fishing.

*Ethnicity:*

Gloucester and New Bedford are the two large ports with strong ethnic affiliations among their fishing populations.[1] Probably 80 percent of Gloucester's fishermen are Italian. Although large immigration flows ended in the mid-1970's, there are at least 26 vessels (out of approximately 200) on which only Italian is spoken. Even among the fishermen who arrived at a very young age, Italian is often the first and virtually only language spoken. Some of these men depend on their wives to communicate with the English-speaking population when necessary.

New Bedford has a large Portuguese-dominated offshore dragger fleet and a significant number of Norwegians among their fishermen, particularly captaining scallopers. Among the smaller ports, Provincetown is notable for its Portuguese fleet, although the majority are third- or even fourth-generation by now (Husing, 1980).

The ethnic affiliation is significant primarily because it links the fishermen of these populations through time with fishing communities in Italy, Portugal and the Azores, and Norway. This historical perspective permeates the community and affects the way not only fishing, but all aspects of life are organized. Although individuals do not all behave the same, as a group, particularly in the Portuguese and Italian communities, choices made regarding education,

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[1]1 See Miller and Van Maneen's ~~Boats don't fish, People Do~~(1979), and Poggie and Pollnac (1980) for more discussion of ethnicity in these ports.

occupation, marriage, leisure time, etc. reflect the sense of continuity and identification with their ethnic heritage.

In contrast to the offshore dragger fleets, small boat fishing in Gloucester and New Bedford is dominated by those who are usually referred to as "Yankees," which includes those from a mixed ethnic heritage, most of whom come from several generations born in the United States or Canada (Peterson and Smith, 1981).

The ethnic affiliations cause the fishing communities in these large population centers to mimic aspects of life in rural communities. For example, it is still as common to find relatives fishing with relatives on Gloucester boats as it is in Stonington, Maine. One of the consequences of this is that when a boat is "put out of business," for whatever reason, an extended family may be affected and there may be fewer relatives with jobs outside the fishing industry that can support those affected.[2]

Along the same lines, many fishermen rely on a pooling of family resources for their initial vessel purchase and for upgrades. This "implies a more resilient ability to endure revenue fluctuations than normal business borrowers, but also implies capital will be slow to leave the industry following a more permanent downturn" (Doeringer et al., 1986:47).

Aside from Gloucester, New Bedford and Provincetown, the majority of ports in New England have an ethnic mix typical of any New England town. Stonington, Maine, has predominantly a "Yankee" fleet including a number of fishermen of French-Canadian extraction.

*Owner-operators and the role of kinship*
Typically, groundfishing requires a variety of skills from crew members ranging from sorting fish according to species and size, to judging quantities for boxing, to setting and retrieving gear, net-mending, etc. Even more specialized skills such as engine, hydraulics and electrical system repairs are handy. In addition, captains must be able to locate productive grounds and avoid obstructions that can cause net damage ("hangs") (Doeringer et al., 1986).

Normally, boys start out fishing on a relative's boat for a half-share in the summer while still in school. Those who are interested can learn many skills by watching and asking questions of other crewmembers. The actual operation of the vessel is directed from the pilothouse, however, and the knowledge of navigation and location of fishing grounds was once a closely guarded secret, controlled by the captain (Doeringer et al., 1986). Logbooks with hangs and catch notations were often a prized possession handed down from father to son (or between

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[2] The "extended family" includes grandparents, uncles, aunts, nieces, nephews, and cousins, "extending" relationships beyond the nuclear family of parents and siblings. When anthropologists refer to an extended family, they are often interested in those relatives who participate in an exchange of goods and/or services, especially in times of need.

other close relatives).

Though operational issues are still significant and sons can certainly gain an advantage if they are able to obtain historical catch information from their captain-fathers, recent technological advances have made it much easier to navigate and to return precisely to the desired grounds. Nevertheless, it may be easier for sons of captain-owners to eventually become captain-owners than it is for sons of crewmembers to become captain-owners. (Financial considerations may also play a role in that captain-owners may be in a better position to help their son finance the purchase of their vessel, or may pass the boat on as a part of their son's inheritance.)

**Community dependence on fishing:**
In many of the rural ports fishing and related businesses provide a main source of income for a significant portion of the population. Property taxes on fishermen's houses support the schools, mortgages on boats provide income for banks. Fuel companies, ice companies, trucking firms, dealers and processing firms are often community members as well. Although insurance companies, net manufacturers and electronics firms are more often based outside of fishing communities, their agents or dealers often live in the communities.

In addition, the spouses of fishermen on small vessels often work in support industries, frequently cottage industries, such as hook-baiting, shrimp peeling or crab-picking. These support industries also provide employment for handicapped individuals for whom employment alternatives are limited.

In the more urban centers, fishing may play a much smaller role in the community as a whole, but may contribute a vital piece of diversity to the economic structure. Primary production can cushion a town when service industries fluctuate. In three of the major ports, Gloucester, New Bedford and Portland, the quantities and values of the catch ($40, $157.7, and $49.1 million, respectively in 1991, Table E.6.4.1.1.2.1) are so high that fishing industry is truly a mainstay of their economy.[3]

Declining catches have already caused some consolidation of support industries. Processing plants have closed in Stonington and Gloucester within the last year. Other service industries are attempting to diversify in order to survive natural and/or management-caused changes in the industry.

The urban centers in general offer more opportunities for alternative employment than do rural areas since they often support various manufacturing processes, construction businesses, etc.

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[3] Dewar (1983) noted, "Troubles of fisheries affect the welfare of many workers and communities. Fishing-related activities could easily have provided between 15 and 20 percent of a coastal town's jobs in the late 1970s. Certainly this many jobs were linked to fishing in the early 1980s."

"Banging nails" is often referred to as a logical alternative occupation. Of course, such alternatives are less accessible in an economic recession. Other alternative occupations are lacking in many areas because of the limited education of many fishermen and because some employers are reluctant to hire someone who has "been his own boss."

Employment in the tourist industry is seen as unlikely in many instances because the characteristics that make suitable personnel in service positions are perceived as antithetical to values held by many fishermen and their families. Pride and independence, "doing what they want, saying what they want, wearing what they want, etc.," so valued in the fishing community are not particularly valued in service jobs. On the other hand, the quaintness added to a community by the presence of the fishing industry often attracts tourists. Many tourists enjoy seeing a working waterfront, especially if they are able to walk up close enough to talk to the fishermen or others working at the docks.

**Organizations:**
There are an array of associations for fishermen, most often based on gear type. Most of these organizations have at least one member who actively lobbies for the group and gear type in management fora or even in front of town boards (especially vis a vis waterfront issues). The organizations with higher membership are more apt to have paid staff who can represent them at meetings and consequently, have had a more active voice in the development of the fisheries management plan. Traditionally, it has been the large vessels that are more frequently represented than the small, but a number of organizations representing small boats or a mixture have been faithful attendees and commentators on the proposed plans. Captain-owners are far better represented than crew members.

However, many active fishermen do not feel well-represented. They comment that it is difficult for someone who is not actually fishing to properly understand the active fisherman's perspective. On the other hand, the sheer numbers of meetings and the distances involved preclude a fisherman attending any but the most important meetings. Unfortunately, some complain, it is impossible to know ahead of time which meetings are going to affect the individuals most.

There are several very active wives associations that cross-cut the associations by gear characteristic of the fishermen's associations. The most prominent are in Maine, Gloucester and Chatham. These associations lobby in management fora, but also serve social functions of supporting each other and organizing festivals as well as promoting seafood consumption.

Only a very few organizations try to represent geographically-dispersed fishermen. Maine Fishermen's Wives, the Maine Gillnetter's Association, and Atlantic Offshore Fishermen's Association are primary examples of those who attempt to do so. Other organizations limit their efforts to their own town and often their own gear type. In each port profile, the numbers of fishermen said to be represented by each group is indicated.

*Social service outreach:*
Social agencies that reach out to the fishing community exist in New Bedford, Pt. Judith and Gloucester. Substance abuse is their primary concern. In some communities, religious organizations also provide social services.

**Lifestyle:**

Incomes for fishermen run the gamut from $10,000 to $110,000 per year. Estimates are difficult to make and fishermen are notoriously close-mouthed about their incomes. What is certain, however, is that fishermen take a share of the proceeds of the catch after expenses. This form of profit-sharing makes the crewmembers as anxious for a good trip as the captain-owner. It also counterbalances the hierarchical organization of a boat's crew. The crewmember is also rarely on a contract and is able to leave the boat if he is dissatisfied with the income or working conditions. On draggers, the finding of a new site is easiest for skilled netmenders, but good cooks and others with specialized skills are also welcomed.

The greatest differences in income are probably between captain/owners and crewmembers. The owner-operator takes the major risk in the fishing operation, but he can be well compensated since he receives a captain's share and the boat share. Theoretically anyway, a highliner (successful fisherman) captain-owner among the small vessels can bring home a range of income comparable to that of the captain-owner of a large vessel because the small vessel's costs are much lower than that of a large vessel.

The owner-operators are in a tenuous position, however, from the standpoint of credit. Most middle-aged and young captain-owners have very large mortgages on their vessels with their house as collateral. If they lose their boat, they also lose their house, a source of great anxiety among fishermen and their families.

Crewmembers have a wide range of incomes. One described his as "just below the poverty line." He happened to be joking, but one of the service agencies noted that there are fishermen's families receiving assistance (welfare or food stamps).

Some Maine fishermen comment that earlier in their career they could make a living even taking winters off from fishing, just spending the time working on their gear. However, within the past 10 or 20 years lifestyles have radically changed for fishermen, particularly for those in rural Maine. A decade or two ago it was not unusual to find solid middle-class families living in houses without hot running water or indoor bathrooms. Central heating is still a luxury many live without. For the most part, however, fishing families now want and expect the same level of consumer comfort as the majority of the nation's middle-class. Bathrooms, hot water, trucks, cars, televisions, Nintendo, Pizza Hut, etc. are considered necessities, not luxuries. In consequence, an average, middle-class life style is much more expensive to support than it was in the recent past.

In addition, boats and gear are much more expensive. Almost everyone has more power, safety equipment, electronic and fishing gear than ever before. All costs have gone up.

Nevertheless, there are still fiercely independent individuals and families who pride themselves on limiting their acquisition of goods and comforts, making as much of their gear as they can and being as self-sufficient as possible.

Many fishermen comment that they have been able to make a decent living from the sea, but their wives tend to add that the long hours and danger of their work is barely compensated, particularly if analyzed as an hourly wage. Most fishermen believe that the industry is unfairly accused of being greedy and the sacrifices individuals make that truly benefit the nation are not appreciated.

**Fishermen's role in management:**

Due to the expense and difficulty involved in "at-sea" enforcement, fisheries management must frequently rely on an honor system, rather than simply relying on a perception of there being a high potential for an enforcement action. For management to be effective, fishermen must believe that the management regulations are appropriate and just for all, so that the majority will abide by the regulations and help bring pressure to bear on those who try to circumvent the rules. Consequently, fishermen's perceptions about management are significant.

As noted above, despite organizational representation, many fishermen do not feel that they have a voice in the process of fisheries management. Since fisherman's time at sea is contingent upon so many variables including weather, vessel conditions, regulations, not to mention more personal issues such as health and family considerations, and since the product of that time is also unpredictable given the mobility of their prey, most fishermen feel compelled to fish as much as possible. Many took time off from fishing to attend the public hearings for Amendment 5 because it was clear that their interests were going to be affected by their responses. That is not so predictable for the average council or subcommittee meetings.

Others have actively participated in industry advisory meetings to try to develop alternatives that fishermen can support. Many have found the process discouraging, however, with divergent views of appropriate measures expounded by the various participants and the slow pace of consensus development.

Many fishermen express a frustration with the system that sets up regulations, but then does not consistently or strictly enforce them. Again and again, fishermen say that if the regulations were enforced across the board, if a few people actually lost their right to fish, that everyone would adhere to the regulations. A true fishermen (one who loves his job) would not be willing to risk violating the regulations if he risked losing his right to fish.

Fishermen commonly assert that they are conservationists at heart, they want to see the fisheries continue for their children and grandchildren. Although quite a few disagree with the biologists about the extent of stock depletion, most agree that there is problem that needs to be addressed. However, if violations have no serious consequences and it is obvious that others are violating or pushing the limits, then fishermen feel foolish sticking to the letter of the law and suffering economically as well.

Some fishermen believe that pressure on groundfish could be relieved if government would help develop domestic and foreign markets for underutilized species and provide appropriate information to fishermen and dealers trying to supply these markets. One example offered of research useful to businessmen was what time of year herring has a fat content of 10-15 percent for sales in Europe.

With a few exceptions, prices for underutilized species are (and always have been) too low to cover fishermen's time and expenses (Peterson and Smith, 1979). Fishermen argue , however, that government could aid in marketing efforts and in procurement of "underutilized" species for schools, prisons and the military , or the Food for Peace program. Others who have managed to develop niches in the underutilized species markets fear government-aided competition, fearing not only a flooding of the market, but also a reduction of fish stocks.

Fishermen in rural areas, particularly the small vessels, believe that theirs is a different way of life that is not going to be accommodated by the regional fisheries management system. For example, Stonington (Maine) fishermen lament when the large 90- to 110-foot, New Bedford scallopers fish out local scallop beds in a few days that would have supported the Maine scallopers all winter. But they feel that the tendency toward economic efficiency, and the manipulation of the management process by larger, wealthier communities will disregard the needs of the small fishermen.

### E.6.4.3.1.2 New Bedford, Massachusetts: A Port Profile

**What's it worth? Landings and value:**

In 1991 New Bedford, Massachusetts had landings with the highest value of any port in the country. Catches of yellowtail flounder, scallops, cod and other groundfish caught on Georges Bank provided the bulk of the 106.4 million pounds of fish and shellfish worth $157.7 million landed in the city (National Marine Fisheries Service, 1992). Ninety percent of the sea scallops landed in New England are landed in New Bedford.

Approximately 2,000 men are directly employed as fishermen (10 percent of the 20,997 males employed in New Bedford). Thousands of other people are employed in supporting services such as processing, manufacturers of equipment, transport companies, supply houses, oil companies, welders, pipe fitters, stores, settlement houses, etc.

*Vessels*
The numbers of permitted vessels, and the numbers that landed in the port of New Bedford are presented in section E.6.4.1.1.2 above. Of the three hundred to four hundred vessels that land in the port in any year, many are seasonal or transient vessels. The groundfish vessels are primarily large draggers, over 50 gross tons and 75 feet. Approximately 150 draggers and 115 scallopers call New Bedford their homeport. These numbers reflect a marked decrease in dragging and significant increase in scalloping since 1985 when Doeringer et al. (1986) found that the New Bedford fleet had about 200 draggers and 55 to 60 scallop boats.

In addition, New Bedford has a number of gillnetters, a few offshore lobster boats, tuna fishermen (purse seines), swordfishermen (driftnets) and a few vessels that seek underutilized species such as squid, dogfish, butterfish and whiting.

The size and value of the scallop fishery to New Bedford makes it imperative that some detailing of its organization and operation be considered in the port profile that is otherwise primarily concerned with the groundfish fishery.

**Ownership and operation**
About half the vessels are owner-operated. Few people own more than one or two vessels although there is one individual who owns seven scallopers and another who owns seven draggers. There are a number of individuals who own one dragger and one scalloper.

Large draggers ideally carry six men, but many work "short-handed" now with four or five men.  The smaller catches require fewer crewmembers to sort, ice, and shovel the fish into the hold.  Some fishermen expressed concern about safety noting that only two men are on deck at "set out" and "haul back" when going short, a situation that may have serious consequences on large vessels.  In the early '70's many of the vessels carried as many as nine men.

Steaming time for draggers can be anywhere from 6 to 12 hours to reach the shoals or yellowtail flounder areas, 18 to 20 hours to Georges Bank for cod and haddock.

Scallopers generally carry a crew of nine men.  A ten- or eleven-member crew is said to be ideal, but owners do not have to file withholding tax if they carry fewer than ten.  Some scallopers will increase the numbers of crewmembers during the summer to handle larger catches, a few taking as many as 14 men.  On their 10- to 15-day trips, the scallopers steam 18 to 24 hours to Georges Bank (60% of the fleet).  Most scallopers lay over three or four days between trips to maintain the vessels, replenish supplies, spend time with families.

A small group of scallopers, 19 boats at most, fish back to back.  These usually have three crews for two boats (or four or five crews for three boats) so that when a boat returns and unloads, it can be turned around quickly and leave with a fresh crew.

*Crew*

Draggers are more inclined to keep the same crewmembers for several years than are scallopers.  A dragger may lose one or two members when winter sets in, but the majority will stay at least three to five years.  Many young crewmembers try to move up to mate with the goal of eventually buying their own boat.  It is not uncommon, however, to find boats with crewmembers who have fished together for over 20 years.

On scallopers, captain and mate or engineer may be related, but the crew tends to be younger and more mobile than on draggers.  In addition, there are fewer opportunities for upward mobility than on draggers.  Though crewmembers may make more money than they do on draggers (on the average), the work is physically very hard.  The gear is heavy, lots of stones and rocks come up in the dredge and have to be removed.  The rings have to be replaced on the chain bags and the trips are long.  Crewmembers sometimes quit just to take a vacation.

*Living conditions on board*

Working conditions can be harsh, especially in bad weather, but many of the newer, large vessels have pleasant accommodations for crew with staterooms (two or three men), flush toilets, rugs on the floor, radio, TV, VCR.[4]  Small vessels still make do with

[4] One observer pointed out that rugs are not simply for "adornment," but contribute to safety.

bunks, galley and table all together in a cramped space near the bow, and a bucket in the engine room for privacy. Common to both large and small vessels, however, is a shortage of leisure time. Only during long steams to and from the grounds or during meals do fishermen have "time-off," and reading is the primary recreation.

Owner captains increasingly have cellular phones which afford them more privacy than do VHF marine-band radios (particularly valued for business reasons); however, high service charges limit their use. Many still rely on marine radio-telephone for their calls to shore and the radio talk among boats continues for comraderie and security.

*Weather*

The large size of the vessels allows fishermen to go out in heavier weather than they did traditionally. Lately, the boundaries of fishing weather have been pushed out farther due to the high costs of living, the scarcity of fish, and the prices that have not kept pace with the prices of gear. Scallopers, in particular, will fish worse weather than they used to.

Despite recent implementation of the Vessel Safety Act mandating a sharp increase in safety equipment, fishing vessels and fishermen continue to be lost. Some fishermen cite the pushing of weather limits due to regulations as one of the contributing factors.

*Expenses*

Fuel, ice, food for crews and replacement gear add up to considerable expense. One of the expenses that is frustratingly high for some owners is the interest on their mortgage. Because of the uncertainty of catch due to diminished stocks and regulatory changes, many owners have been unable to refinance vessels to take advantage of the much lower interest rates now available.

Insurance rates are also extremely high, often as high or higher than the mortgage. Fishing is a dangerous occupation, and personal injury settlements have been high. Mortgage and insurance on a 70-80 foot, ten-year old otter trawl can run $6-8,000 per month. Scallopers, with larger crews, may cost $8-10,000 per month for mortgage and insurance, plus $900 per month in unemployment tax.

Settlement houses charge $170-$200 per month to handle a vessel's taxes, paperwork, checks to crew, etc.

Electronics are relied on to a greater extent than in the past. One fishermen noted that while scanners are not common, most people have Lorans for navigation. His grandfather, in contrast, relied on landmarks to locate his favorite fishing spots, using the techniques of triangulation and dead-reckoning.

### Selling the catch

New Bedford has an auction owned by processors and dealers. Like the Boston auction, the dealers bid on the product, sight unseen. In New Bedford, a whole boatload is bought at a time, whatever the mix. Before the 1985 strike by the union, the auction was a public auction, but faced with harassment (e.g., car-bashing) and demands made by the union, the dealers started their own auction.

The New Bedford auction is said to "set the price or standard," at least for scallops and, probably, yellowtail; it reflects what dealers are selling for and what is bought from outside of New Bedford. Canadian, Chinese, Peruvian, and Icelandic scallops all compete with New Bedford scallops. Groundfish prices may be set by the Boston auction, since it handles larger volumes of groundfish.

New Bedford has over 20 dealers who purchase seafood from fishing vessels. Boats often have a commitment to sell to a specific dealer on a regular basis. Not all vessels "go on the board," i.e., use the auction. Some vessel owners allow their skippers to decide whether to sell at the auction, or sell directly to a dealer.

A couple of informants were quite open about the power of the dealers in their relationships with fishermen. "Price-fixing and price-cutting are accepted as a way of life, we don't know any other way," one former fisherman said. Two or three dealers are said to control the prices paid to fishermen, getting together at the Seafood Exchange. The dealers bid on the catches, but often pay the fishermen less than bid, claiming that the fish was not first quality. Even if an outraged fishermen has a NOAA inspector certify his catch, the fisherman has no power to force the dealer to pay what he bid. "There are 14,000 pounds of fish on the floor, what's he going to do? Shovel it back into the hold?" queried a fisherman.

The other dealers are bound by the prices set by the powerful dealers otherwise they lose their sales because they can be undersold by the larger dealers. It is clear that fishermen everywhere face constraints imposed by the harvest of a highly perishable product with wide daily fluctuations in supply and demand, a circumstance that seems to give dealers a wider range of options than it does fishermen.

Furthermore, one fisherman who said he has never had a problem with dealers owing to his consistently high quality product, said that most fishermen like the system of selling the whole catch to one dealer, so it can all be unloaded at once, payment is given and the fishermen can go home.

### Dockage and use of piers

There has always been a shortage of dock space. Most boats tie up at the five city-owned piers and a number take out (i.e., unload) in New Bedford, but tie-up at the Fairhaven piers. During holidays, such as Christmas, New Year's and the blessing of the fleet, and during storms, the boats are rafted, tied four or five abreast.

Three hundred boats pay $250 annually for the right to tie-up at the city piers, but it is "first come, first serve." There is room for 75 vessels to be tied to the piers; lighting, but no security is provided. It is nerve-wracking to have a vessel "rafted (i.e., tied up to others) even two or three deep," fears of fire and of damage are high when many vessels are in at the same time.

Private contractors pay the city $250 annually for a pier user fee which allows them to service the vessels. This permit entitles them to one unit such as a truck or other vehicle, additional units cost $50 each.

Vessels are not allowed to unload to trucks at the city-owned piers, they must unload only to the 15 to 20 processing plants that are clustered at the South Terminal. This limits opportunities to evade the "price-fixing, price-cutting," since fishermen can't unload to trucks that could then transport the catch to Boston, Portland or New York fish auctions and/or directly to smaller markets.

**City's economic base**

Moody's 1990 Municipal Credit Report describes New Bedford as a primarily residential community with "a large local fishing industry and a significant manufacturing component [that] add diversity to the economic base." Since 1990, however, New Bedford has lost some of its manufacturing component. Polaroid, which in 1990 was still producing film and was considered by Moody's as a major employer and taxpayer, has closed its plant. Achushnet, a manufacturer of golf balls remains, as does some apparel manufacturing. Moody's report notes that the resident population remains poor and the per capita income declined relative to the state since 1979. In 1990 the city's debt burden was modest, but Moody's report pointed out that this would be rising significantly due to sewer improvements mandated by the Clean Water Act.

**Incomes and standard of living**

Skippers used to make up to $100,000 per year. Now the range is more apt to be $60-80,000 annually. Deckhands make anywhere from $30-50,000 per year on a decent boat.[5] "Per men," captain, mate, cook and engineer, often receive a stipend for their extra responsibilities. The stipend varies, sometimes it is fixed at $100 per trip, other times is a percentage of the catch. As in most fishing communities, the majority of the

[5] In 1979, almost half of the New Bedford fishermen earned $20,000 or more per year (Doeringer et al, 1986).

fishermen's income is not based on a salary, but rather is a share of the proceeds from the sale of the catch after expenses are paid.

As was noted in previous sections, the income of fishermen is based on extremely long hours devoted to a dangerous occupation and does not entail paid vacations, weekends-off or retirement pensions. Nevertheless, many fishermen say fishing provides them with a "good living," one that would be difficult to achieve in another occupation with the same level of satisfaction, particularly given the average educational level.

At one time, New Bedford had a strong fishermen's union. Fishermen could count on social security and a pension when they retired. Because crews were larger, boat owners paid withholding tax for their employees. Now on most boats, crewmembers are considered for tax purposes to be self-employed and thus responsible for paying their own withholding tax. Many young men fail to do so. An organization has recently been formed that is lobbying for changes in the tax regulations that would require withholding on boats with eight or more crewmembers.

As expenses for fishing vessels have increased, crews are bringing home less. Nevertheless, most consider themselves middle-class. The 38,646 households comprising New Bedford's population (fishing and non-fishing included), according to the U.S. Census data, have a median income of $22,647. Of the 26,677 that are families, the median income is $28,373 and non-family households have a median of $10,179. Per capita income is $10,923.

Captains and "per men" usually own their own homes or condominium, a car or two, and often a truck. In 1990, the median house price in New Bedford was $115,900. Crewmembers usually own at least a car. Owners often have large mortgages on their vessels with their homes as collateral.

Some say that the income does not truly compensate for the danger and grueling hours fishermen put in, but that fishing "gets in your blood" and is a satisfying occupation.

**Community Organization:**
**Ethnicity and families**

In the dragger fleet, Portuguese predominate. Some are immigrants, others are second generation, but many maintain a strong Portuguese identity.[6] A lack of fluency in

[6] As described in the Gloucester port profile, some fishermen guarantee jobs for their immigrant relatives, reducing the flexibility in hiring that is otherwise valued in running a fishing boat.

English contributes to the formation and maintenance of a close community.(Doeringer et al., 1986:57). Traditionally, family ties among crewmembers were common.[7] Brothers, brothers-in-law, cousins, uncles still do fish together if they "get along." However, an awareness of the dangers of wiping out a whole group of men in one family should the vessel go down is a matter of concern to some.

At one time Norwegians dominated the scallop industry and they retain a major presence as captains, while the crews tend to be of a mixed heritage. Now, most scallop fishermen are second- and third-generation American, a mixture of Norwegian, Newfoundlanders, and a few Portuguese. In the summer, fishermen from Maine and various southern states expand the scallop fleet.

*Wives and family considerations*

Many wives work, though not necessarily in the fishing industry. Wives of Portuguese crewmembers often work in fish processing plants. Second and third generation women are more apt to have jobs as secretaries, teachers, accountants, etc.

Few wives actually "keep the books" as they did in the past, most owners rely on settlement houses to pay crew, taxes, and other bills.

Family ties tend to be maintained and extended in fishing communities, to provide a support network for wives and children of active fishermen. Grandfathers who are retired fishermen often play an important role in their grandchildren's lives, being present for school plays and activities fishing fathers often miss. These networks are perceived as essential to many wives and would make it difficult if not impossible to move to different ports.

Although wives often mention the difficulties involved in raising a family with a fisherman husband-father absent for so much of the time, they also note that there is a measure of independence that is appealing, particularly in contrast to the "catering he expects when he's around."[8].

Fishermen and their families tend to socialize with others in the industry regardless of whether or not they are relatives.

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[7] "Fifty-seven percent of fishermen interviewed in 1978 [in New Bedford] had at least one kinsman among the crew they fished with" (Doeringer et al, 1986)

[8] Other positive benefits are noted in Doeringer et al. (1986) such as "living near the shore," "spontaneity of the unpredictable schedule" and the positive effects fishing has on their husbands.

**Education and alternative employment**

The educational level ranges from grammar school to college- or service academy-educated. However, many in the industry have not graduated from high school. In 1980, the median level of education was nine years and less than ten percent had education beyond high school and two-thirds had not graduated from high school (Doeringer et al., 1986).

Until the last few years, the income of fishermen was quite good compared to shoreside jobs, even for those with college education. One fishermen mentioned that 14 years ago he was making $500 per month in the military service when his cousin showed him a $1,000 check for a ten-day trip so he decided to quit the service for fishing.

Despite declining incomes in the last two years or so, the lack of alternative employment, particularly in the poor economy of today, keeps young people moving into the fishing industry. While perhaps lower than in the past, incomes for fishermen, crewmembers as well as "per men," are still significantly higher than equivalent jobs ashore. Among successful scallopers, crewmen can make $35-40,000 per year; skippers make $70-80,000 annually.

Nevertheless, there are boat which barely survive. One groundfisherman mentioned 10-day trips, 16 hours per day working, and a paycheck of $85 for the 10 days. The Mariner's Assistance Program tries to help crewmembers of boats that have several poor trips in a row.

The 1990 U.S. Census found that of the 64,554 people in New Bedford over the age of 25 years, 49.7 percent were at least high school graduates and 9.7 percent were at least college graduates. Currently, the trend is said to be towards increased education with parents encouraging their children to prepare for alternative employment. However, New Bedford has lost much of its alternative economic base in recent years. Polaroid, Goodyear, Revere and Continental have all shut down.

Stereotypes of fishermen in different fisheries are prevalent. Scallopers are described as "seafarmers" having "weak minds and strong backs." Draggers are said to require more experienced fishermen, particularly skilled net menders. Also, fishing over the shoals requires "everyone to know what they are doing." The switch to steel-hulled boats has made obsolete the old saying about "iron men on wooden boats," giving way, one informant joked, to "iron boats with foolish men."

The practice of young men fishing with anyone who will take them (usually an uncle, brother or father) on weekends and summer vacations, when they are in high school, often for a reduced share, can "hook" the youth on fishing. Fishing becomes a secure "fall-back" occupation for many.

Fishing attracted many participants because of the "freedom, the money to be made, the independence and the perception that success depended on what one did with oneself.[9]" Some fishermen are losing the satisfaction derived from the freedom and independence factors due to the perception of being hemmed in by multiple regulations.

**Social welfare issues**

Most agree that the fishing community is no different from the larger community. There are some problems, but no worse or better than among other groups. Whether problems will increase with changes in management is difficult to predict. Individuals cope with change in different ways.

Scallopers do have a reputation for occasionally attracting young men who are substance abusers, though owners and operators try hard to keep their vessels "clean." The size of the vessels (making it harder to catch abusers), the frequency with which new crewmembers are required (because of their mobility), and the amount of spending money crewmembers have ashore may all contribute to the problem.

According to one fisherman, the drug problem was obvious in as much as 50 percent of the scallop crews because "their wrecks of cars littered with MacDonald's wrappers," the garbage bags they use as seabags, their disheveled appearance and their "don't give a damn" attitudes all indicate substance abuse by many of the young crewmen .

One difference between scallop and dragger fishermen is that the former are apt to feel more upwardly mobile. Crew on scallopers are not generally "being groomed" to be captains, while on draggers young fishermen believe they may have an opportunity to become a "per man" or eventually, captain.

**Management and enforcement**

Some fishermen report violations, but often don't like to do so. Some fear their voice will be recognized, others maintain that there is not a lot of respect for law enforcement because of a perceived lack of fairness. Complaints are voiced about the frequency with which some boats are boarded and the complete absence of boarding of other vessels. Some estimate a 70 percent compliance rate with mesh regulations

[9] Fishing as a "way of life" and satisfactory occupation has been analyzed by several social scientists. See, for example, *The Structure of Job Satisfaction Among New England Fishermen* by Pollnac and Poggie, 1979, Anthropology Working Paper #31, Sociology-Anthropology Department, URI, Kingston, Rhode Island.

and higher compliance with closed areas. More people are being caught, so more people are complying with the regulations.

More than one fisherman blamed fishermen's greed for the conditions of the stocks. "People never cared about the future, just that one trip [they were making]. They've done everything to violate every law, cheat, smuggle, do anything to make a living. They're hungry and greedy people, killing the goose that laid the golden egg." Others disagree, saying that they believe in conservation, but have been discouraged by the lack of enforcement of regulations.

Some blame the government for the programs that have encouraged the entry of more boats and more technically-sophisticated equipment into the fisheries. Guaranteed loans, in particular, are viewed as largely responsible for the overcapitalization in the industry. Before the loan program, a vessel purchaser had to pay 50 percent down, then pay off the boat in five years. With the loan program, buyers only had to put down 12 percent and were given 15 years to pay off the debt at a low interest rate.

**Organizations**

~~Fishermen's Legal Action Committee (FLAC)~~ was started in the summer of 1992 to serve the non-owner fishermen and small boat owners in the pursuit of their livelihood. In December the organization had 60 members. It publishes a newsletter and usually has one or two articles in the ~~Barnacle~~, a local paper for fishermen. The organization is trying to arrange health insurance for members and wants to start a credit union. Paralegals help answer legal questions. One of the issues they are working on is "employee status." Initial efforts include lobbying to change H.R. 2048 so the tax definition of self-employment is moved from boats with nine crewmembers to ones with seven.

*Contact: Alan Cass, Box 213, Fairhaven MA 02719. Telephone: 508-998-1329*

~~Mariners' Assistance Program~~ is an offshoot of the New Bedford Child and Family Service established in 1843 to take care of the whalers' orphans. The program provides a wide variety of services to the fishing community including: referrals to drug and alcohol treatment centers; programs for teenage parents; mental health programs; Big Brother and Big Sister; provides financial assistance after two or three "brokers" in a row, i.e., when the boat does not catch enough to pay the crew after expenses; also help with job searches and applications for public assistance and may even provide a ride.

*Contact: John Saunders. Telephone: 508-997-6595*

~~New Bedford Seafood Cooperative~~ is owned by 140 fishing boats, most over 60 feet, landing perhaps 80-90 percent of New Bedford's catch. Dragger-owners make up slightly more than half the membership, landing primarily yellowtail caught in southern New England, also landing cod and haddock from Georges Bank. The rest of the membership is primarily made up of scalloper-owners, though there are a few members who own the various other types of vessels that make up New Bedford's fleet.

One-half to three-quarters of the membership of these Massachusetts boat-owners also operate their own vessels.

The cooperative pumps 16 million gallons of fuel into boats, owns barges, trucks.

*Contact: John Bullard, NB Seafood Cooperative, Co-op Wharf, New Bedford, MA 02740. Telephone: 508-993-9926*

~~Offshore Mariner's Association~~ represents captains of about 140 fishing vessels, 55 percent groundfishing boats, 45 percent scallopers. Director speaks out for membership at public hearings of Massachusetts Division of Marine Fisheries, the New England Fishery Management Council and various advisory meetings.

*Contact: Howard Nickerson, Executive Director, Offshore Mariners' Association, Inc., 114 MacArthur Dr., New Bedford, MA 02740. Telephone: 508-990-1377*

~~Offshore Mariners' Wives Association~~ is a small group of primarily scalloper's captain's wives who organized as a political action committee to help keep fishermen informed and to help promote fishing in a positive way. The group organizes the Blessing of the Fleet each year.

*Contact: Maria Kilshaw, President, Offshore Mariners' Wives Association, 114 MacArthur Dr., New Bedford, MA 02740. Telephone: 508-996-4019*

~~Seafarers International Union,~~ with 450 members, protects fishermen and their families, emphasizing health care. Owners of about 90 draggers and 8 scallopers have a contract with the union. After 120 days fishing, the fishermen and their families receive medical coverage. In addition, after age 60 and ten years fishing, fishermen receive a pension.

*Contact: Henri Francois, 50 Union St., New Bedford, MA 02740. Telephone: 508-997-5404*

~~Seafood Dealers Association of New Bedford~~ is a 25-year old association of eight or nine dealers and processors. Attorney Mickelson acts as spokesperson for dealers point of view at Council meetings and congressional hearings.

*Contact: Harvey Mickelson, 30 Cornell St., New Bedford, MA 02740. Telephone: 508-993-8800*

#### E.6.4.3.1.3 Gloucester, Massachusetts: A Port Profile

**Landings and value:**
Gloucester boats landed 107.2 million pounds of fish in 1991, considerably less than the 150.9 million pounds landed in 1983, but the value increased to $40 million ($2 million more than in 1983).[10] According to National Marine Fisheries Service (1992), Gloucester still ranks first in New England for poundage landed (eleventh nationally), and tenth place nationally in value. The landings include a variety of groundfish, dominated by cod and pollock. Large quantities of whiting are also landed July through November. Monkfish is an incidental catch.

*Vessels*
In addition to what can be inferred about the vessels fishing out of Gloucester from section E.6.4.1.1.2, information gathered in interviews of the port agents further characterize the port. For example, there are currently as many as 35 transient vessels, including six Maine boats in Gloucester for the herring season. The port agents emphasize the fluidity of the fleet with temporary and transient vessels landing in Gloucester on any given day.

The port agents' characterization of boat size actually is an indication of fishing patterns rather than tonnage. Large vessels are those that characteristically fish at least 7 to 8 days, have a crew of approximately 6 and generally take 2 trips per month. The medium vessels are those fishing 2 to 4 day trips with one or two day layovers, making at least 4 trips per month, weather permitting. The small vessels are day boats. The implication for management of this characterization is that large boats might start fishing closer to shore and taking shorter trips than they usually do in order to maximize fishing time per day at sea. This would only remain profitable if inshore stocks could support the increased fishing pressure.

Of the transient or temporarily Gloucester-based vessels, the majority come from Maine. The attraction is price and/or that during certain times of the year, draggers catch lobsters which cannot be legally landed in Maine by otter trawlers.

In the last decade, the drop in the numbers of vessels whose homeport is Gloucester has been sharp, in 1983 there were 235 vessels over 5 tons, currently there are fewer than 120 over 5 tons. One of the port agents noted that 90 boats sank in the '80's. Some of the sinkings have been investigated for insurance fraud. Many of the old, wooden-hulled vessels that sank have been replaced with newer vessels, but the NMFS port agents indicate that the fleet is still relatively old with a number of wooden, Eastern rigs, antiques at 50 years old. The newest vessel is four years old.

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[10] Reportedly, some vessels that traditionally landed in Gloucester or Boston are now taking out in Portland, Maine.

A couple of vessels have up-to-date electronics, most have a minimum due to the expense. The larger, more advanced vessels in New England were built by processors who will not invest in the fishing industry now because of the uncertainty of its future. New, offshore vessels cost in the million dollar range, inshore vessels about $100,000.

**Ownership and operation**

A majority of the vessels are owner-operated. At least one individual owns two vessels and operates one. Twenty-eight of the 32 largest draggers belong to the Cape Ann Vessel Association. Twenty-seven of these are owned and operated by Sicilians, all but two owners are immigrants.

Crews, while theoretically composed of 6 members, usually run short one or two men these days, but are fairly stable. The trip lengths widely vary depending on catch. Commonly, port agents and representatives of fishermen say that the large vessels take 7- to 10-day trips and layover 2 or 3 days. A number of the wives say that the boats are currently taking 10- to 12-day trips. Steaming time to Georges Bank is 18-20 hours.

There are 500 to 700 fishermen in town, with ages ranging from 18 to 60 years old. The majority of skippers on the large vessels are fairly young, between 30 and 40 years old, with the exception of the whiting fleet that is said to be composed of fishermen getting ready to retire. The young skippers are just building their homes, investing in their vessels, and do not plan to leave fishing for 20 years or so.

**Selling the catch**

Most sell to one or the other of the six or seven fresh fish buyers in Gloucester. Only four of these are capable of handling the largest vessels (take out, store, sell), particularly if more than two come in at one time. The inshore vessels box, unload to trucks and ship directly to New York. The majority of the fish ends up in Boston or New York for auction. The rest is sold directly to small processors in Gloucester.

The quantities of fish are still relatively high, although the volume is greatest in the lower valued species. For example, in the winter much of the catch is herring which is shipped to Maine. One observer noted that there is an occasional a shortage of gurry (fish by-products) needed by the pet food industry. Now that a long-time processor of fish waste is out of business, fewer fisherman land the high volume, oily fish that once comprised a large percentage of Gloucester's landings.A group of fishing-related interests is currently involved in efforts to attract development of a state-of-the-art, environmentally sound, protein recovery plant in Gloucester to process underutilized species. Water and sewer systems are viewed as limiting factors, though.

Wheeling and dealing is said to be a part of fish dealing in Gloucester, "as well as everywhere else." Both dealers and vessel-owners can benefit. One scheme said to be used to benefit owners is a kickback on the sale of fuel and food. (Since the crew is paid a share after expenses, the price of fuel and food is inflated on paper and the extra given back to the owner under the table.)

Another way the owners can benefit to the detriment of their crew is to borrow money from the dealer and pay back in fish that does not appear on the weighout slip. Some owners will only sell to dealers for cash, offering more opportunity for manipulation.

The dealers manipulations of price and other alleged activities are similar to those described for New Bedford. One woman complained that a dealer had refused to pay the agreed-upon price to her husband, claiming that the processor to whom he sold had refused part of several catches because they were spoiled, but later the processor contacted the fisherman directly, requesting more of his high quality, daily catch. The processor assured the fisherman that he had never turned down his product.

Nevertheless, some say that processors and dealers are more honest than they once were since the fishermen are better educated, more alert to the potential for rigging scales, etc. Fishermen are also said by some to take greater pride in their product and take better care of it than they once did. An increase in attention to quality product and utilization of everything that is caught is "an important factor in the evolution and success of fishery management, " said one observer.

Occasionally fishermen complain about dealers and imagine that they can eliminate the middleman. However, one person pointed out that the dealers have to have a facility to unload and ship the product, sufficient capital to carry accounts, and a sales force. These intermediaries perform important functions that fishermen depend on since the fishermen usually do not have the time or other resources to perform them independently.

There is potential for growth, at least one person suggested, in dealing in imported fish. This is not a cash operation, however, and very different from current fish-dealing practices. The fish is frozen, with a long shelf-life, so it is a business comparable to dealing in other commodities, such as grain.

**Dockage and use of piers**

Some boats tie-up at the wharves owned by dealers and in return they buy their fuel from that dealer as well as sell their catch to him. Others tie-up at the State Fish Pier for a fee.

**Town's economic base:**
Although fishing dominates Gloucester's image and attracts tourists, there is a vocal group of waterfront owners who, it is said, would prefer to sell their land for shopping malls and condominiums. However, a large portion of the harbor is designated as working harbor, a marine-industrial zone from which residential building is banned.

Some individuals estimate that at least 40 percent of the community's employment and revenue is dependent on the fishing industry. Although fishermen make up a little less than 10 percent of the employed males in the labor force of Gloucester (about 600 fishermen of 7,290 employed males), fish landings were sold for $40 million and the related economic activity is said to multiply the local benefits of landings. The multiplier effects include employment in support industries such as suppliers of fuel, ice, food, equipment, transport and processing of product, etc. In addition, property taxes, income tax and federal and state corporate taxes on vessels are generated by the fishing-related businesses.

Others say that most people in the community do not view fishing as an important industry, since they see that the city government has a budget of $44 million dollars and may employ more people than the fishing industry. Many in the fishing community claim that there has been an influx of people who have little understanding of the fishing industry and its benefits for the community. Part of the reason for this lack of understanding may be attributable to the fact that the fishing community has traditionally been rather insular, interacting only with others in their business, with little input into broader issues facing Gloucester. Contributing to the insularity of the fishing community is its strong ethnic identity, particularly in the offshore fleet.

**Incomes and standard of living**
Reports on incomes are highly varied. Some claim that incomes have remained fairly high, at least among the large vessels. These offshore boat crews average $30-40,000 per year while their captains earn $50-55,000 annually.[11] The medium and small vessels incomes are more variable. The highliners' crews earn an average of $20-25,000 and captains earn $35-40,000 per year, though they can make more if they "hit shrimp." On other vessels, not considered highliners, crews may earn $15-20,000 annually and captains $20-25,000.

Vessel owner-operators also have extremely variable income. One wife of an offshore

[11]In 1980, interviews by Peterson and Pollnac suggested that earnings in excess of $15,000 to $20,000 were typical of offshore fishermen in the '70's and '80's (Doeringer, et al. 1986).

vessel owner-operator noted that their annual income was about $40,000. However, the boat share covers the vessel's mortgage ($4,000 per month), boat insurance ($7,000 per month) and the family's health insurance ($500/month), in addition to the normal operating costs.

Others maintain that fishermen are barely making a living, that the Gloucester fleet is down to "barebones" and the fishermen are no longer "getting rich." Some fishing industry observers agree, pointing out that income figures should be described in terms of an hourly wage and compared with hourly wages of workers in other dangerous occupations to avoid misrepresentation.

Most fishermen do own their own homes if they bought before the market "went out of whack." As elsewhere, the homes have been used as collateral on many vessels. The average house in Gloucester was bought for $50-75,000 if purchased before the mid-1980's. Now, the median house price in Gloucester is $177,100 according U.S. Census data.

Most vessel owners also own trucks and cars and crewmembers own cars. Occasionally, managers and others cite new vehicles as evidence of a thriving industry. Fishermen owner-operators point out, however, that the tax system (i.e., depreciation deduction) dictates the frequency with which a work vehicle is purchased.

Some say that the fishermen who complain that they are not making enough money are probably not working as long or hard as they should. "If you're a fisherman, you should be out fishing, not coming in at one o'clock in the afternoon." Others note that changes in work patterns are affected by fish species, abundance and regulations, as well as changing attitudes towards familial responsibilities. For example, a catch of dogfish requires early afternoon landings for delivery of a quality product.

According to U.S. Census data, the median annual income for the 11,550 households in Gloucester is $32,690. For the 7,634 of these households that are families, the median is even higher at $39,827. Non-family household income is much lower at $17,258 and the per capita income is $16,044 (fishing and non-fishing).

**Community organization:**
**Ethnicity and families**

The dominant ethnic group in Gloucester is Italian. Although major immigration waves stopped in the mid-70's, there are still a significant number of fishing community members who immigrated more recently, and many who speak only Italian or Sicilian. Some say that "everyone in Gloucester is related, depending on which village in Italy they (or their parents) came from." In general, interaction among fishing and non-fishing families is limited. In fact, there is little interaction among Italian and non-Italian families, even within the fishing community. No groundfish fishermen or their wives hold political office.

In the few fish cutting plants still operating in Gloucester, contract labor is used. This temporary labor force is generally brought in from Lowell or Boston and is often Cambodian or Cape Verdean.

*Wives and familial considerations*
Kinship is significant in the Italian fishing fleet.[12] Relatives often fish on the same boat, contribute to younger relatives' purchases of vessels or new equipment and sponsor new immigrants, guaranteeing jobs on their vessels for the newcomers.[13]

Estimates of the numbers of wives who work varies, but it may be as many as 60 percent. Those with extended families, who can call on their parents to care for their children, find it easier to work. Wives who work frequently do so for the benefits, particularly health insurance. Some of the wives still keep the books for their husband's vessel, but there are at least six settlement houses in Gloucester. Gloucester fishermen's wives have organized and as a group have played an active role in management council hearings, at least since the 1970's. In addition, they have worked to promote the use of seafood, demonstrating cooking techniques in many public events.

A fisherman's wife has to be the mother and father to the children when her husband is out fishing for ten days at time, yet has to answer to her husband as well. The younger generation of men is more involved with family decision-making.

Fishermen and their families socialize together, particularly within the Italian community. Conversations almost always revolve around fishing no matter what the occasion for the gathering, weddings, baptisms, etc.

**Social welfare issues**
Fears were expressed that the tie-up time will lead to substance abuse among bored fishermen. Wives will be forced to work, to keep up on mortgage payments, so they won't be home to occupy (and watch over) their husbands. Fishermen, it is feared, will increase their drinking while socializing. Depression, it is thought, will also be

[12] Doeringer et al (1986:59) note that "family participation...is commonplace. Sons and nephews are expected to work on the boats, wives help with the accounting, and uncles, fathers and grandfathers provide funding for new boats, as well as advice and representation at shoreside meetings. "

[13] Doeringer et al (1986:59) point out that these economic guarantees are "legal as well as kinship commitments." Consequently, these limit the flexibility normally associated with decisions about expansion and contraction of the fleet (or even crew size).

increase. Some have suggested that disillusionment with fishing, making it just another job, will also result from increased regulations.

In the 1970's, Gloucester ranked third in the country in per capita alcohol consumption according to a former bar owner. Nevertheless, social controls are still fairly strong in Gloucester. To date, neither drug use nor domestic abuse has been a major problem in the fishing community.

**Education and alternative employment**

Among the older generation of fishermen still fishing, many left high school to go fishing.[14] A number of immigrants completed the fifth grade in Italy, said by some to be roughly equivalent to a high school education. Now, most young people finish high school and several have gone on to college or even graduate school before entering the fisheries.

The 1990 Census found that seventy-five percent of the population of Gloucester over 25 years old has at least graduated from high school and 20.4 percent have graduated from college. This places fishermen in the lower educational ranks in the community, making them less competitive for alternative jobs.

Fishermen in their 50's are too young to retire and furthermore, have too many obligations to support with the kind of jobs they might be able to obtain outside of fishing, particularly if they have had only a minimum of formal education.

Despite regulations, the appeal of fishing—freedom to "be my own boss," working outside, making a decent living—proves irresistible to many. Most immigrants want their children to be educated and to work in a more prestigious occupation than fishing, but the high cost of college and graduate school, the lack of employment opportunities in today's poor economy, and the decent income still possible in fishing attracts some young people.

There are three fresh-fish processing plants left in Gloucester (Connolly, Star Fisheries and Ocean Crest) plus maybe a few more one- and two-men operations, most owned by people nearing retirement. Fairtry recently closed. Evidently there is insufficient product being sold in Gloucester to keep more processors active. Women who are spouses and daughters of fishermen are often employed in unskilled labor positions in leather goods and frozen fish block processing plants.

Generally, Gloucester is considered an economically depressed area with high

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[14] "In 1980, less than 14 percent of the commercial fishermen had education beyond high school and 43 percent had not graduated from high school" (Ibid:51)

unemployment. Tourism provides seasonal work opportunities, but at relatively low wages. However, there are a number of outside agencies expressing an interest in Gloucester's revitalization.

A group of people in Gloucester are encouraging the community to come up with innovative ways to increase the benefits the city derives from fishing. Some of the ideas center on "value-added" industries that would be eminently suited for the State Fish Pier. For example, deriving pharmaceuticals from sealife, development of new products such as minced fish to replace hamburger and liquid protein additives made from fish, and making fish meal from fish waste processing. Other ideas include providing a base for deep sea mining operations and encouraging recreational fishing with a municipal marina. Aquaculture might also be considered.

Some of these suggested alternative activities or uses for the harbor would integrate with the existing cultural environment better than others. There are also other constraints on the development of new and related industries. Gloucester has major road access only from the south, the land is dominated by granite ledges and wetlands, the city relies on a surface supply of water, wastewater disposal is a problem and there are no farmlands available for development.

### Management and enforcement

*Compliance , reporting violations and sanctions*

Reportedly, liners have not been used for the last three years. Most of the fishermen are afraid they'll be caught if they cheat and have to pay large fines. However, some observers say that current fines are just "the cost of doing business" and don't change compliance rates, instead, they suggest, boats that don't comply should be tied up.

Asked whether they would report observed violations, most fishermen or their wives hesitated, then admitted that it would be unlikely. One woman explained that all the fishermen are friends, "they've baptized and confirmed each other's kids." One noted that as times become more difficult, however, as those who "you watch go inside" (e.g., closed areas) are "able to give their wive's diamonds and you aren't..." [Pause indicating that attitudes about reporting violations may change.]

*Gear conflict*

Gear conflicts occur between gillnetters and draggers in inshore areas particularly.

### Organizations

~~Atlantic Fishermen's Union~~

> *Contact: Mike Orlando, Vice President, 11 Rogers Street, Gloucester, MA 01930*
> *Telephone: 508-283-1167*

~~Cape Ann Gillnetters Association~~

*Contact: Paul Cohan, President, 79 Livingstone Ave., Beverly, MA 01915. Telephone: 508-922-3941.*

~~Cape Ann Vessel Association~~ represents 27 of the largest, offshore trawlers based in Gloucester.

*Contact: Ed Lima, Executive Secretary, P.O. Box 7057, Gloucester, MA 01930. Telephone: 508-281-2203*

~~Gloucester Fisheries Association~~ represents the interests of land-based operations in fisheries, including dealers and processors.

*Contact: David Sneed, Executive Director, 51 Main St., P.O. Box 539, Gloucester, MA 01931. Telephone: 508-281-8011*

~~Gloucester Fisheries Commission~~, the only municipal fisheries commission in the state, advises the mayor and city council on measures for promotion and protection of the Gloucester fishing industry. In addition to the other associations on this list, members include the Chamber of Commerce, the Fish Pier Advisory Board and four members at-large.

*Contact: Tony Verga, Executive Director, Fitz Hugh Lane House, Harbor Loop, Gloucester, MA 01930. Telephone: 508-281-9703*

~~Gloucester Fishermen's Wives Association~~ with 125 members representing both captains and crewmembers, is active on several fronts. The group promotes the use of fish with cookbooks and cooking demonstrations, but more importantly, plays a role in lobbying for the fishermen at national, regional and local levels.

*Contact: Angela San Filippo, President, Gloucester Fishermen's Wives Association, 3 Beauport Avenue, Gloucester, MA 01930. Telephone: 508-281-0650*

~~Gloucester Inshore Fisheries Association~~ (or Fisherman's Wharf Association?)represents the inshore draggermen.

*Contact: Joe Testaverde, Executive Director, 39 Mansfield St., Gloucester, MA 01930. Telephone: 508-283-2976*

~~Seafood Workers Union~~ represents lumpers and Gorton's plant workers.

### E.6.4.3.1.4 Stonington, Maine: A Port Profile

**What's it worth? Landings and value:**

Between 7 and 11 million pounds of fish, plus significant quantities of all other seafood except lobsters and scallops are unloaded at the Stonington pier annually.

Lobster is handled by the Stonington Lobster Cooperative and several other dealers.

**Vessels**

In 1991, Stonington had 36 vessels permitted in the multispecies fishery, but because of the relatively small population, 1252, it ranked fourth among all ports on the northeast in per capita permits with 28.8 per thousand (see table E.6.4.1.1.2.3 earlier). Of these permitted vessels, 26 are tonnage vessels.

Ten years ago, Stonington, Maine, an island community linked to the mainland by a bridge, was the home port for 10 to 15 small draggers plus two year-round scallopers and gillnetters. Currently there are 10-15 vessels that gillnet in season (April to November) employing 33 to 60 full-time, "capable, aggressive" fishermen. Most of these vessels switch to longlining in winter, though some continue netting and others go scalloping, urchining or shrimping, while a few go lobstering.

Another 150-200 inshore lobster boats, employing 200-400 fishermen seasonally, also use Stonington as a home port. Many of these switch to inshore scalloping after November 15th, or after the lobster season (whichever is later). As scallops have become harder to find, urchining has filled-in.

Only one dragger and five or six full-time offshore scallopers still operate out of Stonington. It was considered a major scalloping port for many years, but scallops are currently not as abundant and "sets," i.e., new beds of scallops created when scallop larvae settle on appropriate bottom, appear sporadically. Clamming and musseling are also important to Stonington. A couple of vessels drag for mussels, clamming is primarily a shoreside activity. The large number of islands in the vicinity with clam beds gives anyone with boots, a hoe and a strong back some opportunity for fishing. Worming resources are also available, though currently mostly exploited by temporary residents.

**Ownership and operation**

In 1992, most of the commercial groundfish fleet is composed of small, owner-operated, gillnetter/longliners. Weather permitting, many vessels take 13 to 20 hour trips, seven days a week (in season). In summer, some vessels will make five-day trips.

The variety of fishing is significant. Few vessels are able to fish for the same species year round, but a thoughtful, experienced fisherman can make a good living with various combinations. The decisions about what species to target and what gear to use are personal. Individuals seem to "have an affinity for one or another fishery." In addition, start-up costs and experience affect the choices. Fishermen may be limited to particular species by their knowledge and by compatibility with their vessel or available gear.

Men in their early 50's note that when they were young, even those who were not from a fishing family could get started fishing with a skiff and a few used lobster traps. Slowly, and with hard work, they would build up their businesses. Starting out with only scavenged equipment is not practical now, considerably larger investments are needed.

Young men from the island can still get a start with a co-signer on a mortgage. The co-signer may be a parent, a dealer, friend, or grocery-store owner. One fisherman explained with a quote from his young son: "Ya know, Daddy, it's no fun living here, I don't have one father, I have about 30!" The fisherman noted that children on the island are known and each develops a reputation; responsible, hard-workers are recognized. Adults look out for one another's children and all have someone to talk to, even if their own parent is fishing or otherwise occupied.

One fishermen said that his expenses for an overnight trip run about $240 for fuel, food and ice for a 44-foot dragger. Landings vary with the season and other factors, but 1,000 to 1,500 pounds is considered respectable. Weather, however, interferes with his fishing. When the wind is over the 15-25 mph range, he won't go out.

**Selling the catch plus dockage and use of piers**

A few years ago, a fish pier was built in Stonington that radically changed business arrangements. The pier, a state bond funded project, gave fishermen access to the water independent of any dealer. Prior to the pier's construction, dealers forced fishermen to buy bait (for lobstering) and fuel from them, in addition to selling product to them, in order to have a place to unload, or tie-up while working on the boat. Dealers also extended credit, increasing the hold over individual vessels.

Now, fishermen can make independent arrangements for trucks to come down to their boat to provide services. Some now have trucks pick up their catch and truck it directly to the auction at the Portland Fish Exchange, or to wholesalers in Boston. The four established dealers, may be having some difficulty competing with the independent operations, particularly since their overhead is much higher. Trucking costs for individual fishermen are approximately 5 cents/pound. In addition, auction and brokerage fees are charged, varying according to the species. The dealers may be able to achieve economies of scale, offering the same services for lower cost since they are dealing in larger quantities.

Fishermen support expenditures on the pier through fees. Unloading rights are set at $10 per linear foot, plus $60 for parking. Dealers pay low rates, $200 per truck for product handling; $100 per truck for servicing vessels. The harbor committee purposely set rates low on the pier to encourage competition. Moorings cost only $15 annually for commercial vessels; $50 for recreational.

**Dependence of Stonington on fishing industry**

Fishing or fishing-related industries provide well over half the economic base of Stonington. "Don't imagine it would be here [without fishing]," said one interviewee. Besides fishing, a boat yard is one of the two largest employers in the town of 2,500 inhabitants with about 70 employees, although somewhat fewer are employed in winter. A nursing home provides the steadiest year-around employment, also of about 70 people. *Commercial Fisheries News* employs nine people. In addition, there is some tourism and a summer resident community with related service jobs. Quarrying which provided the original economic base of the community provides 10 to 12 other jobs. A sawmill employs three to five people. A sardine factory closed in July 1992, a loss of 50 to 80 jobs. Since then the factory was purchased by an urchin wholesaler-lobster processor, providing perhaps about 25 jobs.

The closing of the sardine factory was a matter of serious concern since it provided an important source of income for many of the fishermen's wives throughout the winter. It was also significant socially as it provided an opportunity for women to get out of the house and to talk as they worked, an important activity in the maintenance of community relationships. Thirty to forty lobster boats are also serviced by the sardine factory location, so maintenance of the site's water-dependent use was important.

Tourism and an influx of retirees or wealthier (than local residents) property buyers in the last six or seven years has been changing the tax structure of the town. Property was reevaluated last year and the rate went down, but the assessment of property along the shoreline trebled. Much of the downtown property has been purchased by summer residents and is boarded up in the winter. Affordable housing is badly needed for young couples in the community.

Efforts to exploit the advantages of tourism can be seen in the introduction of "knick-knacks and other junk" to the hardware store's inventory and efforts of a local contractor to develop a trailer park Some townspeople believe that the island is not big enough for further development, that it is already "too congested for the natives."

The development has another negative side in that costs for services continue to rise. The island depends on well-water and many of of the wells recently had to be replaced. The landfill was closed and a transfer station developed at high cost. Recycling is just getting started. The town is spending $4 million to put in a sewer for 200 people, generating anxiety about the impacts of the chlorinated effluent on the lobster in the harbor, in addition to the financial burden.

Others suggest that the town must perform a "balancing act" to achieve the right mix of tourism and fishing. "If you take fishing away, the tourists wouldn't come," one fisherman whose wife sells real estate noted. "The only problem with summer people, they turn around and ruin the very reason they came in the first place (e.g., by demanding the same goods and services accustomed to at home)," he added. Perhaps some areas of shoreline should be reserved (for fishing) comparable to the green area drawn on Long Island to protect the potato farmers.

**Incomes and standard of living**

"Like everywhere, fishermen's incomes run the gamut from $10,000 to $120,000." A small boat owner noted that captains usually receive about five percent more than crew and have an income range of $25-30,000.[15] Another informant said the range was lower with half the captains earning about $20,000 and crews earning $13,000 to $18,000 annually. Crewmembers sometimes supplement their income with gear repair and / or urchining.

Fishermen form the upper middle-class of people on the island, not including the summer-home-only inhabitants. One fisherman's wife commented ruefully that a large percent of their income, however, was reinvested in the business.

Thirty years ago, fishermen were said to make enough money catching fish and salting it down to hold them over through the winter when they would work on gear. Now, fishermen's income is "just below poverty," one joked. Old fishermen own their houses, having had the help of FHA loans, but young men are living on credit paying for their cars, trucks, houses, boats, insurance, etc. The average, used ranch-style house of 1200 square feet, on an acre or two is said to sell for about $80,000. New houses tend to be in the $100-200,000 range.

**Life style changes:**

One observer noted that the change in fishing routine to a year-around activity can be attributed to a change in expectations, specifically, a difference in views about life style. Within the last 30 years there has been a very real shift towards the acquisition of the comforts of modern life that more urban areas have enjoyed for many decades. In Stonington, cold running water and outhouses were not unusual for even those of the solid "middle-class." Central heat is still a luxury. However, bathrooms, hot water, trucks, cars, televisions, Nintendo, pizza hut, etc. are now considered necessities. As a consequence, an average, middle-class life style is much more expensive to support than it was in the recent past.

[15] This figure is not much different from the $23,380 net income average for full-time fishermen noted by Peterson and Smith in *Small Scale Commercial Fishing in Southern New England* (Woods Hole Oceanographic Institution Technical Report, 1981, page 31).

In addition, boats and gear are much more expensive. The start-up cost of $30,000 for a 30 foot boat in the 1970's would now easily be $80-100,000. Everyone has more power, safety equipment, electronics and fishing gear than ever before. All costs have gone up.

There are still fiercely independent individuals and families. For example, one lobsterman still makes his own traps, catches his own bait, and limits his acquisition of goods and modern comforts. Though not a high school graduate, he is a skilled fisherman and good businessman, routinely getting above average prices for his lobsters.

**Community organization:**
As is common in most of the small towns in Maine, there is a strong attachment to Stonington as a community and islanders would not leave to find jobs elsewhere if they could find employment here.[16] Fishermen will travel elsewhere in search of fish, fishing out of South Bristol in the spring, for example, for a month or so, but not moving their residence.

Several individuals noted that people look out for each other on the island. It's a small community so people are close. Leisure time, after daily checks on the boat and maintenance (net mending,etc.) usually revolves around family activities or perhaps "having company in."

One change that has occurred over time is a closer link with Deer Isle. The small towns were once great rivals, but now they have a consolidated school, use the same pier, belong to the same organizations, sell fish to the same buyers, etc. Deer Isle once had two ports, but both silted over. The customhouse at one handled record quantities of mackerel in its day.

There is no dominant ethnic or religious group. Various Protestant denominations, several gospel churches, Catholic (many are descendants from the Italian stone-cutters who came when quarrying was predominant) and a large Latter Day Saints community in Deer Isle are the most evident religious groups.

**Education and alternative employment**
Most of the gillnetters seem to be in the 22 to 40 years old range with a high school education. Children are still going into the industry as fishing is considered a proud way of life. It can provide a decent living and the freedom it offers is treasured.

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[16] Acheson (n.d.) discusses the critical importance of the community and kinship in small Maine towns in his *Social and Cultural Aspects of the New England Groundfishery*.

In addition, young people want to stay in the area and consistent alternative employment is not available. The factory women are probably not employable in the tourist industry. Referred to as typical "Down Easters," the women are described as accustomed to "say what they want, do what they want, wear what they want" and disinclined to "pander to rich outsiders." For now, the former factory women pick crabmeat at home, babysit, knit lobster trap heads or work as cashiers at the local stores to earn supplemental income.

**Social welfare issues**

There is no formal organization dedicated to fishing families as there is in some of the larger ports; however a number of informants noted that the islanders look after one another. Although people are very concerned about the potential impacts of the groundfish management plan, their concern is not overtly manifested in alcohol or other substance abuse.

**Management and enforcement**

Those interviewed all noted that fishermen in Stonington were "conservation-minded." They "see a wrong and try to change it." Some of the fishermen have become frustrated with attempts to inform the "bureaucracy." They believe that Stonington and other rural ports have a "different thinking" than fishermen in Portland and south where, they maintain, the company bottom line is the most important consideration.

"I've preached, hollered and yelled for years now, the size limits on cod and grey sole are too low," said one fisherman. He changed his net to 5 1/2-inch mesh seven or eight years ago and currently uses a 6-inch mesh.

Enforcement is viewed as critically important. Fishermen should be licensed so that when they break the law, their license can be revoked, said one informant. "A slap on the wrist" is how many of today's sanctions are regarded.

Fishery regulations have everyone stirred-up. Stonington fishermen don't feel that they have a voice in the process. Part of the problem stems from the difficulty in attending the many meetings, six hours away, that result in plan development. It is difficult for someone who is not fishing to properly represent active fishermen, yet active fishermen cannot take enough time away from fishing to attend so many meetings.

As a result, Maine fishermen feel they cannot work the system in the way that Gloucester and New Bedford or Pt. Judith fishermen do. Most Maine fishermen believe that theirs is a different way of life that's not going to be accommodated by fisheries management for the region. For example, large (90-110 feet) New Bedford boats routinely fish out scallop beds within a few days time that the Stonington fishermen lament could have supported 10 or 20 of their boats all winter long.

Maine fishermen would like to see strict conservation measures enacted that would allow fishing to continue forever. The views of those interviewed are that the measures should be direct physical measures such as closed areas for spawning and juveniles, and limits on sizes of boats, nets, and horsepower, even though these measures are economically less efficient. They argue that improvements in the enforcement process will increase the effectiveness of existing management measures. Broadly generalizing, a Maine fisherman's inclination is to be law-abiding, ~~if~~ he feels that regulations are being adhered to in the whole region. Those who break the rules should not be allowed to fish again. Real fishermen would then not take the risk of willfully violating the regulations.

Concern about Amendment 5 is compounded by marine mammal regulations. Although one person claimed that Stonington fishermen rarely have interactions with harbor porpoise since they fish outside the bays where the harbor porpoise tend to congregate, the regulations will cause problems. One observer noted that Stonington is on the migration route of the mammals and that there is sufficient incidental catch to cause problems.

**Comments on catch and gear types (by former lobsterman):**
Urchining "saved us last year." This is a considerable change from year's past as they were only considered an aggravation when lobstering. The fishing of urchins has probably contributed to increased lobster catch since urchins eat kelp beds which lobsters use as hiding grounds. The reduction in urchins through fishing, resulting increased kelp beds, is drawing lobsters closer inshore. Depletion of finfish is also contributing to increases in juvenile lobster since there is less competition for food and decreased predation.

**Organizations**
The annual Maine Fishermen's Forum, produced by a Board of Directors that has representation from all fishing organizations, the University of Maine and *Commercial Fisheries News*, is very popular and provides one opportunity for fishermen to interact and participate in discussions about management, gear, etc.

~~Island Fishermen's Wives,~~ with 13 members primarily organizes safety courses and demonstrations, including life raft use and CPR courses. They also provide support services for those who have lost boats. The group sends a representative to the Maine Gillnetters Association meetings and occasionally lobbies on fishing-related issues in different fora.

*Contact: Donna Brewer, President, P.O. Box 293, Stonington, ME 04681. Telephone: 207-367-5100.*

~~Maine Fishermen's Wives Association~~ has about 25 members in various ports, though most live around Portland. The organization sends at least one representative to New England Fishery Management Council meetings and fishermen's advisory group meetings.

*Contact: Gail Johnson, President, Marine Trade Center, 2 Fish Pier, Portland, ME 04101. Telephone: 207-773-3737*

~~Maine Gillnetters Association~~, with about 40 vessel owners on its executive committee and general and associate membership of a couple of hundred people (2.5 crewmembers per vessel), is primarily concerned with representing the interests of gillnetters in management discussions (both with regard to groundfish and marine mammals). Members come from all along the Maine coast.

*Contact: Ted Ames, Executive Director, P.O. Box 317, Stonington, ME 04681. Telephone: 207-367-5907*

~~Maine Lobstermen's Association~~, sells health insurance (family's cost $560/month) and is involved in the Lobster Institute (for marketing).

*Contact: Pat White, Executive Director, P.O. Box 147, Damariscotta, ME 04543. Telephone: 207-563-5254.*

~~Maine Scallopers Association~~

*Contact: John Jones, President, P.O. Box 404, Stonington, ME 04412.*

**Some Neighboring Ports' Fishing Activities:**

East of Stonington, fishing and fishing-related activity is common. Lobster dominates on Swan's Island. Mt. Desert island, despite the tourism attracted to Acadia National Park, has a number of active fishing ports, including Bass Harbor. Winter Harbor has lobstering, scalloping, some urchining and 2 gillnetters. Prospect Harbor has lobstering and a sardine factory; Corea has lobstering and 2 gillnetters. In Milbridge lobstering and scalloping dominate. Jonesport and Beals is a big port with lobstering, scalloping, quahogging, periwinkling, musseling, 6 gillnetters and marine worming (bait). Bucks Harbor and Cutler have lobstering, quahogging, scalloping, and aquaculture. In Lubec, salmon aquaculture is important, a herring canning factory is in business, urchining, lobstering and hand-lining is also carrried out. Another major processing business uses herring scales to put the sparkle in nail polish and the metallic sheen in some paints.

Aquaculture has been welcomed in areas bordering the Bay of Fundy because the 24 feet tides and fast running currents makes lobstering difficult. Clamming and worming are further inshore than the aquaculture pens, so there has been little gear conflict.

### E.6.4.3.2 Native American Fishing

Native American fishing in the northeast is limited and not directed at those stocks which are the object of this action. In the mid-Atlantic region, there has been no native American fishing since the 19th century. In New England, the native American fishing activity is primarily inshore, focused on riverine or anadromous stocks. This effort is also very localized, being limited to only a few locations. (Clay, pers. comm.)

### E.6.4.3.3 Subsistence Fisheries

"Subsistence", when used by anthropologists to describe an activity or a level of food production, is generally defined as a system in which people grow, gather, or catch food only for their own use and not for sale (and not recreationally). Under a subsistence economy, such food is essential since alternative sources of nutrition are limited or not available. By this definition, there are no subsistence fishers in this region. A broader definition of "subsistence" is sometimes used which includes "small scale, traditional, craft or inshore" as distinguished from "large-scale, industrial, offshore, or company-owned" operations. (Clay, pers. comm.) This type of characterization is discussed in other sections of this document describing the fleet structure.

### E.6.4.3.4 Safety Aspects of the Fishery

The following is taken from a recent report published by the National Research Council entitled ~~Fishing Vessel Safety: Blueprint for a National Program~~. The 260-page book describes in great detail all aspects of fishing vessel safety. For the purposes of this document (to assess the impacts of a proposed management action on public health and safety), the following excerpt is particularly relevant.

> **Fisheries Management Influences on Fishing Industry Safety**
>
> Fishing has been romanticized as the last frontier, a natural environment where fishermen see themselves as hunters who work independently and have life-styles outside of traditional occupational patterns. The implied freedom from outside interference and influences is a myth. While work takes place in relative isolation, harvesting of most fisheries is highly regulated.
>
> Fishery regulations are enforced through vessel-boarding programs conducted by the National Marine Fisheries Service and the U.S Coast Guard, and in cooperation with state authorities. The eight regional fisheries management councils have had difficulty accommodating effective conservation and conflicts over fishery allocations and safety. The management system's inability to match harvesting capacity to biological productivity of fishery stocks has resulted in a highly competitive operating environment in which fishermen may take unnecessary risks to maintain their livelihood. This practice has resulted in overcapitalization in some fisheries and more marginal operators who find it economically difficult to adequately maintain and equip their vessels to improve safety in a hostile environment. Furthermore, early closures, short seasons, and selective gear allocations have caused many operators to abandon the fisheries their vessels were designed for and enter fisheries far from home port, change to new fishing gear, or enter entirely new fisheries. Under these circumstances the vessel operator and crew may face new risks and potential safety problems.
>
> Under the regional council system established by the MFCMA, comprehensive fisheries management plans (FMPs) are prepared using the concept of optimum yield (OY) as the standard. OY is defined as maximum sustainable yield (MSY) modified by economic, social and political factors. In virtually all cases in which OY was determined to achieve sustainable yield, the target MSY has been subsequently raised to accommodate fishermen's needs. This practice increases pressure on fish stocks and results in short-term overfishing and decline in abundance. There have been few effort-limitation schemes to balance harvesting capacity to biological production in the United States, and

they have been narrowly applied.

The management councils (FMCs) are also charged by the MFCMA to consider safety in their FMPs. Section 303(a)(6) of the MFCMA as amended states [that the FMCs] "consider and may provide for temporary adjustments after consultation with the Coast Guard and persons utilizing the fishery regarding access to the fishery for vessels otherwise prevented from harvesting because of weather or other ocean conditions affecting the safety of vessels." The FMCs clearly have the opportunity to address safety factors related to weather or ocean conditions within each management plan. Yet, in virtually every case, safety has been subordinated in favor of economic interests. Where conservation decisions and use determinations are combined, constituents exert pressure to serve more users. Competition intensifies as returns decrease, fishing time is reduced to achieve quotas, and more fishermen compete for fewer fish. *With stiffer competition for dwindling resources, more fishermen take risks and accidents increase.* (italics added for emphasis)...The data and anecdotal information are inconclusive about whether the number of incidents for olympic-style fishing is significantly higher than might have occurred during an extended season.

Thus, the fishery itself impacts public safety, and the management of the fishery for objectives other than safety seems to increase the risk to members of the industry. More importantly, management systems that do not control total harvesting capacity and management systems that increase the competitiveness of fisheries operating at the limits of sustainability create an environment of greater risk. Ultimately, however, the individual decisions made by the vessel owner, captain or fisherman within this framework determines the risk exposure.

The following table provided by the U.S. Coast Guard provides some indication of the casualty rates in the region. According to their communication, these statistics reflect only those casualties that were reported to the Coast Guard or as a result of Coast Guard involvement in search and rescue missions. They cannot be interpreted as a complete picture of the regional fishing vessel casualty picture. Also if a vessel was involved in more that one type of casualty, such as a sinking and a death, it would appear in both columns. (Bob Higgins, pers. comm.)

| | DEATH | INJURY | SUNK | FIRE | FLOOD | DISABLED | AGROUND |
|---|---|---|---|---|---|---|---|
| **1988** | 4 | 22 | 27 | 12 | 28 | 122 | 30 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1989** | 13 | 36 | 31 | 17 | 38 | 211 | 42 |
| **1990** | 6 | 52 | 26 | 17 | 58 | 52 | 34 |
| **1991** | 8 | 51 | 20 | 18 | 46 | 146 | 30 |
| **1992** | 13 | 76 | 30 | 10 | 25 | 96 | 28 |

**TABLE E.6.4.3.4.1** FISHING VESSEL CASUALTY REPORTS 1988-1992. First District zones: Portland-Boston-Providence. Source: U.S. Coast Guard, First District Commander (pers. comm.)

### E.6.4.4 Impacts of human activity (fishing) on the environmentE.6.4.4 Impacts of human activity (fishing) on the environment

The impact of fishing on the stocks comprising the fishery is described primarily as fishing mortality. The impact of the fishery also extends beyond the target species through predator -prey relationships, competition among the region's inhabitants for food and essential habitat, and other forms of ecosystem interaction. These relationships, to the extent that they may be affected by the proposed action, have been discussed in section E.6.3 Biological Environment. In addition to the complex impacts of removing fish from the ecosystem, however, are the more direct impacts of the activity of fishing on the environment. These impacts are discussed below in three sections: trawling and dredging impacts, bycatch and processing discards, and lost gear.

#### E.6.4.4.1 Trawling and dredging impacts

Trawling and dredging impacts on the sea floor have been of concern for centuries. An English report from 1376, for example, pointed to the potentially destructive nature of dredging (see Messieh et al. 1991; Shepard and Auster, 1991; Jones, 1992). Nevertheless, these harvesting practices have continued and there is now a renewed interest in their impact on the target species and associated fauna. The International Council for Exploration of the Sea, primarily a European scientific body, has recently produced three documents that discuss the effects of trawling and dredging (ICES C.M.1988/B:56; ICES C.M.1991/G:7; ICES C.M.1992/G:11) while three other reviews, that focus on the effects of trawling on the seafloor, have been published by Australian, Canadian, and New Zealand Scientists (Hutchings, 1990; Messieh et al. 1991; Jones, 1992). There are also several comprehensive bibliographies that have been produced as part of the ICES effort to document fishing effects on the ecosystem (Redant, 1987;1990). The salient points for northwest Atlantic fisheries from all these reviews are summarized below but ancillary information relating ecosystem effects of fishing activities can be found, in particular, in the 1991 and 1992 ICES documents while a more exhaustive list of literature is available in the bibliographies and the other reviews.

Although concern about the effects of fishing on the environment have been around for centuries the gear and techniques utilized prior to the start of the 20th century had a very restricted and local environmental impact. The first steam engines and steam powered capstans were, for example, introduced in the 1860s and 1870s. Mechanical power replaced sail power and diminished the importance of the wind as a factor controlling fishing. The first American steam trawler, the SPRAY, was built in Boston and launched in 1905 together with the otter trawl. The steam trawler and development of the otter trawl on this side of the Atlantic ushered in an era of potential environmental impact in the northwest Atlantic that we are now just beginning to consider.

One of the first quantitative investigations of the effect of gear on the bottom was carried out by Graham (1955) on plaice in the North Sea when he compared catches from fished grounds and control areas. Graham concluded that trawling had no long lasting impact on the macrobenthos. Other European researchers have reported on the impact of the gear utilized by their fleets (Rendant 1987, 1990). Studies on the impact of otter trawling are rare, and specific studies of otter trawling impacts on soft bottom area off the US coast are nonexistent, although Apollonio (1989) suggested that banning the otter trawl might be the key to better fisheries management. The impact of fishing on hard bottom has been investigated along the southern coast of the US. Wenner (1983) suggested that trawl gear may reduce the amount of productive fish habitat and this stimulated a study of sponge assemblages and corals. Dolah et al. (1987) followed a hard bottom assemblage of sponges and corals after a single trawling event through the area. They concluded that after one year the trawling effects could not be detected. In contrast, an Australian study in a region that experienced a substantial increase in pair trawling over 16 years, showed a significant decline in the sponge by-catch (Sainsbury, 1987). Loss of these sponges and associated cnidarian benthos lead to a reduction in the fish catch (Sainsbury, 1988; Hutchings, 1990).

The European literature on trawling impacts is much more extensive than any work in either US or Canadian waters (ICES, 1991; Messieh et al. 1991). Much of the work in the North Sea has focused on beam trawls which are not utilized in the New England fisheries. Nevertheless, some of the conclusions regarding the physical disturbance are potentially transferable to the northwest Atlantic fisheries. It is interesting to note that beam trawling in the southern North Sea has actually been associated with an increase in the growth rate for flatfish (especially sole). In areas that are trawled the habitat has been altered to favor the production of polychaetes which are the primary food for sole. The ICES young fish surveys do not show any reduction in the recruitment of flatfish populations and therefore it was concluded that there is no major deterioration in the environments of the nursery areas (ICES, 1988). It should be noted, however, that this conclusion reflects an alteration of the environment towards lower species diversity and essentially maintains the area for the monoculture of fish. Other studies have also shown that one of the immediate consequences of trawling is more food being available to predatory fishes (Arntz and Weber, 1970; Medcof and Caddy, 1971; Caddy, 1973). In these cases, however, neither increased growth rates for the fish or changes in species diversity were investigated.

Trawling physically removes many of the epibenthic animals and the impact that this has on the ecosystem must be considered. As stated above, a decrease in species diversity might be expected in area that are heavily fished (Jones, 1992; Hutchings, 1990; Sainsbury, 1987). Although this may be considered in positive terms from the point of view of fish production (eg. North Sea sole) a number of papers point to the negative implications that this has on the over all benthic community as well as some fish populations. Jones (1992) reviews papers dealing with the destruction of non-target benthos and points out several examples of habitat loss, some of which have resulted in the necessity to close a fishery. Bryozoan beds in Tasman Bay, New Zealand, for example, serve as habitat for juvenile snapper and tarakihi and many of these beds were destroyed by trawling. The remaining beds were ultimately closed to fishing (Bradstock and Gordon, 1983). Trawling has also been suggested as a cause for the spread of benthic animals such as mussels through the Norderaue area of the Wadden Sea (Reise, 1982; Reise and Schubert, 1987).

As pointed out in an ICES ecosystem report (ICES, 1991), one of the fundamental problems with many, if not all, of the trawl studies that attempt to evaluate the consequences of physical disturbance of the environment is that of scale. The time and space scale necessary to truly judge the consequences of fishing do not correspond with the actual extent and intensity of these activities. The tendency is to extrapolate from relatively small localized studies to regions or even different geographic localities altogether. It must be recognized that fishing disturbances are likely to be patchy within and between different habitats. The degree of patchiness and the frequency of the disturbance has a profound influence on the ability of the sea bed to recover from such a perturbation.

#### E.6.4.4.2 Bycatch and Processing Discards

In addition to the physical impacts of the trawls themselves the consequences of discarding both the by-catch and processing wastes need to be discussed. By-catch information specifically for the northwest Atlantic is limited to a paper by Jean (1963) dealing with the New Brunswick fishery and a paper by Howell and Langan (1987) that focuses on Gulf of Maine flatfish. There are also some unpublished reports by the Northeast Fisheries Science Center (Mayo et al. 1981) and there is a current effort by the NEFSC to collect this information to utilize in it Stock Assessment Workshops (eg. Clark and Power, 1991). Howell and Langan (1987) found mean discard rates in the Gulf of Maine flatfish fishery to range from 5 to 25% of the catch by weight and 12 to 57% of the catch numerically in 1983 depending on the species of fish and gear. Data on the amount of fish processing wastes is not available although a rough estimate of organic matter returned to the sea could be calculated based on the landings data and knowledge of a total weight/gutted weight relationship for the different groundfish species (see ICES, 1991). The fate of this organic matter is also unknown although there is one reported instance of scallop processing waste being identified in the stomachs of cod (Langton and Bowman, 1980).

**E.6.4.4.3 Lost Gear**

Lost gear and the potential for continued fishing by that gear is also an impact on the environment that should be considered. Unfortunately quantitative data documenting the extent of lost gear is extremely limited. Cooper et al. (1988) estimate, for example, that there were 2,497 ghost gillnets on the ocean floor of Jeffreys Ledge or within the vicinity of Stellwagen Bank based on a manned submersible survey of the area in 1985 and 1986. They do, however, point out that this is an extrapolation from direct observations over a series of submersible transects and a much more extensive survey would be required to confirm this number. They also observed the behavior of lost gillnets and Carr (1988) noted that the ghost nets continued to fish with a vertical profile of 0.1 to 2.0 m off the bottom although the profile of most of the nets observed rarely reached the 2.0 m height. Cooper et al. (1988) estimated that most of the derelict gillnets observed were 4 to 7 years old and were lost when the gillnet fishery was very active and composed of fishermen with relatively little experience. Subsequent to these studies Carr et al. (1992) did some experimental work to try to reduce the ghost gillnet fishing problem. They observed an experimental net over two years and concluded that it continued to fish over time but the species composition of the catch changed with a reduction in the nets vertical profile. The greatest reduction in fishing ability seemed to be due to fouling of the net and the increased visibility to fish.

### E.6.4.5 Impacts of human activity other than fishing on the environment of the fisheryE.6.4.5 Impacts of human activity other than fishing on the environment of the fishery

#### E.6.4.5.1 Contaminants

Considered in this section and capsulized here are the effects of two major pollutant categories, metals and organic compounds, upon each of thirteen species that are covered by this Fishery Management Plan. No attempt was made to review the literature for any pollutant effects associated with other species. Also not considered are effects of ocean dumping or mining, eutrophication and consequent low dissolved oxygen, or sewer outfalls and the like, as these subjects are covered elsewhere.

The highest concentrations of chemical contaminants are to be found in coastal, industrialized or heavily urbanized, and waste-disposal areas. Such estuarine, coastal habitats are also the spawning and nursery areas for many important commercial fishes. These early life stages are most susceptible to toxicants, the larvae more so than the eggs, as the latter have the protection of a membrane (Dethlefsen 1976, Mangor-Jensen and Flynn 1985, Foyn and Serigstad 1988).

In some fish species, tissue concentrations of pollutants do not necessarily reflect sediment concentrations of those pollutants, whether metals or organics (Greig and Wenzloff 1977, Greig et al. 1983, MacDonald 1991). The work of Marthinsen et al. (1991) illustrates the difference in this respect between fish and species: they found that PCB levels in Atlantic cod reflected a decreasing PCB pollutant gradient from the mouth of Norway's largest river, whereas PCB levels in the European flounder did not. In winter flounder, PCB body burdens were accumulated from prey species in the sediments, rather than from the water column (Connolly 1991).

More closely associated with pollutant exposure, abnormally high levels of detoxifying enzymes may signal (for a short time) exposure to organic contaminants (Addison and Edwards 1988), although this response varies with sex gonadal maturation (Spies et al. 1988a, 1988b, George 1989). Similarly, induction of metal-binding proteins may signal (for a short time) exposure to heavy metals (Overnell 1988, Garvey 1988, Fowler and Gould 1988, George 1989).

Different PCB's, however, have sometimes conflicting effects (Hansen et al. 1983), with some inhibiting others (Gooch et al. 1988). A hormonal suppression by one PCB of the detoxication process, for example, has been observed in sexually mature female winter flounder (Forlin and Hansson 1988). There is a significant inverse relationship between PCB content of eggs and length and weight of larvae at hatch (Black et al. 1988). Goksoyr et al. (1991) have shown that in the early life stages of a fish, the normal protective manufacture of enzymes that break down and eliminate organic toxicants is delayed until after hatching.

Tissue concentrations of organic contaminants such as PAH's, PCB's, and pesticides are significantly correlated with body-fat content (Reid et al. 1982); PCB body burdens vary with season in female but not in male fish (Marthinsen et al. 1991). And the fattier the liver, the slower the clearance rates of these fat-soluble toxicants (Skare et al. 1985).

Biochemical synthesis of a specific enzyme system is associated with liver pathology in fish, a phenomenon that could play a role in the production of mutagenic agents from environmental chemicals by generating breakdown products more toxic than the parent compound (Smolowitz et al. 1989). Ulcer-like lesions are considered to be a result of hormonal imbalance caused by PCB assimilation (Stork 1983). Chronic exposure of adult cod to crude oils produces severely disabling lesions and reproductive impairment (Khan and Kiceniuk 1984; Kiceniuk and Khan 1987).

In the case of organic toxicants, cadmium strongly depresses several detoxifying enzyme systems (George 1989), and appears to depress PCB uptake in winter flounder (Carr and Neff 1988). Moreover, in the European flounder *Platichthys flesus*, exposure to diesel oil produced no increase in detoxifying activity when copper was added to the oil (Addison and Edwards 1988). Overloads of even essential trace metals (notably copper) interfere with normal intracellular metal regulation, with general lowered fish health and often reproductive failure. These phenomena have been observed most clearly in a marine bivalve, the sea scallop (Gould et al. 1985, 1988).

It is certain that pollutant stress affects recruitment to an overall health of fishery stocks, to an indeterminate degree that obviously varies erratically with time and site. Usually it is not possible to attribute specific effects observed in the field to specific pollutants (Wolfe et al. 1982), although abnormally active detoxifying systems in fish, including metal-binding proteins, suggest contamination by organics and/or metals. Recruitment of fishery stocks is also undoubtedly influenced by lowered spawning biomass brought about by overly-heavy fishing pressure (Cohen et al. 1991).

Human activities have indeed altered the balance of our living marine resources for the worse. We must hope that the situation is not yet irremediable.

Of the thirteen species comprising the multispecies management unit, only two have been the subject of a considerable number of publications. The European literature abounds in both experimental and field work with the Atlantic cod, *Gadus morhua*, from which the more relevant reports have been abstracted for inclusion here with American and Canadian papers. (Research on the same species found in the northwest Atlantic, wherever the work is performed, should be applicable here.) In the American Northeast, the winter flounder, *Pleuronectes americanus*, has also been the focus for much experimental work. The number of field and laboratory reports on the remaining eleven species, whether cause-and-effect or circumstantial evidence or even informed speculation, ranges from sparse to non-existent.

Abbreviations used are: MFO = mixed-function oxidases or oxygenases active in catabolizing organic hydrocarbons, including: P450's = a family of cytochrome enzymes (activation catalysts); AHH = aryl hydrocarbon hydroxylase; and EROD = ethoxyresorufin 4-o-de-ethylase. PCB = polychlorinated biphenyl compounds; WSF = water-soluble fraction (of crude oils); PAH = polycyclic aromatic hydrocarbons; BαP = benzo-α-pyrene, a PAH; and DDT = dichloro- diphenyl-trichloroethane. For blood chemistry, Hct = hematocrit and Hb = hemoglobin. Units of concentration used are ppb = parts per billion = µg/L = µg/Kg; ppm = mg/L = µg/g; and $LC_{50}$ = the concentration (of toxicant) at which 50% mortality is observed.

**ATLANTIC COD** (*Gadus morhua*)

**Metals:** Observations of toxic effects of heavy metals on cod are comparatively few; most of the work has been with petroleum hydrocarbons. Cod from the Baltic Sea, however, that were found to have elevated levels of cadmium in liver and kidney tissue also had externally visible skeletal deformities (compressions of the spine and deformities of the jaw) (Lang and Dethlefsen 1987). The cadmium content in cod liver and kidney increased from the western to the eastern sector of the study area. Cod muscle showed areal differences in Zn, Cu, and Cd concentrations, reflecting the areal concentrations in seawater (Perttila *et al.* 1982). Cod muscle tissue was also reported to have a higher storage capacity for mercury than the liver, of possible concern to the consumer (Julshamm *et al. 1982*). Threshold concentrations of toxic mixtures (Cu plus Zn, for example, with an anionic surfactant) need not be high to produce toxic effects in codfish (Swedmark and Granmo 1981). Limited water circulation in estuarine and coastal waters would be most likely to produce examples.

**Organic contaminants:** ***Pesticides:*** Cod larvae are far more sensitive to the chlorinated pesticide DDT and its breakdown product DDE than are the membrane-protected embryos. Percentages of malformed and dead embryos and larvae increased with increasing concentrations of DDT, which was overall more toxic than DDE (Dethlefsen 1976). Laboratory exposure of 3-yr old cod to low levels of DDT produced tachycardia (rapid heartbeat), a decrease in the frequency of respiration, and disruption of the CNS (central nervous system) regulation of muscle contraction in stomach and gut. Upon removal of the toxicant, however, normal functions returned after 6-7d (Shparkovskii 1982).

Following a 1972 DDT ban in Norway, cod liver samples showed decreasing concentrations of DDT; 10 years after the ban, the highest level of cod liver DDT was about one-third of the corresponding 1972 residue level. The slow clearance of liver DDT in cod as compared to other species examined may be attributed to the substantially higher fat content of cod liver (Skare *et al.* 1985). Chlorinated pesticides (DDT and its analogs) have the ability to accumulate in the lipid-rich tissues of cod liver in quantities far exceeding the amount present in the flesh (Sims *et al. 1975*), a fact more important to the fish than to the consumer.

Most organochlorine compounds in livers of cod caught off the east coast of Canada in 1980 showed no change in concentrations over the previous 8 years, with the exceptions of PCB and the DDT group, in which there was a general decline between 1972 and 1975, with no significant change thereafter (Freeman and Uthe 1984).

***PCB's:*** Cod having ulcus syndrome (epidermal lesions) had significantly higher PCB residue concentrations in liver tissue than did cod without the syndrome. The ulcus syndrome is thought to be due to an imbalance in corticosteroid metabolism caused by elevated PCB's (Stork 1983).

Levels of PCB congeners in liver samples of male and female cod reflected a decreasing PCB pollution gradient away from the mouth of the Glomma, Norway's largest river. PCB levels in female cod varied significantly with seasonal sampling (levels in Sept./Oct. greater than corresponding levels in June and Nov./Dec.); no such effect was seen in male cod (Marthinsen *et al.* 1991). Different PCB congeners produce different effects in marine fish: Feeding Aroclor 1254 to juvenile cod to produce liver concentrations of ca. 900ppm (wet wt) induced the enzyme ethoxyxoumarin o-de-ethylase 30-fold, but had no effect on ethoxyresorufin o-de-ethylase (EROD) activity. Feeding Aroclor 1016 to juvenile cod induced no enzyme activity of this P450 group (Hansen *et al.* 1983).

***PAH's:*** Cod eggs and newly-hatched larvae, exposed to radiolabeled aromatic hydrocarbons (PAH) and a PCB for 24h, accumulated both from the seawater. After being moved to uncontaminated seawater, the yolk-sac larvae showed no apparent elimination of PCB, although there was a clear elimination of some PAH (BαP-derived radioactivity) (Solbakken *et al.* 1984). Metabolic breakdown of PAH's has also been detected in adult cod (Bell 1983, cited in Davies *et al.* 1984), in parallel field and tank studies: fish exposed to nominal levels (50ppb) of benzo[α]pyrene in the water showed liver AHH values 5-40 times that of the control.

***Oil:*** ~~Early Life Stages~~. Crude oil extracts can affect the energetic processes of cod eggs and larvae in addition to causing structural and developmental damage. One such extract (8 ppm total dissolved hydrocarbons dissolved and dispersed oil) had no significant effect upon oxygen uptake in late-stage cod embryos and larvae with functional yolk sacs. Early embryos and starved larvae, however, had reduced oxygen consumption when placed in the extract, and the starved larvae became narcotized (Davenport *et al.* 1979). Exposure of cod eggs to the water-soluble fraction (WSF) of crude oils (50-150ppb) does not significantly affect surface membrane permeability, nor is osmoregulatory ability of the embryo affected by these ecologically realistic concentrations (Mangor-Jensen and Fyhn 1985). Another laboratory exposure to the WSF of North Sea crude oil (50ppb) strongly suppressed oxygen consumption by cod larvae at the time of final yolk absorption (5-7d post-hatch), when the larvae begin to feed; no effect on oxygen uptake was seen in the eggs (Serigstad and Adoff 1985). Kühnhold (1974, cited in Longwell 1977) found through laboratory exposures that cod eggs were most sensitive to crude oil during the first few hours post fertilization, and that by 10h after exposure, mortalities were significant. The oil retarded development and in some cases delayed or prevented hatch. Those larvae that did hatch showed a high level of abnormal development or abnormal swimming movements, and died within a few days.

Effects found in cod eggs and larvae exposed to WSF's (6ppm) and suspensions (30ppm) of crude oil, cuts (oil distillation fractions), and some low-boiling aromatics included several morphological abnormalities: delay and irregularities in cleavage and development, poor differentiation of the head region, protruding eye lenses, abnormally bent notochord, and various levels of inhibition of hatching and assimilation of yolk (Lønning 1977). Such morphological disturbances will result in the ultimate death of the larvae, which in turn can lead to serious effects on the fish population in the polluted area. Further work with the same life stages confirmed the variety of adverse morphological changes, and noted a significant decrease in growth rate (Tilseth *et al.* 1981) and a concentration-dependent reduction in feeding (Solberg *et al.* 1982a, 1982b). Such oil-induced disturbance of physiological and behavioral patterns would reduce feeding capability at the onset of feeding, with consequent high mortality in the field.

Exposure to high concentrations (1000ppm) of oil dispersants blocked fertilization of cod eggs and larvae, and induced rapid cytolysis of the developing eggs and larvae (Lønning and Falk-Petersen 1978). At lower concentrations, effects were noted at 10ppm but not at 1ppm. Cod embryos were more sensitive to the dispersants than were sea urchin embryos (Lønning and Falk-Petersen 1978); the strong effects of these dispersants may be correlated with their solubility in seawater.

Larval cod alone, exposed to sublethal amounts of the WSF of crude oil, had reduced growth, morphological changes (malformed upper jaw), lower specific weight (neutral buoyancy), reduced feeding ability and swimming speed, and a serious disturbance of the swimming pattern. Larvae exposed to 4.1ppm or higher did not recover their feeding ability within 24h of transfer to clean water (Tilseth *et al.* 1984). Cod larvae less than 20mm are the size most harmed by exposure to a 50±20ppb WSF of oil (Foyn and Serigstad 1988). The effect of a 1- to 2-h exposure of cod eggs to the WSF is not acute but instead long-term, leading to starvation of the cod larvae. There is no recovery from the effects of exposure to the oil WSF when cod eggs or larvae are placed in clean seawater (Foyn and Serigstad 1988).

Illumination of a microlayer of Ekofisk crude oil by artificial sunlight was clearly shown to induce formation of toxic photoproducts from the oil, both polar and non-polar. In larval cod exposed to the water phase of the illuminated oil, the 24-h $LC_{50}$ was reached when concentrations of polar components reached 1.0 to 2.0ppm. The exposure led to discontinuance of feeding by the larvae at all tested concentrations (Solberg *et al.* 1982a).

In direct field-related observations, developing cod embryos exposed to hexane extracts of sea-surface microlayer from 5 marinas located in the North and Baltic Seas showed site-related effects; extracts from 2 locations produced significant embryo mortality as well as severe deformities in live hatched larvae. The greatest biological effect was seen with petroleum hydrocarbon concentrations between 180 and >200ppb. Greatest toxic responses were observed in samples collected when a sheen was visible (Kocan *et al.* 1987). Genetic evaluation of cod eggs collected from the site of the *Argo Merchant* oil spill (Longwell 1977) showed that: 1) oil droplets and tar were found to adhere to one half of the cod eggs examined; 2) 63% were at phases earlier than tail-bud stage; 3) 20% of the eggs were dead or moribund; 4) all of the dead eggs had cytological abnormalities; and, 5) cod eggs spawned in the laboratory at the same developmental stages as the egg samples from the spill site contained only 4% dead or moribund; those from the vicinity of the oil spill, therefore, had an apparently higher mortality rate than usual.

Goksoyr *et al.* (1991) exposed cod eggs and larvae and juvenile cod to a WSF of North Sea crude oil (1-6wk, 40-300ppb) and examined them for induction of P450, which is biosynthesized "on demand" to catalyze the breakdown of pollutant hydrocarbons. Although the exposure began during the egg stage, induction response was delayed until after hatching. The P450 induction response was dose-dependent, and recovery in clean water resulted in normalization of P450 levels (Goksoyr *et al.* 1991). Immunochemical response (*i.e.* specifically induced P450c) in the liver of juvenile cod and in homogenates of whole larvae reflected the exposure of those life stages to a WSF of crude oil in a dose-dependent way. Larvae and juveniles that were allowed to recover in clean seawater showed a decline toward control levels within a few days (Goksoyr *et al.* 1988). Laboratory exposure of juvenile cod to crude oil and oil dispersant produced significant changes in physiological parameters (heart rate, respiration, gill ventilation rate and amplitude) that did not occur until pollutant concentrations were close to lethal levels (Johnstone and Hawkins 1980).

~~Adult Stage~~. Mature cod chronically exposed to WSF's of crude petroleum depleted their stored energy of neutral lipids (24wk, 100-200ppb total hydrocarbon) (Dey *et al.* 1983), showed reduced growth, gill hyperplasia, filament fusion, increased skin pigmentation, hepatic granulation, and increased gall-bladder size (13wk, 150-300ppb) (Khan *et al.* 1981), and produced an oil-inducible MFO activity that was elevated 4 times higher in the liver and 3 times higher in the gills than in control fish (4mo, 300-600ppb) (Payne and Fancey 1982). Kidney tissue did not appear to be significantly affected. Further histological examination of tissues from such chronically-exposed cod (13wk, 50-300ppb) showed increased numbers of mucus-producing epithelial cells, capillary dilation, delayed spermatogenesis, and an increase of melanomacrophage centers in the spleen and kidney (Khan and Kiceniuk 1984). No mortalities occurred in such cod (21wk, 30-500ppb), but significant reductions in food consumption and body condition were seen, gall bladders were enlarged during summer-autumn when the fish were feeding actively, the rate of gametogenesis was reduced in male cod exposed to oil fractions in summer-autumn, and spermiation delayed in fish exposed in winter-spring (Kiceniuk and Khan 1987). Chronic exposure of cod to crude oils, it was concluded, results in severely disabling lesions and reproductive impairment.

Cod captured close to oil platforms showed significantly higher levels of oil-inducible AHH in their livers than did fish caught in areas well away from oil activity (Davies *et al.* 1984). In the laboratory, detection thresholds for behavioral changes in cod upon sudden exposure to oil compounds were observed at only 0.1-0.4ppb (Hellstrøm and Døving 1983). Changes noted were snapping, darting, coughing, and restless swimming activity. In another exposure, cod avoided concentrations of total petroleum hydrocarbons down to 50ppb, either in solution or an emulsion; mortality due to oil spills among large free-swimming fish has hardly ever been recorded, Bøhle (1983) concluded, because they can move away from contaminated areas.

A risk-assessment model (Spaulding *et al.* 1983) designed to assess the probable effects of an oil spill on cod predicts that: 1) 60 days after a spill, most of the hydrocarbon impact on cod has taken place (using the number of spawned eggs per spawning cycle as reference); 2) 41.5% of the spawned cod have been adversely affected by oil concentrations in excess of 50ppb; 3) cumulative loss to the population peaks at 23.9% in the 7th year after the spill; and 4) of the 4 seasons, winter and spring spills had the greatest impact. Another assessment model (Spaulding 1985) predicts that timing of maximal impact from an oil spill follows spawning activity: spills occurring in winter and spring (March, in particular) have the greatest impact on cod. For spills of release duration less than 30d, the water circulation pattern during October and November is sufficient to remove all residual hydrocarbons from Georges Bank by the time cod spawning begins in early December.

~~Disease in Oil-Exposed Cod~~. A comparison of fitness in cod collected from relatively clean and polluted sites showed slower reaction times in fish from the polluted site (Olofsson and Lindhal 1979). Of 100 live cod collected from Halifax Harbor, 73 had histopathological lesions in their livers (Freeman *et al.* 1983). "Fatty change," a degenerative process in the liver, can be induced by chronically ambient organic contaminants or heavy metals (Freeman *et al.* 1981b). (Exceptional accumulation of liver lipid, with other pathological signals, suggests that body burdens of PCB, pesticides, or other organic toxicants constitute a substantial component of pathogenesis (Freeman *et al.* 1983). Pathological changes in cod liver seem to become progressively greater with increasing size of the fish, although temporal variations in contaminant levels in tissues of cod may continue to occur (Misra *et al.* 1988).

In a laboratory exposure, hemoprotozoan-infected cod reacted more sensitively to petroleum hydrocarbons than did non-infected fish (Khan 1987), as measured by poor body condition, excessive mucus secretion by the gills, retarded gonadal development, and greater mortality. And in the field, parasitic infections accompanied by lowered host resistance, were found to be more prevalent in cod after chronic exposure to petroleum hydrocarbons (Khan 1990).

**HADDOCK** (*Melanogrammus aeglefinus*)
Very little information was found for pollutant effects on haddock, whether experimental exposures or field studies.

**Metals:** A short acute exposure of 4-wk-old haddock larvae to copper (18h, 500ppb) produced toxic effects, including increased mortality (50% as compared to 15% for controls) and severe olfactory lesions (Bodammer 1981).

The mean concentration factor (CF) for $^{137}$caesium was 58 for haddock caught in the North Sea, which was well below the value recommended by the International Atomic Energy Agency as the limit for human dose assessment (Steele 1990).

**Organic contaminants:** There appears to be little problem with organic contamination in haddock, other than events related to oil. Offshore haddock fisheries have very low levels of PCB's (Capuzzo *et al.* 1987). After Norway banned DDT and PCB, haddock and cod from a Norwegian fjord had clearance rates for these compounds that were slower than those found for the fish species wolffish, sea scorpion, a European wrasse, and lemon sole (Skare *et al.* 1985).

Levels of oil-inducible AHH activity were higher in haddock collected from areas around oil platforms than in fish from clean areas. These data are the first to indicate that oil in sediments around oil platforms may be biochemically available to fish in the area (Davies *et al.* 1984), probably *via* the food chain.

The higher the aromatic content of an oil dispersant, the greater its toxicity to unfed haddock larvae (Wilson 1977). Larvae were more susceptible to a dispersant's toxic effects immediately subsequent to first feeding. There are now numerous dispersants that are 2 to 3 orders of magnitude less toxic than the kerosene-based dispersants available earlier.

**YELLOWTAIL FLOUNDER** (*Pleuronectes ferruginea*)

**Organic contaminants:** A fisheries assessment during the 1980's indicated minimal displacement of the yellowtail flounder fishery, along with plaice, cod, and redfish, by development of offshore oil-drilling platforms and production of oil (Kulka 1991). The major fisheries were in large part located away from the significant oil discovery areas off Newfoundland. Yellowtail flounder eggs collected during the first 3d following a gasoline spill near Falmouth MA, however, had an 81% mortality rate (13 of 16 eggs died) (Griswold 1981).

**Unidentified contaminants:** The highest rate of fin-rot disease in yellowtail flounder was seen in fish collected from the New York Bight (Ziskowski *et al.* 1987). Of 15 different fish species, 33% of all larval cestode cysts were found in yellowtail gut, 1979-1982; liver lesions and skeletal anomalies could also be grossly observed (Despres-Patanjo *et al.* 1982, Murchelano *et al.* 1986). "Although pollution has been implicated in the high prevalence of lesions in eastern North Atlantic bottom fish, conclusive cause and effect relationships [remain to] be established" (Murchelano *et al.* 1986). With the exception of lymphocystis and fin rot in winter flounder, no distinct trends could be discerned in the distribution of diseases whose prevalence appears to be linked with pollution.

**POLLOCK** (*Pollachius virens*)

**Organic contaminants:** Although laboratory experiments showed that pollock were able at least partially to catabolize the PAH phenanthrene and excrete breakdown products from that PAH, no observations were made on physiological effects in the fish itself (Solbakken *et al.* 1980). In field work, pollock eggs from the area of the *Argo Merchant* oil spill, collected shortly thereafter (which was during the pollock spawning season), had oil adhering to the outer membrane and showed evidence of cytogenetic damage (Longwell 1977).

**AMERICAN PLAICE** (*Hippoglossoides platessoides*)

**Metals:** American plaice collected off Newfoundland and Labrador had arsenic concentrations in muscle tissue that were similar to levels in sediments, but lower than concentrations in the local shrimp upon which they prey. The plaice arsenic levels were much higher than those found in other fish species from the same area (redfish, Atlantic cod, turbot) (Kennedy 1976).

**Organic contaminants:** Elevated levels of polycyclic organochlorines (pesticides) found in livers of male American plaice sampled in the North Sea during the winter were associated with their site of collection. Fish with high contaminant body-burdens in that northern European habitat were found near areas of major riverine input and other sources of pollution (Knickmeyer and Steinhart 1990). In eastern Canadian waters, however, inducible monooxygenase activity in American plaice livers was low and did not vary significantly over a presumed organic pollution gradient in New Brunswick (Addison *et al.* 1991). The inference was that organic pollution was low and uniformly distributed in this estuarine-river system.

**WINTER FLOUNDER** (*Pleuronectes americanus*)

**Metals:** Concentrations of metals in the muscle tissue of winter flounder caught in the New York Bight and Long Island Sound were relatively low, and did not reflect the high levels found in some sediments, namely those from the Christiansen Basin and the "Mudhole" (30km SSE of the Basin, in the northern part of the Hudson Shelf Valley) (Reid *et al.* 1982). Concentrations of metals in the New York Bight Apex are ten to a hundred times greater near waste disposal areas than in uncontaminated sediments (Carmody 1973).

Metal levels in some Long Island Sound sediments have been found to be as high as those in the Christiansen basin (Reid *et al.* 1982); high concentrations of metals and organics in Hempstead Harbor NY sediments qualify it as a Superfund Site (US EPA 1984). In a comparison of two sites along the west-to-east pollutant gradient in Long Island Sound, Hempstead Bay is considered heavily polluted as compared to waters off Shoreham NY, based on metals in sediment data, yet Cu, Mn, and Zn concentrations in livers of winter flounder caught at those stations were twice as great for Shoreham as for Hempstead (Greig and Wenzloff 1977). There thus appears to be no general trend of metal concentrations in liver in relation to metals in sediment (Greig and Wenzloff 1977), an observation that seems to be true as well for PCB levels in the liver of windowpane flounder (Greig *et al.* 1983), which were not related to an assumed pollution gradient.

In related experimental studies, the order of sublethal metal toxicity (2mo, 10ppb metal) for adult winter flounder was $CdCl_2 > HgCl_2 > AgNO_3$ (Calabrese *et al.* 1977). Mercury accumulated in tissues of winter flounder exposed to this metal while no statistically significant amount of cadmium was taken up in tissues of fish in an analogous exposure. Mercury, but not cadmium or silver, provoked statistically significant hematological responses. Cadmium, the most potent inducer of the transcription gene for metal-binding proteins in winter flounder (Chan *et al.* 1989), induced several significant metabolic responses: ligand sensitivity was lowered in kidney and heart enzymes; enzyme induction occurred in kidney, gonad, heart, and skeletal muscle; and in the liver, glycolysis and shunt activity increased. These same phenomena were observed in mercury-exposed flounder but to a lesser extent, and silver-exposed fish showed very little effect (Calabrese *et al.* 1977).

In developing embryos of winter flounder, no effect was produced by cadmium (0-1000ppb) on percent total hatch, nor by the interactions between cadmium and salinity, cadmium and silver, and silver and salinity. Cadmium did, however, influence the viable hatch response, the viable hatch decreasing with increasing Cd concentrations. Cadmium's most toxic effect on viable hatch was at 10‰, the lowest salinity tested, and became less significant with increasing salinity. Addition of silver to cadmium solutions decreased cadmium toxicity; silver alone exerted no lethal effect over the concentrations used (Voyer *et al.* 1982).

Kidney tissue from adult winter flounder exposed to cadmium (2mo, 10ppb) showed an increased expenditure of energy (for synthesis of enzymes to maintain homeostasis under sublethal cadmium stress) and a loss of sensitivity to normal metabolic control (magnesium modulation of ligand affinities) (Gould *et al.* 1977).

Exposure of winter flounder to sublethal cadmium or mercury (2-5mo, 10ppb) elevated (Hg) or depressed (Cd) gill respiration; cadmium and to a lesser extent mercury induced liver enzyme activity, lowered ligand sensitivity (kidney and liver, especially Cd); and mercury but not cadmium produced various hematological disturbances (Calabrese *et al.* 1975, 1977). No uptake of Cd into either blood or gills was detected, but mercury increased over control levels in both blood and gills in a dose-dependent manner (Calabrese *et al.* 1975). Recovery from the hematological changes seen in winter flounder exposed to mercury alone was virtually complete in the 10ppb-exposed group after a subsequent 60-day recovery period, and partial recovery was seen in the 20ppb-exposed group (Dawson 1979).

Absorption of leucine from food is diminished in winter and summer flounder taken from the polluted water of Sandy Hook Bay NJ, as compared to fish taken from cleaner areas. This effect was enhanced by low levels of mercury; methyl mercury is a less effective inhibitor (Farmanfarmaian 1981): inorganic mercury (0.4m*M*, 108ppm) completely abolished sodium transport ability in flounder urinary bladders *in vitro*, an effect that persisted during the period of experimentation (110min). An analogous experiment with methyl mercury (0.4m*M*, 100ppm) produced only a transient inhibition (Renfro *et al.* 1974). Mercury also blocks essential potassium movement in the urinary bladder (Venglarik and Dawson 1986). Exposure of winter flounder to methylmercury had no effect on osmoregulation, ion regulation, or blood volume regulation. Neither was there any effect on transepithelial electrolyte transport in gill or intestine, but in bladder and kidney more energy was expended to perform that function in methylmercury-exposed winter flounder than in control fish (Schmidt-Neilson *et al.* 1977). In preparations of winter flounder intestine, inorganic mercury [100μ*M*, organic mercury (*p*-chloromercuri- benzene, 1μ*M*), and organic arsenic (oxophenylarsine, 250μ*M*)] all inhibited adenosine triphosphatase (ATPase) and decreased cell potassium, and inorganic mercury decreased uptake of tyrosine. The conclusion was that mercurial and arsenical effects on tyrosine absorption are due to inhibition of Na-K-ATPase, which thus decreases the driving force for the cellular uptake of tyrosine (Musch *et al.* 1990).

Concentrations of silver above 54ppb in a flow-through bioassay (18d, 54 - 386ppb) produced greatly reduced percent viable hatch in winter flounder embryos and larval mortality. Embryos exposed to 180 and 386ppb hatched earlier than those exposed to lower concentrations, and many had physical abnormalities. Mean total length and mean yolk-sac volume of hatched larvae from the 386ppb silver exposure were significantly smaller than those measurements at lower concentrations (Klein-MacPhee 1984).

Electron microscopic examination of the olfactory organs of copper-exposed larval winter flounder (18h, 500ppb) showed moderate to severe cytopathologic lesions (Bodammer 1981). In *in vitro* preparations of winter flounder intestine, copper inhibited chloride absorption and damped the stimulatory effect of higher pH. Concentrations as low as 50μ*M* were effective. Inhibition was not reversed by addition of a copper chelator. Zinc, on the other hand, stimulated chloride absorption at concentrations between 10μM and 50μM (Charney *et al.* 1988). $Cu^{2+}$, $Ni^{2+}$, $Fe^{3+}$, $Co^{2+}$, $Cd^{2+}$, and $Cr^{2+}$ all significantly decreased the absorption of $Zn^{2+}$ across the wall of the intestine (Shears and Fletcher 1983).

**Organic contaminants:**

***PCB's***: PCB concentrations in winter flounder are derived from the sediment. A food-chain model demonstrates that uptake across the gill is exceeded by dietary uptake of PCB's; contaminated prey species provide most of the PCB observed in flounder (80-95%). Assimilation efficiency of PCB declines from high values for trichlorophenyl to low values for the more highly-chlorinated homologues (Connolly 1991).

Fin erosion, especially seen in winter flounder, appears to result from exposure of demersal fishes to contaminated sediments. PCB concentrations in muscle, liver and brain tissues were higher in fishes with fin erosion from contaminated sites (primarily winter flounder) than in fish from reference sites. The erosion pattern of the fins and the association of higher prevalence of fin erosion with greater degrees of sediment contamination suggest that fin-sediment contact in an area where toxic contaminants have accumulated on the bottom is an important factor in development of the disease. Increases in liver sizes and/or lipid content may be a response to DDT and/or PCB exposure (Sherwood 1982).

PCB levels in winter flounder liver were significantly correlated with body fat content. "If fat content is inversely related to environmental stress, [no direct] relation between environmental contamination and PCB body burdens can be drawn, and may contribute to the observed absence of dramatically elevated burdens in the inner Bight." The highest concentration of PCB's in winter flounder flesh (0.56ppm, wet wt) was found 21km south of the eastern end of Long Island. PAH's, predominantly phenanthrene, ranged from 28 to 246ppb wet weight (Reid *et al.* 1982).

Winter flounder collected from 3 southern New England areas with differing degrees of PCB and PAH contamination (New Bedford Harbor, NBH; Gaspee Point, GP; and Fox Island, FI) reflected their sites in having analogous varying degrees of PCB-contaminated liver, with NBH> GP> FI. Liver EROD activity was the same at all three sites, but P450 was significantly higher in the NBH fish (Elskus *et al.* 1989). The data suggest that P450's catalytic activity (for EROD) is being competitively inhibited at NBH, possibly by some congeners of PCB (Gooch *et al.* 1988).

Work in Long Island Sound showed concentrations of PCB in winter flounder gonads to be highest (0.73ppm wet wt) in the months just before spawning, as compared to levels in other months (0.056-0.36ppm). After spawning, PCB concentrations in gonads decreased to very low levels (0.03-0.08ppm). Liver PCB concentrations declined somewhat before and during the spawning season (0.33-0.60ppm), returning to higher levels after the spawning season (1.1-2.3ppm). Overall, levels of PCB's were higher in gonad and liver samples from the more polluted sites in Long Island Sound (Greig and Sennefelder 1987).

Sexually mature female winter flounder showed lowered EROD activity and P-450E levels, thought to be a hormonal effect acting primarily to suppress induction of P450E, the activation catalyst for EROD (Förlin and Hansson 1982, cited in Elskus *et al.* 1989). In heavily urbanized areas of Long Island Sound having higher PCB's in the sediments (New Haven, Hempstead, Norwalk), winter flounder tended to have lower reproductive success, when spawned in the laboratory, than did flounder from less urbanized sites. Winter flounder embryos from the New Haven site had the most abnormalities and the lowest percent viable hatch. Fish with high liver concentrations of PCB (Boston) had small larvae (Nelson *et al.* 1991). Eggs of winter flounder from

New Bedford Harbor (MA) were significantly higher in PCB content (39.6ppm dry wt) than those from Fox Island (a relatively clean area in Narragansett Bay RI), and larvae hatched from these New Bedford eggs were significantly smaller in length and weight. There was a significant inverse relationship between PCB content of the eggs and length or weight at hatch (Black *et al.* 1988).

Experimental work has shown that other contaminants can affect PCB assimilation; in winter flounder exposed to a PCB (24h, 1ppm) in the presence or absence of added cadmium (200ppb), the fish dosed with added cadmium had significantly lower PCB in their liver and gills than did those dosed with PCB alone (Carr and Neff 1988). Weis *et al.* (1992) exposed (2wk) developing winter flounder embryos to varying concentrations of treated waste water effluent or various extracts thereof. PCB's were present in all effluent batches used. Highest mortality and precociousness, but diminished hatch, occurred in embryos treated with undiluted effluent; the organic acid fraction and organic bases fraction had lesser mortality, and the neutral organics fraction had mortality rates less than that of the controls. The larvae grew faster in the organic acid fraction; their increased growth rate is thought to be due to hormesis.

***PAH's:*** In male and female winter flounder collected over a 2-yr period from a relatively non-polluted area in Nova Scotia waters, seasonal variation (about tenfold) in hydrocarbon-inducible enzyme activity was less than that caused by environmentally realistic levels of pollutants. Liver MFO's in this species, therefore, might be used to indicate environmental contamination (Addison *et al.* 1985, Edwards *et al.* 1988).

High levels of polycyclic aromatic hydrocarbons (PAH) have been found in Boston Harbor sediments (Malins *et al.* 1985). Various pathologies seen in liver tissue excised from winter flounder collected from that area were construed as arising from PAH-induced genetic mutations leading to tumor formation (McMahon *et al.* 1988a, 1988b). Experimental work led to substantiation: winter flounder fed chlordane- and benzo(α)pyrene-contaminated food developed proliferative lesions similar to cholangiocellular carcinomas in winter flounder taken from Deer Island Flats (Moore 1991). Both benzo(α)pyrene (BαP) and BαP metabolites produced by polychaete worms were accumulated in liver tissue when winter flounder were fed the contaminated worms. Risk assessments for predators must therefore take into account metabolites produced by prey as well as the parent compound (McElroy and Sisson 1989). Cytochrome P450 was induced in winter flounder in the laboratory by injection of the PAH β-naphthoflavone. Fish collected from Boston Harbor and Buzzards Bay had the same enzyme. Other hydrocarbon-inducible enzyme activities (EROD and AHH) were elevated in both injected and field-collected fish (Stegeman *et al.* 1987). Immunohistochemical techniques on liver tissue from winter flounder further revealed evidence of liver histopathology, the hydrocarbon-inducible P450 enzyme. The presence of P450 was associated with liver pathology in winter flounder taken from Boston Harbor. The study shows that P450 could play a role in the production of a mutagenic agent from environmental chemicals taken up by the fish (Smolowitz *et al.* 1989). Corroborative work on winter flounder collected near Mount Desert Island (ME) showed that high liver AHH and EROD activities were associated with a band in electropherograms of liver microsomal preparations that corresponded to the position of cytochrome P450. Fish with low AHH and EROD activities showed the band only faintly (Foureman *et al.* 1983).

***Pesticides***: Abnormal gastrulation and a high incidence (39%) of vertebral deformities were seen in developing eggs from adult winter flounder experimentally exposed to sublethal amounts of DDT (1-2ppb). No similar effects were noted in eggs from flounder similarly exposed to dieldrin. No residues of either insecticide were detected in the milt of exposed or control male winter flounder (Smith and Cole 1973).

The $LC_{50}$ for chlordane, injected intraperitoneally in winter flounder, was 11,000mg/kg. Chlordane in high doses induced severe liver damage, and at subacute doses produced macrophage aggregation and a persistence of necrogenic effects in the liver. Dimethylsulfoxide increased chlordane's toxic effects almost 200-fold (Moore 1991).

Pesticide levels were elevated in winter flounder from a tributary of Buzzards Bay MA, indicating significant levels of contamination in this area. Winter flounder collected near Lynn MA contained heptachlor in amounts close to the FDA limit for humans, and also contained elevated levels of DDT (0.117ppm wet wt) (Connolly 1991). The highest concentrations of chemical contaminants were found in coastal harbors and industrialized centers (MacLeod *et al.* 1981), whereas offshore areas had very low levels (Connolly 1991).

***Oil:*** Winter flounder were exposed to oil-contaminated sediment either weathered for a year or freshly oiled (1L oil in 45kg sand). After 4mo, flounder livers had a cytochrome P450 induction rate that was seven-fold (over unexposed controls) in fish exposed to weathered oiled sediment, and a thirteen-fold induction rate in fish exposed to freshly oiled sediment. Benzo($\alpha$)pyrene seemed to be a good inducer of cytochrome P450 (Payne and Fancey 1982).
In 1984, examination of winter flounder collected from the site of an oil spill and from a reference site showed that reliance on the measurement of liver MFO parameters alone could lead to false negatives in biological monitoring programs. The kidney provided statistical differences in elements of the MFO system between control and oil sites, whereas the liver did not (Payne *et al.* 1984). Using oiled sediments under a controlled laboratory exposure, the same research team later found that biomarkers indicating exposure to oil were (in order of decreasing sensitivity): liver MFO activity,

liver condition index (liver wt/total body wt), kidney MFO activity, spleen condition index, and muscle protein and water content. Liver lipid and glucose levels and condition indices for gut, kidney, testis and whole fish were not affected at any exposure level (Payne *et al.* 1988). *In-vitro* work with the skin of winter flounder exposed to crude oil suggests an added capacity for increased mucogenesis in direct response to stress associated with environmental conditions (Burton *et al.* 1984). The level of exposure to oil at which liver hypertrophy continues to increase while MFO activity begins to decrease is the "point of crossover." It may represent the point at which the detoxication mechanism is overwhelmed (Hutt 1985, cited in Payne *et al.* 1988).

High numbers of liver macrophage aggregates (MA) were reported as a response to exposure to stressful environmental stimuli, including chemical contamination (Wolke *et al.* 1985). Yet exposure of winter flounder for 4 months to varying concentrations of crude oil in sediments reduced the number of melanomacrophage centers in livers. Liver hypertrophy increased with increasing oil exposure. Splenic atrophy occurred only at the two highest levels of exposure (250 or 500ml of oil per 45kg of sand). Oil exposure was shown to affect the immune response in winter flounder by reducing the number of phagocytic cells available to ingest foreign particles (Payne and Fancey 1989).

Fewer parasites in fish exposed to oil might be attributed to toxicity induced by water-soluble fractions of crude oil and/or modification of the gut environment (Khan and Kiceniuk 1983). Juvenile and adult winter flounder, some infected with the blood parasite *Trypanosoma murmanensis*, were exposed to sediment contaminated with crude oil (6wk, 2600-3200ppm) or to clean sediment. Mortality was significantly higher (89% for juveniles, 49% for adults) in infected, oil-exposed fish than in fish with either condition alone. Deaths were associated with severe fin and tail necrosis, erratic swimming behavior, and failure to bury in the sediment. Blood chemistry changed: Hct, Hb, plasma protein, and condition factor were all lowered. Clubbing of gill tissue, mucus hypersecretion, and congestion and enlargement of the spleen were also observed. Exposure to oil increased the incidence of infection and death, whether the exposure occurred before or after infection with *Trypanosoma* (Khan 1987).
Four years later these results were corroborated, with additional data adding reproductive impairment and presumptive immunosuppression to the list of effects (Khan 1991). Total concentrations of the hormone androgen (both free and conjugated) in plasma of sexually mature male winter flounder exposed to crude oil were statistically lower than controls. Oil exposure had no effect, however, on total plasmatic androgens and estradiol in female and male flounder during early maturation of the gonads (Truscott *et al.* 1983).

***Pollution-Linked Disease:*** The intensity and prevalence of parasitic infections were significantly lower in oil-treated winter flounder. The effect was more pronounced in fish exposed to water-soluble extracts than in those exposed to oil-contaminated sediment (Perry *et al.* 1991).

Circumstantial evidence is widespread: proliferative lesions in endocrine, exocrine, respiratory, sensory, excretory and digestive organs and alteration of plasma protein were found to be characteristic of winter flounder from moderate to highly contaminated inshore areas. Concentrations of polycyclic aromatic hydrocarbons, PCBs, other organic compounds and trace metals associated with sediments were elevated in urban embayments. Liver disease was absent in populations from uncontaminated offshore areas. Tissue concentrations of PCB's reflected those detected in the sediments. Degree of sediment chemical contamination and disease suggest a causal interrelationship (Gardner *et al.* 1989).

Winter flounder sampled from the inner New York Bight had statistically higher incidence of fin-rot disease when compared to either offshore waters of the New York Bight or inshore within Massachusetts Bay (Ziskowski *et al.* 1987). A Boston Harbor field study, in which tumors were not found in fish smaller than 32cm in length, revealed a pattern in liver pathology: a progression from toxic necrotic lesions to neoplasia, suggesting pollutants as the likely inducers of the lesions (Murchelano and Wolke 1991). Histopathological analysis of livers from winter flounder revealed one liver neoplasm in a fish from the western end of Long Island Sound and none in fish from the eastern end of that west-to-east pollution gradient (Turgeon and O'Connor 1991).

Boston Harbor sediment extract, injected peritoneally, was acutely toxic to winter flounder; after 10d, perivascular edema was observed in survivors (Moore 1991). Fish exposed for 90-120d to sediment from Black Rock Harbor (Bridgeport CT) developed neoplastic or proliferative lesions in the kidney, olfactory and lateral line sensory tissues, gastro-intestinal tract, and buccal (cheek) epithelium; cytopathology and cell necrosis were detected in the pituitary; parasitism (degenerative lesions from trematodes and microsporidian infection) was also related to organic contamination. In the field, winter flounder collected from Black Rock Harbor and New Bedford Harbor (MA) had similar lesions (Gardner and Yevich 1988).

Abnormalities observed in winter flounder embryos included evidence of cytotoxicity, chromosome damage, slower developmental rates and cell necrosis. Embryos of fish from New Haven CT (Morris Cove) were usually the most aberrant, while embryos from Hempstead and Shoreham NY and from both Boston Harbor sites showed subtle indications of abnormality (Perry *et al.* 1991). New Haven sediments are contaminated with high levels of PCB's, aromatic hydrocarbons, chlorinated hydrocarbons, and trace metals (Gronlund *et al.* 1991). High prevalence of liver lesions, blood cell abnormalities, liver DNA damage, liver neoplasms, concentrations of organic chemicals and trace metals, and high levels of PCB's in gonads in winter flounder from New Haven have been found (Greig and Wenzloff 1977, Greig and Sennefelder 1987, Gronlund *et al.* 1991).

Incidence of small inclusions (micronuclei, MN) in red blood cells were elevated sixfold in flounder from the New York Bight Apex as compared to fish from the inshore Gulf of Maine and Block Island Sound, and twice those found in Georges Bank and Long Island Sound flounder. Inshore New Jersey and Virginia fish had significantly higher MN frequencies than those from the Gulf of Maine and Block Island Sound. There were higher frequencies of MN in flounder from Hempstead and Shoreham, N.Y. as compared to most other sites in the Sound. Erythrocyte MN were consistently higher in flounder from the more highly contaminated stations examined (Hughes and Hebert 1991) (New York Bight Apex and Hempstead, contaminated with metals and PAH (Carmody *et al.* 1973, MacLeod *et al.* 1981, US EPA 1984). Winter flounder collected from the coastal mid-Atlantic had statistically higher erythrocyte mutation frequencies than those from more offshore waters. Flounder from western Long Island Sound had significantly higher frequencies of micronuclei than those from the New York Bight, with fish from both these areas having significantly higher mutation frequencies than flounder sampled elsewhere. The higher incidence suggest a link with environmental pollution (Longwell *et al.* 1983).

High mean blood lymphocyte counts in winter flounder were correlated with liver necrosis and suspected levels of sediment chemical contamination; winter flounder collected from Boston Harbor had higher numbers of immature erythrocytes than did those from less urbanized environments. Disturbances in the distribution of blood cells and alterations in lymphocyte counts were related to neoplastic lesions and indicative of chemical contamination in sediments (Daniels and Gardner 1989).

Winter flounder collected from lower Narragansett Bay RI produced the smallest yolk-sac larvae with the lowest survival rate, while fish collected at Madison CT produced the largest yolk-sac larvae with the highest survival rate. Survival was also higher in the Madison group than the Morris Cove CT group from Long Island Sound (Buckley *et al.* 1991). These results are consistent with observations of embryonic development suggesting that reproduction of winter flounder at the Morris Cove site has been compromised by high contaminant levels (Nelson *et al.* 1991).

Further circumstantial evidence associating pollutants with abnormalities has been reported for Massachusetts Bay. Biochemical variables such as hepatic and pectoral fin ascorbic acid concentrations, hepatic glycogen and lipid levels, plasma glucose concentrations, brain serotinin and norepinephrine concentrations, and the concentration and ratio of various free amino acids in muscle tissue were significantly lower in winter flounder from Boston Harbor. The histological difference between the Boston Harbor and Plymouth Beach (reference site) fish was the high prevalence of degenerating hepatic parenchymal cells in the Boston Harbor fish. Low tissue concentrations of ascorbic acid and hepatic glycogen had significant statistical associations with the presence and severity of these hepatic lesions (Carr *et al.* 1991).

***Mixed Contaminants***: Halifax Harbor sediments, which are enriched with heavy metals (As, Cd, Cu, Hg, Pb, and Zn), organic carbon, and PAH's, are considered to have caused the necrogenic effects (hepatocyte basophilia, macrophage aggregation and hepatic epithelial vacuolation) observed in livers of winter flounder caught in Halifax Harbor (Tay *et al.* 1991).

Of 3 study sites in Long Island Sound, New Haven CT had the highest concentrations of aromatic hydrocarbons (AH's) and polychlorinated biphenyls (PCBs) in sediment, and the highest prevalence of histopathological changes and DNA alterations in the livers of winter flounder from this site (Gronlund *et al.* 1991). Liver macrophage aggregate (MA) (Wolke *et al.* 1985) index was significantly higher in winter flounder from the New Haven site as compared with those from the Niantic CT site. No differences in contaminant concentrations in fish or in frequencies of red blood cell micronuclei were found between sites. None of the sites sampled had contaminant levels or prevalence of lesions as high as were found at Boston Harbor MA or Raritan Bay NY (Gronlund *et al.* 1991).

Levels of organic and inorganic contaminants in sediments and fish tissue were examined to evaluate possible correlations between biological effects and contamination. PAH's found in the stomach contents of winter flounder appear to be sediment-derived. Concentrations of PCB's were greater in the stomach than sediments with the exception of Salem and Boston Harbors, MA, an indication that the chlorinated hydrocarbons were accumulated by prey organisms. Concentrations of PCB's and chlorinated hydrocarbons increased in flounder livers relative to both stomach contents and sediment. Some pathological conditions had distributions similar to contaminant distribution. The distribution of certain contaminants and certain types of lesions appear related, but it is unclear whether the compounds or combination of compounds that were examined may be causing these maladies (Zdanowicz *et al.* 1986).

**WITCH FLOUNDER** (*Glyptocephalus cynoglossus*)

No references were found in the literature to date of any pollutant effects in the witch flounder that are attributable to metals or organics.

**REDFISH** (*Sebastes marinus*)

**Metals:** No adverse effects were found in redfish having a mean concentration of 800ppb arsenic in muscle tissue (Kennedy 1976).

**Organic contaminants:** An 8-yr study of redfish collections showed that oil-exploration activity did not adversely affect the redfish stock (Kulka 1991).

Another contaminant widely distributed in the environment is di-2-ethylhexyl phthalate (DEHP), a man-made organic compound. Concentrations found in redfish were less than 0.001ppm, in both fatty and wet-weight tissues; no adverse effects were reported. The low levels found in redfish (and plaice) from the deeper parts of the Gulf of Maine, as compared with much higher levels in herring and mackerel, suggest that DEHP contamination in fish is an inshore phenomenon (Musial and Uthe 1980).

**WHITE HAKE** (*Urophycis tenuis*)

White hake collected from Boston Harbor 1979-1983 had a significant prevalence (1.89%) of fin-rot disease; winter flounder collected from this area during same time period had a prevalence of only 0.71% (Murchelano *et al.* 1986).

**WINDOWPANE FLOUNDER** (*Scophthalmus aquosus*)

**Metals:** In a 1975 field collection from Delaware Bay, windowpane flounder had detectable levels of mercury in muscle tissue, but no detectable mercury was found in the water, detritus, algae, or shrimp found in the fishes' environment (Gerhart 1977). There was no correlation found between mercury body-burdens and the food chain or habitat.

A laboratory exposure of windowpane flounder to mercury (2mo, 10ppb) produced increased plasma sodium levels, and work with field-collected fish showed higher blood parameters (Hct, Hb) at the most polluted station (Dawson 1990). The field results indicate an increase in hematopoiesis; both observations suggest an attempt to compensate or even overcompensate for an imposed metabolic stress. The same laboratory exposure of windowpane flounder to mercury produced abnormal localized swellings in the gill and some fragmentation of cellular membranes (Pereira 1988), changes that may affect gill function.

**Organic and unidentified pollutants:** No relation was found between windowpane flounder liver concentrations of PCB and a pollution gradient in Long Island Sound, nor was there any general trend of metal concentrations in liver in relation to metals in sediments (Greig *et al.* 1983).

A high incidence of fin erosion was observed in windowpane, winter, and yellowtail flounders exposed to materials dumped in the New York Bight (O'Connor 1976). (Winter flounder had the highest incidence.)

Numbers of red blood cell MN in field-collected windowpane flounder were 2 to 3 times higher in fish from the most polluted site in Long Island Sound than in fish from the reference station (Longwell *et al.* 1983).

Both planktonic eggs and field collections of adult windowpane and winter flounders across a pollutant gradient in Long Island Sound showed mitotic abnormalities in specimens from more polluted coastal areas. Longwell *et al.* (1992 consider their findings to represent a "...considerable...cumulative effect on...early-life survival."

**WHITING** (*Merluccius bilinearis*)

**Metals:** Detectable concentrations of Hg in muscle of silver hake (whiting) could not be related to feeding habits or environment (Gerhart 1977).

**Organic contaminants:** Although computer searches revealed no reports on the effects of organic contaminants on the American whiting, some papers on the European whiting, *Merlangius merlangus*, may be relevant:

PCB, DDE, and dieldrin contamination in ovaries in North Sea whiting was significantly correlated with reduced viable hatch (Westernhagen *et al.* 1989, cited in Dethlefsen 1989).

European whiting captured near offshore drilling platforms, which use oil-based muds for operation, showed no significant difference in AHH activity from whiting captured in control areas. Laboratory exposure of 3 fish species (whiting, cod, and haddock) to 50ppb B$\alpha$P showed that whiting had the least response, with AHH activity only 0-3 times that of control fish, which had much greater variability (Davies *et al.* 1984).

**RED HAKE** (*Urophycis chuss*)

**Metals:** No correlation was found between detectable mercury concentrations in red hake muscle tissue and the fish's eating habits or environment (Gerhart 1977).

**Contaminant mixtures, unidentified:** A significant fraction (7.5%) of red hake collected from the New York Bight had external ulcers, whereas none from outside the Bight area had any lesions (Murchelano and Ziskowski 1979).

Although the general experience of fishery scientists has been that fin rot is almost never seen in red hake, a collection of that species collected from Boston Harbor 1979-1983 had a significant (3.4%) prevalence of fin-rot disease (Murchelano *et al.* 1986). During this same survey, white hake had 1.89% and winter flounder only 0.71%, anomalously low for that species.

**OCEAN POUT** (*Macrozoarces americanus*)

No references have been found in the literature to date of any pollutant effects in the ocean pout that are attributable to metals or organics.

### E.6.4.5.2 Nutrient loading

**Nutrient Loading and Eutrophication in the Gulf of Maine/ Georges Bank Region**

During the past few decades, estuarine and coastal waters of the Northeastern United States, adjacent to highly urbanized and high-intensity agriculture areas, have experienced significant increases in the concentrations of nitrogen, phosphorus and other algal nutrients. In the eastern US and western Europe, contemporary nutrient loading of rivers is probably 10-50 times greater than prehistoric loading (Hinga, et al., 1991) as a consequence of deforestation, sewage disposal and agricultural fertilizers (Walsh, 1981; Stoddard et al., 1986; Rosenberg, 1985; Larsson et al., 1985; Smith et al., 1987). Upgrading the treatment of sewage wastes to "secondary", in the past several decades, has effectively reduced certain pollutants (biochemical oxygen demand, particulates, trace metals and pathogens), but nutrient loadings remain relatively unaffected (e.g. Ayers et al., 1988).

Besides sewage and industrial wastes, other inputs of nutrients to the coastal zone, such as agriculture and suburban runoff, as well as nitrates from acid rain, may also contribute significantly to nutrient over-enrichment (Fisher, 1988; Paerl et al., 1990; Hinga et al, 1991). In coastal rivers entering the Northeast Atlantic, a trend of increasing nitrate loading concurrent with decreasing phosphorus loading between 1974-1981 was reported by Smith et al.,(1987). The projected demographic trend for the Northeast coastal zone, combined with the anticipated modest effort to control the loadings of nutrients emanating from these sources, suggests that nutrient over-enrichment will continue to have adverse effects on coastal water quality and fisheries well into the next century. The problem of nutrient over-enrichment in US coastal waters is a national issue which NOAA is addressing through the Coastal Ocean Program, and EPA through its Estuarine Programs.

**Nutrient Fertility, Primary Productivity, and Fishery Productivity**

Nutrient fertility, the availability of nutrients through new inputs and recycling, plays a significant role in the trophodynamics, productivity and health of aquatic ecosystems. Eutrophication, or the state of "enhanced nourishment" (GESAMP, 1990) may occur through natural processes (e.g. upwelling) or from inputs of nutrients derived from human activities. The effects of eutrophication are not necessarily adverse ones. For instance, a doubling of benthic production and increases in the growth rates of bottom feeding fishes followed increases in planktonic productivity which, in turn, resulted from experimental additions of inorganic fertilizers to Scottish sea lochs (Raymont, 1949; Mearns et al.,1982). Iverson (1990) developed convincing arguments that carnivorous fish production in coastal and open ocean environments (including the Gulf of Maine) is controlled by the amount of new nitrogen entering the euphotic layer and consequent new primary production, and not by systemic differences in trophic transfer efficiency or number of steps in the food chain.

Nixon (1988,1992) reported a strong association between landings of finfish and shellfish and the annual phytoplankton primary production and nitrogen input to numerous estuarine and marine ecosystems, with the fisheries yield approaching 1% of the phytoplankton carbon production in the most productive systems. In a series of nutrient enrichments experiments in mesocosms, a 15-fold increase in phytoplankton chlorophyll and a 4.5-fold increase in daytime primary production accompanied a 60-fold nitrogen enrichment, and total system production of the mesocosms increased with nutrient loading (Nixon, 1992). High production in marine ecosystems is "virtually always associated with a high rate of inorganic nutrient input to the surface water" (Nixon,1992). In fresh water systems, similar relationships have been evident for many years from both empirical (Vollenweider, 1976; Lee and Jones, 1984) and experimental studies (Schindler 1975; 1987), except that phosphorus, not nitrogen, is the key nutrient.

Thus, a quantitative relationship between nitrogen inputs, primary production, and fisheries yields is evident when comparing a spectrum of ecosystems. Within some individual systems, the evidence suggests that increases in nutrient inputs increase not only the "quantity" of primary production, but also affect the "quality" of the production (phytoplankton species and size composition and nutritional content). These qualitative changes may not always be most advantageous to the food web or man's utilization of resource species. Thus, enhanced nutrient availability to the phytoplankton represents a "double-edged sword" in that it enhances overall system production but may, at the same time, generate conditions favoring more frequent or persistent blooms of noxious or toxic phytoplankton, or depressed concentrations of dissolved oxygen and fish/invertebrate mortalities, when algal blooms greatly exceed the assimilation capacity of herbivores or the capacity of system to physically disperse the blooms.

### Effects of Nutrient over-enrichment

There is considerable concern and *some* evidence that nutrient over-enrichment has resulted in several undesirable eutrophication effects in estuarine and coastal areas of northeast United States, including:

> Increased incidence, extent and persistence of blooms of noxious or toxic species of phytoplankton associated with mortality of humans, mortality or reduced productivity of economically or ecologically important marine species, decreases in fishery harvest, and reduced aesthetic value of coastal areas;
>
> Increases in the frequency, severity, areal extent, and persistence of hypoxia, the condition of depressed concentrations of dissolved oxygen in bottom waters, occurring during summer in Chesapeake Bay, Raritan-Hudson estuary, Western Long Island Sound, and inshore New York Bight and portions of Boston Harbor. This has resulted in benthic mortalities, reduced growth and production, and changes in resource distribution;
>
> Alterations in the species and size-composition, and the nutritional-biochemical "quality" of the phytoplankton community causing changes in the structure, function, and productivity of the fisheries food chain;
>
> Alterations in the ultraplankton community (bacterioplankton and smallest phytoplankton) which may increase transfer of chemical contaminants through the fisheries food chain and increase the potential for bacterial fish diseases.
>
> Increased turbidity of surface water from planktonic algae leading to "shading" and losses of bottom macrophytes such as eelgrass, loss of critical estuarine habitats for early life stages of fish, and reduced aesthetic appeal of recreational waters;

### The Eutrophication Status of the Gulf of Maine-Georges Bank Region

Since long-term, coherent, time-series measurements of *in situ* concentrations of all forms of nutrients, processes affecting nutrients, and of nutrient loading in the Gulf of Maine-Georges Bank area are lacking (Loder et al., 1991), other scientific approaches, each with many assumptions and much imprecision, are required to assess the status, trends, and ecological consequences of nutrient loading in this region. Retrospective approaches have been used successfully to derive assessments of nutrient loading and eutrophication. For example, stratigraphic analyses of sediment cores, have shown that anoxia and eutrophication have increased in the Chesapeake Bay since the time of European settlement (Cooper and Brush, 1991).

An extensive nationwide review of oxygen depletion and eutrophication in estuarine and coastal waters was conducted during the mid-80's by Whitledge (1985) and coworkers. They reviewed the scientific literature, federal, state, and county databases and reports, and contacted individuals familiar with each of the systems. Their general finding was that episodes of low concentrations of dissolved oxygen (<4 mg/l) were more chronic in river-estuarine systems in the southern portion of the northeast, from Narragansett Bay to Chesapeake Bay, than the in the northern systems, except for episodes of low dissolved oxygen in Boston Bay/Charles River, and the freshwater portion of the Merrimack River, between miles 20-30. Generally, episodes of depressed levels of DO were associated with loading from municipal and combined sewers. The only two areas on the open continental shelf affected by recurring hypoxia are coastal waters of the New York Bight and inshore Gulf of Mexico off Louisiana (Whitledge, 1985). Offshore bottom waters in the Gulf of Maine and Georges Bank have not experienced episodes of hypoxia or anoxia. Loder and Becker (1989) concluded:

> "At the present there does not seem to be a problem of eutrophication in the Gulf of Maine overall, but as we have seen there are problems starting to occur in localized coastal areas. These are the first warning signs that parts of the system are being stretched beyond their normal assimilation capacity with regards to nutrients. The problems will only get worse if steps are not taken to set control practices in place"

Assessment of the degree of nutrient over-enrichment using field measurements of nutrient concentrations can have limitations because dissolved inorganic forms of plant nutrients, N,P,Si, may be rapidly photoassimilated by phytoplankton into particulate organic matter, and rapidly recycled by the plankton community and seabed into inorganic forms. There is emerging evidence that denitrification (Seitzinger, 1988) is a potentially significant component of the nutrient budgets of coastal ecosystems. Unless all forms of the nutrient are frequently measured, inorganic salts, gasses, nutrients bound organically in particulates, or in dissolved organic matter, as well as key rate processes, and nutrient sources and sinks, then sporadic field measurements of just the inorganic dissolved nutrients will probably not yield a picture of the total nutrients in the system adequate for the construction of nutrient budgets and tracking temporal trends in nutrient loading. Thus, from a practical point of view, algal growth (and blooms) may be more closely related to the rate of nutrient supply than to field measurements of nutrient standing stocks (Howarth, 1988).

Another approach to eutrophication assessment, used by the NOAA/EPA Team on Near Coastal Waters (NOAA/EPA, 1988,1989) combines information on the estuarine drainage area, nitrogen and phosphorus loading rates, and the physical and hydrological characteristics (i.e. fresh water inflow, flushing rates), to **infer** the nutrient concentration status of each system and its relative **susceptibility** to increases (or decreases) in nutrient loading and eutrophication. This approach is not a definitive assessment but a "screening device". It does not account for nutrient recycling or offshore natural inputs or atmospheric nutrient inputs. It deals with annual temporal scales (average annual freshwater inflow and salinity), and nutrient inputs are assumed to be vertically and horizontally uniformly distributed within each system. Though the "nutrient concentration status" categorization scheme is a relative one, for management application it may be translated as:

> "A low concentration status supports maximum diversity of benthic resources, submerged aquatic vegetation, and fisheries; medium concentration supports moderate diversity and results in reduction of submerged aquatic vegetation, and occasionally high chlorophyll levels; high concentration results in a significant reduction in resource diversity, loss of submerged aquatic vegetation, frequently high levels of chlorophyll and occasional red tide or algal blooms." (NOAA/EPA, 1988).

The table below summarizes the nitrogen and phosphorus "concentration status" for major estuarine systems bordering the Gulf of Maine.

### Summary of Physical and Hydrologic Characteristics, Nitrogen and Phosphorus Discharges, and Predicted Nutrient Concentration Status for Estuarine Systems Bordering the Gulf of Maine[1]

| | Total Drainage Area sq.mi. | Water Surface Area sq.mi. | Average Depth ft. | Average Daily Fresh Water Inflow (100 cfs) | Volume (billion cu.ft.) | Pop. Density 1980 (per sq.mi.) | Total Nitrogen Discharge tons/yr | Nitrogen Concen.. Status mg/l | Total Phosp. Discharge tons/yr | Phosp. Concen. Status mg/l |
|---|---|---|---|---|---|---|---|---|---|---|
| Pasamaquoddy Bay | 3200 | 157 | 72 | 62 | 315 | 11 | 293 | 0.008 L | 28 | 0.001 L |
| Englishman Bay | 900 | 76 | 38 | 16 | 80 | 12 | 150 | 0.014 L L | 220.002 L | |
| Narraguagus Bay | 400 | 70 | 32 | 9 | 63 | 17 | 104 | 0.016 L | 11 | 0.002 L |
| Blue Hill Bay | 800 | 115 | 75 | 13 | 241 | 28 | 154 | 0.016 L | 35 | 0.004 L |
| Penobscot Bay | 9400 | 361 | 72 | 161 | 725 | 58 | 7808 | 0.102 M | 771 | 0.010 M |
| Muscongus Bay | 300 | 72 | 43 | 6 | 85 | 67 | 56 | 0.013 L | 16 | 0.004 L |
| Sheepscot Bay | 10100 | 103 | 41 | 176 | 118 | 66 | 8745 | 0.077 L | 641 | 0.006 L |
| Casco Bay | 1200 | 164 | 42 | 21 | 191 | 172 | 1412 | 0.086 L | 465 | 0.028 M |
| Saco Bay | 1800 | 17 | 32 | 36 | 15 | 71 | 1257 | 0.057 L | 193 | 0.009 L |
| Great Bay | 1000 | 15 | 11 | 20 | 5 | 243 | 636 | 0.098 L | 204 | 0.031 M |
| Merrimack River | 5000 | 6 | 12 | 84 | 2 | 423 | 10111 | 1.021 H | 1625 | 0.164 H |
| Massachusetts Bay | 1200 | 364 | 77 | 29 | 786 | 2228 | 7995 | 0.216 M | 4091 | 0.110 H |
| Boston Bay | 700 | 69 | 26 | 18 | 50 | 2789 | | | | |
| Cape Cod Bay | 800 | 548 | 77 | 18 | 1178 | 392 | 377 | 0.026 L | 187 | 0.013 M |

[1] Data Sources:

NOAA, NOS, Strategic Assessment Branch, 1990. Estuaries of the United States, Vital Statistics of a National Resource Base, Rockville, MD, 79pp.

NOAA/EPA Team on Near Coastal Waters, 1989. Susceptibility of East Coast Estuaries to Nutrient Discharges: Passamaquoddy Bay to Chesapeake Bay, Summary Report, NOAA, NOS, Strategic Assessment Branch, Rockville, Maryland, 38pp.

The following excerpts from NOAA/EPA Team on Near Coastal Waters (1989) highlight the interpretations given to the table above for those systems having a medium or high nutrient potential concentration status.

Penobscot Bay:

> "the medium phosphorus concentration classification may be influenced by a minor reduction (<20%) in phosphorus loading. The N/P molecular ratio of

the loading is 22, suggesting that phosphorus may be a limiting nutrient in the estuary."

Casco Bay:

"the low nitrogen concentration classification may be influenced by a minor increase (<20%) in nitrogen loading. The N / P molecular ratio of the loading is 7, suggesting that nitrogen may be a limiting nutrient in the estuary."

Great Bay:

"the low nitrogen concentration classification may be influenced by a minor increase (<20%) in nitrogen loading. The N / P molecular ratio of the loading is 7, suggesting that nitrogen may be a limiting nutrient in the estuary."

Merrimack River:

"the high nitrogen concentration classification may be influenced by a minor reduction (<20%) in nitrogen loading. The N / P molecular ratio of the loading is 14, and does not strongly indicate the presence of a limiting nutrient in the estuary."

Massachusetts Bay:

"the high phosphorus concentration classification may be influenced by a minor reduction (<20%) in phosphorus loading. The N / P molecular ratio of the loading is 4 suggesting that nitrogen may be a limiting nutrient in the estuary."

Cape Cod Bay:

"these concentration classifications are not likely to be influenced by minor changes (<20%) in nutrient loadings. The N / P molecular ratio of the loading is 4, suggesting that nitrogen may be a limiting nutrient in the estuary."

The table above suggests that certain coastal areas in the GOM are experiencing or have the potential to experience problems related to human-source nutrient loading. There is concern that coastal water near densely populated areas, such as that bounded by Cape Ann, Cape Cod and Stellwagen Bank may experience changes in nutrient concentrations, changes in nutrient ratios and in phytoplankton species (Loder and Becker, 1989) resulting from the redirection of sewage-nutrients from Boston Harbor to an offshore effluent outfall scheduled to begin operation in July, 1995 (MWRA, 1991). Loder and Becker (1991) estimate that the nitrogen loading from the outfall will be 3-5x that estimated for the Merrimack River or, expressed another way, ~10% of nitrogen loading from Gulf of Maine rivers.

A comprehensive monitoring plan has been devised by the Massachusetts Water

Resources Authority (MWRA, 1991). One facet of the plan consist of field surveys of nutrients, dissolved oxygen and on their potential effects on phytoplankton, primary productivity and zooplankton in the "nearfield" and "farfield" areas surrounding the effluent outfall, before and during its operation. Detectible changes in phytoplankton chlorophyll in the nearfield area are expected; the exact magnitude of the change is dependent upon many physical and biological factors, and is not certain (MWRA, 1991).

For purposes of comparison, using the above approach (NOAA/EPA,1989), the predicted concentration status for Long Island Sound is 0.271 mg/l for nitrogen (Medium) and 0.041 mg/l for phosphorus (Medium). Episodes of hypoxia (DO <3 mg/l) occurred in the sewage-polluted western portion of Long Island Sound during the 1970s and perhaps became more recurrent and possibly more severe in the late 1980s, and in the summer, 1987, an unprecedented episode of anoxia and fish kill occurred in both the Western and Eastern Narrows (Parker and O'Reilly, 1991). During intensive bottom trawl surveys of the western Sound, the Connecticut Department of Environmental Protection observed:

> "the late summer absence or reduced presence of fishes and lobsters in hypoxic zones. Both the number of species and the total number of fishes caught were greatly reduced in hypoxic waters" (LISS, 1990, p.12)

The Long Island Sound Study (LISS, 1990) identified low dissolved oxygen (hypoxia) as the highest priority environmental issue and has recommended several interim management strategies which would reduce nutrient loadings and improve water quality. Similar strategies to control the amounts of nitrogen and phosphorus entering Chesapeake Bay were proposed by the scientific and technical advisory committee for the Chesapeake Bay Program (STAC, 1986).

**The Annual Nitrogen Cycle**

The following generalized annual cycle of nitrogen on Georges Bank and the Gulf of Maine is based on Draxler et al., 1985; Walsh et al., 1987; O'Reilly et al., 1987; Pastuzak et al., 1982; Townsend 1992). Over the shallow areas on Georges Bank, the highest nitrogen concentrations are measured during December through early February, the time when incident solar radiation and nutrient uptake by phytoplankton are lowest. During the phytoplankton spring bloom, a rapid depletion of nutrients, beginning in March, occurs throughout the shallow, well-mixed water column. From May through October, high phytoplankton productivity effectively lowers and maintains nitrate levels near the limit of detection. During this period, nutrient recycling and injections of "new" nutrients, through tidal stirring and upwelling, contribute comparable amounts to the nutrient requirements of the phytoplankton. During fall-overturn, in the deeper areas of the Bank and adjacent

Gulf of Maine, large concentrations of nitrate, phosphate and silicate again appear in surface waters. Over shallow Georges Bank (in 1979; Draxler et al., 1985) following overturn, nitrate was replenished while silicate was depleted, presumably by the Fall Bloom (O'Reilly et al., 1987) consisting probably of diatoms.

Throughout the Gulf of Maine, winter nitrate concentrations in the upper water column are high (~8 uM), and are slightly higher in bottom water (Townsend, 1992). In near-surface, stratified waters on Georges Bank and in the Gulf of Maine, nutrient depletion is also evident from May through October, while below the thermocline, high concentrations of major nutrients are present throughout the year. (In the central and western Gulf of Maine, nitrate concentrations exceeding 15 *u*M (Draxler et al., 1985) were recorded in the deep water (>100m) most of the year.) The presence of concentrated sources of nitrogen, phosphorus, and silicate below the seasonal thermocline makes this source important to phytoplankton in areas near tidal mixing fronts and upwelling (Yentsch and Garfield, 1981)

**Atmospheric Deposition of Nitrogen**

The importance of human-originating inputs of nitrogen from atmospheric dry and wet deposition in the nutrient budgets of coastal areas in the Northeast has emerged only relatively recently. Atmospheric deposition of biologically available nitrogen has been estimated to represent a potentially significant (20-30%) contribution to estuarine and coastal nutrient budgets and must be considered in eutrophication management strategies (Fisher et al., 1988; Paerl et al., 1990, Hinga et al., 1991). Atmospheric nitrogen emissions are projected to increase during the next several decades (Irving, 1991). To date, the exact contribution of acid rain and atmospheric dry deposition to the nitrogen budget of the Gulf of Maine-Georges Bank region have not been determined. The estimated atmospheric wet deposition of nitrate in Gulf of Maine coastal waters is ~ 15 kg/hectare and dry deposition might add a comparable, but probably lesser amount of nitrate (Artz, 1992).

The importance of atmospheric deposition relative to other human sources of nitrogen (sewage treatment plants, agriculture) is likely to vary with the type and size of the system and the watershed. Atmospheric nitrogen may be eclipsed by other human sources in heavily farmed and urbanized areas, (such as Long Island Sound, Chesapeake Bay, and New York Harbor), while in coastal ecosystems having relatively lightly developed watersheds, (such as GOM), atmospheric nitrogen may dominate over inputs from sewage and agriculture (Hinga et al., 1991).

The nitrogen budget developed by Schlitz and Cohen (1984) supports this generalization, where nitrogen flux from rainfall is twice that from river transport; or the contribution from rivers and atmosphere are comparable, using the revised higher estimate for river borne nitrogen (Loder and Beckman, 1989). Nevertheless, for the GOM-GB region as a whole, human sources of nitrogen, via rivers and atmospheric deposition, may represent only 3-5% (Schlitz and Cohen, 1984; Loder and Beckman, 1989) of the flux of new nitrogen, and could not generate ecosystem-wide eutrophic conditions.

**The Relative Importance of Loading from Human Sources in the Nutrient Budget for the Gulf of Maine-Georges Bank Region**

Several nutrient budgets have been constructed for Gulf of Maine-Georges Bank area in an effort to explain the high primary and fishery productivity of the area (Schlitz and Cohen, 1984; Walsh et al., 1987; Loder, 1990; Townsend, 1992). These budgets indicate that when considering the entire Gulf of Maine-Georges Bank region, nitrate-rich slope water, entering through the Northeast Channel, strongly dominates over other sources of new nitrogen. The Northeast Channel represents a major nutrient artery which potentially controls the fertility and production of the Gulf of Maine region (Schlitz and Cohen, 1984; Ramp et al., 1985; Mountain and Jessen, 1987). In the nitrogen budget proposed by Schlitz and Cohen (1984) the estimated contribution from the Northeast Channel, Scotian Shelf, river discharge and rainfall is 81.7%,15.6%,0.9% and 1.8%, respectively of the total.

Loder and Becker, (1989), suggest that the contribution from rivers was underestimated by Schlitz and Cohen by a factor of 2-3. Nevertheless, in this ecosystem-wide analysis, the magnitude of human sources, via rivers and atmosphere deposition, is quite small when compared with natural sources of new nitrogen from offshore. The relative importance of human sources of nutrients will be greater in estuarine and nearshore coastal areas influenced by estuarine plumes (Loder and Becker, 1989).

Townsend (1992) categorized the major nutrient sources to the phytoplankton primary producers in Gulf of Maine euphotic layer: winter convective overturn; flux from the Eastern Maine Coastal Current/Plume system; vertical eddy diffusion, coastal upwelling, and recycled production. This study indicated that the greatest uncertainties are in estimates of the vertical eddy diffusion across the seasonal thermocline and in the contribution of recycled nitrogen.
These offshore, oceanic nutrient sources apparently influence the nutrient status and dynamics of coastal waters in the western Gulf of Maine. Townsend et al. (1987) estimate that:

> "as much as 44% of the new nitrate which enters the Gulf of Maine at depth through the Northeast Channel upwells in the eastern Gulf becoming part of the [coastal] plume, and hence this feature appears to be very important to the nutrient budget and general biological oceanography of the inner Gulf of

Maine."

Consequently, with this type of mechanism to deliver offshore nutrients into nearshore waters, the resolution of river-borne human sources from natural sources of nutrient enrichment, particularly regarding investigations of nutrient loading and episodes of noxious plankton blooms (such as PSP blooms), becomes very difficult.

**Nutrient Loading and Noxious Algal Blooms**

Accumulating information on the incidence of phytoplankton blooms worldwide over the last thirty years has persuaded some specialists that the problem is increasing. Various factors including increases in inputs from human activity and global change in conditions that regulate growth of phytoplankton have been postulated to explain the apparent increased bloom incidence. Long-term increases in loading from human sources, and artificial alterations in the ratios of nitrogen, phosphorus and silicon in coastal rivers have been linked to new appearances of noxious species, and to increased frequency and duration of noxious phytoplankton blooms (Smayda, 1991, Anderson, 1985, Riegman, 1991). Increases in nitrogen/silicate ratio or P/Si may favor nuisance/toxic flagellate species over diatom species (Officer and Ryther, 1980; Smayda, 1990). Blooms of noxious and toxic phytoplankters can have effects throughout the marine food web (White 1982;1988; White et al., 1992), including "reduced fecundity, survival and recruitment, and increased mortality of first feeding, juvenile, and adult stages" (Smayda,1991).

Of particular concern in the Northeast is: the recurring blooms ~~Alexandrium tamarense~~ in the western Gulf of Maine (Franks and Anderson, 1992a,b); the emergence of paralytic shellfish poisoning (PSP) in shellfish on Georges Bank, presumably from the toxic phytoplankter ~~Alexandrium tamarense~~; "brown tides" of ~~Aureococcus anophagefferens~~ and their catastrophic effects on bay scallop, blue mussel, eelgrass and other resources in Long Island embayments and Narragansett Bay; and blooms of the ichthyotoxic dinoflagellate ~~Gyrodinium aureolum~~ and several "Red Tide" species in coastal waters in the New York Bight and the Gulf of Maine (Mahoney et al., 1990; Heinig and Campbell, 1992). Extensive blooms of *Emiliania huxleyi* have also occurred in the Gulf of Maine (Ackleson et al., 1988).

Historically, paralytic shellfish poisoning (PSP, *Alexandrium tamarense*) in eastern North America was a regional problem primarily localized in the northern half of the Gulf of Maine, in relatively unpolluted areas. Apparently, during about the past 25 years, the causative dinoflagellate, and the PSP have spread southward. The greatest known expansion of the problem occurred in 1972 when high PSP levels were detected at sites along the entire Maine coast and, for the first time, southward to New Hampshire and Massachusetts. In Maine, during 1980, the estimated economic losses from PSP were in excess of $7,000,000 (Shumway et al., 1988). In the Gulf of Maine-Georges Bank region, the relative roles played by human and non-human sources of nutrients in triggering PSP blooms is not presently known. To date, a strong recurring association has been found between the blooms of *Alexandrium tamarense*, PSP toxicity, and the plume of relatively brackish stratified waters forming in the western Gulf of Maine during spring (Franks and Anderson, 1992a,1992b). The extent to which this inshore water mass is enriched by human activity and whether man has had an increasing direct role (more nutrients or changes in nutrient ratios), or indirect role (increased freshwater runoff and enhanced stratification of the coastal plume) in fostering environmental conditions favorable towards blooms of *A. tamarense* is not known.

### E.6.4.5.3 Ocean disposal

#### E.6.4.5.3.1 Dredging and spoil disposal

**Introduction**

Population growth along with a wide variety of industrial developments dependent on water borne commerce creates a need for dredging and the associated disposal of dredged material. Because of the large number of navigable harbors, the amount of dredged material that is generated from the maintenance of those facilities, and the inexpensive nature of ocean disposal, open-water disposal is routinely utilized. Nationally, more than 65 percent of all dredged material is dumped in the ocean. Unfortunately, domestic and industrial waste disposal activities contaminate many of those sediments. As researchers improved our collective comprehension of the complexity of the marine ecosystem, the effects of disposal of contaminated harbor sediments has become apparent. Dumping pollutants in the ocean is a contributor to the declining health and abundance of fish habitats and the resources that rely on those environments.

**Dredging**

Dredging creates and maintains navigable waterways, turning basins, harbors and marinas. Dredging projects in the coastal zone are diverse in specific purpose and in the severity of the related impacts. The potential adverse impacts of dredging include: (1) increased turbidity, (2) altered habitat, (3) disruption and direct removal of community structure and the life it contains (e.g., seagrass beds, shellfish beds, spawning and nursery areas), (4) disruption of natural water circulation patterns, and (5) release of trapped nutrients, organic material, and toxic pollutants from the materials. In the short-term these impacts can affect marine organisms by clogging gills; reducing light penetration; facilitating eutrophication; depleting available dissolved oxygen; and by making heavy metals, pesticides, or other pollutants bioavailable due to dredging. These pollutants can accumulate in resource tissues to unhealthy concentrations contributing to long term chronic or lethal effects. Also, some species can be adversely impacted by excessive turbidity from dredging operations. However,if dredging and disposal are curtailed during sensitive life stages, adverse impacts can often be avoided.

**Ocean disposal of dredged materials**

The disposal of dredged materials has environmental effects beyond those associated with the actual dredging operations. The Corps of Engineers presently disposes of approximately 65 percent of its dredged material in open water. Land disposal offers the possibility of preventing adverse environmental impacts that cannot be controlled in open-water disposal. However, drawbacks to land disposal include the difficulty in securing large tracts of land, access easements, polluted water runoff, saltwater intrusion into ground waters, and costs of transporting materials to the selected site.

Because of these handicaps it is easy to see why open water disposal is so frequently selected. However, disposal of polluted spoils poses a threat to estuarine and open water areas. Major pollution problems are generally associated with the organically enriched silts and clays that are usually mixed with domestic and industrial wastes of urban or industrial harbors.

Specifically, concerns with disposal of materials in the ocean can be summarized as follows:

1 - Contaminants found in industrial wastes, dredged materials and sewage sludge can assimilate into the marine food web. Accumulation of certain contaminants in the tissues of marine organisms can affect physiological functions resulting in a compromise of fish health and fecundity, and represents a health hazard to human consumers.

2 - Dredged materials dumped in the ocean can smother and eliminate populations of sessile or partially mobile benthic communities. Organisms living within these communities are eaten by many species of predaceous fish and invertebrates. Those consuming species often support recreational and commercial fishing activities.

3 - Organic sludges and some dredged materials contain materials that create high oxygen demand. Ocean disposal of these products may result in oxygen depletion or anaerobic conditions over portions of the ocean or estuarine bottom and overlaying waters. Such sediments can kill benthic communities and they typically alter habitats, causing the proliferation of stress-tolerant organisms of much less value to the ecosystem. Dredged material disposal can prompt the closure of shellfish beds due to pathogenic contamination.

4 - Materials disposed of in the marine environment contain compounds that may promote the growth of undesirable species of phytoplankton. In some cases, the disposal provides the very nutrients that are naturally limiting for planktonic growth. The sudden availability can act as a "trigger" for plankton blooms.

Increasing concern regarding the escalating amount of sewage sludge requiring ocean disposal and the types of waste contaminants in those materials obligated regulatory agencies to examine the entire situation. They found that the effects of ocean disposal were becoming more pronounced even at the deepest sites. These findings prompted the passage of legislation prohibiting further ocean disposal and mandating upland processing.

Although considerable evidence exists equating specific contaminants with damage to the marine ecosystem and fishery resources, the long term effect of present and past ocean dumping practices remains unresolved and controversial.

The Ocean Dumping Act of 1977 sets out criteria for evaluating dredged material disposal. Suitability of dredged material for ocean disposal is interfaced, in part, with the London Dumping Convention which identifies contaminants of concern and specifically prohibits disposal of selected toxic materials.

Under current ocean dumping regulations (40 CFR 220 et seq.), only dredged materials that have been evaluated and proven acceptable for ocean disposal may be routinely dumped. Criteria for this evaluation are intended to prevent further degradation of the marine environment. National and regional dredged material testing protocols have been developed by EPA and the Corps, in cooperation with the USFWS, coastal states, and NMFS. Materials that do not pass the regional protocols are deemed unsuitable for unrestricted ocean disposal. Confined ocean disposal, known as "capping", is one of the management alternatives for the disposal of some materials that fail the initial assessment process. Capping may not be an appropriate strategy that can be routinely applied to ocean disposal activities. However, at the Mud Dump in the New York Bight, and at the Central Long Island Sound Dump Site, capping of certain toxins may be viewed as an acceptable option due to water depth, oceanographic conditions, sediment types and the availability of suitable capping material. These parameters are continuously monitored to insure the acceptability of capping.

The guidelines for performing sediment tests on dredged materials are described in the revised draft "Ecological Evaluation of Proposed Discharge of Dredged Materials into Ocean Waters" (EPA/Corps 1991) and the regional "Guidance for Performing Tests on Dredged Materials to be Disposed of in Open Waters". The application and interpretation of test results performed under these guidance documents are discussed in more detail below.

The evaluation procedures for determining suitability of dredged material for ocean dumping emphasize the potential for biological effects rather than simple presence of possible toxicants. Additionally, it is only necessary to proceed through the tiered evaluation process until the accumulated information is deemed sufficient to determine suitability or noncompliance with the regulations regarding ocean disposal. There are four tiers of analysis:

Tiers I & II rely on existing information and relatively simple testing procedures for determining potential environmental impact of the dredged material(s) under review. Those materials with non-existent or minimal levels of toxicant and little likelihood of environmental impact are candidates for ocean disposal. Materials failing the initial review must advance to subsequent tiers for further analysis of toxicant availability and environmental impact.

In tier III testing, sediment toxicity in the water column, bioassay, and bioaccumulation tests are performed. Benthic community impacts are assessed by comparison of the latter results with reference sediment exposures. If the results show openwater disposal unacceptable then the materials must be evaluated under tier IV investigations if the applicant or the Corps wishes to continue to seek ocean disposal. Tier IV is the consideration of steady state bioaccumulation levels, biological evaluation of dredged material, and the evaluation of "special" management practices that might be employed to mitigate the impacts associated with placing the material(s) in the open ocean.

The determination of suitability for ocean disposal is based in part on the outcome of the bioassay and bioaccumulation tests. Bioassay tests are designed to indicate the presence of toxic material through limited but controlled exposure to specific organisms. The regulations consider as potentially undesirable statistically significant mortality increases and increased elevations of body burden of contaminants above those found in reference animals.

The EPA has primary responsibility for the management of open water disposal sites. Those responsibilities integrate permitting, enforcement, monitoring, and data interpretation. To comply with federal mandates EPA evaluates the impacts of ocean disposal by comparing them to pre-disposal, baseline conditions. Monitoring for that purpose takes into account both short-term and long-term potential environmental effects. Impacts occurring before, during, and following the disposal activity and long-term or cumulative environmental changes are also evaluated. EPA conducts monitoring surveys at approved and potential ocean disposal sites to determine dredged material distribution and movement (including resuspension and transport), benthic colonization of dredged material, sediment chemistry, food chain interactions between the benthos and fish, and bioaccumulation of contaminants in organisms.

In addition to the restrictions noted above, Section 7(a)2 of the Endangered Species Act (ESA) requires agencies to ensure that proposed projects will not jeopardize the continued existence of listed species. NMFS is developing a recovery plan for sea turtles, and final plans for the northern right whale and humpback whale are complete. These plans describe actions deemed necessary to achieve recovery and could be in conflict with the continued use of some open water disposal sites. They include implementation schedules that identify the federal agencies best suited to address each recovery action. NMFS will advise and coordinate efforts toward achieving the goals of each plan.

Finally, there is the issue of what are the appropriate levels of contaminants that can be safely placed in the waters of the U.S. Evidence is accumulating that levels of persistent pollutants such as polychlorinated biphenyls (PCB) and cadmium are rising in both the sediments and biota of the continental shelf. Although it is presently impossible to equate those increases to any single human action, it is impossible to exclude dredged material disposal in open water as a vector of introduction. The charge of the federal agencies is to protect and ~~enhance~~ the health and availability of our nation's public trust resources. To achieve this goal the above criteria for proper disposal of dredged material need to be followed closely to protect living marine and estuarine resources.

## NORTHEAST DREDGED MATERIALS DISPOSAL SITES

### A) The New York Bight

**Mud Dump Site** - Located six nautical miles east of Sea Bright, New Jersey, this site annually receives 6 to 8 million cubic yards of dredged material from the metropolitan New York area. Used as a disposal site since the end of World War II, the site is the major recipient of dredged material from the Harbor and the navigation channels that serve it. However, this site will reach its capacity by the end of the century, forcing government agencies to establish a new site.

**Cellar Dirt Site** - Located approximately eight nautical miles east of Monmouth Beach, New Jersey, this site is exclusively used for the disposal of excavated dirt and rock. New York City disposed of 50,000 cubic yards of material at this site in 1985.

**Sewage Sludge (12-Mile) Site** - Located approximately 12 nautical miles east of Sea Bright, New Jersey, this site is the former repository of sewage sludge from an assortment of municipalities, including New York City, within the Hudson river Basin. The site was last used in 1986, during that year approximately 8 million wet tons of sludge were dumped there.

**Acid Waste Site** - Located approximately 20 nautical miles east of Monmouth Beach, New Jersey, it was formerly used for the disposal of aqueous wastes. The site was first established in 1948 for deposition of a wide assortment of aqueous wastes. The type of materials authorized as acceptable for placement was restricted over time. Allied Chemical Corporation dumped 30,000 wet tons of hydrochloric acid in 1988, and was the last permittee to use the site.

**Inlet Dredged Material Disposal Sites (IDMDS)**

**New York Sites:**

**Rockaway IDMDS** - Located 2 nautical miles southeast of Rockaway Inlet, this site receives the material dredged from the entrance channel to Jamaica Bay every two to five years.

**East Rockaway IDMDS** - Located 1.3 nautical miles southwest of East Rockaway Inlet, the site receives approximately 200,000 cubic yards of material from the inlet every two years.

**Jones IDMDS** - Located 1.5 nautical miles southwest of Jones Inlet, the site receives approximately 300,000 cubic yards of material every two years.

**Fire Island IDMDS** - Located 1.7 nautical miles southwest of Fire Island Inlet, the site can receive approximately 250,000 cubic yards of material every year.

**New Jersey Sites:**

**Shark River IDMDS** - Located 0.4 nautical miles northeast of Shark River Inlet, the site is rarely used for the disposal of dredged material.

**Manasquan IDMDS** - Located 0,3 nautical miles northeast of Manasquan Inlet, the site received some 35,000 cubic yards of material annually until 1978. The site has not been used since then.

**Absecon IDMDS** - Located 0.5 nautical miles southeast of Absecon Inlet, the site received approximately 60,000 cubic yards annually until 1978. The site has not been used since then.

**Cold Spring IDMDS** - Located 1 nautical mile southwest of Cold Spring Inlet, the site receives approximately 11,000 cubic yards of material annually from the inlet dredging.

**B) New England including Long Island Sound**

**Rockland, ME.** - Located approximately 3.3 nautical miles northeast of the Rockland Harbor breakwater, this site receives approximately 193,000 cubic yards of dredged material every year and has been used since 1973.

**Portland, ME.** - Located 3.5 nautical miles from the Rockland Breakwater, this site has received approximately 158,000 cubic yards of dredged material every year since 1973.

**Cape Arundal, ME.** - Located approximately 2.75 nautical miles southeast of Cape Arundal, this site receives approximately 123,000 cubic yards of dredged material every year. The site was established in 1985.

**Foul Area** - Located in Massachusetts it is now termed the Massachusetts Bays Disposal Site. It receives approximately 293,000 cubic yards of dredged material every year.

**Buzzards Bay, MA.** - Located 1.4 nautical miles from Chappaquiot Point, West Falmouth, this site is used infrequently as a disposal site for dredged material. Since 1979, 92,000 cubic yards of material have been disposed of at the site.

**New London, CT.** - Located approximately 2 nautical miles south of the Harbor entrance, this site has received approximately 176,000 cubic yards of dredged material every year since 1972.

**Cornfield Shoals, CT.** - Located approximately 6.5 nautical miles southwest of the entrance to the Connecticut River, this site has received an annual average of approximately 68,000 cubic yards of dredged material.

**Central Long Island Sound Disposal Site, CT.** - Located 5 nautical miles south of the entrance to New Haven Harbor, this site has received approximately 368,000 cubic yards of dredged material every year since 1955.

**Western Long Island Sound** - Located approximately 2.7 nautical miles south of Noroton, Connecticut, this site has received approximately 885,000 cubic yards of dredged material since being opened in the early 1980's.

**Infrequently Used Inshore Disposal Sites in New England**

**Wellfleet, MA.** - Located adjacent to the harbor entrance, this site was last used as a disposal site in 1983.

**St. Helena, ME.** - Located outside the harbor entrance, This site was last used as a disposal site in 1988. However, only 385 cubic yards of dredged material were dumped. In 1984, approximately 61,000 cubic yards of dredged material were disposed of at this site.

**Frenchman's Bay, ME.** This site is used infrequently for the disposal of dredged material.

**Saco Bay, ME.** This site was used once, in 1989 for the disposal of approximately 51,000 cubic yards of dredged material.

**Sandy Bay, ME.** This site was used once, in 1987 for the disposal of approximately 6,000 cubic yards of dredged material.

**Sheep Island, ME.** This site was used twice, in 1987 and in 1988 for the disposal of 2,000 cubic yards and 103,000 cubic yards of dredged material.

#### E.6.4.5.3.2 Sewage sludge

**Sludge Dumping in Gulf of Maine**

Ocean dumping of sludge has not been permitted by the U.S. Environmental Protection Agency (US EPA) at any location in the Gulf of Maine. However, for decades sludge was discharged into the waters of Boston Harbor from the Deer Island and Nut Island Waste Water Treatment Plants. According to Massachusetts Water Resources Agency (1987), an average of 87 dry tons of anaerobically-digested sludge was discharged to Boston Harbor on a daily basis. This discharge was eliminated in December 1991.

While the fate of this material was not definitively known, given that it was discharged only on the outgoing tide, it is presumed that the majority, although not all, was ultimately deposited in Massachusetts Bay and incorporated into the sediments. The quality of the sludge discharged was variable, but generally contained elevated concentrations of heavy metals and contaminants such as PAHs and PCBs. Given the multiple sources of such contaminants, including discharge from combined sewer overflows and liquid wastewater effluents, atmospheric deposition, and ocean dumping of industrial wastes, among others, it is difficult to isolate a specific cause and effect relationship between discharge of sludge and impacts to groundfish in the Massachusetts Bay / Cape Cod Bay system.

**Sludge Dumping in the Middle Atlantic Bight**

South of Cape Cod, most ocean dumping of sewage sludge occurred at a site 12 miles off Sandy Hook, New Jersey, in the northern New York Bight. From 1924 until 1987 when the site was closed, it was used by up to 200 sewage treatment plants, and though the number of municipalities using this site decreased over time, the volume of sludge increased as facilities improved (Environmental Processes Division 1988). Since 1960, when dumping rates were recorded, there had been a general increase reaching a maximum annual amount of 7.6 million metric tons (wet weight) in 1983 (Suskowski and Santoro 1986). Sludge inputs in the early 1980s were, at the time, the largest known to any oceanic sludge dumpsite (Norton and Champ 1989).

Composition of the sludge changed over time as improved sewage treatment and lowered industrial inputs reduced contaminant concentrations. A comparison of 1973 and 1987 loadings indicated decreases in total sludge solids, biochemical oxygen demand and most heavy metals; for example, amounts of cadmium, chromium and mercury were reduced by at least 45% over the 14-yr period (HydroQual, Inc. 1989; Reid et al., in review). Estimated annual pollutant loadings to the New York Bight apex from sewage sludge and other major sources (ca. 1980) are given in Stanford and Young (1988).

Considerable effort has gone toward determining fates and effects of the dumped sewage sludge (e.g., Gross 1976a, b; Mayer 1982). However, determination of fates and effects had been confounded by the other waste inputs in the area. Sludge disposal had ranked only third in loadings of organic carbon and most contaminants to the inner Bight; dredged material ranked first and the Hudson-Raritan outflow second (Stanford and Young 1988).

The phaseout of sludge dumping in the inner Bight between March 1986 and December 1987 prompted a multidisciplinary study by the National Marine Fisheries Service (NMFS) and collaborators to examine ecosystem responses and thus infer what the fates and effects of the sludge had been (Environmental Processes Division 1988). The study included monthly sampling of a large suite of physical, chemical and biological variables from July 1986 through September 1989.

During the study, 991 otter trawls were made at 25 stations covering an area of 100 sq km. Abundance and composition were recorded for 75 species, representing 46 families of fish and megainvertebrates. The New York Bight apex hosted a wide variety of migratory species, while the demersal biomass was dominated seasonally by only a few. Atlantic rock crab, *Cancer irroratus*, was the most abundant in summer, replaced by little skate, *Raja erinacea*, and spiny dogfish, *Squalus acanthias*, during winter (Wilk et al. in press).

Five species made up >75% of the fish biomass: little skate; spiny dogfish; winter flounder, *Pleuronectes americanus*; red hake, *Urophycis chuss*; and ocean pout, *Macrozoarces americanus*; little skate and winter flounder occurred at >80% of all stations. Four species made up >90% of the megainvertebrate biomass: Atlantic rock crab; horseshoe crab, *Limulus polyphemus*; American lobster, *Homarus americanus*; and longfin squid, *Loligo pealei*; Atlantic rock crab occurred at >85% of all stations (Wilk et al. in press). Of the groundfish species (those which are the object of this action) in the demersal catch at the three most intensively sampled stations, winter flounder and ocean pout made up 10 and 6.7 percent of the species wt/tow, the remaining target species made up <7 percent. Similarly, in numbers/tow winter flounder and silver hake comprised 11.4 and 5.8 percent, respectively. The remainder amounted to <9 percent. Cod, *Gadus morhua*, and haddock, *Merluccius bilinearis*, *Melanogrammus aeglefinus*, were either generally absent or merely traces.

The null hypothesis of no difference in species biomass due to abatement of sludge disposal was tested for total fish and megainvertebrates as well as for the most frequently occurring species (Pikanowski 1992). The null hypothesis could only be tested on species that were available throughout the year. Therefore, although catches included cod, haddock, yellowtail flounder *Limanda ferruginea*, windowpane flounder *Scophthalmus aquosus*, silver hake and ocean pout, only winter flounder fell into this category. Total fish and megainvertebrates, Atlantic rock crab, little skate, and winter flounder showed no significant change (P>0.05) in relative abundance after cessation of dumping. Only American lobster showed a significant change (P<0.05) in relative abundance, increasing after dumping stopped. However, this may have resulted from a redirection of commercial fishing effort, i.e., lobster pots were set out in the area of the dumpsite after dumping stopped because pots were no longer in danger of either becoming fouled or buried in sewage sludge (Wilk et al., in review). The transitory nature of the demersal fish community in the vicinity of the dumpsite suggests the impact of sewage sludge on these species is problematical, particularly since the site has been closed.

The diets of several species included in the multispecies management plan (e.g. yellowtail flounder, winter flounder, windowpane flounder, silver hake, and red hake) have been examined in the sewage sludge affected area of the NY Bight apex, although large samples were not always available (Steimle, 1985; Steimle and Terranova, 1991; Steimle, in review; Steimle, et al., in review). In general, the diets reflected the availability of common prey in the most sewage-affected areas of the Bight apex and were basically consistent with the results of other diet studies for these species outside the sludge-affected area. The only indication of a significant shift in diet which could be related to sewage sludge abatement was the decrease in frequency of the polychaete *Capitella* sp., utilized as prey by winter flounder. Corresponding to a decline in populations of *Capitella* following the cessation of dumping, frequency also decreased in winter flounder diets. The percentage of empty stomachs from winter flounder and red hake collected in the sludge-affected area during disposal was about 13%. This percentage did not decline within two years after abatement, but instead increased. This increase appears to be related to a >50% decrease in benthic macrofaunal biomass at the sludge-affected station after abatement (Reid et al., in review).

Responses of benthic macrofauna to cessation of sludge dumping were somewhat greater than changes in fish diets, but were still limited (Reid et al. in review). The area which had been thought to represent greatest sludge accumulation and effects had been dominated by *Capitella* spp. and nemerteans (ribbon worms), and had fewer overall species than found in other parts of the Bight apex. After cessation, total numbers of species increased significantly relative to numbers at other sites sampled, as did numbers of species of molluscs, crustaceans and amphipods. As noted, there were significant decreases in abundances of *Capitella* spp. and ribbon worms. However, 34 and 39 months after cessation of dumping there was little evidence of colonization of the sludge-affected area by species that were dominant at the other sites.

During a study of demersal fish (including winter flounder and spot, *Leiostomus xanthurus*) in estuaries between Chesapeake Bay and Frenchman's Bay, ME as part of the National Status and Trends Program, Zdanowicz and Gadbois (1990) demonstrated increased concentrations of synthetic organic contaminants in stomach contents relative to sediment and a further increase in liver tissue concentrations relative to the stomach contents. Similar processes related to bioaccumulation also appear to have occurred at the 12-mile dumpsite. Sediments near the 12-mile site are contaminated with organic compounds (PCBs, PAHs and chlorinated pesticides) as well as trace metals such as Pb, Cu, Zn, Hg, Cd, and Cr (Boehm 1982; Zdanowicz 1982; 1991; Deshpande and Powell, in review).

Concentrations of these sewage derived materials generally decrease with distance from the center of the 12-mile dumpsite except that depositional areas to the west in the Hudson Shelf Valley tend to be more contaminated than shallower, sandy sites located similar distances to the east. Lobster and winter flounder from the dumpsite were found to have higher levels of PCBs than animals from adjacent reference areas (Draxler et al. 1991). Uptake of contaminants for both prey and predators may result directly from exposure to water and/or sediment or from transfer up the food chain, which is suggested by findings of elevated trace metal concentrations in the benthic prey of demersal fish in the dumpsite area (Steimle and Zdanowicz, pers. comm.).

**Sludge Dumping at the Philadelphia Site**

Sewage sludge was also dumped at a site near the mouth of Delaware Bay between 1961 and 1973, and at the "Philadelphia Dumpsite", 70 km east of Ocean City, MD, from 1973 to 1980 (Devine and Simpson 1985). Since amounts dumped were much smaller than in the New York Bight (e. g., a maximum of about 700,000 metric tons/yr at the Philadelphia site), and the sites are peripheral to the distributions of the species covered in the management plan, effects are not considered.

### E.6.4.5.3.3 Ocean dumping of industrial wastes

Three sites in the northeast have been heavily used for disposal of industrial waste. The probability exists also that other, non-designated, sites were also used. However, the sites designated specifically to receive industrial wastes in ocean waters were:

1) the Massachusetts Bay Industrial Waste Site (IWS), located approximately 19 nautical miles off Boston;

2) the New York Bight Acid Waste Site, located off New York near the 12-Mile Sludge Dump Site as noted above; and

3) the 106-Mile Deepwater Industrial Waste Site, located about 106 nautical miles from New York harbor and 105 nautical miles off Atlantic City, New Jersey.

**Massachusetts Bay IWS:** The IWS in Massachusetts Bay, off Boston, was used for nearly 100 years for the dumping of industrial and commercial wastes. The principal disposal site is a circular area with a radius of 1 nautical mile with the center at 42°27.7' N and 70°35.0' W. Located approximately 19 nautical miles from Boston Harbor and in approximately 90 meters of water.

While records are incomplete or unavailable, it is clear that a wide variety of waste materials were disposed at the IWS. Among the materials dumped there were low level radioactive wastes (LLW) as well as toxic and hazardous chemicals. According to a review by Wiley ~~et al.~~ (1992), between 1953 and 1959 roughly 4,000 containers of LLW were dumped in Massachusetts Bay at four designated sites, principally within or near the IWS. Some defense-related LLW may have been deposited as early as 1946. Its resting place is unknown. Much of the material dumped in the later years was encased in reinforced concrete. Unfortunately, it is suspected that not all the material, particularly that disposed in the earlier years, was protected in this fashion.

The other major class of materials disposed at the IWS was toxic and hazardous wastes. These were generally held in 55-gallon drums, many of which were either mechanically punctured or pierced with firearms during the disposal operation to insure that the barrels sank and the materials inside would be dispersed and diluted. While specific records of the actions taken during disposal are virtually non-existent, the cargo manifests that are available list materials that are believed to have carcinogenic, mutagenic, neoplastic, or teterogenic effects. Compounds containing heavy metals and halogenated organic compounds are also included on the manifests. The full nature of toxic materials dumped at the IWS is unknown. Wiley ~~et al.~~ (1992) estimate, based on intensive side scan sonar and ROV surveys of the site, that approximately 21,000 containers are present in or near the IWS. In addition, it is likely, based on available records and eyewitness accounts of the dumping activity, that many more containers were dumped in areas of Massachusetts Bay other than the IWS. Dumping at the IWS ceased around 1976, and the site was de-designated by the EPA in the early 1980's.

The "Foul Area" IWS is heavily fished by bottom trawlers and fixed-gear fishermen. In 1971, the FDA issued a Notice to Harvesters requesting fishermen avoid the area as organisms harvested there might be contaminated. The catch is dominated by American plaice and witch flounder, with wolffish, redfish, cusk, haddock and pollock caught in lesser amounts. The total number of fish species collected at the site was 41. The NMFS catch data for the "10-minute square" encompassing the IWS (which also includes the productive Stellwagen Bank system) during the period 1982-1984 was 6,316,000 kg of fish.

The site is being studied by the EPA to determine whether the IWS material, particularly the LLW, is having or has had any effect on the Massachusetts Bay ecosystem, and to determine whether remediation should be undertaken.

**New York Bight Acid Waste Site:** The Acid Waste Site (40°16' to 40°20' N and 73°36' to 73°40' W) was established in 1948 for the disposal of acid and alkaline wastes generated by the industries of metropolitan New York and New Jersey. The site received interim designation by the EPA in 1973, and was last used in 1988. EPA has determined that effects from the dumping at the Acid Waste Site were localized and transient (EPA, 1980), and that no long-term effects are likely as a result of past discharges at the site. Therefore, monitoring has been terminated.

**Deepwater Municipal Sludge Site (106-Mile Site):** Described previously as the interim disposal site for municipal sludge from 1986 to 1991. It was closed by EPA. The 106-Mile Industrial Waste Site was within the larger 106-Mile Sludge Site to allow effects of sludge dumping and the discharge of industrial waste to be monitored cumulatively. The Site is circular with a radius of 3 nautical miles centered at 38°45' N and 72°20' W.

Between 1961 to 1978, approximately 5.1 million metric tons of liquid chemical waste were dumped at the 106-Mile Site, in addition to approximately 380,000 metric tons of sludge and other municipal wastewater residues.

EPA (1989) indicates that commercially important species are not generally fished within the 106-Mile Dump Site, but the general area (the Middle Atlantic Bight) supports commercially important fisheries of yellow-tail flounder, red hake, Atlantic mackerel, spiny dogfish, tilefish, and shellfish (surfclams, lobster and red crab). The study further mentions that landings of yellowfin tuna, silver hake, and haddock occur in the area.

Like the Acid Waste Site, the EPA has determined that no lasting effects have been seen at this site, and therefore, continued monitoring is unnecessary. However, the nearby 106-Mile Sludge Site was extensively monitored pursuant to provisions of the Ocean Dumping Ban Act of 1988, under the auspices of the 106-Mile Site Monitoring, Research, and Surveillance Program. Living marine resources were a principal focus of the monitoring effort.

**Effects of Industrial Waste Disposal on Fisheries Resources**

As mentioned previously, much of the waste materials were simply discharged into open ocean waters, as it was believed dilution and dispersion would insure that the impacts to living marine resources would be minimal (EPA, 1980). Such a belief has guided the decision-making of federal agencies but concern about the containerized waste, such as at the IWS in Massachusetts Bay, has yielded the initiation of new monitoring efforts to allow a better understanding of the long-term effects of these discharges. Nevertheless, the declining abundance of commercial fish stocks in areas remote from the disposal sites suggests that overfishing or other factors remain the primary cause of the decline in resource abundance.

### E.6.4.5.4 Coastal habitat loss

The principal threats to coastal habitats stem from contaminants and nutrient over-enrichment (both of which were discussed above in this section) as well as physical habitat alteration (discussed in section E.6.4.4). Fisheries resources are dependent on inshore ecosystems for reproduction, growth and survival, but estuarine dependency for commercial species is lower in the Northeast than in some other U.S. coastal regions (Chambers, 1992). A review of the issues and potential threats is necessary, however, in light of the depressed state of groundfish stocks and high level of coastal development in New England.

Estuarine and coastal lands and waters are used for many purposes that often result in conflicts for space and resources. Some uses may result in absolute loss or long-term degradation of the general aquatic environment and of specific aquatic habitats, and pose potentially significant, but as yet unquantified threats to the biota and their habitats. Issues arising from these activities and the perceived threats associated with them are of serious concern to the public.

Multiple-use issues are constantly changing, as are the real or perceived impacts of certain activities on living marine resources relative to habitat loss. The following discussion identifies and describes some of the multiple-use issues identified by the NMFS (USDC, 1985). High priority issues include urban and port development, ocean disposal, dams, and agricultural practices. Medium priority activities include industrial waste discharges, domestic waste discharges and OCS oil and gas development.

**Waste Disposal and Ocean Dumping:** As discussed earlier, waters in the Northeast have been and continue to be used for the disposal of sewage sludge and dredged material. The once common practice of at sea disposal of chemical wastes and radioactive materials is now prohibited. Effects of these activities on commercially valuable fish species are described in a number of the monitoring studies already mentioned. Although few species covered by the Multispecies FMP are estuarine dependent (notable exceptions are some flounders and pollack), concentrations of toxic heavy metals, chlorinated hydrocarbons and petroleum products contribute to the degradation of New England coastal waters (USDC, 1985).

Organic loading of estuarine and coastal waters produces excessive algal blooms, shifts in abundance of algal species, biological oxygen demand increases in the sediments of heavily affected sites and anoxic events in coastal waters and waters. Harmful human pathogens and parasites can be found in biota and sediments in the vicinity of ocean dump sites. The presence of excessive concentrations of pathogenic and indicator species of bacteria has triggered the closure of shellfish harvesting grounds. (NOAA / National Ocean Service, 1991).

The dumping of fish and shellfish waste, generates much of the same concerns. mentioned previously. The closure of land-based processing plants, because of their inability to meet national Pollution Discharge Elimination System (NPDES) or State Pollution Discharge (SPDES) effluent requirements, serves to enhance the appeal of at sea disposal. Associated problems include increased biological oxygen demand, algal blooms and concentrations of pathogenic bacteria. The onus of proof of no environmental harm rests with the entity pursuing at sea disposal.

**Coastal Urbanization:** Tremendous development pressures exist throughout the coastal area of the Northeast Region. More than 2,000 permit applications are processed annually by the NMFS Habitat Branch for commercial, industrial and private marine construction proposals. Proposals range from those which would have relatively little impact to major dredging and filling projects that encroach into aquatic habitats and could result in their elimination as a functioning component of the marine ecosystem.

Associated with marine construction are a number of impacts which affect living marine resources both directly and indirectly through habitat loss and modification.

Many of these projects are of sufficient scope to singly cause significant long-term harm or permanent impacts to aquatic biota and habitat. Most, however, cause minor losses or temporary disruptions to organisms and environment. The concern with small scale projects lies in the cumulative effects of habitat loss and degradation resulting from the large number of these activities.

Associated with urban development is the increase in non-point source contamination of estuarine and coastal waters. Highways, parking lots, and the removal of terrestrial vegetation and fringe marshes facilitate runoff containing soil particles, fertilizers, biocides, heavy metals, grease and oil products, PCBs and other materials that can be harmful to marine biota and their habitats. Atmospheric emissions resulting from certain industrial processes contain sulphurous and nitrogenous compounds that contribute to acid precipitation, a concern in some fresh water sections of tidal streams. These non-point pollutants accumulate in water, sediments and living marine resources. (USDC, 1985).

Accompanying the increased development of coastal areas is the demand for potable, process, and cooling water, waste water treatment and disposal, and electric power. Demands increase as groundwater becomes depleted or contaminated and fresh water is diverted via dam and reservoir construction or other methods. Reducing flows to estuaries can reduce nutrient levels and increase salinity and thus decrease the overall productivity of estuarine systems. Moreover, the reduction of nutrient-rich oxygenated water from a large estuary can significantly lower the biological productivity of large areas of coastal shelf water normally exposed to the estuarine plume (Chambers, 1991).

Water that is not lost through consumptive uses is returned to the rivers and streams as point source waste water discharges. Although it is generally treated, the domestic discharge often contains contaminants such as chlorine compounds, nutrients, suspended organic and inorganic compounds, trace metals and bacteria.  In addition to creating thermal plumes, industrial discharges may contain many dissolved and suspended pollutants , including metals, toxic substances, halogenated hydrocarbons, petroleum products, nutrients and organics. (USDC, 1985).

Construction in and adjacent to waterways often involves dredging and/or filling activities which result in elevated suspended solids emanating from the project area. Excessive turbidities can abrade epithelial tissue in marine organisms, clog gills decrease egg buoyancy, and reduce light penetration, thereby affecting photosynthesis and causing localized oxygen depression. Suspended sediments subsequently settle and can destroy or degrade productive shellfish beds and spawning sites. Often, but not always the effects of turbidity and siltation are temporary and short-term (USDC, 1985).

Problems also exist with both domestic and industrial wastewater discharge. Sewage treatment effluent produces near-field changes in biological components as a result of chlorination and increased contaminant loading. Industrial wastewater effluent is regulated by the Environmental Protection Agency through NPDES permits as a means of identifying, defining, and where necessary controlling all point source discharges. The problem remains, however, that it is difficult or impossible to estimate the singular, combined and synergistic effects of industrial and domestic wastewater discharges on the aquatic environment in general, and on fishery resources specifically.

**Energy Production and Transport:** Energy production facilities are widespread along Northeast coastal areas and include land-based nuclear power plants, hydroelectric plants and fossil fuel stations. The resultant impacts from these facilities on the marine and estuarine environment include water consumption, heated water and reverse thermal shock, entrainment and impingement of organisms, discharge of heavy metals and biocides, destruction and elimination of habitat and disposal of dredged materials and fly ash (USDC, 1985).

Although Congressional action has precluded Outer Continental Shelf exploration in the most productive fishing grounds of the Northeast, any future drilling and transport could affect biota and their habitats through the deposition of drilling muds and cuttings. Oil spills resulting from well blowouts, pipeline breaks and tanker accidents are of major concern. Seismic testing operations could interfere with fishing operations and damage or destroy fishing gear.

**Port Development and Utilization:** All ports require shore-side infrastructure, mooring facilities and sufficiently deep channels for operations. Upgrading of facilities may include activities such as dredging and disposal of dredged materials, filling of aquatic habitats to create fast land for port improvement and expansion and degradation of water quality. All have well-recognized implications to living marine resources and habitat.

**Agricultural Development:** Agricultural development can affect fish habitats directly through physical alteration and indirectly through chemical contamination. Fertilizers, herbicides, insecticides, and other chemicals are washed into the aquatic environment with non-point source runoff draining from agricultural lands. These discharges can directly affect aquatic vegetation which will in turn result in impacts to the food web. Agricultural runoff also transports animal wastes and sediments that can affect spawning areas and degrade overall water quality and the benthic substrate. One of the most serious consequences of erosional runoff is that it necessitates the frequent dredging of navigational channels results in dredged material that requires disposal, often in areas important to marine resources (USDC, 1985).

**Marine Mineral Extraction:** Mining for sand, gravel and shell stock in coastal and estuarine waters can result in impacts to or the loss of benthic organisms, modifications to substrate, changes in circulation patterns and decreased dissolved oxygen concentrations at deeply excavated sites. Sand and gravel mining re-suspends materials at the mining sites with the possibility of turbidity plumes moving several kilometers from individual sites.

**Coastal and Wetland Use and Modification:** Intense population pressures have adversely affected many estuarine and marine habitats along the New England coast. Demand for land suitable for home sites, resorts, marinas, and industrial expansion has resulted in the loss or alteration of large areas of wetlands through dredging, filling, diking, ditching, erosion and shoreline modification.

As residential and commercial use of coastal lands increases, so does the recreational use of coastal waters. Marinas, public access landings, private piers, and boat ramps all vie for space and encroach upon sensitive coastal habitats.

Greater pressures are exerted to develop remaining coastal areas as population densities increase. Other competing uses further contribute to the destruction or modification of wetland areas. Agricultural development can significantly affect wetlands. Common flood control measures in low-lying coastal areas include dikes, ditches and stream channelization. Wetland drainage is practiced to increase tillable land acreage. Wildlife management techniques that also destroy or modify wetland habitat include the construction of dredged ponds and low-level impoundments which can be detrimental to marine fishes since these changes do not replicate the functions of the habitats they replace.

Each coastal state, as well as the Army Corps of Engineers, has provisions for regulating projects proposed for wetland areas. Although they are restrictive and have to a great extent ameliorated wetland modification and destruction, construction that is judged to be in the public interest or to be water-dependent continues to occur, as does illegal, unauthorized construction. The primary threats associated with this issue, such as coastal construction activities, non-point source pollution etc., have been discussed earlier in this section.

### E.6.4.5.5 Mining operations

The effects of coastal and deep ocean mining for extraction of marine sediments (aggregate extractions) can best be elucidated by reference to previous reports from the International Council for the Exploration of the Sea (ICES), Working Group on

Effects of Extraction of Marine Sediments on Fisheries (ICES, 1991 and 1992). These materials developed over the past two decades include reference to North American case studies and results. Other sources include reviews and EIS' that have been done in regard to sand and gravel mining, dredging, and trawling within the coastal zone, as such activities relate to economic growth and industry within urban areas including Boston, New York, and Baltimore harbors, and Canadian waters (New England River Basin Commission, 1973; Schlee, 1975; and Messieh ~~et al~~., 1991).

The National Oceanic and Atmospheric Administration (NOAA), U.S. Army Corps of Engineers (COE), and the U.S. Geological Survey (USGS) have conducted extensive broad research on these issues and at various times have considered the attendant issues from several special points-of-view. For instance, the U.S.G.S. has studied colloidal material and its possible roles in transport of sediments and contaminants (Rees, 1991). In regard to specific, documented effects of ocean mining on the fisheries, the best information still remains within recent ICES reports. A NOAA paper by Orlando ~~et al~~. (1988) stresses the importance of understand the cumulative effects of shoreline modification, including dredging and mining.

Locally, Stubblefield and Duane (1988) identified two areas in Massachusetts Bay and ancillary waters where sand and mixed aggregates are known to occur in amounts sufficient for mining. One of these areas is off Boston Harbor, between Hull and Plymouth, the other is a significant bank of mixed aggregates forming Stellwagen Bank, although Stellwagen Bank has now been designated a National Marine Sanctuary and, under the terms of the designation, mining is prohibited. Beds of aggregates are to be found in other areas in the Gulf of Maine (for instance off Cape Ann) but in many instances the beds are limited in size or occur in waters too deep to be mined easily. Various reviews (e.g., Cruickshank, ~~et al~~. 1987) have speculated on potential sources of industrial amounts of sand and gravels.

Mining is usually done by 1) surficial scrapping or 2) point excavation of materials to some greater depth; suction dredges generally are used to lift materials removed from the surface, or pits, to receiving barges. By and large, the environmental effects of such removal have, in the past, been listed as 1) the "destruction" of existing benthic biota; 2) resuspension of fine sediments with subsequent impacts on adult fish or juveniles and larvae; 3) changes in the profiles or surfaces of mined areas; and 4) long-distance consequences of entrained fine materials being carried tens or scores of kilometers from the dredging site. Literature exists on the development of deep excavation or "borrow" pits which consequently become aerobic during certain periods of the year with attendant direct impacts on fish, including adults, juveniles, and larvae (Pacheco, 1983). In many areas of the Gulf of Maine and in the New York Bight there also remains concern about how mining in one area may affect fish, eggs, and demersal larvae and juveniles at some distance from the mining sites. The mechanisms discussed in the paper by Rees (1991) is of interest in these regards.

There is little likelihood that, regionally, individual adult fish would be affected drastically by specific mining operations since active adults of most species are usually able to avoid such local activities. Beyond this, however, observations in the English Channel, and off the eastern coast of England, as well as along the shores of Holland and other low countries, suggest that there may be impacts ranging from minor local effects to significant economic losses. DeGroot (1979), for example, noted that dredging and construction of a sand island would cause long lasting damage to the fisheries of a particular area, as well as permanent economic loss to the fisheries; in 1990 $5.3KK (US $) would have been lost due to this activity. Also, DeGroot and others have expressed concern about specific impacts on Baltic herring and noted that catches in trap-nets, set near certain dredging activities off Finland, were affected by a mining operation. However, there are no data that suggest declines in the trap-net catch could be related directly to the mining activities.

Data on possible effects on marine mammals are almost nonexistent. Studies done by Battelle (1987) suggested that while suspended sediments might occur due to mining, elevated levels should have no effect on whales. Such judgements were speculative, however, since the occurrence of whales is highly seasonal. There was, and continues to be, concern about secondary consequences on marine mammals since direct impacts of mining on benthic or demersal forage species have been measured, which in turn may affect both fisheries and mammals.

The most recent comprehensive reviews of effects of extraction of marine sediments on fisheries are in a draft report prepared by the ICES Working Group on the Effects of Extraction of Marine Sediments on Fisheries (ICES 1992a). This report contains considerable background materials and an extensive bibliography on ocean mining, as well as references to possible effects. Section 3 of the draft report, "Effects of Activities on Living Resources and Fisheries", is a detailed narrative containing information on physical impacts on the seabed and water column, as well as specific biological effects.

In discussing the removal of substrata from coastal and shelf environments, the authors noted that where "pits" are developed, there is relatively little possibility for transport of gravel from adjacent areas into such depressions. Consequently, infill occurs slowly and, with reduced strength of bottom currents within the pits, there often is deposition of finer organic sediments resulting in organic enrichment and concomitant oxygen depletion (see Pacheco, 1983, and Messieh, ~~et al~~., 1991). Recent studies done using severely contaminated sediments show that "typical" marine invertebrates may respond behaviorally and physiologically in ways that are detrimental to individuals as well as to organisms higher in the food web (Olla, ~~et~~

~~al.~~,1988).

A principal concern is expressed in the aforementioned ICES report in regard to dredging in areas representing spawning grounds for certain species of commercial fish. Secondarily, there is concern about removal of important benthic forage species used by a wide range of fish species and various life history stages. The ICES report also touches on how primary productivity might be affected because of increase in turbidity resulting from dredging in inshore areas, such as Boston Harbor or Raritan Bay. Finally, in considering the physical/chemical effects, it was noted if screening of sediments is done at sea, materials returned to the sea floor may change adversely the nature of the surficial sediments and, hence, the ability for marine organisms to recruit in sediments when specific sediments types are required for this process.

From a chemical point-of-view, the report noted that the bulk of mined aggregates are "clean" sands and gravels and because of their relatively large particle size, low surface area relative to total bulk, and low surface activity (few clays or organic materials to interact chemically) there is usually relatively little chemical interaction with the water column. The report also pointed out that when sediments are disturbed in inshore estuarine or deeper channels where fine materials have accumulated, there is a possibility for release of harmful chemicals from sediments to overlying waters.

There are well documented instances where dredging has caused change in the existing biological communities. The scale or magnitude of dredging operations is a prime factor in the severity of effects upon benthic and associated demersal fish communities. It has been noted that in a situation parallel to "block cutting" of forest lands, occasionally cuts or folds in the seafloor have been created which are separated by undisturbed "hummocks" of sediment containing adult populations of benthic organisms. Such species are capable of repopulating the surrounding dredged furrows or pits. McCaulay, ~~et al.~~, (1977) documented such occurrences.

In addition to the size of the area being dredged, and the time of year (dredging should be avoided during periods of spawning and early life history recruitment), another important factor has to do with the type of dredging used. The impacts of anchor dredging upon the sea floor and biota are usually severe but localized, whereas, suction dredging over larger areas has a less profound effect, but is much more widespread.

DeGroot (1979) reported on an example of the effect of inshore dredging on benthic community types where, in a small area of the Seine Bay, sand and gravel that overlaid a rocky substratum were removed and recolonization studied. In this case, no redeposition of sediment upon the exposed rocky ground occurred and, as a result, a hard ground fauna developed over time which had less food value for fish species than did the pre-existing soft bottom fauna.

Where recovery of benthic communities in highly stressed areas was investigated, the studies noted that infaunal communities in areas exposed to strong tidal currents or periodic storm disturbance are often dominated by short-lived (opportunistic) species, at least in surficial sediments. The ICES summary of benthic sensitivity to sediment removal and sediment redeposition noted that most benthic organisms will be destroyed in the immediate area of dredging activity. At the periphery, "edges" (ecotones) will often occur where benthic species are found in particular abundance. As noted previously, where pits are formed they may become an aerobic at certain times of the year and thus represent traps for various larvae, juvenile fish, and benthic invertebrate forage species. The draft ICES Report (ICES, 1992a) recognized that certain species were especially sensitive. These include sand eels and certain herring that lay demersal eggs which adhere to stones and gravel. In the case of herring, when aggregates are removed, the eggs are taken with them; in the case of the sand eel, an important forage species for many different gadoids, the eggs may become surrounded by sand and finer particles, and killed.

Finally, various species of crab and lobster use certain aggregates as habitat, or as migratory and feeding pathways. Often crabs burrow in sand and, obviously, when dredging occurs individuals are taken up and physically destroyed, or injured so they eventually die. Thus, again, dredging should consider those forms that might be present within a particular habitat, at specific times of the year.

As a basis for future management of dredging in areas that represent spawning grounds, or habitat for important marine resources, ICES and its Working Group highly recommended that such areas be mapped so that resources can be avoided or managed during removal of sands and gravels. They suggested that marine mining activities should be monitored on a regular if not continuous basis to provide permanent records available to regulatory authorities and the scientific community. If dredging for aggregates were so monitored, it would be possible to understand better what the consequences of such activities might be within specific areas. In the final section of the ICES report a lengthy series of conclusions and recommendations was given which represent state-of-the-art thinking about the effects of extraction activities on living resources and commercial and recreational fisheries.

The draft ICES Report (ICES, 1992a) included that in most member nations, the at-sea mining industries are "well established and growing". Given this, it is obvious that greater attention must be given to compiling existing data and information and organizing long-term monitoring, research, and assessments. The physical impacts must be understood, including 1) change in topography and sediment types, 2) turbidity and sedimentation, and 3) burial (of fauna and sediments) due to at-sea processing.

Further, the Report suggested that while most aggregate mining involved "clean" sediments, even these can have certain chemical impacts, ~~albeit~~ minor ones. As already noted, the extent and timing of aggregate extraction is important in regard to biological effects as are 1) types of dredges, 2) overside disposal of "wastes", 3) depth of water and sediments, 4) types of sediments, and 5) the nature of indigenous species and benthic community structure.

The Report noted that of 12 countries surveyed, 11 have specific legislation governing submarine extraction of minerals. Seven have specific terms and conditions relative to environmental and fisheries management. The Report also noted that monitoring must consider "sensitive" as well as endangered species and should be conducted with minimum requirements for electronic data gathering including 1) position(s) of mining vessels, 2) time of deployment of gear, and 3) unusual events; monitoring could include underwater video and photography, sediment sampling, side-scan sonar, and assessments of the benthos and suspended sediments and plankton.

The latter would include data on change(s) 1) in the benthos, including shellfish and demersal fish species; 2) recolonization rates; and 3) long-distance transport of sediments via plumes. Finally, in regard to ICES concerns for mapping, the NMFS and the USGS are conducting a joint program to map large areas such as the Georges Bank (Valentine and Lough, 1991). This mapping endeavor includes consideration of the geologic and oceanographic environmental factors as well as the distribution and abundance of fin-and shellfisheries. Equally important, many U.S. and Canadian agencies are becoming equally concerned about the effects of trawling and dredging for fin-and shellfish on the Continental Shelf and in inshore waters (Messieh, ~~et al~~., 1991).

Studies and assessments of mining as well as fishing endeavors will be important in assessments designed to put management of both on a sound basis, emphasizing measurements and documentation as opposed to assumed impacts.

## E.7.0 ENVIRONMENTAL CONSEQUENCESE.7.0 ENVIRONMENTAL CONSEQUENCES

### E.7.1 BIOLOGICAL IMPACTS OF THE PROPOSED ACTIONE.7.1 BIOLOGICAL IMPACTS OF THE PROPOSED ACTION

In this section the impacts of the proposed action on groundfish stocks, other commercial stocks, marine mammals and endangered species, and on the general biological environment are discussed. The predicted impacts of specific proposed measures are described if those measures are expected to have a biological impact. (Some proposed measures relate to enforcement and administration of the FMP, and have no biological implications.) In some cases, preferred and non-preferred alternatives are proposed, but they are intended to accomplish the same objective. In so far as they may have different biological impacts, they are discussed; otherwise they are considered equivalent from a biological perspective. Where the measures differ in economic, social or administrative impacts, they are discussed in the appropriate section.

#### E.7.1.1 Impacts on fisheriesE.7.1.1 Impacts on fisheries

##### E.7.1.1.1 Fisheries under the Multispecies FMP

###### E.7.1.1.1.1 Fishing mortality reduction impacts

The impacts of the proposed fishing mortality reductions on the stocks under the Multispecies FMP were projected on a simulation model designed by the Population Dynamics Branch of the NEFSC. The output, in the form of catch streams were then fed into an economic model to project revenue streams. The results of the modelling effort were incorporated into a bioeconomic evaluation of the impacts of the proposed action, and presented to the Council in January, 1993. Since the paper integrates both the biological and economic impacts into one document, it is presented in its entirety in Appendix IV. Further background on the biological model can be found in Overholz *et al.* (in press, 1993), entitled "Strategies for Rebuilding and Harvesting New England Groundfish Resources".

###### E.7.1.1.1.2 Impacts of increasing mesh size

The impact of increasing mesh size on fishing mortality is limited to those age classes that are partially recruited to the larger mesh. In other words, the fully recruited age classes (those fish whose size prevents any escapement from a given mesh size) will be caught at the same rate whether they are caught by 5.5-inch mesh or 6-inch mesh. The contribution of a partially recruited age class to the spawning stock biomass depends on the maturation rate of the particular species.

The projected %MSP levels under the current mesh size and with a 1/2-inch increase in mesh size under current fishing mortality rates and fishing mortality rates reduced by 50 percent are shown in Table E.7.1.1.1.2. A more detailed discussion of this analysis which has been reviewed by the SSC is provided in Appendix II.

The impact of this partial reduction in F on the %MSP level of a stock depends on its age structure; with fewer large, mature fish in the population, the contribution of increasing mesh size to increasing %MSP will be greater than if the spawning stock biomass is the product of fully recruited fish, provided those fish that now will be able to escape the mesh as a result of the increase are sexually mature. Thus, the projected benefits of a 1/2-inch increase in mesh are greater for southern New England yellowtail than for the cod stocks.

| STOCK | CURRENT F | | 50% of CURRENT F | |
|---|---|---|---|---|
| %MSP | CURRENT MESH | CURRENT MESH +0.5 IN. | CURRENT MESH | CURRENT MESH +0.5 IN. |
| GOM COD | 9.4 | 11.7 | 19.2 | 22.1 |
| GB COD | 8.7 | 10.6 | 18.3 | 20.5 |
| GB YELLOWTAIL | 15.7 | 20.8 | 27.7 | 33.3 |
| SNE YELLOWTAIL | 7.0 | 10.6 | 13.2 | 17.9 |

**TABLE E.7.1.1.1.2** Percent of maximum spawning potential (%MSP) impacts of increasing current mesh size by 1/2 inches under current and reduced (by 50%) fishing mortality rates. NOTE: The most recent Stock Assessment Workshop (SAW 15) concluded that fishing mortality rates for both cod stocks have increased over those data used to generate this table (i.e. %MSP has decreased).

Source: Groundfish PDT, "Effects of Mesh vs. Effort Controls on Spawning Stock Biomass of Gulf of Maine and Georges Bank Cod and Georges Bank and Southern New England Yellowtail Flounder", 1992 (unpublished).

**Impacts of changes to the small mesh fisheries on groundfish stocks**

The current management system provides for small mesh fisheries through the Exempted Fishery Program (EFP) in the Gulf of Maine, and outside of the Regulated Mesh Area by the absence of minimum mesh size regulations except for the Southern New England Yellowtail Area and the seasonal Nantucket Shoals Area. The mesh regulations in these areas would be precluded by the proposed regulations which would apply large-mesh regulations throughout the range of the stocks on any vessel possessing more than the possession limit.

#### E.7.1.1.1.3 Impacts of area closure

The impact of temporary or relatively small (in terms of the range of individual fish or the stock range) area closures on overall fishing mortality rates cannot be quantified for several reasons: the fishing effort which generated that partial mortality (from inside the area) may simply be displaced to another area; the fish that are protected inside the boundaries become unprotected if they swim out of the area or when the area is reopened; and when the area is reopened, fishing almost always resumes at a higher initial rate of effort as vessels target the previously protected fish. Historically, area closures have been used to protect concentrations of spawning or juvenile fish rather than as a fishing mortality reduction measure. Although the efficacy of these measures to improve spawning success or protect pre-recruits is a matter of some debate among scientists, they are reasonable and have traditionally been supported by the industry.

In the case of the proposed actions, the two haddock measures are modifications of existing closures. Trawl survey data and landings data indicate significantly lower catch rates and landings of haddock and other groundfish species from Area I in comparison to Area II. Haddock abundance in Area I has declined over the recent past and there is no indication of significant haddock spawning activity in Area I. Suspending the Area I closure is not expected to have a negative impact on the spawning or abundance of haddock or other groundfish stocks, but will reduce the enforcement burden on the Coast Guard which will allow for improved enforcement of other, more effective measures.

In the case of the expansion of Area II, significant landings of haddock are reported from the area around the current boundary line and when the area is opened. There are reports of illegal fishing just over the boundary during the closure. Haddock that are aggregated to spawn in this area are extremely susceptible to being targeted, particularly around the margins of the area and upon the termination of the closure. Based on historical landings, nearly one quarter of the total landings of haddock are caught within the area included in the proposed expansion during the closure, and about one third of haddock landings are caught within the expanded area during January through June. Based on an analysis of the fishing effort in the area and displacing that effort to other areas in the region with the next-highest catch rates in the 1988-90 period, the haddock that would have been saved amounts to 21 percent of the total landings of haddock while the landings of other groundfish would have increased by 1 percent.  Without calculating for displaced effort, the haddock saving would have amounted to 33 percent and other groundfish species to about one percent of the total landings. (Ham, et al. 1991)

The proposed southern New England yellowtail closure is designed to protect large year classes of yellowtail flounder during their growth from around ten inches to the minimum legal size of 13 inches.  In 1988 and 1989, millions of undersize yellowtail were discarded in this area at rates as high as 75 to 80 percent of the fish caught. These fish represented a strong 1987 year class, which had been indicated by the bottom trawl survey standardized index of abundance.  The spring bottom trawl survey index of age-two fish has been shown to be an effective predictor of year class strength  This predicting capability should be enhanced by the recently initiated winter flatfish survey.  At the time the spring survey is conducted, age-two yellowtail are around ten inches and begin to get caught by the fishing gear but they generally do not reach legal minimum size of thirteen inches until one year later.  Historical data supported by anecdotal information provided by fishermen, indicate that age-two and age-three yellowtail are often highly concentrated in this area.  Since yellowtail flounder can be caught in significant amounts by scallop dredges, all gear capable of catching yellowtail would be prohibited from fishing in this area during the closure.

As with the other area closures, attributing some measurable reduction in overall fishing mortality rates to a proposed night fishing ban within twelve miles is not possible with the data and analytical techniques available. Nevertheless, there are several supporting arguments for this proposal based on projected impacts.  Data for analyzing the differences in catch rates between inshore and offshore areas, or day and night periods is limited but there do appear to be some differences, particularly an increase in night catch rates (McBride, et al., 1992).  Secondly, concentrations of juvenile fish are known to occur in significant numbers in shallower waters including those within twelve miles from shore (Wigley and Gabriel, 1991).  Thirdly, historical records indicate significant spawning activity within twelve miles of shore for most of the commercially important groundfish stocks including cod, haddock, pollock, yellowtail flounder and winter flounder (Bigelow and Schroeder, 1953).  This spawning activity is not as evident today as it was historically, in part due to the fishing effort in these areas.  Fishermen also report that non-migratory sub-groups of commercially important stocks of groundfish inhabit this inshore area and provide a steady renewable source of income for the local fishing community, but are susceptible to overfishing by an increase in effort.  The reduction in fishing opportunity time is expected to reduce the fishing effort expended on this nearshore area and may offset some of the compensatory behavior of offshore vessels under the effort reduction program. These offshore vessels may try to increase fishing time under an effort reduction system by fishing closer to shore which will increase the mortality on these inshore spawning, juvenile and resident stocks, but these vessels may elect to stay offshore if they can only fish during daylight hours.

**E.7.1.1.1.4 Impacts of the haddock possession limit**

The purpose of this action is to prevent a directed fishery for haddock since the abundance is at a historically low level. Recently, haddock has been caught primarily as a bycatch, with over ninety-five percent of the landings being caught on trips where less than 2,500 pounds are landed. Under the effort reduction program, the possession limit will help prevent a redirection of effort onto higher-value haddock in the event that there is a good year class entering the fishery. This possession limit is intended to work in conjunction with other measures such as the expansion of Area II and the mesh size increase. The area which is covered under the expansion of Area II is where the large haddock catches are taken which will help to address the potential discarding problem which is a consequence of possession limits. In the short term, a proportionally small part (less than five percent) of the haddock catch would be subject to discarding as a result of this measure. The disincentive to continue to fish for haddock upon catching the possession limit may reduce the potential for discarding more than predicted since vessels will presumably leave the area where large hauls of haddock are taken. If the possession limit becomes so restrictive as to result in increasing discards due to an increase in the abundance and geographical distribution of large concentrations of haddock, then the framework measures for adjusting the effort control mechanisms could adjust the possession limit.

**E.7.1.1.1.5 Impacts of the groundfish possession limit**

To the extent that vessels fishing for species other than groundfish encounter more than the possession limit of groundfish, discarding may increase. These fisheries are either small-mesh fisheries, or large-mesh fisheries targeting non-groundfish species such as dogfish. Vessels that are fishing for groundfish under the possession limit (i.e. seeking and catching the allowed limit) will also discard groundfish they catch in excess of the limit (or land them illegally). Highgrading, or the discarding of lower-value species in order to retain the limit of higher value species, will also likely occur. The degree to which these behavioral changes will take place is not predictable. Estimating discards even in current fisheries has proven extremely problematic for management and assessment scientists, and quantifying potential discards is virtually impossible.

Evidence from the Exempted Fishery Program in the Gulf of Maine indicates that vessels in the whiting fishery currently catch significantly less than 500 pounds under the 10%/25% limit of the current EFP regulations; the proposed rules may allow whiting boats to retain more groundfish than they currently do, although there is no reason why this should increase their discards. In fact, discards may decrease since vessels will not be required to maintain groundfish bycatch levels below a percentage of the trip catch. Vessels engaged in shrimping, under the proposed rules, will be required to use a finfish excluder device, and will not, under normal operating conditions, be netting significant amounts of finfish.

In the southern New England small mesh fisheries the species that are targeted are generally not mixed with significant amounts of groundfish. Those trips that have historically landed significant amounts of groundfish along with small mesh species have done so by targeting the groundfish during part of the trip. The ability to switch target species, from small mesh species to groundfish, within a trip is an important economic element of this fishery, and is an issue being addressed in this action. Regardless of how the management issue (allowing more than one mesh on board) is resolved, the possession limit is not expected to have negative biological impacts in the small mesh fisheries since the small mesh operations will remain the same. To the extent that fishermen who in the past could retain both small and large mesh species in the same trip elect to target groundfish with large mesh instead of fishing for small mesh species for the entire trip, groundfish mortality could increase.

#### E.7.1.1.1.6 Impact of proposals to reduce the take of harbor porpoise on the fishery

The proposed action includes an objective of reducing the take of harbor porpoise in the sink gillnet fishery. The Council has adopted the approach of developing measures that would address both the overfishing of groundfish and the take of harbor porpoise. If the proposed measure or any other measure developed through the framework mechanism is able to accomplish this dual purpose, then the expected impacts of reducing the take of harbor porpoise are not expected to be any different than those of the effort reduction measures. If, on the other hand, the proposed measure, or any future approach that is adopted, is insufficient to accomplish the harbor porpoise objective without reducing gillnet fishing effort more than the fifty percent target, then the impacts of such a measure would need to be reevaluated.

#### E.7.1.1.1.7 Impacts of other measures

In addition to the proposed measures relating to mesh size, area closures, fishing mortality reductions, and catch limits, a number of other measures are proposed in this amendment. These other measures relate primarily to the improvement of enforcement and administration of the management regulations and include mandatory reporting of landings and effort data and permitting of vessel operators and dealers. To the extent that improvements in the management system will result in the achievement of the biological objectives of the amendment, then the impacts of the other measures are expected to be positive. No significant negative biological impacts are expected from these administrative and enforcement measures.

### E.7.1.1.2 Impacts on other fisheries

In Section E.6.3.3 at least 45 commercial fisheries in the Northeast are identified that are not managed under the Multispecies FMP but which are geographically coincident. The range and size of these stocks varies considerably from the inshore bay scallop and oyster fisheries to the pelagic tuna or mackerel fisheries. The degree to which these other fisheries will be able to absorb displaced groundfish effort ranges from those such as the surf clam and ocean quahog fisheries, in which entry is closed, to the spiny dogfish fishery where there is a large underexploited biomass that has actually increased in recent years.

Likewise, the degree to which a particular vessel can adapt to another fishery, by virtue of its size or gear configuration, also varies. Some underutilized alternative stocks, dogfish, for example, can be fished with the same gear used to catch groundfish. In other cases, the groundfishing vessel is entirely inappropriate or requires major rerigging. These factors complicate the analysis of the impacts of the proposed action on other stocks.

Further, one of the most unpredictable elements in this analysis is personal preference. On both the market side and the producer side, the element of choice is significant. While the codfish has historically been the mainstay of the New England fishing industry, other species have fallen in and out of favor rather dramatically. Thus, some of the region's highest priced fish today, bluefin tuna and monkfish, were, within the lifetimes of some fishermen now fishing for them, discarded or sold as cat food at a few cents per pound. Other stocks have also seen significant rises in consumer demand including pelagic sharks, loligo squid, and sea urchins. These fisheries have already provided an alternative to groundfishing for many fishermen or their vessels and are reaching the limits of their exploitability. Other stocks, in contrast, have suffered from a great decline in market demand such that they are greatly underexploited. These include mackerel and herring which supported much larger fisheries in the past than they do today.

Personal preference and ability of individual fishermen is also a factor in trying to predict where effort might be displaced. Fishermen have often expressed strong views about specific gear types or fishing methods they do not want to use. Whether from a perceived conservation position or a simple aversion to a particular way of fishing, these views limit the appropriateness of some alternatives. Individuals have widely varying abilities or desires to travel to other ports or further offshore, for example. The response of fishermen to changing conditions (whether it be resource, market or management conditions) has varied in the past. Some fishermen have been highly successful in developing a market tailored to a unique operation or specific product while others have shifted their operation among existing, more traditional fisheries.

Another factor to be considered in assessing the impacts of Amendment #5 on other fisheries is the changing management regime throughout the region. As with the groundfish fishery, almost all other fisheries in the Northeast have seen a rise in fishing effort and have become overfished. The respective management agencies have responded with measures that restrict the degree to which the fishery can be exploited or entry to the fishery. If the groundfish stocks do not rebound sufficiently to sustain the labor and capital at the reduced level of effort, these increasing restrictions in other regional fisheries greatly limit the range of alternatives. With a limited choice among well established fisheries, displaced groundfishing effort looking toward the underexploited stocks may need to seek external stimulus for the development of markets for those products.

Some efforts to develop markets for underutilized stocks to provide alternatives to groundfishing have already begun (see Section E.5.2.3 - Alternatives Outside Council Jurisdiction) The 1992 NOAA Reauthorization Act establishes a regional fisheries reinvestment program which allows the use of Saltonstall-Kennedy funds to assist in the development of economically viable fisheries for underutilized species. In 1992, the US Dept. of Agriculture listed Atlantic mackerel and dogfish as qualifying under the Food for Peace Program, PL-480, which may generate some export market for these stocks. Locally, fishermen's wives' organizations, chambers of commerce, seafood councils or other organizations have tried to cultivate demand for underexploited species through cooking demonstrations, festivals and other promotional activities. In the past, efforts to generate demand and to provide the harvesting capacity for underutilized species have met with varying degrees of success.

In summary, there is no practical way to predict where the effort displaced from groundfishing will go. Human nature being what it is, the likelihood exists, even if groundfishing catch rates increase dramatically as fishing effort is cut back, that the displaced effort, the idled capital and underemployed labor will be directed to other fisheries in order to increase profits. Working in opposition to this force are three main elements: an evolving and more-restrictive management regime in other regional fisheries, the inability or reluctance of individuals to modify their behavior, and a constantly changing demand sector. Of the 45 identified fisheries, and whatever number of unidentified or yet-undiscovered fisheries, the ones with the greatest unexploited biomass, such as mackerel, dogfish and herrings, offer the most obvious potential. Just how the effort shift will unfold, however, is not predictable.

### E.7.1.2 Impacts on threatened, endangered species and marine mammalsE.7.1.2 Impacts on threat

As indicated by information consolidated by the National Marine Fisheries Service through their Interim Exemption Program for Commercial Fisheries (Proposed Regime to Govern Interactions Between Marine Mammals and Commercial Fishing Operations, 1991), impacts to protected species as a result of interactions with the Northeast multispecies groundfish fishery occur to varying degrees, depending on the gear type employed. With a proposed moratorium on entrants into the fishery in addition to an effort reduction program, the impacts of the fishery on protected species can at least be expected to remain stable and possibly decrease.

Otter trawls and sink gillnets are the principle gears used to harvest the groundfish species referenced in the Amendment #5 management unit (see section E.6.4.1 for a complete description of gear). Despite significant levels of fishing effort exerted by the otter trawl fleet, entanglements of protected species are rare events (D. Christiansen, NEFSC, Woods Hole, MA, pers. comm.). Similarly, there is little evidence of significant interactions with groundfish hook gear, which accounts for a very small fraction of the effort in the fishery.

**Marine Mammals**

Among the protected marine mammal species present in the management unit, those which have documented interactions in the groundfish fishery are the right whale, humpback whale, harbor porpoise, harbor seal and gray seal. (See section E.6.3.4 for a complete list of protected species known to occur in the region.) While the entanglement of seals by several groundfish gear types has been reported (Gilbert and Wynne, 1987 and 1985) and despite the fact that OSP estimates do not exist (Proposed Regime to Govern Interactions Between Marine Mammals and Commercial Fishing Operations, 1991), the present level of take does not appear to significantly impact these species.

**Whales**

Entanglement has been identified as a major source of mortality among humpback whales. According to the Final Recovery Plan for the Humpback Whale (1991) from 1976 through 1986, 18 entanglements were reported for fishing gear in the northeastern U.S. continental shelf waters. Sink gillnets caused 39 percent of these entanglements. Right whales are also subjected to a level of take in the groundfish fishery although collisions with ships constitute the most significant human impact (Final Recovery Plan for the Northern Right Whale, 1991). Despite the occurrence of entanglements, the interactions are relatively low in number, and have little likelihood of increasing in view of the fishing effort reduction program proposed.

Amendment #5 will afford additional protection to endangered whale species which can inhabit the Great South Channel area during the spring months. The proposed action would suspend, for mobile gear, the seasonal closure of a region referred to in the existing plan as Area I. Mobile and fixed gear are currently prohibited from entering the area from February 1 to May 31 to protect juvenile and spawning haddock. Due to a geographical and temporal overlap between the proposed right whale critical habitat now under consideration by the National Marine Fisheries Service and Area I, the Council proposes that the closure remain in effect for fixed gear. Scientists consulted by the Council are in agreement that any increased fishing vessel traffic would not constitute a significant impact to whales which frequent the region.

The incidence of entanglement in fixed gear in the Great South Channel is unknown. Correspondingly, any potential increases as a result of suspending the closure would be difficult to assess. The rationale for retaining the closure for fixed gear is based on the general predictability of the Great South Channel as a high-use habitat for endangered fin, sei and humpback whales, in addition to a right whale feeding and nursery ground. Because of potential changes in cetacean distribution and activities, however, and the circumstances under which fixed gear poses a threat, monitoring and evaluation of this area should occur and judgements reevaluated as new information becomes available.

Since the primary goal of Amendment #5 is to reduce fishing mortality on overfished groundfish stocks in the Northeast, a brief discussion of impacts of the fishery on the forage of protected species may be useful. With the exception of the highly endangered right whale and possibly the harbor porpoise (discussed in the next section), most populations of cetaceans and pinnipeds are considered to be at least stable, if not increasing despite the decline of commercially valuable finfish stocks. This is in part due to their dependency on prey items other than groundfish, such as sand lance for fin and humpback whales, euphausiids and copepods for right whales and herring for harbor porpoise.

In addition to this broad assumption, it might be concluded that to the extent that marine mammal populations are dependent on groundfish species in the management unit, any improvement in those stocks under the proposed program will likewise benefit marine mammals. Given the paucity of data available to make informed decisions at an ecosystem level and the problems inherent in integrating marine fisheries management with marine mammal protection, the subject of potential impacts on the abundance or scarcity of forage species remains highly speculative. The goal of the Magnuson Act to manage fish populations for optimum yield and the Marine Mammal Protection Act which protects marine mammals to achieve OSP may receive attention since both pieces of legislation are the subject of reauthorization during 1993.

**Harbor Porpoise**

The NMFS proposed listing of the Gulf of Maine harbor porpoise as threatened under the Endangered Species Act (ESA) (50 CFR Part 227, January 7, 1993). A written request by Dr. William Fox asking the Council to consider action to reduce the take of porpoise in the Gulf of Maine sink gillnet fishery in the context of Amendment #5, prompted the Council to develop marine mammal management measures relative to this interaction. NMFS has determined that regardless of the status of the ESA listing, the bycatch of harbor porpoise in the gillnet fishery must be reduced. The Council subsequently added a fifth objective to Amendment #5 "to reduce the annual take of harbor porpoise in the sink gillnet fishery by the end of year four after implementation to two percent of the population based on the best available estimates of abundance and bycatch". Current abundance estimates indicate a Gulf of Maine/Bay of Fundy population of 45, 000 and a bycatch of between 4 and 5 percent of the estimated abundance.

Measures to reduce the bycatch of porpoise in the gillnet fishery are not yet fully developed, although the amendment presently includes a provision with blocks of time in which all gillnets must be removed from the water. Framework language is included which will allow measures to be put in place when they are developed or modified as necessary.These measures may also be applicable to and result in changes to the effort reduction program for gillnet boats. Currently, the proposed effort reduction measures apply as bycatch mitigation measures. The Council is considering an industry proposal based on a reduction in the number of nets deployed in high bycatch areas, and the potential use of a time/area closure strategy.

**Marine Reptiles - Sea Turtles**

Data collected by the University of Rhode Island’s Cetacean and Turtle Assessment Program (CeTAP, 1980) indicates that by far the most common species of turtle found in the waters between George’s Bank and Cape Hatteras waters is the loggerhead. Leatherback turtles are the next most abundant species followed by Kemp’s ridleys and rarely green turtles. Although incidental take in groundfish gear is known to occur, the level of take does not appear to have significant impacts on the species which seasonally move northward to areas covered in this amendment.

Bathymetry and surface water temperatures are thought to limit the activity of sea turtles. Aerial surveys of loggerheads at sea indicate they are most common in waters less than 50 m in depth (Shoop et al. 1981; Fritts et al. 1983) but can occur offshore. They enter embayments in the Northeast when temperatures reach 20° C to feed on benthic invertebrates. Net, trap and hook and line fisheries are known to take loggerheads (Crouse, 1982) in addition to the otter trawl fishery in the Northeast (Proposed Regime to Govern Interactions Between Marine Mammals and Commercial Fishing Operations, 1991).

Leatherback turtles have a pelagic distribution and feed primarily on jellyfish (Rebel, 1974). They occur in low numbers in the waters between Cape Hatteras and Nova Scotia and then only during the warmer seasons (CeTAP, 1980). Sightings usually take place in the shallower regions of the continental shelf and in surface temperatures which range between 13° to 27°C. Entanglement occurs primarily in lobster pot lines (Prescott, 1988), but takes have been documented in gillnets and trawl lines (Goff and Lein, 1988).

Both adult and juvenile Kemp's ridleys feed primarily in shallow coastal waters on bottom-living crustaceans (Hildebrand, (1982). Their northward movement from the Gulf of Mexico to coastal embayments occurs when temperatures approach 20°C. With the exception of the Gulf of Mexico shrimp and summer flounder trawl fisheries, levels of takes by other gear types is unknown.

Although most nesting sites are located along the Atlantic coast of Florida, juvenile green turtles occasionally have been sighted as far north as Long Island Sound. They are incidentally taken in net trap and hook and line fisheries (Crouse, 1985).

**Shortnose sturgeon**

An anadromous species that spawns in the coastal river on the eastern seaboard, the sturgeon is not known to use the offshore marine environment. It was rarely the target of a commercial fishery, although it was often taken incidentally to the commercial fishery for Atlantic sturgeon which is now closed or restricted in many New England states. NMFS has recommended removing the shortnose sturgeon from the ESA list for the St. John's River (Canada) and the Kennebec River (Maine) populations because numbers are stable there are few human-induced impacts (Endangered Species Act Biennial Report, 1991).

**Seabirds**

In addition to marine mammals and sea turtles, seabirds are vulnerable to entanglement in commercial fishing gear (Proposed Regime to Govern Interactions Between Marine Mammals and Commercial Fishing Operations, 1991). The interaction has not been quantified in the Northeast multispecies groundfish fishery, but impacts are not considered significant. Endangered and threatened bird species, which include the roseate tern and piping plover, are not impacted by the groundfish gear (Paul Nickerson, U.S. Fish and Wildlife, pers. comm.).

### E.7.1.3 Impacts on habitat and other biotaE.7.1.3 Impacts on habitat and other biota

The number and diversity of regional marine species makes predicting the ecological consequences of the proposed management system, particularly the fifty percent reduction in fishing mortality for the target species, almost impossible. In other words, our knowledge of the marine environment is extensive but imperfect and incomplete. As we approach this resource management problem, essentially from the view of a single species (or more accurately an aggregation of single species), it is imperative to remember that species interact with each other and the environment on numerous levels. Many of these relationships are ill-defined or unknown.

In an attempt to model our knowledge of predator-prey relationships in multispecies fishery systems Wilson et al. (1991) have demonstrated that a multispecies complex of fish shows a good degree of stability, approaching the total carrying capacity for the entire system. Unfortunately, the behavior of populations of individual species becomes chaotic over time so that to predict some ultimate equilibrium species mix is impossible. The system may be considered to be in a state of dynamic equilibrium in which the species mix at any given point in time is the product a number of factors, particularly competition and predation. Predation can be thought of as representing both natural mortality within the system and external factors such as fishing, pollution and/or other conflicting, non-fishery, uses of the marine environment.

Although this outlines a rather pessimistic view for resource management, Wilson et al. (1991) demonstrated broad qualitative patterns in their modelling efforts that could be utilized for informed management decisions through a more complete understanding of the ecological relationships in the system. In the meantime, scientists are of the opinion that reducing fishing mortality rates on the commercially important species will enable the ecosystem to approach a state characterized by a much greater biomass of these species occupying the same ecological niche as is now taken up by skates and dogfish. The ecosystem of the region historically had this characteristic prior to the 1960's when greatly increased fishing pressure completely disrupted the system dynamics and created a state of disequilibrium still evident in the current macrofaunal species mix. A reduction in fishing effort on the order of fifty percent will also potentially reduce the impact of the groundfish fishery on other biota in the system (through reduced gear interaction and bycatch); however, the extent to which the impact will occur is not predictable, particularly when the effort may simply be displaced to other fisheries using the same gear, or gear which has other impacts on the ecosystem.

Other scientists argue that more overt action needs to be taken in order to restore that historical mix of species, that the less desirable species should be removed from the ecological niche in order to enable the higher value species to expand. Effort displaced to those stocks as a result of the proposed action would accomplish this. Opponents to this approach cite the precarious balance that exists as a result of the biology of the different species, and that caution must be taken in trying to control such a large and complex system. The debates continue, but, clearly, alot of knowledge is lacking about the ecosystem impacts of the proposed management measures, or general fishery management approaches.

To the extent that the fishery might have negative impacts on coastal or ocean habitats, the proposed action, which reduces by fifty percent the effort expended in the fishery, will likely reduce the level of those impacts to a significant degree.

### E.7.1.4 Impacts on Stellwagen Bank Marine SanctuaryE.7.1.4 Impacts on Stellwagen Bank Marine Sanctuary

The designation of Stellwagen Bank as a National Marine Sanctuary does not restrict commercial fishing in the area and is intended to protect and enhance sanctuary resources. To the extent that the proposed action is expected to conserve fish stocks, the impacts are expected to be positive and consistent with sanctuary objectives.

## E.7.2 ECONOMIC IMPACTS OF PROPOSED ACTIONE.7.2 ECONOMIC IMPACTS OF PROPOSED ACTION

### E.7.2.1 BenefitsE.7.2.1 Benefits
### E.7.2.2 CostsE.7.2.2 Costs
### E.7.2.3 Net BenefitsE.7.2.3 Net Benefits

The economic impacts of the preferred and two non-preferred effort reduction alternatives were projected in an economic simulation model developed at the Fisheries Economics Investigation section of the NEFSC. The analysis and results were incorporated into a bioeconomic evaluation of the proposed action and presented to the Council in January, 1993. This integrated report, containing projected costs, benefits and net benefits, is contained in its entirety in Appendix IV (Volume II). Sections 8.2 and 8.3 (the Regulatory Impact Review and Initial Regulatory Flexibility Analysis, respectively) in Volume IV contain additional discussion of the economics of the proposed action. A comparative discussion of the economic impacts of the preferred effort reduction proposal and the non-preferred quota-based alternative is provided below.

### E.7.2.4 Comparison of Direct Effort Reduction versus Quarterly Quota AlternativesE.7.2.4 Comparison of Direct Effort Reduction versus Quarterly Quota Alternatives

Following is a qualitative assessment of the cost and benefits of a quarterly overall quota regulation (Alternative #3) versus direct effort reduction alternatives (Alternatives #1 and #2). The bioeconomic analysis presented in Appendix IV, "Bioeconomic Evaluations of the Impacts of Amendment #5 Alternatives", compares the net benefits of these three alternatives with the No Action alternative. Although the economic impacts were examined by assuming that the fishing time is equivalent across alternatives, it was pointed out that there could be differences in prices and the costs of fishing since effort will be more concentrated under the quota option. This discussion goes beyond the previous analysis and investigates how the differences in the timing and the intensity of the fishing activity can produce different impacts on the costs and revenues under each option.

Obviously, both the days-at-sea reduction and the quarterly quota alternatives will encourage the fishermen to increase their fishing power, i.e, upgrade their vessels so that they can increase their share of the catch. This will result in higher average costs and consequently, will reduce the net benefits. Suppose that the degree of upgrading is same in all three alternatives, so that the increase in the total costs due to higher capital costs are equivalent for these options. However, it is reasonable to expect that the timing of the fishing activity will be different in each case since the maximum number of days that a vessel can fish is significantly less for the first two alternatives (190 opportunity days for the first alternative ) as compared to the quota alternative (two months out-of-groundfishing, therefore 305 days). This difference in the timing and pattern of the fishing effort can result in differences in the operational costs per unit of catch.[17]

In the case of “opportunity-days” or “days-at-sea reduction” alternatives, since each vessel has an allocated maximum number of fishing days, it will be to the advantage of fishermen to use these limited days at the times when they expect the fish stock is most abundant, and thus, unit marginal costs are lower.

In the case of quota alternative, the uncertainties regarding the size of the stocks and the time when the overall quota might be reached may motivate most fishermen to start fishing intensively at the beginning of the season. Since fishing costs are dependent on the size of the fish stock and thus, the harvest of other fishermen, this excess effort and congestion at the beginning of the season, will likely result in higher costs per unit of catch. Therefore, variable costs per unit of catch under the quota regime will exceed the variable costs that would be incurred under the direct effort reduction alternatives (alternatives #1 and #2). However, the mandatory two-blocks-out-of -groundfishing under the quota-regime may reduce the concentration of the effort at the beginning of the quarterly periods. Additional analysis is required to determine to what extent this regime would distribute the fishing effort in a more optimal way -so that it would occur at periods when the fish stocks are at their highest levels.

Some recent studies have also shown that in the presence of fluctuating stocks, management measures which are based on constant effort rule are superior to constant quotas if the marginal revenue return to effort is an increasing function of effort. When stocks are larger than expected, profitable opportunities will be unexploited under a quota regime whereas an effort-control rule will result in a higher catch and revenue. When stocks are low, quota-regime involves catching an increased proportion of the residual stock, at a cost which increases with the intensity of the exploitation (Quiggin,1992).

As noted by many economists, under the quota alternative, the allocated catch may be achieved faster than it would have been in the absence of quota. Nevertheless, this does not imply that the overall average costs are lower since an increase in average catch-rate could be achieved at the expense of higher capital (larger, more powerful vessels etc.) and / or higher labor costs (more crew).

[17] A suboptimal harvest pattern, in various seasons and locations, may lead to uneconomic use of the fish stocks. For further analysis, see Onal et. al. (1991).

Effort-control and overall-quota alternatives will have different results in terms of the distribution of income among vessels of different size. Under quota management, actual fishing days of some vessels can be less than their allocated days (under Alternatives #1 and #2) if the overall quota is reached due to intensive effort by the larger vessels. Thus, in general, overall quota will favor larger-vessels. Also, the extra constraint imposed on the potential fishing days of the individual vessels by the harvest of the others, will increase the tendency to overinvest in fishing capacity. Therefore, not only the operational costs per unit of catch but also the fixed costs may be higher under an overall quota regime as compared to direct controls on the individual fishing days. It is possible to investigate these distributional issues further, by comparing catch rates (CPUE), revenues and operating costs per day absent of smaller boats with the larger vessels.

Finally, effort-control and the quota alternatives will have different implications for the processing sector, and for the consumers. As stated by Anderson(1977), quotas will decrease the length of fishing season. If a greater number of fish is landed in a shorter period, this will put an additional burden on the processing plants during the peak periods. Also, fresh fish will be available for a shorter period of time. In this case, either some part of the fish will be frozen for off-season use resulting in higher costs for the industry, or it will be immediately sold at lower prices. Therefore, expected industry profits will be lower under a quota-regime as compared to direct-effort-control alternatives since in the latter case it may be possible to obtain a more optimal seasonal harvesting pattern.

The analysis up to this point assumed that all three alternatives include a moratorium on new vessel permits. Obviously, a quota alternative without a moratorium can result in complete dissipation of the industry profits and the net benefits, since positive profits will encourage new entry into the fishery until total harvesting costs equal total revenues. Although, the fishing mortality is reduced, an overall-quota regime may significantly increase the social costs of the fishing industry due to increased investment in an already over-capitalized industry.

In sum, it is reasonable to expect that under the quota alternative the average costs of fishing will be higher, quality of fish will be lower and the industry profits will be less as compared to direct-effort-reduction alternatives. Presently, it is not possible to determine the numerical magnitude of the differences for these options. Such a quantitative assessment of costs and benefits under each alternative requires construction of a dynamic optimization model of fishermen's behavior.

## E.7.2.4 Administrative costsE.7.2.4 Administrative costs

There are several aspects of Amendment 5 that will incur costs to the NMFS in administering, monitoring and enforcing the measures proposed. These costs can be broken down into the following general areas: 1) permitting; 2) monitoring and reporting; and 3) enforcement.

### E.7.2.4.1 Permitting

**Vessel Permits**

There are approximately 5400 vessels that are permitted for the Northeast Multispecies fishery. Of these vessels, approximately 4000 appear to meet the eligibility requirements for a moratorium permit by having held a Federal Fisheries Permit endorsed for the Northeast Multispecies fishery as of the control date or renewed the permit during 1991. What is unknown is exactly how many of these vessels will meet the eligibility requirement of having landed groundfish during the period January 1, 1990 and February 21, 1991. Only after the proposed appeal process will the actual number be determined. Commercial landing statistics are incomplete for some vessels or vessel groups participating in the groundfish fishery for a variety of reasons. Small vessels that are state registered may have their landings aggregated with other vessels. Vessels that only land occasionally in the Northeast, vessels that land in smaller ports, or vessels that have their catch trucked to other locations may be also missed.

For the purpose of this analysis, it is assumed that all vessels will meet the eligibility criteria for a permit by qualifying for a moratorium permit, or by electing to participate under the "4500 hook limit" or the "possession limit" exemptions. This would place the total number of permits at 5400. The most recent calculation of administrative costs for permit issuance determined that the cost per permit is $33. This figure reflects the unit cost of administering the current permit system including labor, benefits, rents, mailing, and equipment. What it does not include is the added processing time required when moratorium eligibility has to be determined. When the unit cost is applied to the expected number of permits, the resulting total is estimated to be $178,200.

The majority of vessels apply for more than one fishery on a single application. The total costs associated with permit issuance are based upon vessel permits rather than individual fishery permits. As a result, the total costs are shared among a variety of fisheries. It should also be noted that except for added time and costs related to the determination of eligibility for moratorium permits, this is not an increase over current issuance costs for multispecies permits.

**Appeals - Moratorium Permits**

Under the preferred alternative, there is an appeal process proposed for permit eligibility. Appeals will be heard for vessel owners that failed to meet moratorium permit eligibility and feel that there are circumstances that satisfy the proposed appeal criteria for moratorium permits. Appeals are expected to be processed following procedures established for the summer flounder fishery. Vessel owners applying for a multispecies permit will be required to submit proof of landings if the vessel has not already been recorded in the weighout files. If the vessel was permitted during the required period and valid proof of landings are provided, a permit will be issued. Otherwise, the applicant will receive a letter stating that further proof of landings is necessary or that the vessel does not qualify and an appeal will be required. Applications resubmitted with landings will be reviewed and if accepted a permit will be issued. Those found to be unacceptable would be required to appeal if the applicant believes that appeal criteria are applicable.

Initial review for completeness will be conducted by the Permit Office. The Permit Office will also be able to issue permits for those vessels already determined to be eligible through landings in the weighout files. As stated previously, the cost of this initial review has not been factored into the permit issuance fee. With the recent implementation of Amendment 2 to the Summer Flounder Fishery Management Plan (Amendment 2), it was found that the review took longer than anticipated and the associated costs would be expected to increase from the $33 unit cost. Further review would be conducted by the Fishery Management Operations Division, and if necessary, an Appeal Officer, with the ultimate decision resting with the Regional Director.

Given the several options available to vessel owners (moratorium permit, possession limit exemption, hook exemption) it is difficult to estimate the total number of appeals that will ultimately be heard. If applicants include the necessary documents the first time, the result will be a significant reduction in the time spent on processing permit applications.

Written appeals could be processed by a GS-9 and a GS-12 at hourly wage and benefit rates of $17.92 and $25.97, respectively, while oral appeals would be handled by a GS-14 at an hourly wage and benefit rate of $36.50. The agency may have to make several mailings and phone calls to request further information or clarification of the appeal presented which increases the amount of time spent. It is estimated that if 1000 appeals were reviewed at a rate of 30 minutes an appeal, and 250 of these were oral, at a rate of 60 minutes an appeal, the total estimated cost would be $20,098.

**Dealer Permits**

The Northeast Fisheries Science Center has estimated that there are approximately 700 dealers who purchase groundfish. The regulations implementing Amendment 2 contain a dealer permit requirement which could provide more information on the actual number of dealers. Using the permit issuance cost figure of $33 and the estimated number of dealers, the total annual administrative cost for a dealer permitting requirement is estimated to be $23,100. As with vessel permits, this cost could be shared among fisheries if the dealer applies for more than one fishery.

**Operator Permits**

The number of operator permits that will be issued under the proposed measure is a function of the number of vessels, the size of the vessel, and the number of crew. Larger vessels typically employ a captain and mate who are responsible for vessel operations at various times. Under this requirement both would have to be permitted. With no eligibility requirements on who is able to apply for an operator permit, it is safe to assume that the number of operators applying will be 1.5 to 2 times greater than the number of vessels (8100 - 10,400). When the unit cost of permit issuance is applied, the total estimated costs associated with this proposed measure is $267,300 - $343,200. These costs could be reduced on an annual basis by having the duration of these permits last for period of up to three years. This approach is similar to that used for driver's licenses and would facilitate reissuance by reducing the total number having to be issued each time.

**Small Mesh Alternative - Permits**

As a non-preferred alternative the Council has proposed an alternative to the one-mesh-on-board provision which would allow vessels that had a record of participation in small mesh fisheries to carry small mesh provided that they were permitted by the Regional Director. An examination of the exempted fisheries program and weighout files for the period of 1990-91 determined that there were approximately 1000 vessels that fished with small mesh. If only one small mesh exemption permit is issued per vessel annually and the permit issuance cost of $33 was applied, the estimated cost for permit issuance for this alternative would be $33,000.

**Small Mesh Alternative - Appeals**

Inherent in the non-preferred alternative above is a need for an appeals process. Determination of which vessels historically used small mesh can be done through examination of the various exemption programs (exempted fisheries, Cultivator shoals, midwater trawl) and the weighout database. Unfortunately, the weighout database only lists mesh size for those trips that were interviewed. There may be other vessels that used small mesh that were not captured by these data sources. The appeal process should allow for vessel owners to provide proof that small mesh was used. What this proof would be still needs to be determined. If 500 vessels filed appeals and each appeal took 30 minutes and were processed by GS-9 and GS-12, the total estimated cost would be $5486.

**Appeals - Individual Days At Sea**

Under one of the non-preferred alternatives, appeals are allowed for vessel owner's that choose to take their actual days over the time out/layover day alternative. If a vessel owner disputes the vessel allocation received, a written appeal could be made subject to the proposed criteria. The vessel owner could also request that the appeal be presented at an oral hearing.

Again it is unknown how many vessels would choose to take this alternative and how may would appeal. All trips taken by the vessel for the three year period between 1988 and 1990 would have to be examined in detail. A conservative estimate would be two hours for each written appeal and one hour for each oral appeal. If 200 appeals were made and 50 of those were oral, the total cost is estimated to be $10,603.

**Summary**

Under the category of permit issuance and associated activities, the total estimated administrative costs of the preferred alternative would be $564,598. The estimated costs of the non-preferred alternatives are $38,486 for the small mesh alternative and $10,603 for the individual days at sea alternative.

### E.7.2.4.2 Monitoring

Amendment 5 proposes two alternatives to monitor effort control (days at sea): 1) the electronic vessel tracking system; or 2) a magnetic-strip card system. It is unknown at this time which system will ultimately be chosen by the Council or the actual number of vessels that would opt for either of the systems if given a choice. Whenever possible, the costs presented reflect unit costs which then can be applied to actual or estimated numbers of vessels.

**Electronic vessel tracking system (VTS)**

The VTS incorporates the use of a satellite transponder installed on board vessels required to use the system. The transponder automatically sends position information to a satellite which is then relayed to a shore based vendor. This information would be stored for dissemination by the vendor. Authorized users (NMFS, USCG) could access the information and accurately determine how many days a vessel actually was away from the dock. (A more complete description of this system can be found in Section 4.9.2.1).

The costs for the on board equipment and monthly message costs from the vessel to the satellite would be borne by vessel owner.

Costs to NMFS for the VTS would occur through data retrieval, storage, programming, and equipment costs (if it is necessary to purchase a VTS unit in order to allow access to the information). Costs could also increase through requirements to purchase proprietary software or deal with different systems if more than one vendor or system is chosen. Ideally, the costs should be just connect time on a vendor computer, the associated phone charges, and programming and storage costs on NMFS computers. This is different from developing a system to do the actual tracking. The VTS vendor already bears the costs associated with establishing the system, the hardware, satellite or satellite time, associated programming, personnel to staff their centers which receive the messages, and other related costs. Actual costs to NMFS can only be determined once a vendor or vendors are certified to provide the service.

**Magnetic-strip card system (Mag-card)**

The mag-card system would be utilized to monitor vessel movement in and out of port. After renewal of a valid Northeast multispecies permit, vessel owners would be issued a card containing a coded magnetic strip that is unique to the vessel. The card could be read by card readers placed in either common locations (auctions, dealers, unloading docks, etc.) or at the individual's home if a convenient location is not readily available. The readers would be purchased by individuals or associations and range in price from between $265 to over $500, determined by the quantity purchased. Card readers would be connected to a computer at NMFS through a telephone line which would record and verify the information encoded on the magnetic strip. The computer could initiate a call back to the reader to verify the actual location of the call. (A more complete description of this system can be found in Section 4.9.2.2).

The costs that NMFS would incur through the actual development and administration of the system and relate to the purchase of communications equipment to receive the transmissions from the readers, programming support necessary to set up the system, the cost of magnetic strip cards, storage, and the phone charges. It is estimated that up to 3000 vessels could be subject to this requirement. Other vessels could be exempted from effort control through either the 4500-hook, possession limit or vessel size exemptions.

Initial costs are summarized below:

Installation Costs

| | | |
|---|---|---|
| Magnetic Data Cards (single color, no graphics, with embossed and coded information) | 3,000 @ $0.25 each | $ 750 |
| Front End Microprocessor and communication boards | | $ 5,000 |
| Touchtone Interface Unit | | $ 500 |
| System Development and Technical Support | | $ 30,000 |
| ~~FTS "800" Telephone Service Installation~~ | | ~~$ 305~~ |
| Installation Total | | $ 36,555 |

Once implemented, there would be annual costs of providing communications access, additional cards or replacement cards. Issuance of the magnetic cards would be concurrent with the issuance of Federal Fisheries Permits and would be expected to add to the associated costs of permit issuance due to the increased time required for processing.

Recurring card and communication costs are summarized below:

Annual Recurring Costs

| | | |
|---|---|---|
| Magnetic Data Cards | 3,000 @ $0.25 each | $ 750 |
| FTS "800" Service ($70 / month x 12 months) | | $ 840 |
| Rotary "Hunt" Group ($25 / line / mon x 8 lines x 12 months) | | $ 2,400 |
| Random Verification Call ~~($0.15 / min. x 900 one min. calls / mo x 12 mos.)~~ | | ~~$ 1,620~~ |
| Recurring Total | | $ 5,610 |

The magnetic card would be of one color with embossed (raised) letters. The cost includes encoded information on the magnetic strip which meets specifications accepted as standard throughout the credit card industry. If a multicolored card was chosen, the cost could increase up to $2.00 per card.

Monitoring the information received from either the VTS or mag-card system would be similar. Ultimately the data received will reside on a NMFS computer with strict control on access. There is the likelihood that this could be done automatically with little intervention necessary. Where staff time is required is the compilation and dissemination of the information received. To administer this activity, it is estimated that 520 hours annual would be required. The estimated cost if this was performed by a GS-9 would be $9,318. The costs identified for system development and technical support also include the programming costs associated with the development of report programs.

**Notification - Preferred Alternative**

Under the preferred alternative vessel operators would be required to notify NMFS of when they would be taking their non-groundfish periods. This would increase from 80 days in the first year to a potential of 233 days in year 6. Assuming that vessel operators would elect to take the time in the minimum period of 20-days, this would require 4 to 11 notifications per vessel per year. If 3000 vessels fell under this requirement, the total number of notifications received would be 12,000 in the first year increasing to 33,000 in year 6. Processing of the notification requires opening the envelope, entering the information and filing the notification. It is estimated that this process will take two minutes per notification yielding a total burden to NMFS of between 400 to 1100 hours. At a GS-5 hourly rate of $11.82, this requirement could cost between $4,728 and $13,002. Additional costs are incurred for computer programming, storage costs and dissemination of the information for enforcement. Costs could be reduced through the use of the VTS or mag-card system to receive this type of information.

**Notification - Nonpreferred Alternative**

Under the nonpreferred alternative, months off of groundfish will be determined by the vessel's permit or documentation number. The months off can be determined ahead of time and notice provided to the vessel owners at the time of permit renewal. The costs associated with this alternative are nominal and result from programming and computer costs associated with changes to the permit system and storage of information.

**Mandatory Catch/Effort Monitoring of Vessels and Dealers**

Landings information is collected through voluntary dealer submission and effort information is collected from vessel operators through personal interviews. Several fisheries (Atlantic surf clam / ocean quahog, Atlantic bluefin tuna, swordfish, and summer flounder) require submission of reports by dealers or vessels or both.

The inclusion of the multispecies fishery under a mandatory data reporting system will increase the amount of information being collected. For 1990, there were approximately 66,000 trips from which multispecies finfish were landed out of a total of 105,000 trips. Many of these trips were aggregated for vessels in the undertonnage category or for unknown vessels. Requiring all vessels and dealers landing multispecies to report is estimated to increase the total to 200,000 records.

NMFS is in the process of developing a comprehensive data collection system to support information requirements for all fisheries in the northeast. NMFS has examined the necessary requirements for successful implementation of a universal mandatory reporting system for both vessels and dealers in the northeast. Key features of the system include reporting by all segments on the fishery include charter/party vessels, encouragement of electronic data submission and the capability to receive this data, report submission every two weeks, and consistent audits of the information received.

Preliminary costs have been estimated by NMFS but apply to total costs rather than fishery specific costs. Groundfish trips currently account for 63% of the total number of trips recorded. Applying this figure to the total estimated costs would yield the prorated costs of implementation under Amendment 5.

The administrative cost of a mandatory reporting system is comprised of the following components: printing costs for the report forms, mailing costs, labor costs in processing them, capital costs associated with computer purchasing, equipment and data storage.

The following summarizes the start-up costs estimated for the proposed mandatory data reporting system associated with Amendment 5.

Start up

| | |
|---|---|
| System development | $ 65,220 |
| Equipment | |
| Computer | $ 11,340 |
| File cabinets | $ 3,780 |
| FTS 800 lines | $ 447 |
| Data Communication | $ 9,450 |
| ~~Other~~ | ~~$ 6,300~~ |
| Total | $ 96,537 |

Annual recurring costs have been estimated for two options showing different percentages of data submitted by paper or electronically.

Annual

| | ~~100% Paper~~ | ~~50% Electronic~~ |
|---|---|---|
| Salaries | $270,298 | $231,126 |
| Contract | $ 85,297 | $ 42,648 |
| FTS 800 lines | $ 1,058 | $ 1,058 |
| Phone line hunt groups | $ 378 | $ 567 |
| Travel | $ 12,600 | $ 12,600 |
| Printing | $ 19,883 | $ 9,941 |
| ~~Mailing~~ | ~~$ 12,600~~ | ~~$ 7,702~~ |
| Total | $402,114 | $305,642 |

One of the ways to streamline the current data collection process is through the encouragement of electronic data submission. Electronic submission could occur through several means. Dealers or vessels that have the capability could transmit data, in a specified format, to NMFS utilizing a personal computer (PC) equipped with a modem. Vessels with VTS could submit reports through the VTS if the VTS has messaging capability. There has been recent releases of PC software that allow FAX transmission with the data being automatically entered into a PC computer file. "800" numbers would be established to facilitate transmission at little or no cost for dealers and vessels using electronic means.

Report submission by both vessels and dealers would be every two weeks for all trips or purchases that occurred during the period. If quota monitoring is required, the frequency of reporting of just the quota information could be more frequent.

Inherent in the success of a mandatory data reporting system is a systematic audit of the information received. Data must be complete and accurate. Double reporting by vessels and dealers is one way of providing a cross check. Other means of achieving compliance with a mandatory reporting requirement is through the permitting of dealers and vessels. Submission of the required reports could be a specific permit condition and failure to meet this condition could prevent a permit from being reissued. To determine if reports are missing, negative reports are necessary for those periods when the vessel did not fish or the dealer did not purchase. Consistent and timely audits will identify mistakes more quickly allowing for corrections to be made before they occur again.

More information on the mandatory data reporting system will be forthcoming as development proceeds.

#### E.7.2.4.3 Enforcement

NMFS Office of Enforcement expended approximately 7266 manhours in multispecies enforcement during FY 1992. This equates to roughly $180,000 in salary costs. However, the overhead associated with this program would include vehicle, telecommunications, computer and vessel patrol costs as well as State/Federal training and cooperative efforts costs. The costs for enforcement of the proposed plan could easily approach $450,000 when all operational costs are figured into the plan requirements, but it is impossible to breakdown the costs of enforcing individual measures cannot be calculated, especially when enforcement resources are shred among several management plans. A total of $60,517 was seized and represents the value of the seized property confiscated from this fishery.(Terrill, pers. comm.)

The NOAA Reauthorization Act of 1992 enables the Secretary of Commerce to enter into cooperative agreements with individual states to enforce the Multispecies FMP, and requires that fines collected for violations of the groundfish plan be used for enforcement. (see section E.5.2.3.1, Recent Legislative Action.) These measures should help to reduce overall enforcement costs, but the combined effect of these factors interacting with the proposed action cannot be quantified.

## E.7.3 SOCIAL IMPACTS OF PROPOSED ACTIONE.7.3 SOCIAL IMPACTS OF PROPOSED ACTION

### E.7.3.1 Impacts on individuals, family, and communities

**Introduction to the social impacts assessment**

The purpose of the social impact analysis is to provide the public and managers with systematic information concerning the relative social benefits and costs of proposed alternatives relative to taking no action. While the economic analysis, contained in Appendix IV, describes projected impacts of the action on resource supply and demand, prices, individual and fleet revenues, and employment, this social impact assessment describes the changes that might occur in the social relationships between persons and / or groups, within the communities, and within broader regional social systems resulting from the proposed action relative to taking no action.

NMFS has issued guidelines on how this assessment should be conducted (~~Operational Guidelines~~, 1992, Appendix 2.g.). Four variables are identified as being essential to such an analysis: demographic characteristics, fishery related services and employment factors, the costs (services) and benefits (tax revenues) to local jurisdictions, and the non-economic social and cultural aspects. The first three variables are discussed in other sections of this document (except that local tax information was not presented). This section examines, to the extent that the data permits, the impacts on lifestyles, family and community relationships.

The lack of consistent, long-term, systematic data collection, particularly on the small-scale fleet, severely hampers the assessment of the potential impacts of Amendment 5. Mid-range and small vessels, especially those that fish days and are opportunistic (switching gear and species as the season, availability, and inclination dictate), are particularly under-represented in the collection of statistics on catch and earnings. Sociological and cultural data is even more broadly uncollected than fishery statistics.

For the purposes of establishing a baseline, and for projecting the impacts in this section, the primary data source is interviews with fishermen and others familiar with the industry. Consequently, the analysis focuses largely on fishermen's perceptions of the management process and its ability to successfully manage the resource. The fishermen's perspective is an important consideration in management, due in part to the voluntary compliance that is needed for the management program to be successful.

This lack of systematic data was pointed out by Peterson and Smith in their report, *Small-Scale Commercial Fishing in Southern New England* (Woods Hole Oceanographic

Institution Technical Report, August 1981), but little has been done in the last ten years to remedy this situation. Interviews for this assessment have included some of the under-60-feet vessels that fish days, but should not be construed as truly representative of the group. Information on the impacts on the large vessels is also biased, emphasizing the views of owner-operators and fishing organizations' representatives.

Many fishermen disagree with the catch and economic projections included in this document, and they genuinely fear that the proposed measures threaten the financial survival of today's fishermen. At least two possible conclusions are evident about the social impacts of the proposed action: first, the social and economic changes resulting from the effort reduction program will be substantial; and, second, because the effort reduction program would substantially change the way the fishery is managed, the program will probably redistribute benefits among vessels of different sizes, from different ports and which catch a different mix of species. The extent of this redistribution, and in what directions, cannot be determined and is the subject of considerable debate.

The socio-cultural impacts of Amendment 5 will not be uniform across the region, across vessel sizes or even across gear types. Nor will the impacts be the same for each community, each generation of fishermen, each ethnic group, and each organization. It is partly this certainty—that the impacts will vary—that creates anxiety among all who are involved in the fishing industry. Anxiety about the likely impacts dominates the conversation and thoughts of fishermen as the Council struggles to cut back fishing effort among the disparate elements of the industry.

**Fishermen's perceptions and the effect on management programs**

The effectiveness of any management system depends not only on whether or not the regulations are based on accurate information and proper scientific analysis, but on whether or not the industry complies with the regulations. In fisheries management, compliance with regulations relies to some extent on voluntary compliance because of the difficulty of enforcing regulations at sea.

Decisions about compliance, however, are also affected by a perception of what the impacts of that compliance will be on an individual's ability to make a living or survive financially. The uncertainty about what the impacts will be at an individual level, both in the short term and the long term, causes many fishermen to be extremely negative about the impacts of the proposed fisheries management measures.

The bioeconomic analysis of the proposed measures, contained in Appendix IV, predicts a gradual recuperation of stocks and an initial dip and gradual recuperation in revenues and profits in comparison to taking no action. Long-term bioeconomic benefits (ten years and beyond) of the proposed action greatly exceed the impacts of no-action alternative. The financial projections indicate total revenues are slightly buoyed during the first five years (in comparison to the catch streams) due to higher fish prices. Otter trawl revenues surpass the no-action alternative before five years, gillnet revenues surpass the no-action alternative in six years.

If effort is cut by 50 percent, some scientists argue, the stocks would rebound and landings and catch rates would increase. For a variety of reasons, including scientists' earlier mistakes in predicting some stock sizes (e.g., herring), and past experience with regulatory change (e.g., groundfish quotas in the 1970's), many fishermen do not believe that these new regulations will have the positive benefits predicted. In particular, fishermen question the prediction that total revenues will increase despite lower landings. Many fishermen simply do not believe that prices will increase sufficiently to counteract the losses in landings, citing both the effect of imports on prices and he consumers' willingness to pay a higher price for some species. Fishermen's fears about the impact of the proposed measures could lead to a greater degree of non-compliance with regulations and/or technological innovations which, in turn, could compromise the plan's effectiveness, slowing stock recovery.

Other fishermen believe that, while the effects of the plan may be beneficial in the long run, in the short term their own financial stability is generally viewed as precarious and likely to fail. To the extent that success of a management program is affected by fishermen's perceptions of what the effect of the proposed regulations will be on their lives and businesses, this section, assessing the socio-cultural impacts, includes discussion of the fishermen's points of view.

**Impacts on the "way of life"**

"We will be in the hole, out of business, ruined," fishermen say. Indeed, it is inevitable that some fishermen will be bankrupted by the efforts being made to control fishing for the long-term health of the industry. Bankruptcy *per se*, however, is not unknown in the industry. Business failures are common at every step from the vessel to the retail market. The nature of the business: cyclical supplies, perishable product, multitudes of independent entrepreneurs exploiting their own niche, consumers' fancy, even the vagaries of weather affect the success of the various businesses.

Fishermen can face the constraints and hardships imposed by the nature of their business with equanimity as long as they feel free to work hard to overcome the challenges. "Independence" and "freedom" are two of the most frequently mentioned attributes of fishing that make it a satisfying occupation even though fishing is a highly regulated industry influenced by a number of external factors outside of fishermen's control. Financial rewards are also frequently cited by fishermen explaining what initially attracted them, but it is the "way of life" that seems to keep men fishing despite long hours of hard, sometimes dangerous, physical labor and today's uncertain financial reward. Fishing is also one of only a few employment alternatives available in some communities.[18]

The "way of life" is what many fear is threatened by management under Amendment 5. Just how to characterize what constitutes the beloved "way of life", and how it is threatened is not easy. The desire to preserve a way of life does not necessarily mean that fishermen are wedded to the technology or fishing style of a single point in time, despite a "conservative" reputation, since fishermen as a group are remarkably adaptable. The old dory fishermen handling hooks on a line off wooden sailing vessels have given way to fishermen towing or hauling nets of synthetic fibers with hydraulics and high-tech electronics on diesel-powered, steel-hulled vessels. Changes in equipment, in target species, in markets, and in costs have all been faced by individual fishermen with varying degrees of success. Nevertheless, some aspects of fishermen's lives and jobs have not changed a great deal over time.

The independence and freedom fishermen speak of is both physical and abstract. Anyone who has stood on a deck of a boat, dwarfed by the enormity of the surrounding waters and sky, blown by the unseen wind, can (on a good day) with the barest glimmer of imagination sense the promise of freedom offered by working at sea. The independence and freedom of an owner-captain to decide when, where, how and for what to fish is replicated by the freedom of crew to choose to go out or not on a given trip and/or to seek a different site, perhaps one higher in the hierarchy (e.g., "per man") or one on a highliner vessel. Captains and crew talk about the "mystique", "magic" and "joy" of fishing.

Fishing can be characterized as the epitome of the American Dream. Immigrants, youth with drive and ambition but lacking in academic skills, and other individuals unable to conform to land-based jobs have sought opportunities at sea, and many have had great success. Others, if not high-achievers, have nevertheless been able to provide for themselves and their families with pride. Not everyone achieves the status of captain-owner, but many relish the potential. Furthermore, all have retained the freedom to experiment with different types of fishing, including different gear, different species, different locations, different trip lengths and different degrees of devotion to fishing.

Despite the hierarchical patterns inherent in the fishing community, notable, for

[18] Lack of formal education and limited experience in other occupations as factors preventing employment in alternative occupations were noted by Peterson and Pollnac in the chapter in Doeringer, et. al. 1986.

example, in the competition to become high-liners and in the organization of crews (captain, "per men", deckhands), there is a strong egalitarian ethic that everyone should have an equal opportunity to catch fish. In fact, this egalitarian ethic promotes a general sense that the range of landings and/or income should be relatively stable among vessels of the same class. The value placed on equity could explain why there are often demands by some fishermen for restrictions on innovative gear such as pair trawling or "rock-hoppers" that results in major imbalances among vessels' landings. This position, however, stands in pronounced contrast to the value placed on individual opportunity, and the freedom to choose where and when to fish and how much to catch with whatever technology is available.

A number of the proposed management regulations, including the moratorium, the individual days at sea and the quota (non-preferred alternative), appear to fishermen to limit the equal opportunity, threatening, thereby, the "way of life". The Council has chosen to propose the current version of the preferred alternative, in part because it allocates opportunity equally, and it has done so in full awareness of the fact that the choice is made at the expense of flexibility and individual opportunity.

Besides freedom, independence, equal opportunity and the potential to rise in status and position through one's own efforts, another component of fishing as "a way of life" is a sense of community, connecting all fishermen and their families to others in the industry. Although fishermen are in competition with each other and despite serious gear conflicts, fishermen have much in common. In discussions over coffee before heading out, socializing at family or town celebrations, fishermen generally find common ground with each other. Furthermore, a common danger unites everyone, and even the fiercest competitors will help tow disabled vessels or loan a pump or otherwise aid a fellow fisherman.

Despite many changes in the industry over the years, sons (and occasionally daughters) often follow their fathers' lead, continuing a family tradition of fishing. Families of fishermen, particularly in the Italian and Portuguese communities, frequently rely on each other for help or moral support when their relatives are at sea. The family fishing business, characteristic of many rural or ethnic communities, provides employment, income and security for an network of individuals extending well beyond the immediate family of the owner.

Until now, the multispecies plan's regulations have only slowly encroached on a captain's freedom to choose. The concept of optimum yield which is the foundation of domestic fisheries management requires the consideration of social values, even to the extent that they may modify some optimal biological harvest level. The current management strategy, using closed areas, minimum fish sizes and mesh size restrictions, has placed boundaries around the decisions about where to go, what to catch and how, but has not been generally perceived as threatening basic social or cultural values. Though fishermen have complained about regulations, for the most part they have acquiesced and learned to accommodate to them, or, in some cases, to work around them. The regulations have allowed diversity in the fisheries to continue.

Adjustment to the new package of regulations is likely to be more difficult primarily because of serious financial fears associated with the plan, but also because of the limits on "wiggle room." The restrictions are perceived as more "cut and dried" than in the past, with less potential for bending or circumventing the regulations. Furthermore, the fishermen are hemmed in by regulations limiting access to alternative fisheries.

On the other hand, managers point out that fishermen retain a lot of freedom. They can choose when to take their blocks of time off and, when fishing, they can catch as much as possible, within the bounds of the mesh and minimum size parameters.

**Becoming "just another job"**

Many fishermen view the changes coming out of Amendment #5 as not so gradual as, and more fundamental than is being presented. The package as a whole is what frightens some fishermen. Beyond the question of economic survival is a very fundamental fear that fishing will be ruined by the confusion engendered by the complexity and proliferation of the multiple regulations. A number of men proclaimed that they chose fishing in part because they wanted to "get away from it all." "It" being the complexity of life ashore.

Some of the regulations contained in Amendment 5, such as the moratorium, are perceived as limiting the opportunities for the next generation to enter the fisheries or to achieve a higher position in the hierarchy, a perception that may not be borne out in reality since individuals are not prevented from entering or leaving the fishery, and since there is an excess of fishing potential (numbers of vessels) already permitted. Other regulations, such as the time-at-sea limitations, may have serious economic consequences in the short term. Managers point out that if the regulations succeed, however, the economic consequences may not be severe in the short run and in the long run, will improve revenues while preserving the fisheries for future generations as well.

While gradual implementation of effort reductions (10 percent per year) will more likely postpone the most severe economic consequences (e.g. bankruptcy) than larger initial reductions, they will also delay the accumulation of benefits (i.e. stock rebuilding and improved catch rates). The Council adopted the proposed effort reduction schedule as striking the most optimal balance between the need to rebuild the stocks and the industry's ability to survive effort reductions.

A vessel owner's ability to survive economically depends on the individual vessel's economic performance, it's ability to adapt to changing circumstances, and the owner's financial position. For example, vessels that have experienced mechanical problems, straining the financial resources of their owners, may be in a more vulnerable position. Those who are already marginally successful are more likely to fail once cuts are implemented than those whose financial position will enable them to absorb the reductions in revenues or to balance those reductions with reductions in costs.

Many fishermen say that they would certainly accept and abide by the regulations if they did not have to worry about their vessel mortgages, especially since homes are often used as collateral. Many argue that the government should pick up their mortgage payments, pointing to Canadian welfare payments during the two-year moratorium on cod fishing as an example of a government valuing their fisheries enough to try to rebuild stocks, while protecting fishermen. Other precedents cited include compensation paid to coal miners when the Clean Air Act was implemented. The Council cannot legislate such compensation, although some forms of assistance have been considered in Congress (see section E.5.2.3.1).

If operator ownership becomes lost to corporate or bank ownership, a large measure of freedom and independence will have been lost. Judging from consequences of such ownership in other fisheries (e.g., surf clams-see Hall-Arber, 1992), crew members will also feel the impacts, in some cases losing their jobs, in others being paid a wage lower than their current (average) share or a lower proportion of the proceeds (share) than they currently receive.

In New England, neither banks nor large corporations appear eager to jump into ownership of fishing vessels; although, some banks are recently investigating ways to secure rights to permits of foreclosed vessels. Such consolidation scenarios as those that occurred in other fisheries may be unlikely in the New England groundfish fisheries due to the way the fresh fish market is organized. Changes in tax laws have reduced the incentive for non-participants to invest in fishing vessels. Additionally, the economic failure of one fishing operation represents the opportunity for another fisherman to access the fishery by purchasing the permitted boat.

If bankruptcy rates increase as a result of the proposed action, some communities are likely to face a disproportionate share of business failures. For example, Gloucester which has a larger percentage of medium-sized vessels dependent on groundfishing than does New Bedford, is more likely to be negatively impacted by an increase in the number of individual business failures. The mid-size vessels may be at greater risk than either the large vessels that can switch to high-volume, low-value fisheries, or the small vessels that have lower operational costs and a wider range of small-niche fisheries to explore and exploit. On the other hand, if the short-term benefits exceed projections, communities such as Gloucester will benefit to a proportionally greater degree than those which have less of a dependence on groundfishing.

Rural communities, though there are fewer alternative job opportunities, have a higher proportion of small vessels with lower costs and greater flexibility. These communities have historically been very adaptable in their exploitation of the diversity of species available inshore. Inshore competition may increase, however, if the offshore vessels start fishing inshore to save steaming time.

History warns that the inshore areas can not long support the extremely efficient trawlers built for offshore waters. One fisherman pointed out that the large company boats, such as the O'Hara fleet, when forced by the drawing of the Hague line to fish closer to Maine, contributed to today's "hard times" for draggers in the Gulf of Maine. Fishermen claim an inverse correlation between the arrival and subsequent demise of the company boats and their catch rates.

**Alternatives vary by community and individual's background**

When effort is cut, there will be a surplus of labor. Geography plays an important role in determining the extent to which a community has alternative employment opportunities for their fishermen. The physical characteristics of a region, its population distribution and transportation networks, and other geographical factors which were instrumental in the evolution of a community's character will also determine the impacts of the changes resulting from Amendment #5.

The convolutions of Maine's coastline make industries dependent on road accessibility impractical. Many of the local economies have relied on renewable resources, fish or trees, to generate economic activity. Tourism, a seasonal industry that draws people because of the marine character and remoteness of the coastal communities, is in many parts of coastal Maine the only major employer outside the fishing industry. Jobs in tourism, a very social industry, are often not viable alternatives for fishermen, since fishing is a relatively solitary occupation, requiring limited social skills.

Geography also affects Gloucester's options. Accessible only from the south, built on granite, reliant on surface water and with sewage capacity problems, the diversity of Gloucester's industrial base has been limited. The geography of Cape Ann, where Gloucester is located, can be inferred from the region's economic history which has been based primarily on rock quarries (now closed), fishing, and tourism.

Of the three ports considered in the port profiles, only New Bedford is relatively unconstrained by geography. The city is located along one of the major transportation corridors in the Boston-Washington network. New Bedford's harbor has endowed the city with a long tradition in maritime industries including fishing, whaling, and commerce. New Bedford also benefitted from the growth of manufacturing during the industrial revolution which brought wealth to the city and many surrounding communities. In addition to having a strong yankee tradition, the city's link to the sea, combined with it's industrial base has enabled New Bedford to be the home for many immigrants and first generation citizens. Other factors, however, such as a poor and less-educated population, a now-polluted harbor, rising debt burden and a manufacturing sector hard hit by recession, may limit New Bedford's future ability to readily absorb further economic dislocation in the fishing industry (whether brought about by stock collapse or management).

The socio-cultural impacts of the proposed action on the communities is closely linked with the bioeconomic impacts at the individual vessel level and fleetwide. Communities will respond to the proposed management action in proportion to the economic impacts that result. In turn, the manifestation of economic impacts at the community level will be partly a reflection of the cultural framework of the system and how each community adapts to the changes.

The range of alternative employment available to most fishermen is limited by the average fishermen's lack of formal education. This lack of education crosscuts communities, but is even more pronounced in the communities of recent immigrants, principally Italian and Portuguese, in Gloucester and New Bedford. The skills that fishermen develop in order to master their trade (such as navigation, boat-handling, twine and net work, and a keen sense of where the fish are and when) are not readily adaptable to shoreside occupations. Opportunities in other maritime sectors (coastwise or deep-sea shipping, scientific research and offshore oil development) are extremely limited, especially in New England.

In addition, incomes of fishermen tend to be higher than what they would likely be in equivalent shoreside jobs. This is especially true in New Bedford where unemployment is high and where per capita income is low (relative to the rest of Massachusetts). In all three communities described in the port profiles, fishermen usually considered themselves in the middle to upper-middle class compared with others in their town. Retraining programs, such as those proposed in recent federal legislation, could alleviate some of the displacement problems that might result from reduced fishing employment opportunities, provided other employment opportunities exist for which displaced fishermen could be trained.

In all of the communities where fishing plays an important role, indirect employment, in addition to direct employment, is threatened by the reductions in effort. Fishing is supported by a whole range of services ranging from providers of fuel, ice, bait, food and equipment, to repair services, lumpers (people who unload fish from the boat) and transporters of fish, marketers and processors, insurers and settlement houses. Equipment companies alone provide employment to a whole range of people from high-tech electronics engineers to factory workers constructing fish boxes. Income multipliers vary considerably among different communities.

To the extent that fishermen are able to explore and develop fisheries other than groundfish in the short term, support industries will benefit, such as suppliers of different gear and innovative technology. The projected long-term benefits for the fishing industry under the proposed action will precipitate to the supporting industries and services, resulting in significantly more robust local economies than currently exist or are projected under the no-action alternative.

The extent of negative impacts on support industries will depend on how swiftly the stocks rebound, how diversified the companies are and what their individual economic position is. The current condition of the fishery has already brought many of these support services to or over the edge of solvency. The uncertainty in demand for gear and services decreases the ability of support industries, including fish processors, to engage in long-term planning and may make employment less consistent and the labor force more transient.

Traditionally, the fishing industry has served as a relatively stable sector for many communities experiencing economic difficulties in other sectors. The general economic recession, however, has reduced the industrial base of many communities, further limiting alternative employment. Unless alternative fisheries are developed, effort reductions in groundfish will cause labor to exit the fishery at a time when other sectors of the local economies also have a surplus of labor. In the past, fishing has absorbed short-term labor surpluses in many communities. All three profiled communities, New Bedford, Gloucester, and Stonington, have lost major employers in the past two years. (See port profiles for examples.)

If some vessel owners fail to make their mortgages and lose their boats, rural communities like Stonington, Maine, whose economic base depends to a great extent on fishing, will have a more difficult adjustment than urban communities with a more diverse industrial base. Fishing-dependent communities, however, will vary in their ability to adapt to the proposed action. Stonington may be more able to survive the short-term reduction in groundfish revenues since that community also depends on other fisheries or related industries (aquaculture, urchins, lobsters) than a community such as Gloucester, which does not have as wide a range of developed fisheries

For the many businesses which survive the initial reductions in revenues and benefit from the recovery of the stocks, the long-term benefit would be shared by their communities in proportion to their economic dependence on fishing. Thus, the community of Gloucester would probably realize a proportionally greater benefit from the long-term recovery of groundfish stocks than, say, New Bedford which fishes on a much wider range of species (scallops, small-mesh species, swordfish, etc.). The degree to which cultural or social change may result from the proposed action is linked to the ability of each community to adapt to the economic changes which will occur when the regulations are imposed.

**Impacts on community organization**

Fishermen say that they will do whatever they must to keep from failing and losing everything they have worked for. If fishermen must move to different fishing grounds, change gear, seek different species, they are willing to do so if it appears that by so doing, they can make a living. This flexibility is characteristic of the small boat fleets and has contributed to their survival. The largest vessels have limited options vis a vis gear or species changes because their high fixed costs limit them to catches with high revenue production. In addition, moratoria in other fisheries may constrain switching. To the extent that vessels must leave their base community in search of more profitable fishing areas markets, communities will be disrupted.

Moving home ports might also be difficult, since extended family networks are considered essential to many fishermen's wives. Again, this is particularly true for the Italian and Portuguese wives, but networks of fishing families are important to all. As discussed above, the community connection is also important to the sense of fishing "as a way of life."

Until recently, most fishermen have been reluctant to report violations by others in their community. This is particularly true within the Italian and Portuguese fishing communities where blood ties, religious ties, language and in some cases, the experience of being immigrants, knits together communities otherwise characterized by high levels of competition. In the face of potential economic failure, however, there are indications that more pressure may be brought to bear on the outlaws to conform with regulations and reports of violations may increase. Fishermen's involvement in enforcement could have positive benefits by increasing levels of compliance, but could also produce negative social impacts by dividing communities. Suspicion and dissension could replace trust and unity in the community.

Community cohesiveness is apparently a weaker force than ethnicity. In communities where one ethnic group dominates, there is evidence of a lack of positive interaction among fishermen of different backgrounds. Individuals who do not belong to the dominant group sometimes indicate unfair treatment due to their "outsider" status. The impact of a restrictive management system, or of economic hardship brought about by declining stocks will likely magnify this condition, further polarizing groups within individual communities. The divisiveness could be exacerbated by members of one group only reporting violations by fishermen from ethnic groups other than their own.

**Impacts on the role of fishermen's organizations**

The organizations may be faced with greater demands for help, for example, fishermen may request their organizations to play a greater role in promotion of seafood to help increase demand (and prices). The organizations may also have to provide more social services for those who have lost sites or vessels.

**Impacts of specific measures**

It is the whole package of regulations that will have major socio-cultural impacts. As discussed above, the extent of impacts will largely depend on whether or not a most of the owner-operators can survive financially to continue the "traditional way of life" and whether they can cope with the host of regulations. Though economists may correctly project a short-term financial burden that will be overcome by long-term financial benefits, the long term socio-cultural recovery and benefits will depend on how drastic the short term impacts are.

The impacts of the broader measures (the moratorium and effort reductions) are assessed here, in the context of the individual values and community dependence on fishing for groundfish described in section E.6.4.3.1. There is insufficient data to draw conclusions about the social and cultural impacts of specific measures. Fishermen's perceptions will certainly influence the way the changing management system will impact them, but those perceptions are not necessarily the determinant factor. In many cases the social impact will depend on the bioeconomic impact of a particular measure, such as the impact of increasing mesh size, which is uncertain at this time (what will the catch composition and catch rates be like with 6-inch mesh?). Fishermen's views on mesh increases, for example, are based on what they perceive the change will do to their income, not that the measure itself holds some socially or culturally undesirable characteristic.

**Impacts of the no-action alternative**

Though communities and fishing-related industries are worried about the potential impacts of the new groundfish regulations, there is often a recognition that it is not simply the new rules that are (or will be) the cause of the fishing industry's problems. Most interviewed note that "something has to be done" to help the industry because of the downturn in groundfish landings.

Fishermen talk with awe about the large size of catches ten or fifteen years ago and with discouragement about the length of time necessary to "make a trip," i.e., cover costs, now. Opinion varies as to how poorly the stocks are currently faring. Some say that scientists' techniques are not appropriate and results unbelievable (referring to a "herring assessment"). Others point to the fishermen's perception of fewer fish as due to the larger mesh sizes that result in smaller catches. Nevertheless, despite the skepticism about the scientific assessments, most fishermen agree that the stocks are not in good shape.

Some fishermen believe that there are factors other than fishing whose impacts have not been wholly acknowledged, factors such as pollution, acid rain, toxic dumping, habitat degradation and disruption of nearshore nursery grounds. Regardless of what is responsible for the stocks' condition, without new regulations (and their enforcement), pressure on the stocks would certainly continue with consequent decrease in catches, leading to business failures and bankruptcies. Some consolidation of crews has already begun with most boats fishing "short" a man or two. One fisherman pointed out that in the 1970's his dragger had a five-man crew, including the skipper, but is now down to two. A change to day-fishing from trip-fishing is partly responsible for the decrease in his catch and, consequently, crew size, but he does admit that there has been a clear, if gradual fall in his catch since the 1970's.

A number of fishermen with 30-40 years of experience, did note that stock abundance is cyclical and that downtrends are not unusual. What strikes some of these men as significantly different is that the changes in gear and electronics allow fishermen to fish in spots that may previously have been "regrouping" areas or safe habitat for various species, particularly the hard-bottom (rocky) areas. "There are no hiding places anymore," is a common refrain.

**Moratorium**

Two distinct opinions exist on the subject of moratoria. One side favors a moratorium since it will, in some ways, protect those fishermen who are being forced to limit their effort from additional effort entering the fishery as the stocks begin to rebound. This view is shared by many fishermen and managers alike.

Another side, however, opposes moratorium for a variety of reasons. Many people in the fishing communities feel strongly that a viable fishery depends on the availability of permits to young fishermen. Without a perceived opportunity for advancement, some fishermen fear that it will be more difficult to hire reliable and skilled crew. (The perception may be unfounded, however, since individuals are not prevented from entering or leaving the fishery.) This may be a philosophical problem, a reflection of the egalitarian ethic mentioned earlier, rather than an actual one, however, since the displacement of effort resulting from the regulations, will release some experienced crew to the marketplace and make some permitted vessels available for new owners.

In all ports, the moratorium is perceived as limiting opportunity for those who do not already own a vessel. For the recent immigrants in Gloucester and New Bedford, this may be perceived as the loss of a part of the American dream and the fishing "way of life". However, managers argue that in fact, the moratorium is not really a very restrictive measure. Currently, for example, only a fraction of the existing groundfish permits are actually used. The cost of buying a permitted vessel would reflect its value, so that while there is a surplus of permitted vessels and landings relatively low, the cost of entering the fishery will be relatively low. If the permit becomes intrinsically more valuable due to improved stock conditions, the economic benefit would accrue to the seller of the permit - namely, the current participant in the fishery who is retiring or leaving the fishery for other reasons. The moratorium as currently proposed is not a permanent limited entry system, although some people have opposed it on the grounds that it is the first step to privatizing a public resource.

The proliferation of moratoria in various fisheries could limit the fishermen's flexibility, a serious economic and psychological impediment to those who traditionally shift gear and species depending on season, weather, market conditions and personal circumstances. Rural communities such as Stonington, Maine, may be hardest hit by the moratoria, since it is the small ports that harbor the majority of the "opportunistic" fishermen. Fishermen might not be willing to sell the permits they are not currently using in order to keep their options open. A shortage of available permitted vessels could then drive the prices up, provided there are stocks to justify paying a higher price for a permit.

**Effort Reduction**

The ultimate 50 percent reduction in fishing opportunity frightens most fishermen because they do not believe that stock rebuilding and or price increases will occur fast enough to allow them to survive economically. Part of the reason for their doubt is that many believe enforcement will not be strict enough to ensure compliance and therefore, recovery. Some fishermen mention other impediments to recovery such as the impacts of pollution, habitat destruction and changes in water temperature. These factors may contribute to the stock conditions, but scientists generally concur that overfishing is the greatest problem.

If stocks rebound very swiftly, the negative socio-cultural impacts will naturally be cushioned. However, the effects of effort reduction in the long- and short-term will be determined largely by economics. If ex-vessel fish prices go up because of the shortage of product, more vessels may be able to survive. The less economic disruption there is, the less likely there is to be negative social or cultural change. Fishermen fear that imports will fill the market void created by reduced domestic landings in the short term, and the long-term benefits (economic and social) will be compromised.

Boats with low cash expenses are generally in a better position than vessels with heavy outstanding mortgages. The vessels with skilled crew and up-to-date electronics may have sufficient capability to maximize the return on their effort. Vessel-owners with other sources of capital may also be reasonably secure. Multiple vessel ownership or vertical integration are not common; most company boats left the fisheries after the Hague Line was drawn.

Vessels that can cut costs may have a better chance of surviving as well. Individual owners have various options: some, for example, will lay off crew, though informants observe that crews are already down to a bare minimum. Where crews are less likely to be reduced because of family connections, such as in Gloucester's Italian fleet and New Bedford's Portuguese fleet, wages or profits may be reduced.

Although some fishermen fear that short-term cost reductions may be taken by lowering maintenance standards with concomitant safety repercussions, others argue that maintenance may actually improve. With the forced layovers, there will be more time to maintain the vessels, and underemployed labor available to do the work, particularly in the communities which operate under a kinship system. Good fishermen generally agree that it is cheaper to maintain equipment than to replace it.

**Blocks of time and layovers**

During the development of the proposed management measures, thirty-day blocks out of the groundfish fishery were considered too long because many expenses are due monthly. The four twenty-day blocks "out" in the first year could be workable for many draggers, partly depending on market conditions and weather.

That non-groundfish species can be caught during the "time out" is considered a mitigating factor, but some fear that the market will be flooded with underutilized species (traditionally a "soft" market), so that the prices will be too low to pay expenses, much less compensate for the lack of groundfish days. In addition, those already fishing for underutilized species want their hard-earned market niche to be protected. Government help to open up new markets is urged, and has been the subject of recent federal legislation (see section E.5.3.2.1).[19]

[19] As Dewar (1983) pointed out, gear is always hazardous, but storms increase the risk–lurching boats and slipping gear can knock a man overboard or cut off fingers, arms and legs. Icing and stormy seas make a boat top-heavy or damage it. As

Inshore fishermen are concerned that the large off-shore vessels will start fishing closer to shore to avoid wasting potential fishing days in steaming to Georges Banks. Indeed, at least one Gloucester fisherman with a 90-foot vessel mentioned that he is seriously considering giving up trips for a day-boat operation. One man said, "The large boats will fire two guys and do the day boat routine." If diversity in size and operation is valuable to the New England fisheries, the Council may have to ban large vessels from relatively nearshore areas not already restricted by state regulations. A non-preferred alternative to prohibit night fishing by mobile gear vessels within 12 miles of shore may help to alleviate this potential problem.[20]

Some fishermen claim that forced layovers and notice periods will force them to go out in rougher weather than they normally would. This is an extremely serious safety issue as it is believed by many that boats have been lost when they pushed the weather window due to such management controls as opening and closing areas. On the other hand, others argue that declining stock conditions cause individuals to take greater risks and also precipitate more restrictive management measures (see sections E.6.4.3.4 and E.7.3.4 for discussion of safety aspects). The Council implicitly and explicitly considered the safety consequences in developing the proposed management measures.

There is a positive side to the forced layover days for fishing families, offering families of crew a little more certainty in scheduling. Under the current system, family members rarely know in advance how long the vessel will remain in dock between trips.

How the effort reduction system will affect the communities depends largely on whether the vessel-owners opt for tying-up the boat, or for trying for other species or using alternative gear. Some fishermen's wives express a concern about too much forced leisure, with insufficient funds to use the time enjoyably or constructively, which could lead to increased alcoholism and other problems. Whether or not the availability of leisure time will cause an increase in social problems or promote closer family relationships, social service agencies are already limited by financial constraints

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landings decrease during stormy weather, prices increase, so some captains try to fish during foul weather (Dewar, 1983:38). In the early 1960s fishermen suffered more injuries on the job than any other group except coal miners.

[20] Doeringer et al. (1986:31) point out that "groundfish quotas implemented by the council caused many offshore fishermen to move into areas close to shore once the quotas were met beyond three miles from the coast, thereby interfering with the inshore catch."

on what they can do, and increased needs could only exacerbate their abilities to provide adequate service.

The impact of the layover-day system and time out of groundfishing on other community services such as public dock space cannot be predicted. The lack of dock space and security could become a problem if more vessels are required to tie up than the capacity of the port.

There is not sufficient information to predict what percent of vessels will tie-up versus seek alternative species or gear. Fishermen do not seem to know yet what will work best for their own financial situation. There are certainly some fishermen who will fish on any species they can, regardless of whether or not their financial needs demand it, while others claim that they would enjoy some time off (and out of danger) if the financial outcome was the same.

**Individual allocations**

The freedom to choose when to fish is one of the underlying values that make fishing an appealing occupation despite the physical dangers. This feeling of freedom extends to crewmen as much as to captains, since crewmen are free to choose whether or not to go out on any given trip. Individual allocations allow vessels to retain much of this flexibility that is so highly valued.

On the other hand, individual allocations work to the advantage of large groundfish boats in urban ports that have a recorded history groundfishing that is higher than the median recorded history. As NMFS acknowledges, due to the less-complete coverage of smaller vessels and smaller ports, the smaller vessels and vessels from rural ports are less likely to have a complete recorded history in database.

Another criticism fishermen have of individual allocations is that the individual allocations implicitly breach the egalitarian ethic. Individual allocations, based on historical performance, under an effort reduction system are regarded by many fishermen as a reward to those who have most damaged the resource. The vessels that spent the most days fishing for groundfish, who contributed the most to the resources demise, would be allocated the most individual days. This is perceived as an unfair allocation.

Given an implicit choice between the two values, the most popular view expressed during the past year has been in favor of equality at the expense of flexibility. The freedom to choose when to fish is not easy for some fishermen to relinquish, especially if not everyone in the fleet is equally impacted based on their historical fishing patterns. The support for an equal allocation of opportunity greatly outweighed the support for an equal reduction from individual vessel histories.

### E.7.3.2 Impacts on Native American Fisheries

Since there are no known native American groundfish fisheries in this region (see Section E.6.4.3.2), no direct impacts of this action can be expected. If fishing effort is displaced to those stocks that are the focus of the native American fishing effort, some indirect impact could be expected, but is not predictable or measurable at this time.

### E.7.3.3 Impacts on Subsistence Fisheries

Since there are no subsistence fisheries in the northeast (see Section E.6.4.3.3), there is no need to comment on this issue.

### E.7.3.4 Impacts on safety and public health

No impacts on public health are anticipated by the proposed action. The issue of safety, however, has been a matter of concern for all involved in the development of this amendment. Since commercial fishing is already considered to be one of the most hazardous occupations, primarily because of the influence of weather, any action which will constrain or otherwise affect fishermen's behavior may have impacts on the safety of those individuals.

Fishermen placed in a marginal economic position as a result of a restrictive management system, may make different decisions about going out or staying in than they would under less stressed financial situations. The direct relationship between risk, or casualty rates, and management measures, however, cannot be established. The increased competition brought upon the industry by dwindling stocks and increasing effort (including the edge given by improved technology or fishing methods), on the other hand, more directly influences the individual's decision-making process. To the extent that mis-management of the fishery allows the stocks to reach an overfished condition, a condition where competition for fish is intensified and business survivability is threatened, there is some connection between management systems and safety.

The alternatives that are proposed were developed with safety as one of many considerations. Predicting the impacts of these measures on the safety of individuals can only be done qualitatively since there is a lack of data, and, more significantly, there is no way to predict the behavior and decision making process of individual fishermen. A measure that maximizes individual flexibility, such as an individual allocation of days at sea monitored by an electronic VTS, would most likely have less of a negative impact on safety than an system that creates a "derby" atmosphere, such as an aggregated quota system, in which individual vessels compete against each other for a limited amount of fish.

The preferred effort reduction alternative allows for some element of choice (when to declare out of groundfishing), and dampens to a certain degree the "derby effect" of intensified competition through the layover-day and forced effort reductions. On the other hand, if the weather is unsuitable for fishing at the end of the layover day period, and the operator decides to go out in any case, then the layover day system may be blamed for creating a situation in which safety is compromised. The risk, however, is brought about by the imprudent decision, not by some intrinsic characteristic of the regulation.

Furthermore, mandatory layover days provide an opportunity for important dockside maintenance of vessels and equipment which otherwise may not be attended to in the effort to maximize fishing time. Another consideration is that if fishermen must declare certain periods out of the fishery, they may plan to do so during the winter months when the weather is most severe.

The moratorium is also not expected to have a negative impact on public safety. While the moratorium does prohibit the issuance of new permits, vessels which qualify for a permit may be upgraded within certain limits on size and horsepower increases. Thus, vessels may be upgraded or modernized without significantly increasing fishing power (to the extent that length, tonnage and horsepower affect fishing power).

In addition to these principal measures, the other proposals (mesh size increases, area closures, etc.) are not expected to impact safety directly. The VTS option for effort control may actually improve the overall safety of fishing operations since vessel positions can be quickly determined by a remote observer (e.g. the Coast Guard), and these instruments provide another means of ship-to-shore communication with greater range than VHF or cellular telephone.

This amendment is being developed at a time when a comprehensive set of regulations are being promulgated under the Commercial Fishing Vessel Safety Act of 1988, PL 100-424. While some of these regulations are not yet final, they include stability and construction standards for certain vessels, requirements for survival craft and other safety equipment, and other measures to improve the overall level of safety of the industry. How these regulations will interact with the proposed management measures cannot be predicted, but they are intended to reduce the risks inherent in commercial fishing.

**E.7.3.5 Impacts on groundfish processors**

Processors and wholesalers of groundfish tend to confine their activities to these species, and other finfish landed in New England. With the exception of New Bedford plants which often process both groundfish and scallops, shellfish and molluscs are almost always sold by firms specializing in these products. Some processors and wholesalers are however, expanding their product lines to include shark, salmon and other imported fish, to offset the drop in landings of groundfish. Few groundfish plants produce a frozen product.

With the drop in landings since the peak year in 1980 the processing and wholesaling sectors have restructured. This change is evident in both the number of firms and their employment. Apart from the few plants producing frozen portions and entrees from frozen blocks imported from Canada and elsewhere, the model groundfish processor in New England has between 1 and 15 employees. This is a slight decline from 1985, when the arithmetic average of employees per groundfish processing plant was 18.5 (ITC Pub. No. 1844, May, 1986, p.A 36). In 1990, the arithmetic average of employment for all processors in New England was 24 (Fisheries of the United States, 1991).

Processing plants tend to be small for several reasons. Automation of skinning and cutting is impractical when landings are unpredictable and fish sizes vary, so that there are only limited economies of scale in the processing operation. An increase in landings, as in the early 1980's was reflected more in an increase in the number of processors rather than an expansion in their size. Secondly, the business relationships of the processors, with both their suppliers and their customers, tend to be personal and permanent, although the bonds are now becoming more tenuous as steady product supplies are disrupted. In estimating their long term production and making decisions on the optimal size of plant and equipment, processors depend on their estimate of the quantity and quality of fish from local vessels and from reliable sources in other ports, and on the reliability of their customers, wholesalers, distributors, fish stores, restaurants and other buyers, who are usually well-known to the processor.

Purchases and sales must be made in a very short period of time, often in small amounts, on a daily basis that is constantly changing. In these circumstances, even though a processor may have three or four salesmen, the key elements of obtaining raw material and disposing of the finished product don't lend themselves to large volume and employment per firm. Fish is not a standardized product. Chain stores, of course would like to buy in large volume and plan their marketing campaigns in advance, but have been constantly frustrated by their inability to guarantee constant delivery of supply. To the extent that they have been successful, they have had to accept fish of variable quality. And to the extent that domestic landings have declined, the specialized groundfish plants have found accommodating large volume customers increasingly difficult.

As local supplies of product become less reliable, processors have had to depend on groundfish trucked in from other ports. Likewise, ports which historically specialized and shipped unprocessed product to other processors (for example, New Bedford, which specialized in flounder used to ship cod to the Boston processors) have had to downsize and diversify in response to the decline in yellowtail and haddock. Marketing is also more difficult, because the bonds between buyers and processors are now weaker. Sales are now geographically widespread, thanks to the improved availability of air freight. There were always some Boston firms selling as far west as Dallas or Chicago, but this is now routine. One Boston processor sells a large share of his output a to Los Angeles distributor, who in turn sells to wholesalers and restaurants. Ten years ago he sold 80% of his product by truck; now it's 80% air freight.

The tendency that was noted in 1986, for greater dependence on imported groundfish to keep the processors operating (ITAC Pub. No. 1844, p. A-42--from 14.9% of Northeast production in 1982 to 23.5% in 1985) has continued, although with the current crisis in Canadian stocks, any further rise in imports to offset the proposed reduction in New England landings seems unlikely.

Some processors and wholesalers have diversified either to process or market the landed species that are now replacing groundfish. Most of the groundfish processors interviewed do not find this solution practical; they would have to find new suppliers, and much more difficult, new customers. The insistence of retailers and restaurants and their customers on the traditional species is an almost insuperable obstacle to adaptation by the processors. Households will not switch to "underutilized" species when the price of cod or flounder reaches $7 or $8 a pound (Legal Seafood retail markets are charging $9 a pound for flounder); they are more likely to switch to more familiar protein sources such as chicken.

In response to the drop in landings over the past few years, all processing firms have had to seek new sources of supply, some firms couldn't find sufficient supplies at acceptable prices and have failed and closed their doors, some have diversified out of groundfish, others have downsized through Chapter 11 or otherwise, and several who were interviewed are on the verge of going out of business. The recent experience has shown that the larger firms are more likely to survive through finding different sources, processing different species, and selling to different customer. Smaller firms, often tied to familiar supplies and dealing with a small network of suppliers and buyers will have more difficulty surviving extended downturns in landings.

Whether the drop in total volume and in the regularity of short-term landings is due to no-action on the part of management, or to the proposed effort reduction system, the impact on processors will likely be the same. If an aggregated quota system is adopted, the cycle of supply and shortage will be more frequent and of a higher amplitude, as fishermen race to catch as much as possible before the quota is reached and the fishery closed. If no management action is taken, the downward trend in supply of fish is expected to continue in the long term. On the other hand, under the proposed management system, the landings streams of groundfish are expected to be positive (in comparison to no action) in five years and increase significantly in the long term (see Appendix IV, "Bioeconomic Impacts of Amendment #5 Alternatives"). This should generate positive economic benefits for the processing sector, although those benefits cannot be quantified at this time.

### E.7.4 MEASURES TO MITIGATE IMPACTSE.7.4 MEASURES TO MITIGATE IMPACTS

Although the environmental impacts of the proposed action are not well understood, to the extent that fishing activity has impacts on the environment and within the ecosystem, this action which reduces fishing effort is not expected to have negative impacts. The impacts on the human environment are discussed in Volume IV, the Regulatory Impact Review, Section 8.2, and the Initial Regulatory Flexibility Analysis, Section 8.3, as well as the social impact analysis of this SEIS, Section E.7.3.

### E.8.0 RATIONALE FOR ADOPTION OF THE PREFERRED ALTERNATIVEE.8.0 RATIONALE FOR ADOPTION OF THE PREFERRED ALTERNATIVE

The Council considered a range of alternatives in developing this plan to address the problems of overfishing, harbor porpoise bycatch, discarding of juvenile fish, and overall plan administration and enforcement. The problems are outlined in Section 2.2, Purpose and Need for this Action. This section also includes a discussion of the rationale for a fifty percent reduction in effort.

Section E.5.0 contains a complete description of all the alternatives which the Council considered, including an evaluation and comparison of the principal alternatives which forms the basis of the rationale for the preferred alternative. The public comments, contained in Volume III, as well as technical analyses such as comparison of direct effort reduction versus a quarterly quota (Section E.7.2.4), and the "Effects of Mesh vs. Effort Controls on Spawning Stock Biomass..." (Appendix II, Volume II), provide additional rationale for the Council's selection of the proposed alternative.

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