SPINY DOGFISH FISHERY MANAGEMENT PLAN

(Includes Draft Environmental Impact Statement and Regulatory Impact Review)

August 1998

Mid-Atlantic Fishery Management Council

and the

New England Fishery Management Council

in cooperation with the

National Marine Fisheries Service

and the

South Atlantic Fishery Management Council

Draft adopted by Councils: 11 August (NEFMC) and 17 August (MAFMC) 1998
Final Adopted by Councils:
Final approved by NOAA:

A Publication of the Mid-Atlantic Fishery Management Council pursuant to National Oceanic and Atmospheric Administration Award No. NA57FC0002

22 September 1998 Hearing Draft

UNITED STATES DEPARTMENT OF COMMERCE
Office of the Under Secretary for Oceans and Atmosphere
Washington, D.C. 20230

OCT 1 1998

To All Interested Government Agencies and Public Groups:

Under the National Environmental Policy Act, an environmental review has been performed on the following action.

TITLE: Draft Environmental Impact Statement for the Spiny Dogfish Fishery Management Plan (FMP)

LOCATION: Spiny dogfish are a migratory species and range from Labrador to Florida, but are most abundant from Nova Scotia to Cape Hatteras. Spiny dogfish are considered a unit stock in the Northwest Atlantic Ocean

SUMMARY: With the decline of more traditional groundfish resources in recent years, an increase in directed fishing for spiny dogfish has resulted in a nearly six-fold increase in landings in the last 7 years. The lack of any regulations pertaining to the harvest of this species led the Mid-Atlantic and New England Fishery Management Councils to develop a management plan for spiny dogfish. The FMP proposes the following management measures to conserve the resource: (1) Permit and reporting requirements for commercial vessels, operators, and dealers; (2) establishment of a Spiny Dogfish FMP Monitoring Committee; (3) implementation of a framework adjustment process; (4) a 10-year stock rebuilding schedule; (5) a commercial quota; (6) seasonal (semi-annual) allocation of the quota; (7) prohibition on finning; and (8) a limit of 80 nets (50 fathoms each) in the spiny dogfish gillnet fishery.

RESPONSIBLE OFFICIAL: Hannah Goodale
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Any written comments or questions you may have should be submitted to the responsible official by November 23, 1998. Also, one copy of your comments should be sent to me in Room 5802, OP/SP, U.S. Department of Commerce, Washington, D.C. 20230.

Sincerely,

Margaret McCall
for Susan B. Fruchter
Director, Office of Policy and Strategic Planning

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EXECUTIVE SUMMARY

The purpose of the proposed action is to initiate management of spiny dogfish (*Squalus acanthias*) pursuant to the Magnuson Stevens Fishery Conservation and Management Act (MSFCMA) of 1976 as amended by the Sustainable Fisheries Act (SFA). For most of the first two decades of extended jurisdiction under the Magnuson Act, the spiny dogfish was considered to be an "under-utilized" species of relatively minor value to the domestic fisheries of the US East Coast. With the decline of more traditional groundfish resources in recent years, an increase in directed fishing for dogfish has resulted in a nearly six-fold increase in landings in the last seven years. Recent rapid expansion of the fishery has resulted in a dramatic increase in fishing mortality. Particularly troublesome is the fact that the fishery targets mature females due to their large size. The recent fishery expansion in combination with the removal of a large portion of the adult female stock has resulted in the species being designated as overfished by the National Marine Fisheries Service (NMFS). The SFA requires remedial action by the Councils for stocks designated as overfished and requires that a management program be developed within one year of the date of notification that a species is overfished. The lack of any regulations pertaining to the harvest of spiny dogfish in the US EEZ combined with the recent rapid expansion of the domestic fishery led the Mid-Atlantic and New England Fishery Management Councils (Councils) to develop a management plan for the species.

The management unit for this FMP is defined as the entire spiny dogfish (*Squalus acanthias*) population along the Atlantic coast of the United States.

The overall goal of this FMP is to conserve spiny dogfish in order to achieve optimum yield from this resource in the western Atlantic Ocean.

To meet the overall goal, the following objectives are adopted:

1. Reduce fishing mortality to ensure that overfishing does not occur.
2. Promote compatible management regulations between state and Council jurisdictions and the US and Canada.
3. Promote uniform and effective enforcement of regulations.
4. Minimize regulations while achieving the management objectives stated above.
5. Manage the spiny dogfish fishery so as to minimize the impact of the regulations on the prosecution of other fisheries, to the extent practicable.

The fishing year for spiny dogfish is the twelve (12) month period beginning 1 May.

Management Program for Spiny Dogfish

The Councils are seeking public comment on the following management program adopted by the Council for public hearings:

Management Strategy

The Sustainable Fisheries Act (SFA), which reauthorized and amended the Magnuson-Stevens Fishery Conservation and Management Act, made a number of changes to the existing National Standards. With respect to National Standard 1, the SFA imposed new requirements concerning definitions of overfishing in fishery management plans. To comply with National Standard 1, the SFA requires that each Council FMP define overfishing as a rate or level of fishing mortality that jeopardizes a fishery's capacity to produce maximum sustainable yield (MSY) on a continuing basis.

Each FMP must specify objective and measurable status determination criteria for identifying when stocks or stock complexes covered by the FMP are overfished. To fulfill the requirements of the SFA, status determination criteria for spiny dogfish are comprised of two components: 1) a maximum fishing mortality threshold and 2) a minimum stock size threshold. The maximum F threshold for spiny dogfish is specified as F_{MSY}. The minimum biomass threshold is specified as ½ B_{MSY}. For spiny dogfish, the stock size that would maximize average recruitment is known as the SSB_{max} and is recommended as a proxy value for B_{MSY}. This target value is currently estimated to be 440 million pounds (200,000 mt).

An additional requirement of the SFA is that stocks which are identified as overfished (i.e., stock biomass is less than minimum biomass threshold) must be rebuilt to the level that will produce maximum sustainable yield (B_{MSY}). The SFA guidelines advise that, in most cases, the stock rebuilding period may not exceed 10 years. The most recent stock assessment data indicate that total adult spiny dogfish stock biomass is currently about 280 million lbs (127,000 mt),which is well below the stock biomass target of 440 million lbs (200,000 mt). As a result, the Councils propose to rebuild the spiny dogfish stock to the B_{MSY} level (as represented by the proxy of SSB_{max}) over a ten year rebuilding period through the implementation of this FMP.

The preferred alternative will eliminate overfishing and rebuild the spiny dogfish stock through a two step reduction in fishing mortality rate. The first step allows for a one year exit fishery of 22 million lbs (10,000 mt) to allow a phase out of the directed fishery. This approach was chosen to minimize the impact of the rebuilding program on both the harvest and processing sectors of the industry. For the first year of the rebuilding plan (1999-2000), F will be reduced to 0.2 and then will be reduced to F=0.03 in the remaining nine years of the rebuilding plan (2000-2009). This schedule allows for stock rebuilding to the level which will support harvests at or near the SSB_{max} level in the year 2009.

PROPOSED AND ALTERNATIVE MANAGEMENT MEASURES

Preferred Management Measures

The Councils are proposing a number of preferred management measures to meet the objectives of the FMP (a complete description of these management measures is given in section 3.1). These preferred alternatives are as follows:

1. Permit and reporting requirements for commercial vessels, operators and dealers.

2. The establishment of a Spiny Dogfish FMP Monitoring Committee.

3. The implementation of a framework adjustment process.

4. A ten year stock rebuilding schedule.

5. A commercial quota.

6. Seasonal (semi-annual) allocation of the quota.

7. Prohibition on finning.

8. A limit of 80 nets (50 fathoms each) in the spiny dogfish gillnet fishery.

Alternatives to the Preferred Management Actions

A number of alternatives to the proposed management measures have been identified by the Councils for consideration by the public (a complete description of these management measures is given in section 3.1). These non-preferred alternatives include:

1. Take no action at this time.

2. Alternative rebuilding schedules.

3. A commercial quota with trip limits.

4. A commercial quota with alternative seasonal allocations.

5. A commercial quota with alternative size limits including a slot size limit.

6. Limited entry program for spiny dogfish commercial fishery.

7. A target commercial quota.

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1. INTRODUCTION

1.1 PURPOSE AND NEED FOR ACTION

1.1.1 HISTORY OF DEVELOPMENT OF THE PLAN

The purpose of the proposed action is to initiate management of spiny dogfish (*Squalus acanthias*) pursuant to the Magnuson Stevens Fishery Conservation and Management Act (MSFMCA) of 1976 as amended by the Sustainable Fisheries Act (SFA). For most of the first two decades of extended jurisdiction under the Magnuson Act, the spiny dogfish was considered to be an "under-utilized" species of relatively minor value to the domestic fisheries of the US East Coast. With the decline of more traditional groundfish resources in recent years, an increase in directed fishing for dogfish has resulted in a nearly six-fold increase in landings in the last seven years. The lack of any regulations pertaining to the harvest of spiny dogfish in the US EEZ combined with the recent rapid expansion of the domestic fishery lead the Mid-Atlantic and New England Fishery Management Councils (Councils) to develop a management plan for the species.

In addition, data and analyses in the most recent stock assessment (NMFS 1998) indicate that the spiny dogfish stock in the Northwest Atlantic has declined as a result of the recent increase in exploitation. Recent rapid expansion of the fishery has resulted in a dramatic increase in fishing mortality. Particularly troublesome is the fact that the fishery targets mature females due to their large size. The recent fishery expansion in combination with the removal of a large portion of the adult female stock has resulted in the species being designated as overfished (NMFS 1998). The SFA requires remedial action by the Councils for stocks designated as overfished. The SFA requires that a management program be developed immediately for this species and that targets and thresholds for stock size and fishing mortality be established.

FMPs and amendments must meet the requirements of a number of federal laws and regulations. In addition to MSFCMA, these include the National Environmental Policy Act, the Endangered Species Act, the Marine Mammal Protection Act, Executive Order 12866, and the Regulatory Flexibility Act. This document has been developed to meet these federal requirements and contains all elements of the FMP Act, Draft Environmental Impact Statement, Regulatory Flexibility Analysis, Regulatory Impact Review, and Fishery Impact Statement.

1.1.2 PROBLEMS FOR RESOLUTION

Based upon the NMFS (1994) recommendations and concerns expressed by both industry and the general public, the Councils held scoping hearings in the New England and Mid-Atlantic regions during the fall of 1997 to begin the process of FMP development. The purpose of the scoping hearings was to determine the scope of issues to be addressed and to identify the significant issues and problems relating to management of spiny dogfish. This action was also necessary to comply with federal environmental documentation requirements of the National Environmental Policy Act. The following problems and issues were identified during the scoping hearings.

1.1.2.1 Depletion of Mature Female Portion of the Spiny Dogfish Stock

The spiny dogfish stock was recently designated as overfished. Under the new SFA requirements, a formal definition of overfishing needs to be developed. In addition to the need for a definition of overfishing, a minimum spawning stock threshold must be specified and the stock must be rebuilt a level which will produce maximum sustained yield in 10 years.

1.1.2.2 High Discard Rates in the Non-Directed Fisheries

Virtually all of the spiny dogfish taken as bycatch in the mixed- and multi-species gillnet and otter trawl fisheries in the Northwest Atlantic Ocean were discarded based on sea sample data from 1991-1993. The primary reason for discarding of dogfish taken in these fisheries is small size or lack of market. The result of this activity is to reduce the mean size/age of selection. Since these animals are discarded, they represent economic and biological waste.

Any future harvest policy developed for spiny dogfish must take into account the background mortality that results from discarding of dogfish from these fisheries. The issue of discards is a particularly important issue in the management of spiny dogfish, especially given the new National Standard 7, which mandates that regulations within FMPs developed under the SFA must minimize the level of discards and the mortality of discards which are unavoidable.

1.1.2.3 Spiny Dogfish Life History Makes Stock Vulnerable to Overfishing

Spiny dogfish are long lived and slow growing (see Section 2.1.3.2). This life history strategy (long lived with low reproductive potential) makes the species particularly vulnerable to overfishing. Holden (1973) noted the limited ability of sharks and other elasmobranchs to maintain the levels of exploitation sustainable in fisheries for teleost or bony fish. This is because stock and recruitment are directly related and reductions in adult stock size result in reduced recruitment. In addition, the limited reproductive potential of spiny dogfish offers little flexibility in compensating for increased exploitation.

1.1.2.4 Identification of Essential Habitat for Spiny dogfish

Pursuant to the new requirements of the SFA, the Councils are required to identify essential habitat for spiny dogfish in the western Atlantic Ocean. Therefore, the Councils solicited comments from the public on the identification of and threats to essential habitat for spiny dogfish during the scoping progress.

1.1.3 MANAGEMENT OBJECTIVES

The overall goal of this FMP is to conserve spiny dogfish in order to achieve optimum yield from this resource in the western Atlantic Ocean.

To meet the overall goal, the following objectives are adopted:

1. Reduce fishing mortality to ensure that overfishing does not occur.

2. Promote compatible management regulations between state and Council jurisdictions and the US and Canada.

3. Promote uniform and effective enforcement of regulations.

4. Minimize regulations while achieving the management objectives stated above.

5. Manage the spiny dogfish fishery so as to minimize the impact of the regulations on the prosecution of other fisheries, to the extent practicable.

1.1.4 MANAGEMENT UNIT

The management unit for this FMP is defined as the entire spiny dogfish (*Squalus acanthias*) population along the Atlantic coast of the United States.

1.1.5 Management Strategy

The Sustainable Fisheries Act (SFA), which reauthorized and amended the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) made a number of changes to the existing National Standards. With respect to National Standard 1, the SFA imposed new requirements concerning definitions of overfishing in fishery management plans. To comply with National Standard 1, the SFA requires that each Council FMP define overfishing as a rate or level of fishing mortality that jeopardizes a fishery's capacity to produce maximum sustainable yield (MSY) on a continuing basis.

Each FMP must specify objective and measurable status determination criteria for identifying when stocks or stock complexes covered by the FMP are overfished. To fulfill the requirements of the SFA, status determination criteria for spiny dogfish are comprised of two components: 1) a maximum fishing mortality threshold and 2) a minimum stock size threshold. The maximum F threshold for spiny dogfish is specified as F_{MSY}. The minimum biomass threshold is specified as ½ B_{MSY}. In addition, the SFA requires that a risk averse fishing mortality target be specified as well as a biomass target, which is the stock level associated with MSY (B_{MSY}). For spiny dogfish, Applegate *et al.* 1998 recommended specifying the target fishing mortality rate as F_{rep} with a pup-per-recruit ratio of 1.5, or the fishing mortality rate which allows for the production of 1.5 female pups per female recruit (estimated to be F=0.08 for current size at first entry). The target stock biomass is B_{MSY}.

For spiny dogfish, MSY could not be reliably estimated from a surplus production model, like other stocks that have better catch and effort data. This approach also gives results that are conditioned on the exploitation pattern, which appears to be changing (the fishery has targeted smaller fish with time). In lieu of this approach, Applegate *et al.* 1998 and the Dogfish Technical Committee recommended using yield-per-recruit biological reference points that maximize yield and protect against declines in total recruitment. Yield-per-recruit analyses do not give any advice on the amount of recruitment or how it changes with stock size. To estimate a stock size that would maximize recruitment, a stock-recruitment model was fitted to spawning stock biomass and recruitment observations. The stock size that would maximize average recruitment is known as the SSB_{max} and was recommended as a proxy value for B_{MSY}. This value is estimated to be 440 million pounds (200,000 mt) and was measured as a swept-area biomass index. As a proxy for F_{MSY}, Applegate *et al.* 1998 recommended using F_{rep} with a pup-per-recruit ratio of 1.0 or the fishing mortality rate which allows for the production of 1.0 female pup per female recruit equals (i.e., the stock is replacing itself). This fishing mortality rate is currently estimated to be F=0.11.

An additional requirement of the SFA is that stocks which are identified as overfished (i.e., stock biomass is less than minimum biomass threshold) must be rebuilt to the level that will produce maximum sustainable yield (B_{MSY}). The SFA guidelines advise that, in most cases, the stock rebuilding period may not exceed 10 years. The most recent stock assessment data presented by NMFS (1998) and the Dogfish Technical Committee indicate that total adult spiny dogfish stock biomass is currently about 280 million lbs (127,000 mt), well below the stock biomass target of 440 million lbs (200,000 mt). As a result, the Councils propose to rebuild the spiny dogfish stock to the B_{MSY} level (as represented by the proxy of SSB_{max}) over a ten year rebuilding period through the implementation of this FMP.

The preferred alternative will eliminate overfishing and rebuild the spiny dogfish stock through a two step reduction in fishing mortality rate. The first step allows for a one year exit fishery of 22 million lbs (10,000 mt) to allow a phase out of the directed fishery. This approach was chosen to minimize the impact of the rebuilding program on both the harvest and processing sectors of the industry. For the first year of the rebuilding plan (1999-2000), F will be reduced to 0.2 and then will be reduced to F=0.03 in the remaining nine years of the rebuilding plan (2000-2009). This schedule allows for stock rebuilding to the level which will support harvests at or near the SSB_{max} level in the year 2009.

1.2 PROPOSED AND ALTERNATIVE MANAGEMENT MEASURES

1.2.1 Proposed Management Measures

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2. The establishment of a Spiny Dogfish FMP Monitoring Committee.

3. The implementation of a framework adjustment process.

4. A ten year stock rebuilding schedule.

5. A commercial quota.

6. Seasonal (semi-annual) allocation of the quota.

7. Prohibition on finning.

8. A limit of 80 nets (50 fathoms each) in the spiny dogfish gillnet fishery.

1.2.2 Alternatives to the Preferred Management Actions

A number of alternatives to the proposed management measures have been identified by the Councils for consideration by the public (a complete description of these management measures is given in section 3.1). These non-preferred alternatives include:

1. Take no action at this time.

2. Alternative rebuilding schedules.

3. A commercial quota with trip limits.

4. A commercial quota with alternative seasonal allocations.

5. A commercial quota with alternative size limits including a slot size limit.

6. Limited entry program for spiny dogfish commercial fishery.

7. A target commercial quota.

2.0 DESCRIPTION OF AFFECTED ENVIRONMENT

2.1 DESCRIPTION OF THE STOCK

2.1.1 Species Description and Distribution

Spiny dogfish and *Squalus acanthias* are the accepted common and scientific names for the species (American Fisheries Society 1980). Spiny dogfish are also known as dogfish, horn dog, piked dogfish, and grayfish (Bigelow and Schroeder 1953). Taxonomically, they are classified as members of the Class Chondrichthyes, Order Squaliformes and Family Squalidae.

The spiny dogfish body is a common small shark which inhabits the temperate and sub-arctic latitudes of the North Atlantic and North Pacific Oceans. They can be easily recognized by the presence of two dorsal fins, each preceded by a sharp spine and by their lack of an anal fin. The upper surface of the spiny dogfish is slate grey or brownish in coloration with numerous white spots which extend the length of the body, while the lower surface of the body varies from white to grey (Bigelow and Schroeder 1953; Castro 1983).

Spiny dogfish are distributed on both sides of the Atlantic Ocean. In the Northwest Atlantic, they range from Labrador to Florida, but are most abundant from Nova Scotia to Cape Hatteras (Figure 1). They migrate seasonally, moving north in spring and summer and south in fall and winter. The preferred temperature range is 45° to 55° F. Canadian research surveys indicate that spiny dogfish are distributed throughout the Canadian Maritimes during the summer months. The stock is concentrated in US waters during the fall through spring. Spiny dogfish are considered a unit stock in the Northwest Atlantic Ocean (US and Canadian waters)

2.1.2 Abundance and Present Condition

The status of the spiny dogfish stock in the Northwest Atlantic Ocean was most recently assessed at SAW-26 (NMFS 1998). The results of that assessment suggest that the spiny dogfish stock in the Northwest Atlantic has begun to decline as a result of the recent increase in exploitation. Swept-area estimates of fishable biomass (defined as dogfish $\geq$ 31.5 in) increased six-fold from 1969 to 1989 but have since declined to less than 331 million pounds (150,000 mt). NMFS research survey data documented a steady rise in both abundance and biomass since the early 1970's but total biomass indices of large spiny dogfish have already declined from about 661 million pounds (300,000 mt) in 1990 to about 331 million pounds (150,000 mt) in 1997, approximately equal to levels observed in the early 1970's. However, because the fishery targets mature females, the estimated biomass of mature females has declined more dramatically (NMFS 1998). In addition, length frequency data from both US commercial landings and research surveys indicate a pronounced decrease in the average size of females in recent years. For example, 75% of the females landed in the NEFSC spring trawl survey were below the length at 50% maturity (NMFS 1998). In addition, the mean length of female dogfish landed in the commercial fishery has declined from 38 inches (97 cm) in 1982 to 33 inches (84 cm) in 1996 (Table 1).

Recent levels of fishing mortality have exceeded the replacement level of the stock. The removal of a large portion of the female spawning stock since 1989 has reversed the trend of increasing mature biomass since the late 1970's. The NEFSC spring survey biomass index fluctuated from 13 to 67 kg/tow during 1967 to 1979 (Table 2). Since 1979, the biomass index has ranged between 39 kg/tow in 1983 and 150 in 1990. The biomass index for males has fluctuated between 61 kg per tow in 1990 and 38 kg/tow in 1997. The male biomass index was 59 kg/tow in 1996. The female biomass has shown a greater decline during the 1990s, declining from 89 kg/tow in 1990 to 45 kg/tow in 1997.

Minimum biomass estimates based on swept-area estimates from NEFSC spring surveys, segregated by sizes (representing immature and mature female dogfish) are given in Table 3. The swept area estimate of female biomass between 14 and 31 inches (36 and 79 cm) increased steadily from 37.5 million pounds (17,000 mt) in 1980 (the first year that dogfish captured by the research survey were recorded by sex) to 452 million pounds (205,000 mt) in 1997. Large, mature female biomass, was over 882 million pounds (400,000 mt) in 1982, 1988, and 1990. Since 1990, the estimate of mature female biomass declined to 185 million pounds (84,000 mt), the second lowest value on record since 1980.

2.1.3 ECOLOGICAL RELATIONSHIPS AND STOCK CHARACTERISTICS

2.1.3.1 Spawning and Early Life History

Like other members of the family Squalidae, the spiny dogfish is ovoviviparous (no placenta, live bearing). Female dogfish first reach sexual maturity at about 26 inches (approximate age of 8 years) while males are first sexually mature at 24 inches (approximate age of 6 years). Nammack *et al.* (1985) reported the length and age at 50% maturity of spiny dogfish in the Northwest Atlantic to be 23.4 (59.5 cm) and 6 years for males and 30.6 in (77.9 cm) and 12 years for females.

Mating takes place during the winter months in the North Atlantic. Fertilized uterine eggs become encapsulated in a thin, horny transparent shell known as the candle. Newly fertilized eggs remain encapsulated in the oviduct for 4-6 months and then develop as yolk sac embryos for the ensuing 17-19 months. Prior to fertilization, large ovarian eggs develop over the year concurrently with the second year of development of the previous litter (Nammack *et al.* 1985). The pups are delivered after the two year gestation period on the offshore wintering grounds. Pups measure 8-12 inches at birth (Castro 1983).

Litter size ranges from 2 to 15 pups (average of 6) with fecundity increasing with length (Soldat 1979). About 40 % of the variability in pup production may attributable to size of the parent (Nammack *et al.* 1985). Soldat (1979) reported that the mean fecundity of females increased from 6.2 to 6.8 pups per female as average female size increased from 30.7 in (78 cm) to 38.5 in (98 cm). Nammack *et al.* (1985) found a maximum litter size of 15, with an average of 6.5 pups per female for northwest Atlantic spiny dogfish.

The relationship between stock and recruitment in spiny dogfish, like other elasmobranchs, is direct, owing to their reproductive strategy of low fecundity combined with few, well-developed offspring (Hoenig and Gruber 1990). Although Holden (1977) provides some evidence that fecundity of sharks can increase as stock size declines, size of the female body cavity and energy considerations combine to create an upper limit on pup production per adult female. As a result, recruitment to the stock in spiny dogfish is directly related to and dependent upon the number of adult females in the stock. The direct relationship between adult stock and recruitment is the most critical factor in the development of a rational strategy of exploitation of elasmobranch stocks (Hoenig and Gruber 1990), including spiny dogfish.

2.1.3.2 Age and Growth

Dorsal spine circuli (concentric rings) have been used to estimate age of spiny dogfish in the Northwest Atlantic as well as other regions. The spiny dogfish is a long lived, slow growing species. Nammack *et al.* (1985) reported maximum ages of in the Northwest Atlantic for males and females to be 35 and 40 years, respectively. Holden (1977) reported a maximum age of 25 years for the European population of spiny dogfish. In contrast, McFarlane and Beamish (1987) reported a maximum age of 70 years in the North Pacific. Holden and Meadows (1962) observed ages up to 21 years in the spiny dogfish from the Northeast Atlantic Ocean. Ketchen (1975) reported an age of 64 years and calculated growth parameters of $K=0.048$ and L_{max} of 125.3 cm for female spiny dogfish in the Northeast Pacific. Nammack *et al.* (1985) reported calculated growth parameters of $K=0.106$ and $L_{max}=$ 100.5 cm for the Northwest Atlantic population of spiny dogfish.

Sexually dimorphic growth in spiny dogfish is strongly apparent. Females attain a greater size than males, reaching maximum lengths up to 49 inches (125 cm) and weights up to 22 lbs (10 kg).

2.1.3.3 Length-Weight Relationship

NMFS (1994) reported the following length weight relationships for spiny dogfish

Females: $W = \exp(-15.0251) * L^{3.6069}$ and

Males: $W = \exp(-13.002) * L^{3.097787}$

where W equals weight in kg and L equal length in cm.

2.1.3.4 Mortality

The instantaneous natural mortality rate (M) is defined as annual losses experienced by adult spiny dogfish from all natural and anthropogenic factors except commercial and recreational fishing. As for most elasmobranchs, natural mortality rates for spiny dogfish are poorly known. NMFS (1994) used several methods to estimate M for spiny dogfish. The first method was based on estimates of maximum longevity. Hoenig (1983) related published natural mortality rates (M) to the maximum age (t_{max}) of 83 fish stocks, from which he developed the following predictive equation:

$$\log_e (M) = 1.46 - 1.01 \log_e (t_{max}).$$

Based on a maximum age (t_{max}) of 50 years for spiny dogfish results in M value of 0.083 based on the Hoenig method.

An estimate of M was also derived using method of Holden (1974) who proposed, that the solution of the equation $Z' = xe^{-Ztm}$ would provide an estimate of M for an unfished stock, where x is the expected number of pups produced per female per lifetime and t_m is the average age at which maturity is reached. This method resulted in a value of M for spiny dogfish which was inconsistent with other aspects of their biology and was rejected (NMFS 1994). NMFS (1994) also derived estimates of M by considering the level of mortality necessary to reduce the recruited population to 1% of its initial value for different assumed estimates of longevity. Assuming a maximum longevity of 50 years for spiny dogfish in the Northwest Atlantic yields an estimate of M of 0.092, which was the value assumed for spiny dogfish greater than 12 inches (30 cm) in the NMFS 1994 and 1998 assessments and subsequent analyses conducted by the Spiny Dogfish Technical Committee. This value agrees well Wood *et al.* (1979) and with the empirical value of 0.083 estimated from Hoenig's (1983) equation. The value of M assumed in the current analyses (0.092) is too high if spiny dogfish live longer than 50 years, which may be the case.

2.1.3.5 Food and Feeding

Bowman *et al.* (1984) provided an extensive examination of the diet of spiny dogfish collected from shelf waters of the Northwest Atlantic Ocean during the period 1969-1983. The area studied included continental shelf waters extending from Cape Hatteras, North Carolina to Browns bank, Nova Scotia. The stomach contents of 10,167 spiny dogfish were examined during this period (about 50% of the stomachs were empty). Fish comprised the single most important prey item in the diet of spiny dogfish. Herrings (several species), Atlantic mackerel, American sand lance, and codfishes, including species such as Atlantic cod, haddock, silver hake, red hake, white hake and spotted hake were some of most important prey items identified. Other important contributors to the diet of spiny dogfish included *Loligo* and *Illex* squid, ctenophores, crustaceans (principally decapod shrimp and crabs) and bivalves (principally scallop viscera). Bowman *et al.* (1984) observed a high degree of variability in the diet of spiny dogfish across seasons, areas and years. They considered this a reflection of their omnivorous nature and the high degree of temporal and spatial variability of both dogfish and their prey. Their diet appears broadly related to abundance trends in some of their major prey items. For example, when herring abundance was declining and mackerel abundance appeared to be at a peak during the period 1969-1972, Bowman *et al.* (1984) found mackerel to predominate in the diet of spiny dogfish. Conversely, during 1973-1976 when mackerel abundance was declining the incidence of mackerel in the diet of spiny dogfish was substantially reduced. The incidence of *Loligo* and *Illex* squid in the diet of spiny dogfish was also shown to be related to their abundance. Another example of the opportunistic nature of spiny dogfish feeding was the appearance of scallop viscera in their diet after the increase in sea scalloping in the Northwest Atlantic Ocean beginning in 1978. Bowman *et al.* (1984) reported that trends in the incidence of scallop viscera in the diet of spiny dogfish closely followed trends in the level of sea scallop fishing effort in the study area.

2.1.3.6. Predators and Competitors

As noted in the previous section, Atlantic herring, Atlantic mackerel, and *Loligo* and *Illex* squid are an important component of the diet of spiny dogfish when they are abundant and available. As a result, spiny dogfish are competitors with virtually every marine predator within the Northwest Atlantic Ocean ecosystem. These include a wide variety of predatory fish, marine mammals and seabirds.

For example, bluefish, sea ravens, and the Atlantic angel shark are known to be major *Loligo* predators. The fourspot flounder, witch flounder, roughtail stingray, and white hake are also known to prey on *Loligo*. In many cases, squid remains in the stomach of fish are only identified as "squid" without reference to species. It is likely that some of these are *Loligo* and there are at least 42 other species of "squid"- eating fish in addition to those identified above (Langton and Bowman 1977). Cetacean and seabird predation upon squid is substantial. Kenney *et al.* (1985) estimated that between 154,000 mt and 224,000 mt of squid were consumed off the northeast US annually by whales and dolphins.

Illex are a major source of food for marine carnivores. Adults are heavily preyed on by porpoises, whales, and numerous pelagic fishes (e.g., tuna and swordfish). Other known predators of *Illex* are the fourspot flounder, goosefish, and bluefish. *Illex* is probably eaten by a substantially greater number of fish, however, partially digested animals are often difficult to identify and are simply recorded as squid remains, with no reference to the species. There are at least 47 other species of fish that are known to eat "squid" (Langton and Bowman 1977). As noted above, squid comprise an important component of the diet of marine birds and mammals (Kenney *et al.* 1985).

Atlantic mackerel have been identified in the stomachs of numerous species fish. They are preyed upon heavily by whales, dolphins, silver hake, white hake, weakfish, goosefish, Atlantic cod, bluefish, and striped bass. They also comprise part of the diet of swordfish, red hake, Atlantic bonito, bluefin tuna, blue shark, porbeagle, sea lamprey, and shortfin, mako and thresher sharks (Langton and Bowman 1977).

2.1.4. MAXIMUM SUSTAINABLE YIELD

Maximum sustainable yield (MSY) was estimated for the Northwest Atlantic stock of spiny dogfish at SAW-18 (NMFS 1994). MSY could not be reliably estimated directly from a surplus production model like other stocks that have better catch and effort data. This approach also gives results that are conditioned on the exploitation pattern, which appears to be changing (the fishery has targeted smaller fish with time). In lieu of this approach, Applegate *et al.* (1998) recommended using yield-per-recruit biological reference points that maximize yield and protect against declines in total recruitment. Yield-per-recruit analyses do not give any advice on the amount of recruitment or how it changes with stock size. To estimate a stock size that would maximize recruitment, a stock-recruitment model was fitted to spawning stock biomass and recruitment observations. The stock size that would maximize average recruitment is knows as the SSB_{max} and is recommended was a proxy value for B_{MSY} or the biomass which would produce maximum sustainable yield. This value is estimated to be 200,000 mt and was measured as a swept-area biomass index based on the NMFS spring trawl survey.

As a maximum fishing mortality threshold that would serve as a proxy for F_{MSY}, Applegate *et al.* 1998 recommended adopting the fishing mortality value estimated to stabilize the female population at SSB_{max} while maximizing yield per recruit, also referred to as F_{rep}. This corresponds to a fishing mortality rate that would produce an average of 1.0 pup-per-recruit. Based on the yield-per-recruit analysis conducted by SAW 26, the fishing mortality replacement threshold would be 0.011 with a size-at-entry in the fishery of 27.5 in (70 cm). Analyses conducted by the Spiny Dogfish Committee estimated the long term potential yield for spiny dogfish at this fishing mortality rate (F_{rep}=0.11) to be equal to 15.5 million pounds (7000 mt). Long term potential yield would be higher at larger size-at entry.

2.1.5. PROBABLE FUTURE CONDITION

The Spiny Technical Committee evaluated a number of stock rebuilding options during the development of this FMP for spiny dogfish using a length-based stock projection model. Included in these analyses were projections of stock size and yields assuming maintenance of the status quo which would mean no action. Under the no action alternative, the Technical Committee assumed that fishing mortality would remain at recent levels (F=0.3) and the size at entry to the fishery would remain at 70 cm (27.5 in). Assuming maintenance of the status quo (assuming F remains at the recent level of 0.3), the spiny dogfish population is expected to decline rapidly and projected landings (yield) would be expected to decrease by 80% within 7 years (to less than 11 million pounds or 5,000 mt) and then decline at a slower rate. Thereafter, landings would gradually decline to near zero over the next 20-25 years.

The Technical Committee also examined a suite of management options which would involve reductions in fishing mortality over a period of ten years (see Section 3.1). These projections indicate that if fishing mortality is substantially reduced and maintained at low levels, then the spiny dogfish stock can be rebuilt to levels which will allow sustainable harvests within a ten year planning horizon. If fishing mortality is reduced, then the decline in the spiny dogfish stock will be arrested and stock rebuilding will occur relatively quickly, especially given the slow growth and low reproductive capacity of this stock. This rebuilding can occur relatively quickly due to the large biomass of spiny dogfish of intermediate size which currently exists. Husbandry of this intermediate size group currently in the population will allow the adult female portion of the stock to increase and allow for subsequent stock size increases overall through increased recruitment.

2.2 DESCRIPTION OF HABITAT

2.2.1 Inventory of Environmental and Fisheries Data

According to section 600.815 (a)(2)(i)(A), an initial inventory of available environmental and fisheries data sources relevant to the managed species should be used in describing and identifying essential fish habitat (EFH).

In section 600.815 (a)(2)(i)(B), in order to identify EFH, basic information is needed on current and historic stock size, the geographic range of the managed species, the habitat requirements by life history stage, and the distribution and characteristics of those habitats.

2.2.1.1 Range

The spiny dogfish, *Squalus acanthias,* is a coastal squaloid shark with a circumboreal distribution. In addition to being the most abundant shark in the western North Atlantic, they are also one of the most highly migratory species of the Atlantic coast (Bigelow and Schroeder 1953). Rago *et al.* (1994) report that their general distribution in the Northwest Atlantic is between Labrador and Florida but are most abundant from Nova Scotia to Cape Hatteras, North Carolina (Figure 1).

Spiny dogfish school by size until they mature and then they school by both size and sex. (Templeman 1944, Bigelow & Schroeder 1953, Saulson 1982, Nammack *et al.* 1985, Silva 1993, Rago *et al.* 1994). Schools are often composed of: (1) very large, mature females; (2) medium-sized individuals, either all mature males or all immature females; or (3) small immature individuals of both sexes in equal numbers (Bigelow and Schroeder 1953).

Seasonal migrations occur northward in the spring and summer and southward in the fall and winter (Jensen 1965). Fish that spend the summer north of Cape Cod move southward to Long Island in the fall, and as far south as North Carolina in the winter (Collette and MacPhee In prep.). Winter catches in waters south of North Carolina were reported by Bearden (1965) and Hess (1966) and occurrences as far south as Cuba were reported by Bigelow and Schroeder (1953).

Seasonal inshore-offshore movements and coastal migrations are thermally induced (Bigelow and Schroeder 1953, Jensen 1965). Generally, spiny dogfish spend summers in inshore waters and overwinter in deeper offshore waters. They are usually epibenthic, but occur throughout the water column and are found in a depth range from nearshore shallows to offshore shelf waters approaching 900 m (Collette and McPhee In prep.) .

Climate, physiographic, and hydrographic differences separate the Atlantic ocean from the Gulf of Maine to Florida into two distinct areas, the New England-Middle Atlantic Area and the South Atlantic Area, with the natural division occurring at Cape Hatteras. These differences result in major zoogeographic faunal changes at Cape Hatteras. The New England region from Nantucket Shoals to the Gulf of Maine includes Georges Bank, one of the worlds most productive fishing grounds. The Gulf of Maine is a deep cold water basin, partially sealed off from the open Atlantic by Georges and Browns Banks, which fall off sharply into the continental shelf.

The New England-Middle Atlantic area is fairly uniform physically and is influenced by many large coastal rivers and estuarine areas including Chesapeake Bay, the largest estuary in the United States, Narragansett Bay, Long Island Sound, the Hudson River, Delaware Bay, and the nearly continuous band of estuaries behind the barrier beaches from southern Long Island to Virginia. The southern edge of the region includes the estuarine complex of Currituck, Albemarle, and Pamlico Sounds, a 2500 square mile system of large interconnecting sounds behind the Outer Banks of North Carolina.

The South Atlantic region is characterized by three long crescent shaped embayments, demarcated by four prominent points of land, Cape Hatteras, Cape Lookout, and Cape Fear in North Carolina, and Cape Romain in South Carolina. Low barrier islands occur along the coast south of Cape Hatteras with concomitant sounds that are only a mile or two wide. These barriers become a series of large irregularly shaped islands along the coast of Georgia and South Carolina, separated from the mainland by one of the largest coastal salt-water marsh areas in the world. Similarly, a series of islands border the Atlantic coast of Florida. These barriers are separated in the north by broad estuaries, which are usually deep and continuous with large coastal rivers, and in the south by narrow, shallow lagoons.

The continental shelf (characterized by water less than 650 feet in depth) extends seaward approximately 120 miles off Cape Cod, narrows gradually to 70 miles off New Jersey, and is 20 miles wide at Cape Hatteras. South of Cape Hatteras, the shelf widens to 80 miles near the Georgia-Florida border, narrows to 35 miles off Cape Canaveral, Florida, and is 10 miles or less off the southeast coast of Florida and the Florida Keys. The shelf is at its narrowest, reaching seaward only 1.5 miles, off West Palm Beach, Florida.

Surface circulation is generally southwesterly on the continental shelf during all seasons of the year, although this may be interrupted by coastal indrafting and some reversal of flow at the northern and southern extremities of the area. There may be a shoreward component to this drift during the warm half of the year and an offshore component during the cold half. The direction of this drift, fundamentally the result of temperature-salinity distribution, is largely determined by the wind. A persistent bottom drift at speeds of tenths of nautical miles per day extends from beyond mid-shelf toward the coast and eventually into the estuaries.

Water temperatures range from less than 33 °F in the New York Bight in February to over 80 °F off Cape Hatteras in August. The vertical thermal gradient is minimized during winter. In late April to early May, a thermocline develops in shelf waters except over Nantucket Shoals where storm surges retard thermocline development. The thermocline persists through the summer until surface waters begin to cool in early autumn. By mid-November, surface to bottom temperature along the shelf is nearly homogeneous.

Coastwide, an annual salinity cycle occurs as the result of freshwater stream flow and the intrusion of slope water from offshore. Water salinities nearshore average 32 ppt, increase to 34-35 ppt along the shelf edge, and exceed 36.5 ppt along the main lines of the Gulf stream.

2.2.1.2 Status of the stock

The Spiny dogfish stock was recently assessed at the December 1997 SARC and are currently classified as overfished (NMFS 1998). Figure 2 presents spiny dogfish combined commercial landings and stratified mean catch from spring bottom trawl surveys conducted by NMFS, NEFSC. The combined commercial landings (1963 - 1996) include the U.S., Canada, foreign, and U.S. recreational catches. The U.S. recreational catch data are unknown prior to 1980.

The increase in total commercial landings of spiny dogfish from 1968 through 1974 was due largely to the foreign fleet harvest, most notably the former USSR. This foreign pressure continued through 1977. With the advent of the Fishery Conservation Zone (the predecessor to the renamed Exclusive Economic Zone), the foreign harvest dwindled to a low in 1979, but landings by the U.S. and Canada have been steadily increasing since then. A sharp intensification of the U.S. commercial fishery began in 1990. Estimated landings for 1996, in excess of 61.5 million lbs (28,000 mt), represent the highest landings since 1962.

2.2.1.3 Habitat Requirements by life history stage

The following information on juveniles and adult dogfish habitat requirements is taken directly from the document "FMP EFH Source Document, Spiny Dogfish, *Squalus acanthias* Linnaeus, 1758: life history, food habits, status of the stock, habitat characterization, and distribution and relative abundance" (McMillan and Morse 1998). It does not contain information on eggs and larvae because dogfish are oviviparous (no placenta, live birth). The McMillan and Morse (1998) document is referred to hereafter as the dogfish EFH background document. Most of the tables and figures from McMillan and Morse (1998) are included in this FMP. The McMillan and Morse (1998) dogfish EFH background document is currently being modified for publication by NMFS and can be obtained in its entirety from NMFS, Sandy Hook Laboratory, 74 McGruder Road, Highlands, New Jersey 07732.

Habitat characteristics for juvenile and adult spiny dogfish are provided in Table 4. This table includes the particular study, investigator, geographic area, hydrographic preference, estuarine use, and prey/predator selection.

For this analysis, McMillan and Morse (1998) assumed 32.6 in. (83cm; females) and 23.6 in. (60 cm; males) are the median lengths at which 50% of the individuals are mature. Individuals are classified as either adults or juveniles; i.e. males and females for the particular life stage were combined for distribution and abundance plots.

2.2.1.3.1 Juveniles

Habitat requirements

Catches of juvenile spiny dogfish and their relationship to bottom water temperatures and bottom depths observed on NMFS, NEFSC's spring and autumn bottom trawl surveys are provided in Figure 3. During the spring surveys, observed bottom temperatures ranged from 34-72 °F (1-22°C). Juvenile spiny dogfish occurred in a bottom temperature range between 37-63 °F (3-17°C), while most were caught in waters with bottom temperatures between 46-55 °F (8-13°C). Trawl stations occupied during the spring had a bottom depth range from 16 to 440 ft (5 to 439 m). Juveniles occurred in waters with a bottom depth range between 23 and 1280 ft (7 and 390 m), while most were caught in waters with bottom depths between 164 and 492 ft (50 and 150 m).

During the autumn surveys, observed bottom temperatures ranged from 41-82 °F (5-28°C). Juvenile spiny dogfish occurred in waters between 41-68 °F (5-20°C), with the majority caught in waters between 50-59 °F (10-15°C). Trawl stations occupied during this season had bottom depths ranging from 16 to 1578 ft (5 to 481m). Juvenile spiny dogfish occurred in waters with bottom temperatures ranging from 39 to 1,201 ft (2 to 366m), while most were caught in waters with bottom depths between 82 and 246 ft (25 and 75 m).

Distribution and Abundance

The seasonal distribution and relative abundance of juvenile spiny dogfish from the NMFS, NEFSC research trawl surveys are shown in Figures 4-7. The data analyzed to describe the distribution and abundance patterns were limited to those surveys where the sex of spiny dogfish was determined.

The winter distribution of juvenile spiny dogfish was widespread across the shelf from North Carolina (Figure 4). Juveniles were absent in the western portions of Georges Bank and nearly absent on Nantucket Shoals. The Gulf of Maine was not adequately sampled to describe juvenile distribution during this season.

The distribution and relative abundance of juvenile spiny dogfish caught during the spring surveys are shown in Figure 5. Juveniles were concentrated in offshore waters from North Carolina to the eastern edge of Georges Bank. The highest numbers occurred along the outer shelf (200-660 ft; 60-200m). Juveniles were nearly absent in the northwest portion of the Gulf of Maine.

Due to inadequate sampling during the summer surveys (i.e. the number of surveys where sex was determined only encompassed the Gulf of Maine and were limited to 1993-1995) McMillan and Morse (1998) could not summarize distribution during this season for juveniles (Figure 6).

Autumn distribution and relative abundance for juvenile spiny dogfish is provided in Figure 7. The highest numbers were evident: 1) around Nantucket Shoals; 2) on Georges Bank and; 3) in waters between Lurcher

Shoal and German Bank off the coast of Nova Scotia. It should be noted that juveniles were widespread throughout the Gulf of Maine.

2.2.1.3.2 Adults

Habitat requirements

Catches of adult spiny dogfish, and their relationship to bottom water temperatures and bottom depths observed on NMFS, NEFSC spring and autumn bottom trawl surveys, are provided in Figure 3. During the spring surveys, bottom temperature ranged from 34-72 °F (1-22°C). Adult spiny dogfish occurred in waters with a bottom temperature range between 37-63° F (3-17°C), while most were caught in waters with bottom temperatures between 45-52 °F (7-11°C). Trawl stations occupied during the spring had a bottom depth range from 16 to 1,440 ft (5 to 439 m). Adults occurred in waters with a bottom depth range between 23 to 1,440 ft (7 and 439 m), while most were caught in waters with bottom depths between 164 and 489 ft (50 and 149m).

During the autumn surveys, bottom temperature ranged from 41-82 °F (5-28°C). Adult spiny dogfish occurred in waters with a bottom temperature range between 41-66 °F (5-19°C), with the majority being caught in waters with a bottom temperature range between 50 -59 °F (10-15°C). Trawl stations occupied during this season had bottom depths ranging from 16-1,578 ft (5- 481 m). Adults occurred in waters with a bottom depth range between 39-1,128 ft (12-344m), while most were caught in waters with bottom depths between 32-161 ft (10-49m).

Distribution and Abundance

Winter distribution of adult spiny dogfish was very similar to that of winter juveniles (Figures 4 and 8). Distribution was widespread across the shelf from Cape Hatteras, North Carolina to the eastern edge of Georges Bank. Adults were nearly absent in the New York Bight, Nantucket Shoals, and completely absent on the western portion of Georges Bank.

In the spring, the distribution and relative abundance of adults were somewhat similar to that of the juveniles (Figures 5 and 9). High numbers of abundance were seen along the outer shelf from North Carolina to the northeast peak of Georges Bank, continuing onto Browns Bank. Lesser numbers occurred inshore from Cape Hatteras to Long Island, the western portion of Georges, and central Gulf of Maine.

Due to inadequate sampling during the summer surveys, i.e. the number of surveys where sex was determined only encompassed the Gulf of Maine and were limited to 1993-1995, McMillan and Morse (1998) could not accurately summarize distribution during this season for adults (Figure 10).

The distribution and relative abundance of adult spiny dogfish captured during the autumn surveys is provided in Figure 11. Adults were absent across the shelf from North Carolina to the area just south of the Hudson Canyon. Low numbers occurred along the nearshore area of Long Island. The highest abundance was seen off Nantucket Shoals, then north along the eastern edge of Cape Cod, and into Cape Cod and Massachusetts bays. Another area of high abundance occurred just southwest of Nova Scotia. To a lesser degree than juveniles, adults were scattered throughout the Gulf of Maine and along the northwest edge of Georges Bank.

2.2.1.4 Importance of dogfish in state waters

The primary data source for dogfish in state waters is NOAA's Estuarine Living Marine Resources Program (ELMR; Tables 5 and 6); while not as quantitative as the NEFSC trawl data it does describe the dogfish spatial (Table 5) and temporal (Table 6) relative abundance by life stage and month in the various coastal estuaries (Figures 12 and 13). While dogfish may be important in other states' water, currently, the only state data available to NMFS in a consistent electronic format is Massachusetts Inshore Trawl Survey, Connecticut Trawl Survey - Long Island Sound, and the NMFS Trawl Survey - Hudson-Raritan

Estuary/Sandy-Hook Bay. These data will not be used to designate EFH within estuaries because the data are not currently available in a consistent electronic format for other states. Therefore, it will only be used to confirm ELMR data. These data generally agree with ELMR presence/absence data for these estuaries. Habitat along the coast is generally covered because the NEFSC trawl data are presented by 10 minute squares and, in general, cover the entire coastal area. Data collected from other states' seine and trawl surveys, as it becomes available, will be incorporated in future iterations of this FMP.

2.2.2 Description and Identification of Essential Fish Habitat

2.2.2.1 Methodology for description and identification

According to section 600.815 (a)(1), FMPs must describe EFH in text and with tables that provide information on the biological requirements for each life history stage of the species. These tables should summarize all available information on environmental and habitat variables that control or limit distribution, abundance, reproduction, growth, survival, and productivity of the managed species. The dogfish EFH background document (McMillan and Morse 1998) is considered the best scientific information available in order to meet National Standard 2 of the MSFCMA and will form the basis of this section.

As defined in section 3 (10) of the MSFCMA, essential fish habitat is "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." NMFS interprets "waters" to include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

A matrix of habitat parameters (i.e. temperature, salinity, light, etc.) for dogfish was developed in the dogfish EFH background document and included in this FMP as Table 4. Also included from the EFH background document are the ELMR data by dogfish life stage in major Atlantic coast estuaries (Tables 5 and 6 and Figure 12 for juveniles and 13 for adults). Researchers at Sandy Hook Laboratory are currently in the process of assembling numerous state survey data that can be used to identify EFH more quantitatively than the somewhat subjective means of how the ELMR data were derived. Currently, the Massachusetts Inshore Trawl Survey, Connecticut Trawl Survey of Long Island Sound, and NMFS Trawl Survey of the Hudson-Raritan Estuary are the only state inshore survey data available in the consistent format being compiled by the personnel at Sandy Hook. Due to the strict time constraints of the October-Sustainable Fishery Act deadline, it is unlikely that all the state data will be incorporated in this Amendment. However, as these and other data and information become available on dogfish, EFH designations can be reconsidered; and in fact, every FMP must be reviewed at least every five years. It is important to understand that this EFH is a "work in progress", and that the process will evolve. The identification and description of EFH is a frameworked management provision (section 2.2.8 for process description).

Section 600.815 (a)(2)(i)(C) identifies the four levels of data and the approach that should be used. All the dogfish data are either Level 1 (presence/absence) or perhaps, at best, Level 2 (habitat related densities). No dogfish data are yet at Level 3 (growth, reproduction, and survival rates within habitats) or Level 4 (production rates by habitat types). The Council encourages NMFS and the scientific community to collect more habitat associated data and to strive towards assembling data that can be precisely used for the quantitative identification and description of EFH.

In section 600.815 (a)(2)(ii)(A), the Councils are directed to "interpret this information in a risk-averse fashion". In the next section (B), it states, "if a species is overfished, and habitat loss or degradation may be contributing to the species being identified as overfished, all habitats currently used by the species should be considered essential in addition to certain historic habitats that are necessary to support rebuilding the fishery and for which restoration is technologically and economically feasible."

The Council has interpreted the above direction of interpreting the information in a "risk-averse" fashion as the same as the NMFS policy on risk aversion as expressed by Schaefer (1995). Schaefer (1995) states that, although there is no formal agency (NMFS) definition of risk-averse decision making, it is discussed in several NMFS publications. A succinct agency statement regarding the rationale and objectives of this type of decision making was presented publicly in the *Strategic Plan of the National Marine Fisheries Service -- Goals and Objectives* dated 10 June 1991. This statement, according to Schaefer (1995), still represents the formal agency position on this issue. Under Goal 2 -- Maintain Currently Productive Fisheries, there is a discussion of risk-prone and risk-averse decision making. This clearly explains that the agency advocates risk-averse fishery management decisions because they reduce the risk of overfishing and give the benefit of the doubt to conservation, particularly in the face of uncertainty about the effects of management actions on the managed fishery resources. Also, in *Our Living Oceans,* December 1993, page 24, NMFS indicates that risk-averse decision making is a key element in the development of any improved management system, and that this policy means that managers should err on the side of caution with respect to long-term resource health when making fishery management decisions. Making such decisions based on short-term objectives often places the resource's long-term health at risk.

Currently, two data sets are available for determining dogfish EFH. These data sets are Level 1 or, at best, Level 2 data. The data sets are: 1) NEFSC trawl survey (Level 2) and 2) ELMR data (Level 1). The limited state data in the dogfish background document (McMillan and Morse 1998) were also evaluated and, in general; agree with the ELMR data. Again, the available state data will not be used to designate EFH because the same level of data is not available to NEFSC Sandy Hook for all of the states.

To identify and describe EFH offshore, the Mid-Atlantic Council is relying primarily on data and information derived from the NMFS bottom trawl surveys. These surveys provide the best available information on the distribution and relative abundance of Council-managed species in offshore waters. Precise information on the distribution and relative abundance in inshore areas, especially in estuaries and embayments, has been sparse and incomplete in most cases.

To identify and describe EFH in state water, NOAA's Estuarine Living Marine Resources (ELMR) data will be used. The ELMR program has been conducted jointly by the Strategic Environmental Assessments (SEA) Division of NOAA's Office of Ocean Resources Conservation and Assessment (ORCA), NMFS, and other agencies and institutions. The goal of this program is to develop a comprehensive information base on the life history, relative abundance, and distribution of fishes and invertebrates in estuaries throughout the nation. The nationwide ELMR database was completed in 1994 and includes information for 135 species found in 122 estuaries and coastal embayments. The Jury *et al.* (1994) report summarizes information on the distribution and abundance of 58 fish and invertebrate species in 17 North Atlantic estuaries and is the only volume that includes dogfish. The Stone *et al.* (1994) report summarizes information on the distribution and abundance of 61 fish and invertebrate species in 14 Mid-Atlantic estuaries. The Nelson *et al.* (1991) report covers 40 fish and invertebrate species in 20 estuaries between North Carolina and Florida. Until all the remaining state data are completely available in a uniform format, the ELMR data for adults and amended ELMR data for juveniles will be used to designate EFH in estuarine areas.

Cross (1998) produced an appendix for all the species' habitat background documents produced by Sandy Hook Laboratory that describes the methods used in NEFSC, state, and other surveys. Data were collected in these surveys on distribution and abundance of all life stages and environmental variables. The Appendix document covers data set 1 as identified in the above paragraph, but does not describe the ELMR data.

The NEFSC bottom trawl surveys have been conducted in the fall since 1963 and in the spring since 1968, with season surveys also being conducted in summer and winter on an intermittent basis. Distribution of juvenile and adult fish have been identified through trawl stations that were selected in a stratified random design that provides unbiased estimates of fish availability to the trawl gear in relation to the distribution of the species. Strata were defined based on water depth, latitude, and historical fishing patterns. Station allotments were approximately one station per 200 square nautical miles. At each station, the total catch was sorted by species, and the catch of each species was weighed and measured; very large catches were subsampled. Geographic range extends throughout the US Atlantic EEZ north of Cape Hatteras. Full details of this survey are described in Cross (1998).

The objective of NOAA's ELMR program is the development of a consistent data base on the distribution, abundance, and life history characteristics of important fishes and invertebrates in the Nation's estuaries. The Nation-wide data base is divided into five study regions, of which dogfish are included in one (North Atlantic) of the three (Mid-Atlantic and Southeast) Atlantic study regions. The data base contains the monthly relative abundance of each species' life stage by estuary for three salinity zones (seawater, mixing, and tidal fresh). Data collection was extensive, peer reviewed, evaluated relative to its reliability, but is also somewhat subjective. This subjectivity has generated some anxiety on the part of research scientists and is the main reason that, when the compilation of all the state data is completed in a consistent format, the quantitative state survey data will likely replace the ELMR data. However, at this time, ELMR data do meet National Standard 2 and are very important in describing essential dogfish habitat in the estuaries.

Currently, there is almost no data on dogfish south of Cape Hatteras, although they range to Florida. The Southeast Area Monitoring and Assessment Program (SEAMAP) is a NMFS-sponsored survey conducted by the South Carolina Department of Natural Resources. Data were collected from trawl surveys of coastal habitats between Cape Hatteras and Cape Canaveral from 1986 through 1996. Collections were made at randomly selected sites in predefined strata. During the 1986 through 1989 pilot phase of the survey, 19 strata were sampled. In 1989, five additional strata were added to the southern end of the study area, and each of the 24 strata was divided into an inshore and offshore stratum. Much less effort is expended and less data collected in this survey in comparison to the much longer time series NEFSC trawl surveys. Cross (1998) details the SEAMAP program. While this data set has not yet been analyzed for dogfish, dogfish have been caught by this survey in various years. This information will not be used to designate EFH at this time, only to confirm its presence south of Cape Hatteras.

2.2.2.1.1 Five alternative approaches for describing EFH considered by the Mid-Atlantic Technical Team

The Mid-Atlantic EFH Technical Team developed alternatives to designate EFH for consideration by the Council, as a result of a meeting with several ecologists at the Sandy Hook Laboratory in February 1998. The alternatives were initially developed for bluefish, because the Bluefish Fishery Management Plan was the first plan to be amended with the EFH requirements of the reauthorized Magnuson-Stevens Act. However, the same concepts will apply to all other Council-managed species. At this meeting, five alternatives for EFH identification recommendations were discussed for bluefish. These alternatives were to provide the basis for evaluation of the other Council managed species. These five bluefish alternatives were: 1) no action (NEPA requirement); 2) 100% of area where overfished resources occur; 3) the "bottleneck" concept as identified in the bluefish EFH background document where a critical area may restrict recruitment; 4) identification of EFH based on temperature or other key environmental requirement; and 5) objective criteria using some percentage of the distribution, i.e. 50%, 75%, 90%, or 100% (Cross 1998). The following is a discussion for dogfish of the various alternatives and how they were approached with the Level 2 data (NEFSC trawl survey).

1. The "no action" alternative is included in the FMP because it is required by NEPA (National Environmental Policy Act), but it is not viewed by the Council as defensible. This alternative, or no EFH designation, could not meet the Congressional mandate identified in the 1996 reauthorized Magnuson-Stevens Act. With this alternative, there would be no stock improvement associated with the conservation of essential fish habitat.

2. The second alternative (100% of the distribution) would conform with the 1997 proposed EFH rule's criteria of listing all habitat where an overfished resource occurs as EFH. This alternative is supportable under the Interim Final Rule (1998) with only Level I data (i.e. presence/absence); however, there is Level 2 data available for dogfish. This alternative is also defensible if an association between the overfished status of the resource and the loss of essential habitat can be identified. However, no such association has been identified for dogfish.

3. The third alternative, identify bottlenecks in a history stage or to recruitment, is not applicable

because no such bottlenecks are identified in the dogfish EFH background document.

4. The alternative 4 approach of identifying EFH based on key environmental requirements is not possible because of the lack of good quantitative habitat and environmental data corresponding to relative abundance of dogfish.

5. Finally, the use of some objective criteria, e.g. identifying some distributional percentage of the catches by area, seemed the only logically defensible position. For EFH designations based on Level 2 data, it is assumed that high value areas are those that support the highest density or relative abundance. This approach is supported by the technical guidance manual when Level 2 data (e.g., NEFSC Atlantic trawl survey) are available (USDC 1998).

2.2.2.1.2 Viable alternatives from the five alternatives identified above

Alternatives 1, 3, and 4, above were eliminated by the Council from consideration. Alternative 1 simply because the no action alternative would not meet the Congressional mandate. Alternatives 3 and 4 may prove useful in the future but were presently eliminated because of the lack of data at the current time (McMillan and Morse 1998). While the public may comment on any of the above considered five alternatives, or any other means of identifying EFH, the Council considered only alternatives 2 and 5 viable. In actuality, alternative 2 (100% of the distribution) is one of the options under alternative 5.

The Council seriously considered using Alternative 2 (100% of the distribution) because dogfish has been identified as overfished. When the initial EFH guidelines were proposed in 1997, EFH for overfished species was to be identified as wherever the resource occurred. The Council, commenting on those guidelines in 1997, suggested that the Secretary should establish rules on how much of the total habitat should really be declared EFH. The relevant, nation-wide question is how much habitat is necessary to maintain a healthy stock. The Council also considered using 100% because of the language in section 600.815 (a)(2)(ii)(B), where it states, "if a species is overfished, and habitat loss or degradation may be contributing to the species being identified as overfished, all habitats currently used by the species should be considered essential in addition to certain historic habitats that are necessary to support rebuilding the fishery and for which restoration is technologically and economically feasible."

The Council did not really want to identify all areas where dogfish are found as EFH; thus they endorsed the concept of the Technical Team to use some objective criteria of less than 100% (Alternative 5) when supported by Level 2 data. The Technical Team, after meeting with the bluefish experts, suggested that, for overfished species, 90% of the area where they occur be designated EFH, while, when the resource is fully utilized or under utilized, that 75% be designated as EFH. Where only Level 1 (as in the South Atlantic) data are available, the Council has decided to identify 100% of the area in order to be risk averse. The Guidelines instruct that, when using Level 1 data, "EFH can be inferred on the basis of distributions among habitats where the species has been found and on information on its habitat requirements and behavior."

The Technical Team, Habitat Committee, Habitat Advisors, and Scientific and Statistical Committee all considered the five alternatives and concluded that the objective criteria (Alternative 5) was the most reasonable means for identifying and describing EFH for bluefish, and this same logic was applied to dogfish. The Council deems this approach to be reasonable until delineation with Level 3 and Level 4 data can be available. As more information is amassed, the EFH areas delineated can be increased or reduced, as necessary, since the description and identification provision of EFH is one of the provisions of the FMP that is frameworked (section 2.2.8).

2.2.2.1.3 Options for calculation of EFH under the objective criteria -- alternative 5

Options under Alternative 5, the preferred alternative, are based on the relative densities and areas of higher concentrations of shellfish. Maps of EFH designation options are provided for each gender and life history stage (juveniles and adults; Figures 14a-b and 15a-b). The maps presented display the distribution and abundance data by ten minute squares. This is the most efficient and understandable spatial scale. The data can easily be compared to other data sets, information from the fishing industry, and existing management analyses. The New England Fishery Management Council is approaching the identification and description of EFH in a similar manner with the assistance of the NEFSC. Four options were considered for Level 2 data (offshore areas north of Cape Hatteras) using the objective criteria (Figures 14a-b and 15a-b):

1. The top two quartiles (50% of the observations);

2. The top three quartiles (75% of the observations);

3. 90% of the observations; or

4. 100% of the observations, or the entire observed range of the resource from the surveys.

The "preferred" alternative for EFH designation using these data was chosen to be the highest 90% of the area where juvenile and adult dogfish were caught NEFSC trawl surveys. The CPUE and logged CPUE methods were not chosen because they tend to undervalue the area that is essential to dogfish.

The Level 2 data that are summarized in the ten minute square maps came from the NEFSC trawl survey. Data were assigned to a ten minute square based on the location of the dredge tow sample. Only those squares that had more than four samples and one positive catch were selected (Cross pers. comm.). Catch data were transformed [ln(catch + 1)], and the mean of the transformed data was calculated for each ten minute square. Initially, the catch data were explored three different ways: 1) as straight ranked CPUE; 2) as ranked ln CPUE; and 3) as ranked ln CPUE by area (Figure 16a-b for juveniles and adults).

The ten minute squares were ranked from high to low based on the mean catch. A total abundance index was calculated for the entire data set by summing the mean catch for all squares. The cumulative proportion of the total abundance index was calculated for the ranked ten minute squares beginning with the lowest rank (equals highest catch). Cutoff points at 50%, 75%, 90%, and 100% of the total abundance index were identified, and the squares at each of these cutoff points for each life stage were mapped (Figures 14a-b and 15a-b). These groupings (50%, 75%, 90%, and 100%) represent areas of decreasing average density and increasing area.

To create the EEZ maps, habitat-related density data (catch-per-unit-effort data, or CPUE) from the NEFSC trawl survey data were binned into squares, each square being 10 minutes of longitude by 10 minutes of latitude. Squares with less than 4 tows were dropped from further analyses. The CPUE data within the squares were log transformed [ln (CPUE + 1)], and the mean was calculated for each 10-minute square. Based on this mean, the squares with at least one positive catch were ranked in descending order, and the number of squares cumulatively summed, with the assumption that areas (squares) of the highest value in regard to EFH contained the highest densities of fish. The 10-minute squares contained in the top 50%, 75%, 90%, and 100% of this summation were then mapped separately onto the grid of squares to give percent of area occupied by dogfish for each of the cutoff points (Figures 14a-b and 15a-b).

This approach is fraught with limitations and based on major assumptions, but it is a scientifically objective approach that is based on the best available information. The NEFSC trawl survey does not survey everywhere that dogfish range, and thus, this analyzes is constrained and significantly biased low. State and inshore surveys, for the most part, either do not exist or are not in format comparable currently to NMFS data. None of the surveys collect the habitat information that is most needed (habitat type, substrate, biological associations, etc.). Additional sources of information (fishermen, historical, etc.) are sparse, difficult to verify, and largely anecdotal. However, public involvement in identifying and describing EFH is also solicited during the public hearing process.

However, even while faced with these limitations, we can be reasonably assured of where most of the dogfish tend to be and where they tend to occur in higher concentrations. This is the first step toward a complete designation of EFH. Thus, for the current amendment process, the Council can designate EFH based on the limited information available and set the stage for gathering new and better information. This additional information will help us eliminate the limitations of the current process and either verify or discredit the assumptions used.

One important thing to remember is that this is not the last step in the process, but that the public, Habitat Advisors, Habitat Committee, and the Council will have the opportunity to review and if necessary, modify these EFH designations. During the public hearing process, the public will be asked to comment on these designations and be able to provide additional available information. Following public review, the Council will have the opportunity to modify the EFH designations based on input gathered during this process. According to the Interim Final Rule, NMFS is required to provide their recommendation for the EFH designations, as well.

The Council chose the preferred alternative to be the highest 90% of the area (ranked by CPUE, for the offshore Level 2 data, NEFSC) because it is the most inclusive and thus the most risk averse without going to 100% of the dogfish distribution. Remember that dogfish are significantly overfished. While there is Level 2 data for offshore areas north of Cape Hatteras from the NEFSC trawl survey, all of the problems identified above reflect the low survey bias; therefore, the offshore areas are likely a minimum designation for EFH. The Council made the decision on the description of EFH (the highest 90% of the area where dogfish were collected) with the above factors in mind at the June Council meeting. The Council also decided to use the highest 90% of the area for both juveniles and adults for the designation of EFH since there was no readily apparent significant differences by life stage. There is not current information to support that any life stage appears specifically limiting in terms of an ecological bottleneck-type habitat association, and to maintain consistency the Council concluded there was no justification for different percentages by life stage. The Council is soliciting comments from the public on the appropriate percentages used for describing EFH where Level 2 data are available. Maps of the juvenile and adult dogfish with the associated percentages of offshore EFH designation are in Figures 14a-b for juveniles, and 15a-b for adults.

The actual area (number of 10 minute squares) for each of the standardized percentage (50%, 75%, 90%, and 100%), as well as corresponding variable percentages with catch for both life stages (juveniles and adults), are presented in Tables 7a-b. For example, Table 7b shows that the highest 90% of the catch of adult dogfish were caught within 27% of the area (approximately 230 out of the 850 ten minute squares) where dogfish were caught, while the highest 90% of the area would encompass 765 out of the 850 ten minute squares where dogfish were caught. The logged catch analysis was not included in Tables 7a-b because its area is consistently between the area and catch analyses (Figure 16a-b for the two life stages). The guidelines [Section 600.815 (a)(2)(C)(2)] state that, "Density data should reflect habitat utilization, and the degree that a habitat is utilized is assumed to be indicative of that habitat value." The Technical Guidance manual (USDC 1997a) continues to explain that "EFH is the area of moderate to high abundance. However, under certain conditions, habitats of low to moderate abundance may contribute to enough of the overall species productivity (e.g., reduced population size, when current population size of the species or stock is below historic levels)." Again, the Council selected one of the more inclusive approaches in its designation of offshore EFH because the surveys are inherently biased low for dogfish, and it will require management measures to rebuild this resource in the mandated 10 year time frame.

The only data presently available for dogfish south of Cape Hatteras are the SEAMAP data, which have not been summarized or analyzed in McMillan and Morse (1998). As mentioned earlier, the state data are now being put into a consistent, usable electronic format by the NEFSC and should be available for the next iteration of EFH amendments. The guidelines instruct that when using Level 1 data, "EFH can be inferred on the basis of distributions among habitats where the species has been found and on information about its habitat requirements and behavior." Therefore, in an effort to be risk averse and to follow the guidelines for Level 1 data, all waters with the same habitat parameters that are important to dogfish north of Cape Hatteras (i.e., epibenthic waters with same depth, temperature, and salinity) from Cape Hatteras, North Carolina to Florida will be designated as EFH (Figure 17). The purpose of identifying a broad area south of Cape Hatteras as EFH is so that any project proponents should document the distribution and abundance of dogfish in the areas that may be impacted with their activities. The Council is eagerly soliciting public comments on EFH designation in the South Atlantic because the offshore SEAMAP data are much less complete than offshore trawl data for the area north of Cape Hatteras.

The best available data to identify EFH for juvenile and adult dogfish in estuarine areas are the ELMR data (Tables 5 and 6, and Figures 12 and 13; Jury *et al.* 1994). In order to continue its risk averse approach to EFH, the Council concluded that all estuaries where juvenile and adult dogfish are listed as "common" or "abundant" will be designated as EFH (Table 7). While dogfish are not estuarine dependent, the ELMR data do show that juveniles and adults are "common" and/or "abundant" in most New England estuaries, thus the "seawater" (defined by ELMR as>25 ppt) portion of the estuaries will be designated as EFH.

Since it is an overfished species, and the fishery management unit extends south to Florida, but no offshore data are available south of Cape Hatteras, all waters with the same habitat parameters as north of Cape Hatteras, North Carolina will be designated as EFH. Since no estuarine data are available south of Cape Cod Bay, Massachusetts, but juveniles and adults and have been caught in the southern estuaries, all estuaries with the same habitat parameters as those north of Cape Cod Bay, Massachusetts will be designated as dogfish EFH.

2.2.2.2 Specific description and identification of dogfish essential fish habitat

In general, EFH for dogfish is designated as those areas within federal waters (out to the offshore boundary of the EEZ) of the Atlantic Ocean north of Cape Hatteras that encompass the highest 90% of the area where juvenile and adult dogfish were collected in the NEFSC trawl survey (Figures 18 through 19), and 100% of those areas south of Cape Hatteras (out to the offshore boundary of the EEZ) through Florida, with the same habitat parameters (temperature, salinity, etc.) as the areas designated north of Cape Hatteras (Figure 17), and the major estuaries where juvenile and adult dogfish are designated as "common" and "abundant" ELMR data (Table 8 and Figures 12 and13). Specifically, the Council preferred descriptions of EFH by life stage at this time are:

> **Juveniles:** EFH ranges from the Gulf of Maine through Cape Hatteras, North Carolina across the Continental Shelf in areas that encompass the highest 90% of the area where juvenile dogfish were collected in the NEFSC trawl surveys. South of Cape Hatteras, North Carolina through Florida , EFH is the Continental Shelf waters with the same habitat parameters as north of Cape Hatteras. Generally, dogfish are collected in depths between 33 ft and 1,280 ft and temperatures between 37°F and 68°F. EFH is also the "seawater" portions of all the estuaries where dogfish are common or abundant on the Atlantic coast, from Passamaquaddy Bay, Maine to Cape Cod Bay, Massachusetts, generally in water temperatures ranging between 37°F and 82°F.

> **Adults:** EFH ranges from the Gulf of Maine through Cape Hatteras, North Carolina across the Continental Shelf in areas that encompass the highest 90% of the area where adult dogfish were collected in the NEFSC trawl surveys. South of Cape Hatteras, North Carolina through Florida , EFH is the Continental Shelf waters with the same habitat parameters as north of Cape Hatteras. Generally, dogfish are collected in depths between 33 ft and 1,476 and temperatures between 37°F and 66°F. EFH is also the "seawater" portions of all the estuaries where dogfish are common or abundant on the Atlantic coast, from Passamaquaddy Bay, Maine to Cape Cod Bay, Massachusetts, generally in water temperatures ranging between 37°F and 82°F.

Finally, the MAFMC solicits input from the public on where they perceive EFH for dogfish should be designated. (Figures 20 and 21 are blank and can be submitted to the Executive Director of the MAFMC at the address on the cover of this FMP.)

2.2.2.2.1 Identification of habitat areas of particular concern

According to section 600.815 (a)(9), FMPs should identify habitat areas of particular concern (HAPC) within EFH where one or more of the following criteria must be met: (i) ecological function, (ii) sensitive to human-induced environmental degradation, (iii) development activities stressing, or (iv) rarity of habitat.

The MAFMC is not recommending any area as a Habitat Area of Particular Concern for dogfish at this time. The Council may designate HAPC as more data become available.

2.2.3 Fishing Activities that May Adversely Affect EFH

According to section 600.815 (a)(3), adverse effects from fishing may include physical, chemical, or biological alterations of the substrate, and loss of, or injury to, benthic organisms, prey species and their habitat, and other components of the ecosystem. FMPs must include management measures that minimize adverse effects on EFH from fishing, to the extent practicable, and identify conservation and enhancement measures. Councils must act to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable, if there is evidence that a fishing practice is having an identifiable adverse effect on EFH.

The following is a summary of general impacts of mobile fishing gear from the report "Indirect Effects of Fishing" (Auster and Langton 1998).

The discussion of the wide range of effects of fishing on EFH is based on the definition of EFH within the Act and the technical guidance produced by NMFS to implement the Act. The Act defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." For the purpose of interpreting the definition (and for defining the scope of this report), "waters" is interpreted by NMFS as "aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate" and "substrate" is defined to include sediment, hard bottom, structures, and associated biological communities. These definitions provide substantial flexibility in defining EFH based on our knowledge of the different species, but also allows EFH to be interpreted within a broader ecosystem perspective. Disturbance has been defined as "any discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment" (Pickett and White 1985). From an ecological perspective, fishing with fixed mobile gear is the most widespread form of direct disturbance in marine systems below depths which are affected by storms (Watling and Norse 1997). Disturbance can be caused by many natural processes such as currents, predation, iceberg scour (Hall 1994). Human caused disturbance can result from activities such as harbor dredging and fishing with mobile gear. Disturbance can be gauged by both intensity (as a measure of the force of disturbance) and severity (as a measure of impact on the biotic community). Table 9 summarizes the relative effects of the range of agents which produce disturbances in marine communities.

One of the most difficult aspects of estimating the extent of impacts on EFH is the lack of high resolution data on the distribution of fishing effort. Fishers are often resistant to reporting effort based on locations of individual tows or sets (for the obvious reason of divulging productive locations to competitors and regulators). Effort data in many fisheries are apportioned to particular statistical areas for monitoring purposes. Using this type of data it, has been possible to obtain averages of effort, and subsequent extrapolations of area impacted, for larger regions.

Trawling effort in the Middle Atlantic Bight off the northeast U.S. was summarized by Churchill (1989). Trawled area estimates were extrapolated from fishing effort data in 30 minute latitude x 30 minute longitude grids. The range of effort was quite variable, but the percent area impacted in some blocks off southern New England was over 200% with one block reaching 413%. Estimating the spatial impact of fixed gears is even more problematic. For example, during 1996 there were 2,690,856 lobster traps fished in the state of Maine (Maine Department of Marine Resources unpublished data). These traps were hauled on average every 4.5 d, or 81.4 times $year^{-1}$. Assuming a 1 m^2 footprint for each trap, the area impacted was 219 km^2. If each trap was dragged across an area three times the footprint during set and recovery, the area impacted was 657 km^2. A lack of data on the extent of the area actually fished makes analysis of the impacts of fishing on EFH in those fisheries difficult.

Auster and Langton (1998) summarize and interpret the current scientific literature on fishing impacts as they relate to fish habitat. These studies are discussed within three broad subject areas: effects on structural components of habitat, effects on benthic community structure, and effects on ecosystem level processes. The interpretation is based on commonalities and differences between studies. Fishing gear types are discussed as general categories (e.g., trawls, dredges, fixed gear). The necessity for these generalizations is based on two over-riding issues: (1) many studies do not specify the exact type and configuration of fishing gear used, and (2) each study reports on a limited range of habitat types. However, their interpretation of the wide range of studies is based on the type and direction of impacts, not absolute levels of impacts. Auster and Langton (1998) do not address the issues of bycatch (Alverson *et al.* 1994), mortality of gear escapees (Chopin and Arimoto 1995), or ghost fishing gear (Jennings and Kaiser 1998, p. 11-12 and references therein), as these issues do not directly relate to fish habitat, and recent reviews have been published which address these subjects.

Impacts of fishing on fish habitat (Auster and Langton 1998) include the following:

1. Effects on structural components of habitat;

2. Effects on community structure; and

3. Effects of ecosystem processes.

2.2.3.1 Effects on structural components of habitat

Habitat has been defined as "the structural component of the environment that attracts organisms and serves as a center of biological activity" (Peters and Cross 1992). Habitat in this case is defined as the range of sediment types (i.e., mud through boulders), bed forms (e.g., sand waves and ripples, flat mud), as well as the co-occurring biological structures (e.g., shell, burrows, sponges, seagrass, macroalgae, coral). A review of 22 studies (Table 10) all show measurable impacts of mobile gear on the structural components of habitat (e.g., sand waves, emergent epifauna, sponges, coral), when defining habitat at this spatial scale. Results of each of the studies show similar classes of impacts despite the wide geographic range of the studies (i.e., tropical to boreal). In summary, mobile fishing gear reduced habitat complexity by: (1) directly removing epifauna or damaging epifauna leading to mortality, (2) smoothing sedimentary bedforms and reducing bottom roughness, and (3) removing taxa which produce structure (i.e., taxa which produce burrows and pits). Studies which have addressed both acute and chronic impacts have shown the same types of effects.

Some species with demersal life history stages have obligate habitat requirements or recruitment bottlenecks (without the specific structural components populations of fishes with these habitat requirements would not persist). Few published accounts of the impacts of fixed gears on habitat have been written. Eno *et al.* (1996) studied the effects of crustacean traps in British and Irish waters. One experiment assessed the effects of setting and hauling pots on emergent epifaunal species (i.e., sea pens) on soft bottom. Both impacts from dragging pots across the bottom, and pots resting for extended periods on sea pens, showed the group was able to mostly recover from such disturbances. Limited qualitative observations of fish traps, longlines, and gill nets dragged across the seafloor during set and recovery showed results similar to mobile gear such that some types of epibenthos was dislodged, especially emergent species such as erect sponge and coral (High 1992, SAFMC 1991). While the area impacted per unit of effort is smaller for fixed gear than with mobile fishing gear, the types of damage to emergent benthos appear to be similar (but not necessarily equivalent per unit effort). Quantitative studies of fixed gear effects, based on acute and chronic impacts, have not been conducted.

The issue of defining pelagic habitats and elucidating effects of fishing is difficult because these habitats are poorly described at the scales that allow for measurements of change based on gear use. While pelagic habitat can be defined based on temperature, light intensity, turbidity, oxygen concentration, currents, frontal boundaries, and a host of other oceanographic parameters and patterns, there are few published data that attempt to measure change in any of these types of parameters or conditions concurrently with fishing activity and associations of fishes. Kroger and Guthrie (1972) showed that menhaden (*Brevoortia patronus* and *B. tyrannus*) were subjected to greater predation pressure, at least from visual predators, in clear versus turbid water, suggesting that turbid habitats were a greater refuge from predation. This same type of pattern was found for menhaden in both naturally turbid waters and in the turbid plumes, generated by oyster shell dredging activities (Harper and Hopkins 1976). However, no work has been published that addresses the effects of variation in time and space of the plumes or the effects using turbid water refugia on feeding and growth. There are also examples of small scale aggregations of fishes with biologic structures in the water column and at the surface. Aggregations of fishes may have two effects on predation patterns by: (1) reducing the probability of predation on individuals within the aggregation, and (2) providing a focal point for the activities of predators (a cue that fishermen use to set gear). For example, small fishes aggregate under mats of *Sargassum* (e.g., Moser *et al.* 1998) where high density vessel traffic may dis-aggregate mats. Also, fishes have been observed to co-occur with aggregations of gelatinous zooplankton and pelagic crustaceans (Auster *et al.* 1992, Brodeur in press). Gelatinous zooplankton are greatly impacted as they pass through the mesh of either mobile or stationary gear (unpublished observations), which may reduce the size and number of aggregations and disperse associated fishes. These changes could reduce the value of aggregating, resulting in increased mortality or reduced feeding efficiency.

Lack of information on the small scale distribution and timing of fishing make it difficult to ascribe the patterns of impacts observed in field studies to specific levels of fishing effort. Auster *et al.* (1996) estimated that between 1976 and 1991, Georges Bank was impacted by mobile gear (i.e., otter trawl, roller-rigged trawl, scallop dredge) on average between 200-400% of its area on an annual basis and the Gulf of Maine was impacted 100% annually. However, fishing effort was not homogeneous. Sea sampling data from NMFS observer coverage demonstrated that the distribution of tows was nonrandom. While these data represent less than 5% of overall fishing effort, they illustrated that the distribution of fishing gear impacts is quite variable.

Recovery of the habitat following trawling is difficult to predict as well. Timing, severity, and frequency of the impacts all interact to mediate processes which lead to recovery (Watling and Norse 1997). For example, sand waves may not be reformed until storm energy is sufficient to produce bedform transport of coarse sand grains (Valentine and Schmuck 1995), and storms may not be common until a particular time of year or may infrequently reach a particular depth, perhaps only on decadal time scales. Sponges are particularly sensitive to disturbance because they recruit aperiodically and are slow growing in deeper waters (Reiswig 1973, Witman and Sebens 1985, Witman *et al.* 1993). However, many species such as hydroids and ampelescid amphipods reproduce once or twice annually, and their stalks and tubes provide cover for the early benthic phases of many fish species and their prey (e.g., Auster *et al.* 1996, 1997b). Where fishing effort is constrained within particular fishing grounds, and where data on fishing effort is available, studies which compare similar sites along a gradient of effort have produced the types of information on effort-impact that will be required for effective habitat management (e.g., Collie *et al.* 1996, 1997; Thrush *et al.* in press).

The role these impacts on habitat have on harvested populations is unknown in most cases. However, a growing body of empirical observations and modeling demonstrate that effects can be seen in population responses at particular population levels. For example, Lindholm *et al.* (1998) have modeled the effects of habitat alteration on the survival of 0-year cohorts of Atlantic cod. The model results indicate that a reduction in habitat complexity has measurable effects on population dynamics when the adult stock is at low levels (i.e., when spawning and larval survivorship does not produce sufficient recruits to saturate available habitats). At high adult population levels, when larval abundance may be high and settling juveniles would greatly exceed habitat availability, predation effects would not be mediated by habitat, and no effect in the response of the adult population to habitat change was found.

Empirical studies that most directly link changes due to gear impacts changes on habitat structure to population responses are being carried out in Australia. Sainsbury (1987,1988, and 1991) and Sainsbury *et al.* (In press) have shown a very tight coupling between a loss of emergent epifauna and fish productivity along the north west continental shelf. In these studies, there was a documented decline in the bycatch of invertebrate epifauna, from 500 kg/hr to only a few kg/hr, and replacement of the most commercially desirable fish associated with the epifaunal communities by less valuable species associated with more open habitat. By restricting fishing, the decline in the fish population was reversed. This corresponded to an observed recovery in the epifaunal community; albeit the recovery for the larger epifaunal invertebrates showed a considerable lag time after trawling ceased. This work is based on a management framework which was developed to test hypotheses regarding the habitat dependence of harvested species. The hypotheses, described in Sainsbury (1988 and 1991), assessed whether population responses were the result of: (1) independent single-species (intraspecific) responses to fishing and natural variation, (2) interspecific interactions such that, as specific populations are reduced by fishing, non-harvested populations experienced a competitive release, (3) interspecific interactions such that, as non-harvested species increase from some external process, their population inhibits the population growth rate of the harvested species, and (4) habitat mediation of the carrying capacity for each species, such that gear induced habitat changes alter the carrying capacity of the area.

2.2.3.2 Effects on community structure

An immediate reduction in the density of non-target species is commonly reported following impact from mobile gear (Table 11). In assessing this effect, it is common to compare numbers and densities for each species before and after trawling and/or with an undisturbed reference site.

Time series data sets that allow for a direct long-term comparison of before and after fishing are essentially nonexistent, primarily because the extent to which the worlds oceans are currently fished was not foreseen, or because time series data collection focused on the fish themselves rather than the impact of fishing on the environment. Nevertheless, there are several benthic data sets that allow for an examination of observational or correlative comparisons before and after fishing (Table 12). Long-term effects of fishing included reduced densities of certain types of macrobenthos including sponges, coelenterates, bivalves, as well as seagrass meadows and increases in taxa such as polychaete. Other shifts occurred; for example, a decline in sea urchins to an increase in brittle stars, a decline in deposit feeders and an increase in suspension feeders and carnivores, as well as a decline in animal size.

Data sets on the order of months to a few years are more typical of the longer term studies on trawling impacts on benthic community structure. Otter trawl door marks were visible for 2 to 7 months with no sustained significant impact on the benthic community noted at high energy locations. In the lower energy muddy sand location, there was a loss in surficial sediments and lowered food quality of the sediments. The subsequent variable recovery of the benthic community over the following six months correlated with the sedimentary food quality which was measured as microbial populations, chlorophyll "a" and enzyme hydrolizable amino acids. While some taxa recolonized the impacted areas quickly, the abundances of some taxa (i.e., cumaceans, phoxocephalid and photid amphipods, nephtyid polychaetes) did not recover until food quality also recovered.

The most consistent pattern in fishing impact studies at shallow depths is the resilience of the benthic community to fishing. Most studies demonstrate that most taxa recover from the effects of trawling within months to years. These taxa include worms, bivalves, sea grass, and crustacea. In the case of the most intense trawling, seagrass beds did not recover after two years. Sometimes the community may shift to less commercially desirable species. In experimentally closed areas, there has been a recovery of fish and an increase in the small benthos but, based on settlement and growth of larger epifaunal animals, it may take 15 years for a system to recover. Two studies in the intertidal, harvesting worms and clams using suction and mechanical harvesting gear demonstrated a substantial immediate effect on the macrofaunal community but from seven months to two years later, the study sites had recovered to pre-trawled conditions (Beukema 1995, Kaiser and Spencer 1996). In a South Carolina estuary, Van Dolah *et al.* (1991) found no long term effects of trawling on the benthic community. The study site was assessed prior to and after the commercial shrimp season and demonstrated variation over time, but no trawling effects *per se*. Other studies of pre and post impacts from mobile gear on sandy to hard bottoms have generally shown similar results (Currie and Parry 1996, Gibbs *et al.* 1980, MacKenzie 1982), with either no or minimal long term impact detectable.

Clearly, the long-term effects of fishing on benthic community structure are not easily characterized. The pattern that does appear to be emerging from the available literature is that communities that are subject to variable environments, and are dominated by short-lived species, are fairly resilient. Depending on the intensity and frequency of fishing, the impact of such activity may well fall within the range of natural perturbations. In communities which are dominated by long-lived species in more stable environments, the impact of fishing can be substantial and longer term. In cases such as described in Auster and Langton (1998) for Strangford Loch and the Australian shelf, recovery from trawling will be on the order of decades. In many areas, these patterns correlate with shallow and deep environments. However, water depth is not the single variable that can be used to characterize trawling impacts.

There are few studies that describe fishing impacts on soft muddy bottom communities or deep areas at the edge of the continental shelf. Such sites would be expected to be relatively low energy zones, similar to Strangford Loch, and might not recover rapidly from fishing disturbance. Studies in these relatively stable environments are required to pattern fishing impacts over the entire environmental range but, in anticipation of such results, it is suggested here that one should expect a tighter coupling between fish production and benthic community structure in the more stable marine environments.

2.2.3.3 Effects on ecosystem processes

A number of studies indicate that fishing has measurable effects on ecosystem processes. Disturbance by fishing gear in relatively shallow depths (i.e., 98 - 131 ft [30-40 m] depth) can reduce primary production by benthic microalgae. Recent studies in several shallow continental shelf habitats have shown that primary production by a distinct benthic microflora can be a significant portion of overall primary production (i.e., water column plus benthic primary production; Cahoon and Cooke 1992, Cahoon *et al.* 1990 and 1993). Benthic microalgal production supports a variety of consumers, including demersal zooplankton (animals that spend part of each day on or in the sediment and migrate regularly into the water; Cahoon and Tronzo 1992). Demersal zooplankton include harpacticoid copepods, amphipods, mysids, and other animals that are eaten by planktivorous fishes and soft bottom foragers (Thomas and Cahoon 1993).

The disturbances caused by fishing to benthic primary production and organic matter dynamics are difficult to predict. Semi-closed systems such as bays, estuaries, and fjords are subject to such effects at relatively small spatial scales. Open coastal and outer continental shelf systems can also experience perturbations in these processes. However, the relative rates of other processes may minimize the effects of such disturbances depending upon the level of fishing effort.

Mayer *et al.* (1991) discussed the implications of organic matter burial patterns in sediments versus soils. Their results are similar to organic matter patterns found in terrestrial soils. Sediments are essentially part of a burial system while soils are erosional. While gear disturbance can enhance remineralization rates by shifting from surficial fungal dominated communities to subsurface communities with dominant bacterial decomposition processes, burial caused by gear disturbance might also enhance preservation if material is sequestered in anaerobic systems. Given the importance of the carbon cycling in estuaries and on continental shelves to the global carbon budget, understanding the magnitude of effects caused by human disturbances on primary production and organic matter decomposition will require long term studies as have been conducted on land.

2.2.3.1 Direct alteration of food web

In heavily fished areas of the world, it is undebatable that there are ecosystem level effects (Gislason 1994, Fogarty and Murawski 1998) and that shifts in benthic community structure have occurred. The data to confirm that such shifts have taken place is limited at best (Riesen and Reise 1982) but the fact that it has been documented at all is highly significant. If the benthic communities change, what are the ecological processes that might bring about such change?

One of these is an enhanced food supply, resulting from trawl damaged animals and discarding both nonharvested species and the offal from fish gutted at sea. The availability of this food source might affect animal behavior, and this energy source could influence survival and reproductive success. There are numerous reports of predatory fishes and invertebrate scavengers foraging in trawl tracks after a trawl passes through the area (Medcof and Caddy 1971, Caddy 1973, Kaiser and Spencer 1994, Ramsey *et al.* 1997a-b). The prey available to scavengers is a function of the ability of animals to survive the capture process, either being discarded as unwanted by-catch or having been passed through or over by the gear (Meyer *et al.* 1981, Fonds 1994, Rumhor *et al.* 1994, Santbrink and Bergman 1994, Kaiser and Spencer 1995). Stomach contents data demonstrate that fish not only feed on discarded or damaged animals, and often eat more than their conspecifics at control sites, they also consume animals that were not damaged but simply displaced by the trawling activity, or even those invertebrates that have themselves responded as scavengers (Kaiser and Spencer 1994, Santbrink and Bergman 1994).

It is of interest to note that Kaiser and Spencer (1994) make the comment, as others have before them, that it is common practice for fishermen to re-fish recently fished areas to take advantage of the aggregations of animals attracted to the disturbed benthic community. The long term effect of opportunistic feeding following fishing disturbances is an area of speculation.

Another process that can indirectly alter food webs is alteration of the predator community by removing keystone predators. In the northwest Atlantic, Witman and Sebens (1992) showed that onshore-offshore differences in cod and wolffish populations reduced predation pressure on cancrid crabs and other megafauna in deep coastal communities. They suggest that this regional difference in predation pressure is the result of intense harvesting of cod, a keystone predator, with cascading effects on populations of epibenthos (e.g., mussels, barnacles, urchins), which are prey of crabs. Other processes (e.g., annual variation in physical processes effecting survivorship of recruits, climate change, El Nino, recruitment variability of component species caused by predator induced mortality) can also result in food web changes; while it is important to understand the underlying causes of such shifts, precautionary approaches should be considered, given the strong inference of human caused effects in the many cases where studies were focused on identifying causes.

2.2.3.4 Summary

This review of the literature by Auster and Langton (1998) indicates that fishing, using a wide range of gear, produces measurable impacts. However, most studies were conducted at small spatial scales, and it is difficult to apply such information at a regional levels where predictive capabilities would allow us to manage at an ecosystem scale (Jennings and Kaiser in press). Our current understanding of ecological processes related to the chronic disturbances caused by fishing make results difficult to predict (Auster and Langton 1998).

The removal of fish for human consumption from the world's oceans has effects not only on the target species, but also on the associated benthic community. The size specific, and species specific, removal of fish can change the system structure, but, fortunately, the regions of the continental shelf which are normally fished appear to be fairly resilient. The difficulty for managers is defining the level of resilience, in the practical sense of time/area closures or mesh regulations or overall effort limits, that will allow for the harvest of selected species without causing human induced alterations of the ecosystem structure to the point that recovery is unduly retarded or community and ecosystem support services are shifted to an alternate state (Steele 1996). Natural variability forms a backdrop against which managers must make such decisions, and, unfortunately, natural variability can be both substantial and unpredictable (Auster and Langton 1998).

2.2.3.6 Ghost fishing

Stationery gear may also cause adverse impacts to fish habitat by becoming ghost fishing gear. This occurs when storms, mobile gear, or boats rip traps, gill nets, and pots from their lines. This lost gear cannot be retrieved and may continue to fish for years (Rhodes 1995). In addition, ghost gill nets, traps, and pots change the structural component of the habitat. This can be a problem with commercial and recreational gear. This problem is currently impossible to quantify and the ecosystem effects are difficult to predict.

2.2.3.7 Fishing gear used within the dogfish range

Commercial fishing gear used in 1995 for all fisheries prosecuted from Maine to Virginia is characterized in Table 13 (based on unpublished NMFS weighout data). While total pounds of all species landed is not necessarily an indication of effort, it gives some indication of the relative use of the various fishing gears in both state and federal waters. Bottom gear used from Maine to Virginia include bottom otter trawls, clam dredges, sea scallop dredges, and other dredges. Fishing gear managed by the South Atlantic Council is presented in Table 14.

2.2.3.8 Fishing impacts to dogfish EFH

Dogfish are a predominantly epibenthic species, with no known associations to any particular substrate, submerged aquatic vegetation (SAV), or any other structural habitat (McMillan and Morse 1998). However, because its life history does focus towards the ocean bottom, any mobile gear that comes in contact with the bottom may potentially adversely impact habitat that is important to dogfish. Effort of mobile gear in federal and state waters throughout the entire dogfish range is unquantified. Therefore, it is difficult to predict the exact impact that mobile gear in contact with the bottom will have on dogfish habitat. Although there is no way to gauge the intensity and severity of mobile gear in contact with the bottom (bottom otter trawl, clam dredge, scallop dredge, and dredge-other), these gears are characterized as having a "potential adverse impact" on dogfish EFH (Table 15).

2.2.4 Options for Managing Adverse Effects from Fishing

According to section 600.815 (a)(4), fishery management options may include, but are not limited to: (i) fishing equipment restrictions, (ii) time/area closures, and (iii) harvest limits.

All mobile gear coming into contact with the seafloor within dogfish EFH is characterized as having a potential impact on their EFH. However, the effort of these bottom tending gears is largely unquantified from data that are presently collected by the NEFSC, as summarized by Auster and Langton (1998), and therefore, no management measures will be proposed at this time.

2.2.5 Identification of Non-Fishing Activities and Associated Conservation and Enhancement Recommendations

NOTE: Sections 600.815(a)(5), 600.815(a)(6), and 600.815(a)(7) are all combined here, in order to better clarify the cause and effect association of actions.

According to section 600.815 (a)(5), FMPs must identify activities that have the potential to adversely affect EFH quantity or quality, or both. Broad categories of activities which can adversely affect EFH include, but are not limited to: dredging, fill, excavation, mining, impoundment, discharge, water diversions, thermal additions, actions that contribute to non-point source pollution and sedimentation, introduction of potentially hazardous materials, introduction of exotic species, and the conversion of aquatic habitat that may eliminate, diminish, or disrupt the functions of EFH.

Estuarine and coastal lands and waters are used for many purposes that often result in conflicts for space and resources (USDC 1985a). Some may result in the absolute loss or long-term degradation of the general aquatic environment or specific aquatic habitats, and pose theoretically significant, but as yet unquantified threats to biota and their associated habitats (USDC 1985a).

Multiple-use issues are constantly changing, as are the impacts of certain activities on living marine resources (USDC 1985a). Activities that occur on estuarine and coastal lands and waters and offshore waters may affect living marine resources directly and/or indirectly through habitat loss and/or modification. These effects, combined with cumulative effects from other activities in the ecosystem, may contribute to the decline of some species (USDC 1997a). The following discussion identifies and describes each multiple use issue and the potential threats associated with that issue. The adverse effects to marine organisms and their habitats resulting from any given threat are demonstrable, but usually not completely quantifiable. Environmental and socio-economic issues remain to be satisfactorily resolved with regard to impacts on marine organisms and their habitats.

The threats addressed in this section are germane to the entire Atlantic coast. All Mid-Atlantic Council managed species exist outside the geographic boundaries of Mid-Atlantic Council. Knowledgeable NMFS/Council individuals were asked to identify and prioritize non-fishing "perceived" threats. Once this list was complete, the resulting paper was distributed for review via mail, workshops, and conferences. The list is prioritized in regards to (1) perceived threats of habitat managers and others in the environmental community and (2) potential impact to dogfish habitat (Table 16). Information from the ASMFC workshop (Stephan and Beidler 1997) for habitat managers, which included a broad spectrum of constituents, was also used to identify threats.

Measures for conservation and enhancement of EFH

According to section 600.815 (a)(7), FMPs must describe options to avoid, minimize, or compensate for the adverse effects identified in the non-fishing threats section including cumulative impacts (section 2.2.5). The Councils are deeply concerned about the effects of marine and estuarine habitat degradation on fishery resources.

The MSFCMA 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. Additionally, the MSFCMA provides [305(b)(3)(A)] that "Each Council may comment on, and make recommendations to the Secretary and any federal agency concerning, any activity authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by any federal or state agency that, in the view of the Council, may affect the habitat, including essential fish habitat, of a fishery resource under its authority." [305(b)(4)(B)] "Within 30 days after receiving a comment under subparagraph (A), a federal agency shall provide a detailed response in writing to the Council commenting under paragraph (3)."

The Councils have a responsibility under the MSFCMA to consider the impact of habitat degradation on dogfish. The following recommendations are made in light of that responsibility.

The goal of the Council is to preserve all available or potential natural habitat for dogfish by encouraging management of conflicting uses to assure access by dogfish and maintenance of high water quality to protect dogfish migration, spawning, nursery, overwintering, and feeding areas. Non-water dependent actions should not be authorized in dogfish EFH, if they adversely affect that habitat. Those non-water dependent actions in adjacent upland areas, such as agriculture, should be managed to minimize detrimental effects. Water dependent activities that may adversely affect dogfish EFH, should be designed using environmentally sound engineering and best management practices to avoid or minimize those impacts. Regardless, the least environmentally damaging alternatives available should be employed to reduce impacts, both individually and cumulatively to dogfish EFH. Finally, compensatory mitigation should be provided for all unavoidable impacts to dogfish EFH.

Also, in general, the EPA and States should review their water quality standards relative to dogfish EFH areas and make changes as needed in estuarine and coastal areas. The EPA should establish water quality standards for the EEZ sufficient to maintain edible dogfish. Finally, water quality standards in dogfish EFH should be enforced rigidly by state or local water quality management agencies, whose actions should be carefully monitored by the EPA. Where state or local management efforts (standards/enforcement) are deemed inadequate, EPA should take steps to assure improvement; if these efforts continue to be inadequate, EPA should assume authority, as necessary.

Specific recommendations for the conservation and enhancement of dogfish EFH are found following discussion of individual habitat threats. The permitting/licensing authority should ensure that the project proponents adhere to the following recommendations.

2.2.5.1 Habitat threats prioritized for dogfish EFH

Many anthropogenic (caused by man) actions threaten the integrity of dogfish EFH. These threats have been prioritized based on the following:

Dogfish are epibenthic predators located across the Continental Shelf, into the estuaries (Figure 1, 4-7, 8-11). They are opportunistic feeders, however, some of their prey items, e.g., menhaden, are estuarine dependent. A total of 14 estuaries in the North Atlantic have been designated as dogfish EFH, and cumulative impacts from estuarine and land-based activities can have negative effects on dogfish EFH in nearshore and offshore waters.

Based on these considerations, threats that impact estuaries, inshore areas, and water quality are priority concerns in dogfish EFH (Table 16). The threats may be primary, direct (e.g., physically removing habitat by dredging or filling) or secondary, indirect (e.g., water quality degradation caused by urban or agricultural runoff). Many of the threats associated with dogfish EFH result in both primary and secondary impacts (e.g., coastal development, dredging and spoil disposal). Collectively, these impacts are "cumulative," which are often synergistic (i.e., the whole is greater than the sum of its parts). Some of the more challenging cumulative impacts are discussed in Section 2.2.5.14.

A more detailed discussion of the habitat threats affecting dogfish EFH and other Atlantic coast habitats follows. The described threats, and associated enhancement or mitigative recommendations, are related to both direct and indirect impacts. Again, their priority with respect to dogfish EFH is identified in Table 15.

2.2.5.2 Coastal development

Coastal development involves changes of land use; these activities include urban, suburban, commercial, and industrial, along with the construction of corresponding infrastructure. Coastal development also includes clearing of forestlands and filling of wetlands for agricultural use. Development first occurred in the coastal areas, and this historical trend continues. Approximately 80 percent of the Nation's population lives in coastal areas (USEPA 1993). The U.S. Census Bureau estimates the 1997 world population to be 267.7 million in the United States and 5.84 billion in the world (Zero Population Growth Reporter pers. comm.). The US population rose 85 percent within 50 miles of the coastlines between 1940 and 1980, compared to 70 percent for the nation as a whole (Zero Population Growth Reporter 1994). The US Census Bureau projects that by the year 2000, the US population will reach 275 million, more than double its 1940 population.

Brouha (1994) points out our dilemma and states: "All our scientific work will be for naught if world human population growth and resource consumption are not stabilized soon. Unchecked growth, subsidies that support unsustainable resource use, and natural resource policies focused on short-term economic gains have created a conundrum for the long-term economic integrity and productivity of global ecosystems." However, Ehrlich (1990) may have stated the problem best: "No matter how distracted we may be by the number of problems now facing us, one issue remains fundamental: Overpopulation. The crowding of our cities, our nations, underlies all other problems."

During development, vegetated and open forested areas are converted to land uses that usually have increased areas of impervious surface resulting in increased runoff volumes and pollutant loadings (USEPA 1993). Eventually, changes to the physical, chemical, and biological characteristics of the watershed result. Vegetative cover is stripped from the land and cut-and-fill activities that enhance the development potential of the land occur. As population density increases, there is a corresponding increase in pollutant loadings generated from human activities (USEPA 1993).

Everyday household activities also generate numerous pollutants that affect water quality, including (USEPA 1993): improper disposal of used oil and antifreeze; frequent fertilization, pesticide application; improper disposal of yard trimmings; litter and debris; and pet droppings (USEPA 1993). Runoff from commercial land areas such as shopping centers, business districts, office parks, and large parking lots or garages may contain high hydrocarbon loadings and metal concentrations contributing more pollutants such as heavy metals, sediments, nutrients, and organics, including synthetic and petroleum hydrocarbons (USEPA 1993).

In addition to habitat impacts associated with the primary effects of coastal development, such as wetland filling, forest clearing, land grading, and construction, many secondary impacts resulting from changes in land use and population growth may occur. For example, urban/suburban development in low lying coastal areas and floodplains often causes a need for flood control that results in channel relocation, channelization, and impoundment of streams, rivers, and wetlands. Loss of natural wildlife habitats lead to wildlife management practices that promote wetland impoundment and filling shallows for bird breeding islands that deleteriously affect living marine resources. As population growth continues, the demand for nuisance insect control, such as ditching of tidal marshes and the spraying of insecticides for mosquito abatement, also continues.

Measures for conservation and enhancement

A). Filling of wetlands and shallow coastal water habitat should not be permitted in or near dogfish EFH. Mitigating or compensating measures should be employed where filling is totally unavoidable. Project proponents must demonstrate that project implementation will not negatively affect dogfish, their habitat, or their food sources.

B). Coastal development traditionally involved dredging and filling of shallows and wetlands, hardening of shorelines, clearing of riparian vegetation, and other activities that adversely affect the habitats of living marine resources. Mitigative measures are imperative for all development activities in and adjacent to dogfish EFH to prevent further degradation.

C). Adverse impacts resulting from construction should be avoided whenever practicable alternatives are identified. For those impacts that cannot be avoided, minimization through implementation of best management practices should be employed. For those impacts that can neither be avoided nor minimized, compensation through replacement of equivalent functions and values should be required.

D). Flood control projects in waterways draining into dogfish EFH should be designed to include mitigative measures and constructed using Best Management Practices (BMPs). For example, stream relocation and channelization should be avoided whenever practicable. However, should no practicable alternatives exist, relocated channels should be of comparable length and sinuosity as the natural channels they replace to maintain the quality of water entering receiving waters (i.e., dogfish EFH).

E). Wildlife management projects should not adversely affect dogfish EFH. No impoundment of tidal wetlands or creation of islands should be authorized in dogfish EFH.

F). Mosquito control in dogfish EFH should be implemented using BMPs. Ditching should be in accordance with the principles of Open Marsh Water Management (e.g., restricting ditching to only those areas that are actively breeding mosquitoes; using specialized equipment, such as the rotary ditcher that slurries marsh peat thereby eliminating spoil disposal problems). Insecticides that are used should be selected to minimize impacts to non-target species (e.g., Abate: a short-lived insecticide that inhibits mosquito larvae from pupating).

2.2.5.2.1 Water withdrawal and diversion

As residential, commercial, and industrial growth continues, the demand for potable, process, and cooling water, flow pattern disruption, waste water treatment and disposal, and electric power increases. As ground water resources become depleted or contaminated, greater demands are placed on surface water through activities such as dam and reservoir construction or some other method of freshwater diversion. The consumptive use or redistribution of significant volumes of surface freshwater causes reduced river flow that can affect salinity regimes as saline waters intrude further upstream.

Turek *et al.* (1987) identified numerous studies that have correlated freshwater inflows and fishery resource production. Salinity is a primary ecological factor regulating the distribution and survival of marine organisms. The amount of freshwater entering an estuary influences physicochemical variables (e.g. salinity, temperature, and turbidity) directly affecting physiological processes in organisms. Salinity is also a primary factor regulating estuarine primary production. In addition, salinity governs fish distribution by secondarily restricting predator distribution (Turek *et al.* 1987).

Diversion of freshwater to other streams, reservoirs, industrial plants, power plants, and municipalities can change the salinity gradient downstream and displace spawning and nursery grounds. Patterns of estuarine circulation necessary for larval and planktonic transport can be modified. Such changes can expand the range of estuarine diseases and predators associated with higher salinities that affect commercial shellfish.

Measures for conservation and enhancement

A). Water withdrawals should be regulated to provide flows adequate to maintain the biological, chemical, and physical integrity of waters flowing into dogfish EFH. For example, under low flow conditions, flows should be maintained to prevent shifts in salinity regimes or changes in fish distribution.

B). The transfer of water from one basin to another is discouraged. Interbasin transfers can cause hydrological imbalances in rivers flowing into estuaries that can adversely affect dogfish EFH.

C). Dams constructed for reservoir development should not be sited in sensitive habitats. Dams that block anadromous rivers and streams (into which fish migrate from the sea) adversely affect dogfish directly by impairing prey production (e.g., river herrings) or indirectly by reducing flows that downstream salinity changes.

2.2.5.2.2 Construction

Construction activities within watersheds and in coastal marine areas often impact fish habitat. Some of these projects are of sufficient scope to singly cause significant, long term or permanent impacts to aquatic biota and habitat; however, most are small scale, causing losses or disruptions to organisms and environment. The significance of small scale projects lies in the cumulative effects resulting from the large number of these activities (USDC 1985a).

Tremendous development pressures exist throughout the coastal area of the Northeast Region. More than 2,000 permit applications are processed annually by the NMFS Northeast Region for commercial, industrial, and private marine construction proposals. The proposals range from generally innocuous, open pile structures, to objectionable fills that encroach into aquatic habitats, thereby eliminating their productive contribution to the marine ecosystem (USDC 1985a). The projects range from small scale recreational endeavors to large scale commercial ventures to revitalize urban waterfronts (USDC 1985a).

Runoff from construction sites is by far the largest source of sediment in urban areas under development (USEPA 1993). Eroded sediment from construction sites creates many problems in coastal areas, including adverse impacts on water quality, sensitive habitats, SAV beds, recreational activities, and navigation (USEPA 1993). Other potential pollutants associated with construction activities include: pesticides (insecticides, fungicides, herbicides, and rodenticides); fertilizers used for vegetative stabilization; petrochemicals (oils, gasoline, and asphalt degreasers); construction chemicals such as concrete products, sealers, and paints; wash water associated with these products; paper; wood; garbage; and sanitary wastes (USEPA 1993). The variety of pollutants present and the severity of their effects are dependent on a number of factors (USEPA 1993):

1. The nature of the construction activity;

2. The physical characteristics of the construction site; and

3. The proximity of surface waters to the nonpoint pollutant source.

Construction impacts can also include hydrological changes and water quality changes. Hydrologic and hydraulic changes occur in response to site clearing, grading, and the addition of impervious surfaces and maintained landscapes (USEPA 1993).

In addition, construction in and adjacent to waterways often involves dredging and/or fill activities which result in elevated suspended solids emanating from the project area. The distance the turbidity plume moves from the point of origin is dependent upon tides, currents, nature of the substrate, scope of work, and preventive measures employed by the contractor (USDC 1985a).

Measures for conservation and enhancement

The following measures were taken from Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (USEPA 1993).

A). Watershed protection/site development should be encouraged. Comprehensive planning for development on a watershed scale and for small-scale site development, including planning and designing to protect sensitive ecological areas, minimize land disturbances and retain natural drainage and vegetation whenever possible.

B). Pollution prevention activities, including techniques and activities to prevent nonpoint source pollutants from entering surface waters, should be implemented. Primary emphasis should be placed on public education to promote methods for proper disposal and/or recycling of hazardous chemicals, pet waste management strategies, management practices for lawns and gardens, onsite disposal systems (OSDSs), and commercial enterprises such as service stations and parking lots.

C). Construction erosion/sediment control measures should reduce erosion and transport of sediment from construction sites to surface water. A sediment and erosion control plan should be developed and approved prior to land disturbance for construction sites of less than 5 acres.

D). Runoff from new development should be managed so as to meet two conditions: (1) The average annual total suspended solid (TSS) loadings after construction is completed are reduced, a) by 80 percent or b) so that they are no greater than pre-development loadings; and (2) To the extent practicable, post-development peak runoff rate and average volume are maintained at levels that are similar to pre-development levels.

E). Construction site chemical control measures should address the transport of toxic chemicals to surface water by limiting the application, generation, and migration of chemical contaminants (i.e., petrochemicals, pesticides, nutrients) and providing proper storage and disposal.

F). Watershed management programs of existing developments should be developed that identify the sources, specify appropriate controls such as retrofitting or the establishment of buffer strips, and provide a schedule by which these controls are to be implemented.

G). New onsite disposal systems should be built to reduce nutrient/pathogen loadings to surface water. OSDS are to be designed, installed and operated properly, and to be situated away from open waterbodies and sensitive resources such as wetlands, and floodplains. Protective separation between the OSDS and the groundwater table should be established. The OSDS unit should be designed to reduce nitrogen loadings in areas where surface waters may be adversely affected.

H). Operating onsite disposal systems should prevent surface water discharge and reduce pollutant loadings to ground water. Inspection at regular intervals and repair or replacement of faulty systems should occur.

2.2.5.2.3 Construction of infrastructure

Construction activities of infrastructure, such as highways, bridges, and airports, can result in permanent loss or long-term disruption of habitat (USEPA 1993). For instance, highway construction often involves stream straightening or relocation. Dredging can degrade productive shallow water and destroy marsh habitat or resuspend pollutants, such as heavy metals, pesticides, herbicides and other toxins. Concomitant with dredging is spoil disposal, which traditionally occurred on marshes or in water where the effects were temporary (both short- and long-term) or permanent in terms of its degradation or destruction. Shoreline stabilization can cause gross impacts when intertidal and sub-tidal habitats are filled, or when benthic habitats are scoured by reflective wave energy. Stabilization can also cause subtle effects that result in gradual elimination of the ecosystem between the shore and the water (USEPA 1993).

Construction of bridges in coastal areas can cause significant erosion and sedimentation, resulting in the loss of wetlands and riparian areas (USEPA 1993). Additionally, since bridge pavements are extensions of the connecting highway, runoff waters from bridge decks also deliver loadings of heavy metals, hydrocarbons, toxic substances, and deicing chemicals to surface waters. Bridge maintenance can also contribute heavy loads of lead, rust particles, paint, abrasive, solvents, and cleaners into surface waters. Bridge structures should be located to avoid crossing over sensitive fisheries and shellfish-harvesting areas to prevent washing polluted runoff into the waters below. Also, bridge design should account for potential scour and erosion, which may affect shellfish beds and bottom sediments (USEPA 1993).

Wetland and riparian areas will need special consideration if affected by highway and bridge construction, particularly in areas where construction involves depositing fill, dredging, or installing pilings (USEPA 1993). Highway development is most disruptive in wetlands because it may cause increased sediment loss, alteration of surface drainage patterns, changes in the subsurface water table, and loss of wetland habitat (USEPA 1993).

Measures for conservation and enhancement

The following measures were taken from Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (USEPA 1993).

A). Roads, highways, bridges and airports should be situated away from areas that are sensitive ecosystems and susceptible to erosion and sediment loss. The siting of such structures should not adversely impact water quality, minimize land disturbances, and retain natural vegetation and drainage features.

B). Construction projects of roads, highways, bridges and airports should implement approved erosion and sediment control plans prior to construction, which would reduce erosion and improve retention of sediments onsite during and after construction.

C). Construction site chemical control measures for roads, highways, and bridges should limit toxic and nutrient loadings at construction sites by ensuring the proper use, storage, and disposal of toxic materials to prevent significant chemical and nutrient runoff to surface water.

D). Operation and maintenance should be developed for roads, highways, bridges, and airports to reduce pollutant loadings to receiving waters during operation and maintenance.

E). Runoff systems should be developed for roads, highways, bridges, and airports to reduce pollutant concentrations in runoff from existing roads, highways, and bridges. Runoff management systems should identify priority pollutant reduction opportunities and schedule implementation of retrofit projects to protect impacted areas and threatened surface waters.

F). The planning process for new and maintenance channel dredging projects should include an evaluation of the potential effects on the physical and chemical characteristics of surface waters and riparian habitat that may occur as a result of the proposed work and reduce undesirable impacts. The operation and maintenance programs for existing modified channels should identify and implement any available opportunities improve the physical and chemical characteristics of surface waters in those channels.

G). Bridges should be designed to include collection systems which convey surface water runoff to land-based sedimentation basins.

2.2.5.2.4 Shoreline stabilization

The erosion of shorelines and stream banks is a natural process that can have either beneficial or adverse impacts on the creation and maintenance of riparian habitat (USEPA 1993). Beaches are dynamic, ephemeral land forms that move back and forth onshore, offshore and along shore with changing wave conditions. Although bulkheads and seawalls protect the upland area against further land loss, they often create a local problem. Downward forces of water produced by waves striking a wall can produce a transfer of wave energy and rapidly move sand from the wall, causing scouring and undermining, and increased erosion downstream (USEPA 1993).

Groins are structures that are built perpendicular to the shore and extend into the water (USEPA 1993). Jetties are structures that are built perpendicular to shore to stabilize a channel. Groins and jetties trap sand in littoral drift and halt longshore movement. Sand traps created by these structures often result in inadequate supply of sand to replace that which is carried away. The "downdrift" beaches are often sand depleted, and severe erosion results (USEPA 1993).

Stabilization of eroding shorelines can be beneficial to living marine resources by reducing turbidity and subsequent sedimentation. However, some stabilization techniques can have secondary adverse impacts. Bulkheads harden shorelines, thereby eliminating the interaction between organisms and intertidal habitats during high tides. Wave energy reflecting off vertical bulkhead faces destabilize adjacent benthic habitats rendering them less productive. Additionally, bulkheads are often constructed with chemically treated timber which contain toxic compounds that leach into adjacent waters through time.

Alternatives to vertical bulkheads are stone revetments (riprap) and vegetative stabilization. Unlike bulkheads, stone revetments are not vertical, and consequently, do not reflect wave energy. Also, the hard surfaces and interstitial spaces between the stones adds heterogeneity to local habitats. Vegetative stabilization provides the most natural means of erosion control, as well as, enhancing local habitats. Marsh creation and stream bank "bioengineering" are two methods of vegetative stabilization that have proven effective in many circumstances.

Other types of shoreline stabilization, such as beach nourishment and groin fields, do not prevent erosion. Beach nourishment is the replacement of lost sediments with new sediments. Traditional beach nourishment is not structurally stabilized, but erosion abatement is accomplished through engineering design using appropriate grain-sized sand. Depending on the source of material for beach nourishment, ecological impacts are frequently greater at the borrow site than at the nourishment area.

Groins are vertical structures constructed of rock or wood that are placed at equidistant intervals along eroding shorelines, perpendicular to the shore. Groin fields generally do not incorporate additional sediments to the system, but depend on the trapping of suspended sediments carried by longshore currents. Groins characteristically accrete sediments on the updrift side and become sediment starved on the downdrift side. This problem can be prevented by constructing low-profile groins (i.e., the top of the structure being constructed at an elevation between mean high and mean low tide) that allow sediments to accumulate on both sides of the structure. Jetties are structures similar to groins, but are used to stabilize inlets, not curtail erosion. However, the accretion/starvation sediment patterns displayed by groins are also demonstrated by jetties.

Measures for conservation and enhancement

A). To stabilize eroding stream banks, vegetative methods such as marsh creation and vegetative bank stabilization ("bioengineering") are the preferred methods. Stream bank and shoreline features such as wetlands and riparian areas with the potential to reduce nonpoint source (NPS) pollution should be protected (USEPA 1993).

B). Vegetative shoreline stabilization should be implemented in dogfish EFH whenever feasible.

C). When wave energy is sufficient to preclude vegetative stabilization, stone revetments should be constructed in dogfish EFH. Revetments reduce reflected wave energy and provide habitat for benthic organisms.

D). Bulkheads, or shoreline hardening structures, should not be constructed in dogfish EFH when practicable alternatives exist.

E). Beach nourishment in dogfish EFH should only be considered when an acceptable source of borrow material is identified.

F). When groin fields are considered acceptable for construction in dogfish EFH, low-profile design should be employed.

G). When jetties intercept sediments in dogfish EFH, sand should be "by-passed". By-passing is the transfer of sediments from the accreted side of the jetties to the starved side thereby maintaining longshore sediment transport.

2.2.5.3 Nonpoint source (NPS) contamination

Nonpoint pollution generally results from land runoff, atmospheric deposition, drainage, groundwater seepage, or hydrologic modification (USEPA 1993). Technically, the term "nonpoint source" is defined to mean any source of water pollution that does not meet the legal definition of "point source" in section 502(14) (40 CFR 122.2) of the Clean Water Act. That definition states:

> The term "point source" means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural storm water discharges and return flows from irrigated agriculture.

Nonpoint pollution is the pollution of our nation's waters caused by rainfall or snowmelt moving over and through the ground. Ground water is an important source of surface water and nutrients. The U.S. Geologic Survey (USGS) has determined that 50% of the water in streams comes from ground water. The amount of ground water varies according to the type of rock and sediment beneath the land surface (USGS 1997). Up to one-half of the nitrogen entering the Chesapeake Bay travels through the ground water (USGS 1997). It is possible that about 10% to 20% of the phosphorous entering the Chesapeake Bay also travels through ground water (USGS 1998). Atmospheric deposition transports about 9% of the nitrogen and 5% of the phosphorous loads to the Chesapeake Bay (Alliance for Chesapeake Bay 1993).

As the runoff moves, it picks up and transports natural and anthropogenic pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and ground waters. Major pollutants in runoff include pathogens, nutrients, sediments, heavy metals, oxygen demanding substances, road salts, hydrocarbons, and toxics. Acid precipitation from nonpoint sources are demonstrable problems in Atlantic coastal and estuarine waters (USEPA 1993, USDC 1985a). In addition, hydrologic modification is a form of nonpoint source pollution that often adversely affects the biological, physical and chemical integrity of surface waters (USEPA 1993). The alteration of natural hydrology due to urbanization, and the accompanying runoff diversion, channelization, and destruction of natural drainage systems, have resulted in riparian and tidal wetland degradation or destruction. Temperature changes result from increased flows, removal of vegetative cover, and increases in impervious surfaces. NPS can be divided into three components, each of which will be discussed separately. Conservation measures will be offered for each component.

2.2.5.3.1 Urban NPS

Urban construction is not limited to the shore but also includes inland development that can adversely impact aquatic areas. One of the major problems arising from urban development is the increase in nonpoint source contamination of estuarine and coastal waters. Highways, parking lots, and the reduction of terrestrial and wetland vegetation facilitate runoff loaded with soil particles, fertilizers, biocides, heavy metals, grease and oil products, polychlorinated biphenyls (PCBs), and other material deleterious to aquatic biota and their habitats. Atmospheric emissions resulting from certain industrial processes contain sulphurous and nitrogenous compounds that contribute to acid precipitation, a growing source of concern in some anadromous and fresh water sections of tidal streams. Nonpoint pollution is incorporated in water, sediments, and living marine resources (USDC 1985a).

Cumulatively, the effects of this environmental insult may have far reaching implications for fisheries resources. Estuarine and riverine plumes entering coastal waters are influenced by global and other dynamic forces. These plumes may remain as discrete water masses flowing close to the coast for hundreds of miles.

The purpose of vegetated filter strips is to remove sediment and other pollutants from runoff and wastewater by filtration, deposition, infiltration, absorption, adsorption, decomposition, and volatilization, thereby reducing the amount of pollution entering adjacent waterbodies. The ability of a wetland to act as a sink for phosphorus and the ability to convert nitrate to nitrogen gas through de-nitrification are two examples of the important nonpoint source pollution abatement functions performed by constructed wetlands.

Measures for conservation and enhancement

A). Watershed protection/site development should be encouraged. Comprehensive planning for development on a watershed scale and for small-scale site development, including planning and designing to protect sensitive ecological areas, minimize land disturbances and retain natural drainage and vegetation whenever possible.

B). Pollution prevention activities, including techniques and activities to prevent nonpoint source pollutants from entering surface waters, should be implemented. Primary emphasis should be placed on public education to promote methods for proper disposal and/or recycling of hazardous chemicals, pet waste management strategies, management practices for lawns and gardens, onsite disposal systems (OSDSs), and commercial enterprises such as service stations and parking lots.

C). Watershed management programs of existing developments should be developed that identify the sources, specify appropriate controls, such as retrofitting or the establishment of buffer strips, and provide a schedule by which these controls are to be implemented.

D). Best Management Practices (BMPs) should be employed during urban construction to minimize impacts to dogfish EFH. Numerous specific conservation measures are provided at the end of Section 2.2.5.2.2 Construction.

E). The release of harmful chemical contaminants should be sequestered at their source thereby preventing their entering the atmosphere and subsequently being deposited in dogfish EFH.

F). BMPs should be implemented to manage stormwater to minimize the discharge of contaminants that degrade dogfish EFH or waters flowing into dogfish EFH. Stormwater should not be allowed to mix with sewage effluents (i.e., combined sewage/stormwater outfalls or CSOs). Where CSOs exist, the systems should be retrofitted to separate the two discharges.

2.2.5.3.2 Agricultural NPS

Agricultural development can affect fisheries habitat directly through physical alteration and indirectly through nutrient enrichment and chemical contamination. Fertilizers, herbicides, insecticides, and other chemicals are washed into the aquatic environment via uncontrolled nonpoint source runoff draining agricultural lands. These nutrients and chemicals can affect the growth of aquatic plants, which in turn affects fish, invertebrates, and the general ecological balance of the water body. Additionally, agricultural runoff transports animal wastes and sediments that can affect spawning areas, and degrade water quality and benthic substrate. One of the most serious consequences of erosional runoff is that the frequent dredging of navigational channels results in dredged material that requires disposal, often in areas important to living marine resources (USDC 1985a). Excessive uncontrolled or improper irrigation practices also contribute to nonpoint source pollution and often exacerbate the contaminant flushing, as well as deplete and contaminate ground water.

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, low level impoundments, and muskrat ditches and dikes (USDC 1985a).

Animal waste (manure) includes fecal and urinary waste of livestock and poultry; process water (e.g., from a milking parlor); excess feed, bedding, litter, and soil (USEPA 1993). Pollutants associated with animal wastes include: oxygen-demanding substances; nitrogen, phosphorous, and other nutrients; organic solids; bacteria, viruses, and other microorganisms; salts; and sediments (USEPA 1993). Runoff transporting these wastes and pollutants may result in fish kills; dissolves oxygen depletion; unpleasant odors, taste and appearance; eutrophication; and shellfish contamination (USEPA 1993).

Another source of nonpoint source pollution from livestock is atmospheric deposition. Recent analyses by Dr. Joe Rudek clearly demonstrate that more than two-thirds (65-90%) of nitrogen excreted by the huge swine concentration in coastal North Carolina is evaporated as ammonia and redeposited within about 65 miles maximum – typically into nutrient sensitive waters, including the Neuse River and Tar-Pamlico Sounds (Rader pers. com).

Many agricultural fields are poorly drained. To facilitate crop planting and cultivation, elaborate systems of drainage ditches are excavated. These drainage systems are frequently excavated through wetlands and ultimately discharged into natural waterways. Drainage systems serve as conduits transporting fertilizers, pesticides, sediment, and other contaminants that degrade habitat and water quality.

Measures for conservation and enhancement

A). EPA and appropriate agencies should establish and approve criteria for vegetated buffer strips in agricultural areas adjacent to dogfish EFH to minimize pesticide, fertilizer, and sediment loads to these areas critical for dogfish survival. The effective width of these vegetated buffer strips should vary with slope of terrain and soil permeability.

B). The Natural Resources Conservation Service and other concerned federal and state agencies should conduct programs and demonstration projects to educate farmers on improved agricultural practices that would minimize the wastage of pesticides, fertilizers, and top soil and reduce the adverse effects of these materials on dogfish EFH areas (MAFMC 1990a).

The following measures were taken mainly from Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (USEPA 1993).

C). Delivery of sediment from agricultural lands to receiving waters should be minimized. Land owners have a choice of one of two approaches: (1) apply the erosion component of the U.S. Department of Agricultures Conservation Management System through such practices as conservation tillage, strip cropping, contour farming, and terracing, or (2) design and install a combination of practices to remove settleable solids and associated pollutants in runoff for all but the larger storms.

D). New confined animal facilities and existing confined animal facilities over a certain size should be designed to limit discharges to waters of the U.S. by storing wastewater and runoff caused by all storms up to and including the 25-year frequency storms. For smaller existing facilities, the management systems that collect solids, reduce contaminant concentrations, and reduce runoff should be designed and implemented to minimize the discharge of contaminants in both facility wastewater and runoff caused by all storms up to and including 25-year frequency storms.

E). Stored runoff and solids should be managed through proper waste utilization and use of disposal methods which minimize impacts to surface/ground water. Confined animal facilities required to obtain a discharge permit under the National Pollutant Discharge Elimination System (NPDES) permit program should not be subject to these recommendations.

F). Development and implementation of comprehensive nutrient management plans should occur. The fundamentals of a comprehensive nutrient management plan include a nutrient budget for the crop, identification of the types and amounts of nutrients necessary to produce a crop based on realistic crop yield expectations, and an identification of the environmental hazards of the site. Other items include soil tests and other tests to determine crop nutrient needs and proper calibration of nutrient equipment.

G). Pesticide and herbicide management should minimize water quality problems by reducing pesticide use, improving the timing and efficiency of application (not within 24 hours of expected rain or irrigation), preventing backflow of pesticides into water supplies, and improving calibration of pesticide spray equipment. Strategies such as integrated pest management (IPM) should be used. IPM strategies include evaluating current pest problems in relation to the cropping history, previous pest control measures, and applying pesticides only when an economic benefit to the producer will be achieved, i.e., application based on economic thresholds. If pesticide applications are necessary, pesticides should be selected based on consideration of their environmental impacts such as persistence, toxicity, and leaching potential.

H). Livestock grazing should protect sensitive areas, including streambanks, wetlands, estuaries, ponds, lake shores, and riparian zones. Protection is to be achieved with improved grazing management that reduces the physical distance and direct loading of animal waste and sediment caused by livestock by restricting livestock access to sensitive areas through a range of options.

I). Upland erosion is to be reduced by either: (1) applying the range and pasture components of a Conservation Management System, or (2) maintaining the land in accordance with the activity plans established by either the Bureau of Land Management or the Forest Service. Such techniques include the restriction of livestock from sensitive areas through locating salt, shade, and alternative drinking sources away from sensitive areas, and providing livestock stream crossings.

J). Irrigation systems that deliver necessary quantities of water, yet reduce nonpoint pollution to surface waters and groundwater, should be developed and implemented. To achieve this, uniform application of water based upon an accurate measurement of cropwater needs and the volume of irrigation water applied should be calculated. When applying chemicals through irrigation (a process known as chemigation), special additional precautions apply. In state waters, conflicting laws may take precedence. In no case should irrigation be practiced to the point that runoff occurs from the field.

K). Best Management Practices should be implemented to minimize habitat impacts when agricultural ditches are excavated through wetlands that drain to dogfish EFH.

L). NPDES/ State Pollutant Discharge Elimination System (SPDES) permits in consultation with state fishery agency should be required for agricultural ditch systems that discharge into dogfish EFH.

M). Acceptable swine waste treatment technologies should be developed to replace current practices which rely upon evaporation or movement through groundwater to dispose of nitrogen (Rader pers. comm.).

N). Nitrogen reduction programs should account for airborne delivery (Rader pers. comm.).

2.2.5.3.3 Silvicultural NPS

Federal land management has allowed activities to occur which have degraded riparian and riverine habitat in the national forests, thereby contributing to the decline of marine and anadromous fishes (USDC 1997a). The impacts of forest activities conducted within the framework of these land use plans include effects on marine and anadromous species and significant habitat degradation from timber harvest, road construction, grazing, mining, outdoor recreation, small hydropower development, and water conveyance permitting. These actions have: reduced physical, biological and channel connectivity between streams and riparian areas, floodplains, and uplands; increased sediment yields (leading to pool filling and elimination of spawning and rearing habitat); reduced or eliminated large woody debris; reduced or eliminated the vegetative canopy (leading to increased temperature fluctuations); altered peak flow timing; increased water temperature; decreased dissolved oxygen; caused streams to become straighter, wider, and shallower; and degraded water quality by adding toxic chemicals through mining and pest control. These effects, combined with cumulative effects from activities on nonfederal lands, have contributed to the decline of marine and anadromous fish species (USDC 1997a).

Silvicultural contributions to water pollution has been recognized by all states with significant forestry activities (USEPA 1993). On a national level, silviculture contributes approximately 3% to 9% of nonpoint source pollution to the nation's waters (USEPA 1993). Local impacts of timber harvesting and road construction on water quality can be severe, especially in smaller headwater streams. Studies on forest land erosion have concluded that surface erosion rates on roads often equaled or exceeded rates reported for severely eroding agricultural lands (USEPA 1993). These effects are of greatest concern where silvicultural activity occurs in high-quality watershed areas that provide municipal water supplies or support cold-water fisheries. The USEPA (1993) reported that 24 states have identified silviculture as a problem source contributing to nonpoint source pollution. Some states report up to 19% of their river miles impacted by silviculture. On federal lands, such as national forests, many water quality problems can be attributed to the effects of timber harvesting and related activities (USEPA 1993).

Measures for conservation and enhancement

The following measures were taken from Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (USEPA 1993).

A). Preharvest planning should ensure that silvicultural activities take into account potential nonpoint source pollutant delivery to surface waters. Key aspects of forestry operations relevant to water quality protection that should be addressed include: the timing, location, and design of harvesting and road construction; the identification of sensitive areas or high-erosion-hazard areas; and the potential for additional cumulative contributions to existing water quality impairments.

B). Streamside management areas (SMA) should be established along dogfish EFH and should be managed to protect the water quality of the adjacent waterbody.

C). Delivery of sediment from road construction or reconstruction should be reduced. This is to be accomplished by following the preharvest plan layouts.

D). Existing roads should be managed to prevent sedimentation and pollution from runoff-transported materials. Measures taken can include the use of inspections and maintenance actions to prevent erosion of road surfaces and ensure the continued effectiveness of stream crossing structures. Appropriate actions for closing roads that are no longer in use should also be taken.

E). NPS pollution resulting from timber harvesting operations should be reduced by taking into account the location of landings, the operation of ground-skidding and cable yarding equipment, and preventing of pollution from petroleum products. Harvesting practices that protect water quality and soil productivity can also reduce total mileage of roads and skid trails, lower equipment maintenance costs, and provide better road protection and reduce road maintenance. Appropriate skid trail location and drainage, and proper harvesting in SMAs should be addressed.

F). Impacts of mechanical site preparation and regeneration operations should be reduced, and on-site potential nonpoint source pollution should be confined. Measures such as keeping slash materials out of drainages, operating machinery on the contour, and protecting the ground cover in ephemeral drainages and SMAs should be implemented.

G). Potential nonpoint source pollution and erosion resulting from prescribed fire for site preparation and from methods for suppression of wildfire should be reduced. Prescribed fires should be conducted under conditions to avoid the loss of litter and incorporated soil organic matter. Bladed firelines should be stabilized to prevent erosion, or practices such as handlines, firebreaks, or hose lays should be used where possible.

H). Erosion and sedimentation by the rapid revegetation of areas of soil disturbance from harvesting and road construction should be reduced. The disturbed areas to be revegetated are those localized areas within harvest units or road systems where mineral soil is exposed or agitated such as road cuts, fill slopes, landing surfaces, cable corridors, or skid trails.

I). Pesticide and herbicides should be managed to minimize water quality problems by reducing pesticide use, improving the timing and efficiency of application (not within 24 hours of expected rain or irrigation), preventing backflow into water supplies, and improving calibration of spray equipment.

The following recommendations are taken from Murphy (1995).

J). Riparian buffer zones of appropriate size and design should be required on any forested land adjacent to waterways that include EFH. The buffers should provide all processes that create and maintain fish habitat, particularly shade, stream bank integrity, and recruitment of large woody debris.

K). Enforcement of best forestry management practices for ensuring water quality standards at state and federal levels should be strongly encouraged.

L). Watershed analysis and subsequent watershed planning at the local and state levels should be strongly encouraged.

M). Upland habitat restoration should be encouraged. Restoration of upland habitat should include measures to control erosion, stabilize roads, upgrade culverts for fish passage, and manage watershed uses.

N). Restoration of riparian areas should be encouraged. Restoration goals should restore functions of riparian vegetation by reestablishing mature conifers or other appropriate vegetation.

O). Riparian areas should be revegetated with stable vegetation.

2.2.5.4 Dredging and disposal of dredged material

Dredging and disposal of dredged material can create significant impacts in aquatic ecosystems. The purpose of dredging in nearshore and offshore areas include: creation and maintenance for shipping and recreational boating, construction of infrastructure, and marine mining. During dredging operations, bottom sediments are removed, disturbed, and resuspended (Chytalo 1996). Historically, dredged material was disposed of by being discharged in designated open-water disposal areas near the dredging site. Because of concern about environmental damage, disposal of dredged material has begun to be tightly regulated (Chytalo 1996). Environmental impacts of dredging include:

1. Direct removal/burial of organisms as a result of dredging and placement of dredged material;

2. Turbidity/siltation effects, including increased light attenuation from turbidity, alteration of bottom type, and physical effects of suspended sediments on organisms;

3. Contaminant release, and uptake, including nutrients, metals, and organics from interstitial water and the resuspended sediments;

4. Release of oxygen-consuming substances, such as sulfides;

5. Noise/disturbance to terrestrial organisms;

6. Alterations to the hydrodynamic regime and physical habitat; and

7. Loss of wetland, SAV beds, and riparian habitat.

Excluding the potential of new work being authorized in sensitive habitats, the major problem associated with dredging is disposal of dredged material (spoil). Almost 60 per cent of the spoil generated nationally (approximately 310 thousand metric wet tons) is discharged into estuarine and marine habitats (OTA 1987). This volume can be anticipated to increase as the trend for deeper channels and port expansions escalate.

Although alternatives to in-water disposal have been proposed, such as transporting spoil to inland areas to reclaim strip mines and use as a raw material for manufacturing bricks, only upland disposal in adjacent coastal areas has proven to be practicable. However, as the demand for coastal development increases, the amount of available uplands is diminishing, while the cost of those lands is increasing. Additionally, mounting evidence indicates that long-term use of upland spoil sites cause adverse impacts, such as salinity intrusion in shallow aquifers.

Diked containment islands in estuaries have been effective, cost efficient methods to dispose of dredged material. However, these islands, such as Craney Island in Virginia and Hart-Miller Island in Maryland, require hundreds of acres each for construction. This is an irreversible commitment of estuarine habitat. Consequently, sensitive areas must be identified and avoided. Construction of spoil islands must be restricted to those areas that will have the least impact on estuarine and marine ecosystems. Compensatory mitigation to increase the carrying capacity within the affected estuaries to offset these impacts must also be a requirement of island construction.

More recently, there has been a trend toward the "beneficial use" of dredged material. Some uses of dredged material can be truly beneficial, while some are merely a trade-off of one habitat type for another, usually at the expense of living marine resources. Some examples of true beneficial uses are by-passing sediments removed from natural littoral processes to down-drift, starved beaches, restoration of structure to depleted oyster reefs, and restoration of eroded wetlands to abate erosion. However, other proposed beneficial uses, such as creating bird breeding islands in shallow water habitats, only deplete valuable fish habitats (Goodger pers. com.).

Measures for conservation and enhancement

A). Filling of wetlands or coastal shallow water habitat should not be permitted in or near EFH areas. Mitigating or compensating measures should be employed where filling is totally unavoidable. Project proponents must demonstrate that project implementation will not negatively affect dogfish, their EFH, or their food sources.

B). No dredging or dredge spoil placement should take place in SAV beds.

C). Best engineering and management practices (e.g., seasonal restrictions, dredging methods, disposal options, etc.) should be employed for all dredging and in-water construction projects. Such projects should be permitted only for water dependent purposes when no feasible alternatives are available. Mitigating or compensating measures should be employed where significant adverse impacts are unavoidable. Project proponents should demonstrate that project implementation will not negatively affect dogfish, their EFH, or their food sources.

D). Construction of spoil containment islands should be avoided in dogfish EFH, except when no practicable alternatives are available. In those exceptional cases when island construction is necessary, sites should be selected that result in the least damaging impacts to dogfish EFH.

E). "Beneficial Use" proposals in dogfish EFH should be compatible with existing uses by dogfish. Conflicting uses, such as construction of bird breeding islands, should not be authorized.

The following measures were taken from Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (USEPA 1993).

F). When projects are considered and in review for open water disposal permits for dredged material, state and federal permitting agencies should identify the direct and indirect impacts such projects may have on EFH.

G). No unconfined disposal of contaminated dredge material, sewage sludge, or industrial waste should ever be allowed in EFH.

H). Disposal sites should be located in uplands when possible.

I). The creation of new habitat at the expense of another naturally functioning system (e.g. marsh creation with dredge material placed in shallow water habitat) should be fully justified and documented, given best available information, through a demonstrated net gain in EFH.

2.2.5.5 Port development, utilization, and shipping

Major ports along the Atlantic coast include those at Miami Florida, Jacksonville Florida, Savannah Georgia, Charleston South Carolina, Wilmington North Carolina, Norfolk Virginia, Baltimore Maryland, Wilmington Delaware, Philadelphia Pennsylvania, New York New York, Providence Rhode Island, Boston Massachusetts, Portsmouth New Hampshire, and Portland Maine. These ports handle primarily grains, coal, ores, and manufactured commodities. Some of these ports and many other ports along the Atlantic seaboard (e.g. Gloucester and New Bedford Massachusetts, Rockland Maine, Newport and Point Judith Rhode Island, Hampton-Norfolk Virginia, Ocean City Maryland) also support major commercial and recreational fisheries (USDC 1985a).

All ports require shoreline infrastructure, mooring facilities, and adequate channel depth. Ports compete fiercely for limited national and international markets and continually strive to upgrade their facilities. Dredging and dredged material disposal, filling of aquatic habitats to create fast land for port improvement or expansion, and degradation of water quality are the most serious perturbations arising from port development. All have well recognized adverse impacts to living marine resources and habitat.

The introduction of exotic species and contaminated materials through ballast water release and exchange is an impact of port utilization. Ballast water is used by most ships for stability and maneuverability (Moyle 1991). The water is typically pumped into separate tanks used just for ballast or in empty cargo tanks when departing from port, and discharged when the ship takes on a cargo at another port. Evidence shows that hundreds of species of invertebrates have become established in exotic locales after being transported in ballast water (Moyle 1991). An infamous Atlantic coast example of a ballast water introduction is the zebra mussel (*Orreissena polymorha*).

Another hazard of port utilization is the potential for shipping accidents. Transportation of fossil fuels and other materials may result in major spills of oils and other hazardous materials (Hill 1996). Tributyl-tin, used in commercial anti-fouling paints, was formerly a major concern and has been largely banned, with the notable exception of aluminum hauled vessels (Foerster pers. comm.).

Construction activities associated with port development result in a loss of habitat diversity along the water's edge. Bulkheading, filling, and construction of port features result in general water quality degradation that reduces biotic diversity of important productive areas (USDC 1985a). Habitat types that are destroyed by construction of port infrastructure include: shallow bay bottom; shoreline wetlands; seagrass meadows; and intertidal wetlands (Fearing 1983). The effect of loss of these habitats include loss of nursery area, reduction in water clarity, and shifts in primary productivity (Fearing 1983).

Measures for conservation and enhancement

The impacts of port development and utilization are caused by a need for infrastructure (i.e. filling of wetlands) and adequate channel depths (i.e. dredging and shoreline stabilization). Recommendations to minimize these impacts are located in sections 2.2.5.2.3, 2.2.5.2.4., and 2.2.5.3, respectively.

Impacts that are a result of shipping are addressed in the following recommendations:

A). To avoid introducing exotic species and toxic materials, ballast water should be exchanged beyond 200 miles or treated with chlorine or other toxicants. Procedures should be developed for monitoring ballast water. Factors controlling introduced species should be studied in species' native ecosystems (Moyle 1991).

B). All vessels transporting fuels and other hazardous materials should be required to carry equipment to contain and retrieve the spill.

C). Dispersants should not be used to clean up fuels and hazardous materials unless approved by the EPA/Coast Guard after consultation with fisheries agencies.

2.2.5.6 Marinas and recreational boating

As residential and commercial use of coastal lands increase, so does the recreational use of coastal waters. Marinas, public access landings, private piers, and boat ramps all vie for space. Boating requires navigational space, a place to berth for some boat owners, and boat yards for repair and storage.

Based on an annual average of 40 hours of cruising, the 10 million outboard and inboard/outboard powered pleasure boats in the U.S. impact as much water, fish eggs, larval and juvenile fish, and shellfish, as 800 nuclear and fossil fueled generating stations would in a year. Unfortunately, boating activity is concentrated in a short boating season that also occurs during the period of maximum biological activity in many estuaries (Stolpe 1997).

Marinas and recreational boating are increasingly popular uses of coastal areas. The growth of recreational boating, along with the growth of coastal development in general, has led to a growing awareness of the need to protect waterways. In the Coastal Zone Management Act (CZMA) of 1972, as amended, Congress declared that state coastal management programs provide for public access to the coasts for recreational purposes. Clearly, boating and adjunct activities (e.g., marinas) are an important means of public access. When these facilities are poorly planned or poorly managed, however, they may pose a threat to the health of aquatic systems (and may pose other environmental hazards; USEPA 1993). Since marinas are located right at the water's edge, there is often no buffering of the release of pollutants to waterways. Adverse environmental impacts may result from the following sources of pollution and activities associated with marinas and recreational boating (USEPA 1993):

1. Poorly flushed waterways where dissolved oxygen deficiencies exist;

2. Pollutants discharged from boats;

3. Pollutants transported in storm water runoff from parking lots, roofs, and other impervious surfaces;

4. The physical alteration or destruction of wetlands and of shellfish and other bottom communities during the construction of marinas, ramps, and related facilities; and

5. Pollutants generated from boat maintenance activities on land and in the water.

Impacts on the ecosystem that are caused by marinas include lowered dissolved oxygen, increased temperature, bioaccumulation of pollutants by organisms, water contamination, sediment contamination, resuspension of sediments, loss of SAV and estuarine vegetation, change in photosynthesis activity, change in the nature and type of sediment, loss of benthic organisms, eutrophication, change in circulation patterns, shoaling and shoreline erosion. Pollutants that result from marinas include nutrients, metals, petroleum hydrocarbons, pathogens, and PCBs (USEPA 1993). Other contaminants introduced into surface waters originate from chemically treated timber used for piers and bulkheads. Commonly used chemicals are creosote and CCA (copper, chromium, and arsenic salts).

Other impacts of recreational boating are a result of improper sewage disposal, fish waste, fuel and oil spillage, cleaning fluids, and boat operation and maintenance (USEPA 1993).

According to the 1989 American Red Cross Boating Survey, there were approximately 19 million recreational boats in the United States (USEPA 1993). About 95 percent of these boats were less than 26 feet in length. A very large number of these boats used a portable toilet, rather than a larger holding tank. Given the large percentage of smaller boats, facilities for the dumping of portable toilet waste should be provided at marinas that service significant numbers of boats under 26 feet in length (USEPA 1993).

The propellers from boats can also impact fish and fish habitat by direct damage to multiple life stages of organisms, including eggs, larvae, juveniles, and adults, as well as submerged aquatic vegetation (e.g., prop scarring); de-stratification (temperature and density which is characteristic of some estuaries; e.g., Pamlico Sound, North Carolina); elevated heat; and resuspension of sediments increasing turbidity (Stolpe 1997, Goldsborough 1997). The resuspension of bottom sediment can result in the reintroduction of toxic substances into the water column. This may lead to an increased turbidity, which can affect photosynthetic activity of algae and submerged aquatic vegetation (USEPA 1993). The SAV provides habitat for fish, shellfish, and waterfowl and plays an important role in maintaining water quality through assimilating nutrients. It also reduces wave energy, protecting shorelines and bottom habitats from erosion (USEPA 1993).

Fish waste can result in water quality problems at marinas with large numbers of fish landings or at marinas that have limited fish landings but poor flushing (USEPA 1993). The amount of fish waste disposed of into a small area such as a marina can exceed that existing naturally in the water at any one time. As fish waste decomposes, it requires oxygen, thus sufficient quantities of disposed fish waste can be a cause of dissolved oxygen depression, as well as odor problems (USEPA 1993).

Fuel and oil are commonly released into surface waters during fueling operations through the fuel tank air vents, during bilge pumping, and from spills directly into surface waters and into boats during fueling. Oil and grease from the operation and maintenance of inboard engines are a source of petroleum in bilges (USEPA 1993).

Marina employees and boat owners use a variety of boat cleaners, such as teak cleaners, fiberglass polishers, and detergents (USEPA 1993). Boats are cleaned over the water or onshore adjacent to the water. This results in a high probability of some of the cleaning material entering the water. Copper-based antifouling paint is released into marina waters when boat bottoms are cleaned in the water (USEPA 1993).

A workshop on the environmental impacts of boating held at Woods Hole Oceanographic Institute, December 1994, summarizes the substantiated impacts of boating activity. These include: sediment and contaminant resuspension and resultant turbidity; laceration of aquatic vegetation with loss of faunal habitat and substrate stability; toxic effects of chemical emissions of boat engines; increased turbulence; shearing of plankton; shorebird disturbance; and the biological effects of chemically treated wood used in dock and bulkhead construction. Many of these issues and concerns remain inadequately described. Sufficient hard data was referred to or presented at the workshop, that recreational and commercial motor boat operation is far from a benign influence on aquatic and marine environments. This is particularly so in temperate climes due to the unfortunate synchrony, with only a few exceptions, of vertebrates and invertebrates in estuaries and coastal waters. Therefore, the chance of plants and organisms being affected by power boat operation ought to be regarded as privilege which requires due consideration of environmental impacts, and should be conducted and managed in such a manner.

Measures for conservation and enhancement

The following measures were taken mainly from Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (USEPA 1993), unless otherwise specified.

A). Marina siting and design should allow for maximum flushing of the water supply for the site. Adequate flushing reduces the potential for the stagnation of water in a marina, helps to maintain the biological productivity, and reduces the potential for toxic accumulation in bottom sediment.

B). Water quality must be considered in the siting and design of both new and expanding marinas.

C). Marinas should be designed and located so as to protect against adverse impacts on shellfish resources, wetlands, submerged aquatic vegetation, and other important habitat areas as designated by local, state, or federal governments.

D). Where shoreline erosion is a nonpoint source pollution problem, shorelines should be stabilized. Vegetative methods are strongly preferred.

E). Runoff control strategies, which include the use of pollution prevention activities and the proper design of hull maintenance areas, should be implemented at marina sites. At least 80% of suspended solids must be removed from stormwater runoff coming from the hull maintenance areas. Marinas which obtain a NPDES permit for their hull maintenance areas are not required to conform to this hull maintenance area provision.

F). Fueling stations should be located and designed so that, in the case of an accident, spill contaminants can be contained in a limited area. Fueling stations should have fuel containment equipment, as well as a spill contingency plan.

G). To prevent the discharge of sewage directly to coastal waters, new and expanding marinas should install pumpout, pump station, and restroom facilities where needed.

H). Solid wastes produced by the operation, cleaning, maintenance, and repair of boats should be properly disposed of to limit their entry to surface waters.

I). Sound fish waste management should be promoted through a combination of fish cleaning restrictions, public education, and proper disposal.

J). Appropriate storage, transfer, containment, and disposal facilities for liquid materials commonly used in boat maintenance, along with the encouragement of recycling of these materials, should be required.

K). The amount of fuel and oil leakage from fuel tank air vents should be reduced.

L). Potentially harmful hull cleaners and bottom paints, and their release to marinas and coastal waters, should be minimized.

M). Public education/outreach/training programs should be instituted for boaters, as well as marina operators, to prevent improper disposal of polluting materials.

N). Pumpout facilities should be maintained in operational condition, and their use should be encouraged to reduce untreated sewage discharges to surface waters.

O). In shallow areas, intense boating activities may contribute to shoreline erosion. Increased turbidity and physical destruction of shallow-water habitat resulting from boating activities should be minimized.

P). Emissions from outboard motors should be monitored, and emissions standards should be enforced (Stolpe 1997).

Q). Dry stack storage marinas are recommended, as opposed to wet marinas, in dogfish EFH. Unlike wet marinas that require extensive dredging and other physical disruptions to physical habitats, dry stack storage facilities are located on uplands thereby minimizing the need for dredging and dependence on the use of timber treated with toxic chemicals. Additionally, land storage allows the use of polymer-based bottom paints, eliminating the need for toxic treatments containing copper or tributyl tin.

2.2.5.7 Energy production and transport

Energy production facilities are widespread along Atlantic coastal areas. Electric power is generated by various methods, including land based nuclear power plants, hydroelectric plants, and fossil fuel stations. These facilities compete for space along the coastal zone and require water for cooling. The impacts on the marine and estuarine environment resulting from the various types of power plants include water consumption, heated water and reverse thermal shock, entrainment and impingement of organisms, discharge of heavy metals and biocides in blow down water, destruction and elimination of habitat, and disposal of dredged materials and fly ash (USDC 1985a).

2.2.5.7.1 Hydroelectric

Hydropower plants may alter the following characteristics of water bodies:

1. Dissolved oxygen concentrations and temperature;

2. Create artificial destratification;

3. Withdraw or divert water;

4. Change sediment load;

5. Change channel morphology;

6. Accelerate eutrophication;

7. Change nutrient cycling; and

8. Contaminate water and sediment (Hill 1996).

Water quality contaminants of major concern include mercury, PCBs and organochlorine pesticides. Dams and the need for altered flows may substantially affect anadromous fish runs and/or restoration programs (Hill 1996). In addition, impingement of juvenile and adult fish may occur on trash racks that protect turbines from mechanical damage and turbine entrainment causes mortality of eggs and juvenile fishes. Altered dissolved oxygen levels can cause gas bubble disease to fishes (Hill 1996).

Habitat alterations include dams, which create reservoirs and tailwaters. Tailwaters can scour substrate and benthic organisms, as well as fish and fish eggs, create bank erosion, displace sediment downstream, and limit the establishment of riparian vegetation. In addition, clearing for hydropower projects requires disruption of wetlands and riparian habitat and control of some aquatic vegetation (Hill 1996).

2.2.5.7.2 Nuclear

A major adverse impact of nuclear power plants is water withdrawal and thermal pollution, due to the use of cooling water (Hill 1996). Once-through cooling which requires withdrawal of large volumes of water causes significant impingement of juveniles and larger size classes, and entrainment of eggs and larvae. Reverse thermal shock can also occur when plant operation ceases, causing fish mortality to organisms that are adapted to the warmer outflow. As an alternative to once-through large-water volume usage, cooling towers can be constructed which reduce both impingement/entrainment and thermal pollution. Incidental use of biocides to reduce biofouling also introduces pollutants to the surface waters. Another problem is storage and disposal of nuclear wastes which will last centuries.

2.2.5.7.3 Fossil fuels

Coal- and oil-fired plants and shore based refineries are served by various sized vessels, which transport those fuels. Additional navigational channels may be required, which could result in habitat disruption initially and periodically, and the need to find appropriate sites for placement of dredged materials (USDC 1985a). Transportation of fossil fuels may risk the chance of major oil spills or release of other hazardous materials, increases in automotive emissions, and habitat loss from construction of pipelines (Hill 1996). Coal fired plants generate voluminous amounts of fly ash, sulfur dioxide, nitrogen oxides, carbon dioxide, and traces of mercury contributing to acid rain (USDC 1985a, Hill 1996). The excavation of fossil fuels may have adverse effects on biota, as well (Hill 1996). Mining can contribute to acid mine drainage, human health impacts, vegetation and associated wildlife losses, erosion and stream sediments (Hill 1996). In addition, water withdrawal and diversion may cause impingement and entrainment of fish, as well as thermal pollution (Hill 1996).

2.2.5.7.4 Offshore oil and gas operations

The Outer Continental Shelf (OCS) exploratory and production drilling and transport may 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 can interfere with fishing operations and damage or destroy fishing gear. Contaminants from oil exploration include mostly petroleum hydrocarbons and heavy metals. Effects of hydrocarbon contamination in the water column and sediments may include: mortality of larval fish; mortality from predation due to slower avoidance behavior; bioaccumulation in fish; migration interference for salmon and other anadromous species; and slower maturation of larvae (Howarth 1991). Sublethal effects can cause a decrease in recruitment, as well as complex ecological interactions (Howarth 1991). Cumulative effects of oil on ecosystems include changes in benthic community structure and possible changes in planktonic community structure (Howarth 1991). Oil and gas exploration in the Mineral Management Service's (MMS) Mid-Atlantic, North Atlantic, and South Atlantic lease areas may result in loss or degradation of benthic habitat from the deposition of discharged drilling muds and cuttings. Should production of oil and gas occur in these areas, the transport of the products to onshore storage and processing facilities would pose additional threats to coastal zone and estuarine ecosystems (USDC 1985a).

Measures for conservation and enhancement

A). Appropriate measures should be taken to reduce acid precipitation and runoff into estuaries and nearshore waters.

B). Prior to pipeline construction, less damaging, alternative modes of oil and gas transportation should be explored (Penkal and Phillips 1984).

C). State natural resource agencies should be involved in the preliminary pipeline planning process to prevent violations of water quality and habitat protection laws and to minimize impact of pipeline construction and operation on aquatic resources (Penkal and Phillips 1984).

D). Potential effects of proposed and existing tidal power projects should be estimated; state and federal agencies, regardless of their regulatory jurisdiction, should become involved in this process (Rulifson *et al.* 1986).

E). All vessels transporting fuels and other hazardous materials should be required to carry equipment to contain and retrieve the spill. Dispersants shall not be used to clean up fuels and hazardous materials unless approved by the EPA/Coast Guard and fishery agencies.

F). NPDES permit conditions, such as those relating to dissolved oxygen, temperature, impingement and entrainment, under the Clean Water Act, should be monitored and strictly enforced in dogfish EFH.

G). NPDES permits should be reviewed every five years for all energy production facilities.

H). Offshore oil and gas leasing, exploration, and production should be strictly limited and controlled, so as not to degrade dogfish EFH. Onshore facilities assisting offshore oil and gas exploration and development, and secondary development stimulated by OCS development, should not degrade dogfish EFH. Seismic work should not be carried out with explosives (air bursts only) in dogfish EFH.

The following measures were taken from Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (USEPA 1993) and apply to dams 25 feet or more in height and greater than 15 acre-feet in capacity, or to dams six feet or more in height and greater that 50 acre-feet in capacity. They also apply only to those projects and activities that fall outside of existing jurisdiction of the NPDES permit program.

I). Erosion should be reduced and sediment retained onsite, to the extent practicable, during and after construction of dams. An approved erosion and sediment control plan, or similar administrative document that contains erosion and sediment control provisions, should be prepared and implemented prior to land disturbance.

J). Proper storage and disposal of certain chemicals, substances, and other materials that are used in construction or maintenance activities at dams, should be implemented. These include construction chemicals such as concrete additives, petrochemicals, solid wastes, cement washout, pesticides and fertilizers. Application, generation, and migration of toxic substances should be limited and properly stored and disposed of. This measure also ensures that nutrients are applied at rates necessary to establish and maintain vegetation without causing significant nutrient runoff to surface waters.

K). Operation of dams should be assessed for impacts to surface water quality and instream and riparian habitat, and that the potential for improvement should be evaluated. Significant nonpoint source pollution problems that exist from excessive surface water withdrawals should also be assessed and evaluated.

2.2.5.8 Sewage treatment and disposal

The Atlantic Ocean off the northeastern United States has been used in the past for the disposal of solid wastes and sewage sludge. Some waste treatment methods, such as chlorination, pose additional problems to aquatic species. Habitats and associated organisms have been degraded by long-term ocean disposal, particularly of sewage wastes. Sewage pollution causes closure of shellfish beds, and occasionally, of public swimming areas because of high fecal coliform counts. Dumping of sewage sludge in the Atlantic coastal waters is regulated under Section 102 of the Marine Protection and Sanctuaries Act, while the discharge of treated sewage effluent is permitted under Section 402 of the Clean Water Act.

Organic loading of estuarine and coastal waters is an emerging problem. Ocean disposal of sewage sludge degrades water quality and associated habitats. Symptoms of elevated levels include excessive algae blooms, shifts in abundance of algal species, increased biological oxygen demand (BOD) in sediments of heavily affected sites, and anoxic events in coastal waters. Changes in biological components are frequently a consequence of long-term ocean disposal. Harmful human pathogens and parasites can be found in biota and sediments in the vicinity of ocean dump sites. In 1995, 4.9 million acres of shellfish-growing waters was harvest- limited due to water quality (USDC 1997c). The top five pollution sources reported as contributing were urban runoff (40%), upstream sources (39%), wildlife (38%), individual wastewater treatment systems (32%), wastewater treatment plants (24%), and unknown (6%; USDC 1997a).

The Chesapeake Bay and the Hudson-Raritan Estuary are two of the three estuaries with the largest number of point discharges in the US (USDC 1993a). Most of the point sources of nutrient loading into the Hudson-Raritan Estuary are sewage treatment plants. In 1988, it was estimated that 6.8 million gallons per day of raw sewage were discharged into this estuary, mainly from Manhattan, Staten Island, and Brooklyn, contributing to most of the 50,000 tons of total nitrogen and 32,000 tons of total phosphorus added to the region per year. Wastewater treatment plants contributed 43% of the total nitrogen and 90% of the total phosphorus to the New York Bight (USDC 1993a). Toxics metals were added at a rate of 35,700 tons per year. Contributing to this loading was urban runoff (31%), wastewater treatment plants (19%), direct industrial discharge (14%), and various other sources.

Sewage treatment effluent produces changes in biological components as a result of chlorination and increased contaminant loading. Sewage treatment plants constructed where the soils are highly saturated often allow suburban expansion in areas that would have otherwise remained undeveloped, thereby exacerbating already severe pollution problems in some areas. Sewage treatment pollutant components include solids, phosphorus, and pathogens (USEPA 1993). Eutrophication in surface waters has also been attributed to the low nitrogen reductions provided by conventional onsite-disposal system.

Poorly designed or operating onsite disposal systems can cause ponding of partially treated sewage on the ground that can reach surface water through runoff. In addition to oxygen-demanding organics and nutrients, these surface sources contain bacteria and viruses that present problems to human health. Viral organisms can persist in temperatures as low as -20°F, suggesting that they may survive over winter in contaminated ice, later becoming available to ground water in the form of snowmelt (USEPA 1993). Although ground-water contamination from toxic substances is more often life-threatening, the majority of ground-water-related health complaints are associated with pathogens from septic tank systems (USEPA 1993).

While a variety of other wastes have been disposed of in coastal waters of the New York Bight for over 50 years, sewage sludge has only been dumped offshore of the New York Bight over the last 20 years (Chang 1993). Species abundances of silver and red hakes (*Merluccius bilinearis* and *Urophycis chuss*), summer flounder (*Paralichthys dentatus*), goosefish (*Lophius americanus*), and black sea bass (*Centropristis striata*) declined significantly over temporal and spatial scales during the disposal of contamination laden sewage sludge at the deepwater 106-Mile Dump Site (Chang 1993). There was also a decline in the array of all aggregated species (Chang 1993).

Congress requested the Office of Technology Assessment (OTA) to assess the status of waste disposal in marine environments (OTA 1987). In general, OTA determined that estuarine and coastal waters were severely degraded across the nation and that "many of the adverse impacts on marine waters and organisms are caused by the introduction of pollutants through the disposal of wastes." These wastes include municipal sewage sludge, industrial wastes, dredged materials, industrial and municipal effluents, and urban and agricultural runoff. Based on their assessment, OTA concluded:

1. "Estuaries and coastal waters around the country receive the vast majority of pollutants introduced into marine environments. As a result, many of these waters have exhibited a variety of adverse impacts, and their overall health is declining or threatened;"

2. "In the absence of additional measures, new or continued degradation will occur in many estuaries and some coastal waters around the country during the next few decades (even in some areas that exhibited improvements in the past);"

3. "In contrast, the health of the open ocean generally appears to be better than that of estuaries and coastal waters. Relatively few impacts from waste disposal have been observed, partly because the open ocean has been subject to relatively little waste disposal and because wastes are typically dispersed and diluted. Uncertainty exists, however, about the ability to discern impacts in the open ocean". (Note, however, that studies which would detect these impacts in the open ocean have not been conducted.)

OTA (1987) determined that municipal and industrial discharges, sewage sludge, and dredged material accounted for most of the pollutants found in estuary and coastal waters along the Atlantic coast. OTA (1987) identified Buzzard's Bay, Boston Harbor, Narragansett Bay, Long Island Sound, the New York Bight, and Chesapeake Bay as specific areas that were severely polluted or degraded. Contaminated sediments, containing excessive concentrations of organic chemicals, metals and pathogens have been identified in Boston Harbor, New Bedford Harbor, the New York Bight, Raritan Bay, Hudson River Estuary, the Patapsco River around Baltimore, and the James River Estuary. Contaminated water and sediments in the North Atlantic have had adverse impacts on marine organisms. Fish kills, increases in fish diseases and abnormalities, and restrictions on commercial and recreational harvest of both finfish and shellfish have occurred as the result of this pollution (OTA 1987).

The dumping of sewage sludge is no longer allowed in the Atlantic Ocean. Historically, municipal sewage sludge and industrial waste were dumped in two areas along the North Atlantic coast: the New York Bight and deep water sites 100 miles east of Delaware Bay (OTA 1987). In 1985, approximately 7 million wet metric tons (15.4 million pounds) of municipal sewage sludge, several billion gallons of raw sewage, and 8 million wet metric tons (17.6 million pounds) of dredge spoils were dumped in the New York Bight. Routine dumping of municipal sewage sludge and dredge spoils probably contributed to the depletion of oxygen in the New York Bight during the summer and early autumn of 1976. Near anoxic and, in places, anoxic water was located approximately 4 miles off New Jersey and covered an area about 100 miles long and 40 miles wide during the most critical phases of oxygen depletion (Sharp 1976). The most commercially important species affected by the anoxia were surfclams, red hake, lobsters and crabs. Finfish were observed to be driven to inshore areas to escape the anoxia, or were trapped in water with concomitant high levels of hydrogen sulfide (Steimle 1976). Oxygen levels in 1985, in some areas of the Bight, approached the low values observed in 1976 (OTA 1987).

Measures for conservation and enhancement

A). All sewage should go through tertiary treatment (i.e., nutrient removal) when discharged in dogfish EFH.

B). Dechlorination facilities or lagoon effluent holding facilities should be used to destroy chlorine at sewage treatment plants and power plants.

C). All NPDES permits of public owned treatment works (POTWs) should be reviewed and strictly enforced in dogfish EFH.

2.2.5.9 Industrial wastewater and solid waste

Industrial wastewater effluent is regulated by USEPA through the NPDES/SPDES permitting program. This program provides for issuance of waste discharge permits as a means of identifying, defining, and controlling virtually all point source discharges. However, many problems remain due to inadequate monitoring and enforcement. It is not possible presently to estimate the singular, combined, and synergistic effects on the ecosystem impacted by industrial (and domestic) wastewater.

Point source discharges can potentially alter the following properties of communities and ecosystems: diversity, nutrient and energy transfer, productivity, biomass, density, stability, connectivity, species richness, and eveness (Cairns 1980). Additionally, point source discharges may alter the following characteristics of fish, shellfish, and related organisms: longevity; fecundity; growth; visual acuity; swimming speed; equilibrium; flavor; feeding rate; response time to stimuli; predation rate; photosynthetic rate; spawning season; migration route; and resistance to parasites. Contamination of water quality is generally due to organics and heavy metals, though other characteristics such as flow, pH, hardness, dissolved oxygen may also be altered (Cairns 1980).

Non-point discharges and solid wastes associated with industrial processes also contribute chemical contaminants to dogfish EFH. Chemicals can leak from storage facilities and leach from wastewater lagoons contaminating groundwater that ultimately discharge to rivers and estuaries. Solid wastes historically have been indiscriminately buried and, likewise, have contaminated groundwater with chemical leachates. Although regulatory programs have been enacted to preclude similar actions from occurring today, accidents still occur, and many areas are contaminated from past operations. Consequently, fish that inhabit waters adjacent to these sites, even seasonally, often bioaccumulate contaminants making them unfit for human consumption. Federal and state programs (e.g., Superfund) are designed to remediate hazardous waste sites, thereby reducing the bioavailability of contaminants to fish and other aquatic organisms. Unfortunately, remedial actions sometimes physically modify affected areas so completely that they are no longer suitable habitats for aquatic organisms.

Sediments and biota in specific areas along the Atlantic coast contain elevated levels of PCBs (OOMA 1987). Although PCBs are suspected carcinogens to humans, comprehensive research has not yet been done on the significance of elevated body burdens on the fish themselves, or on reproduction processes and subsequent recruitment of larval, juvenile, and pre-recruits to adult stocks. Whereas laboratory and field effects of a range of organic contaminants have been measured, there is little understanding of how contaminants such as PCBs affect the behavior, biochemistry, genetics, or physiology of these fish at either the lethal or sublethal level. It is significant that where elevated levels of PCBs have been reported in the marine environment they have generally been associated with elevated levels of toxic heavy metals, petroleum hydrocarbons, and other contaminants.

Measures for conservation and enhancement

A). No toxic substances in concentrations harmful (synergistically or otherwise) to humans, fish, wildlife, and aquatic life should be discharged. The EPA's Water Quality Criteria Series should be used as guidelines for determining harmful concentration levels. Use of the best available technology to control industrial waste water discharges should be required in areas essential for the survival of dogfish. Any new potential discharge into dogfish EFH must be shown not to have a harmful effect on dogfish.

B). The siting of industries requiring water diversion and large volume water withdrawals should be avoided in dogfish EFH. Project proponents should demonstrate that project implementation will not negatively affect dogfish, its EFH, or its food supply. Where such facilities currently exist, best management practices must be employed to minimize adverse effects on the environment.

C). All NPDES permits should be reviewed and strictly enforced in dogfish EFH.

D). Hazardous waste sites should be cleaned up (i.e., remediated) to prevent contaminants from entering aquatic food chains.

E). Remedial actions affecting aquatic and wetland habitats should be designed to facilitate restoration of ecological functions and values.

2.2.5.10 Marine mining

Mining for sand, gravel, shell stock, and beach nourishment projects in coastal and estuarine waters can result in the loss of infaunal benthic organisms, modifications of substrate, changes in circulation patterns, and decreased dissolved oxygen concentrations at deeply excavated sites, where flushing is minimal (USDC 1997a). Marine mining elevates suspended materials at mining sites and turbidity plumes may move several miles from individual sites. Resuspended sediments may contain contaminants such as heavy metals, pesticides, herbicides, and other toxins. Mining also results in changes in sediment type or sediment quality, often over areas measurable in square miles. Deep borrow pits created by mining may become seasonally or permanently anaerobic. Finfish appear to seek out these warmer pockets in the late fall, possibly as a result of declining water temperatures in surrounding area (Ludwig and Gould 1988). It may be important for beach nourishment projects to avoid areas that are rich in clam shells or near other "reef" habitats (Steimle pers. comm.).

Consumption of sand from offshore shoals is occurring on al large scale along the U.S. Atlantic coast. Although the offshore shoals are actively being modified by waves and currents, they are relict features which formed at times of lower sea level. As such, once lost, they are not expected to be replaced by natural processes. Cumulative environmental impacts to finfish are expected to since loss of offshore shoals will reduce habitat diversity on the U.S. inner continental shelf.

Deep ocean extraction of mineral nodules is a possibility for some non-renewable minerals now facing depletion on land. Such operations are proposed for the deep ocean proper, where nodules are bedded on oceanic oozes. Resuspension of these oceanic oozes can affect water clarity over wide areas and, if roiled to the near-surface, could also affect photosynthetic activity. Nodule concentrations have been located along the slope/ocean deep zone in Georgia and the Carolinas (Ludwig and Gould 1988). Such mining activities could potentially affect benthic organisms and their habitats, as well as pelagic eggs and larvae (USDC 1985a).

Measures for conservation and enhancement

A). Sand mining and beach nourishment should not be allowed in dogfish EFH during seasons when dogfish are utilizing the area.

The following are applicable to freshwater situations and are recommendations taken from the NMFS National Gravel Extraction Policy (1996).

B). Gravel extraction operations should be managed to avoid or minimize impacts to bathymetric structure in estuarine and nearshore areas.

C). The cumulative impacts of gravel and sand extraction should be addressed by federal and state resource management and permitting agencies and considered in the permitting process.

D). An integrated environmental assessment, management, and monitoring program should be a part of any gravel or sand extraction operation, and encouraged at federal and state levels.

E). Plan and design mining activities to avoid significant resource areas (such as consolidated sand ledges, sand dollar beds, or algae beds).

F). Plan and design mining activities with minimum area and depth to minimize recolonization times (deep holes should be avoided).

G). Mitigation and restoration should be an integral part of the management of gravel and sand extraction policies.

H). Remove unlike material as part of the mining operation to help restore natural bottom characteristics.

I). Remove material from areas where accumulation is caused by human activities.

2.2.5.11 Aquaculture

Aquaculture is an expanding industry in the US. The annual commercial harvest is over 700 million lbs round weight with a value to producers of nearly $600 million (Robinette *et al.* 1991). The commercial culture of channel catfish, salmonids, and crayfish is very successful, and the potential commercial culture of other species is being explored. Most aquaculture facilities are located in farmland, tidal, intertidal, and coastal areas (Robinette *et al.* 1991). Major potential adverse impacts of aquaculture include disease, genetic pollution of wild stock, escape of exotic species, water contamination, and eutrophication (Robinette *et al.* 1991). Also, the use of low-head dams, weirs, and other obstructions may impede the natural movement of estuarine species (Robinette *et al.* 1991).

Escape of exotic species may result in a restructuring of the native ecosystem through such pathways as gene pool deterioration, trophic alteration, introduction of pathogens and disease, and displacement of native species through competition (these impacts of exotic species are discussed separately in section 2.2.5.12; Robinette *et al.* 1991). Cultured species may be genetically altered and/or have a less genetically diverse background than wild species. The release of the reared stock may have an adverse impact to the wild stock. For example, a reared stock may be less resistant to a disease than a wild stock. When the two stocks begin to mix it may lower the resistance of the native stock to the disease (Sindermann 1992).

Measures for conservation and enhancement

The following recommendations are taken from The American Fisheries Society (AFS) Position Statement of Commercial Aquaculture (Robinette *et al.* 1991).

A). Federal and state agencies should cooperatively promulgate and enforce regulations to ensure both the health of the aquatic organism and quality of the food products. Animals that are to be moved from one biogeographic area to another or to natural waters should be quarantined to prevent disease transmission.

B). To prevent disruption of natural aquatic communities, cultured organisms should not be allowed to escape, and the use of organisms native to each facility's region is strongly encouraged.

C). When commercially cultured fish are considered for stocking in natural waters, every consideration should be given to protecting the genetic integrity of native fishes.

D). Aquaculture facilities should meet prevailing environmental standards for wastewater treatment and sludge control.

2.2.5.12 Ocean disposal

Ocean disposal of industrial waste products, dredged material, and radioactive wastes degrades water quality and associated habitats. Concentrations of heavy metals, pesticides, insecticides, petroleum products, and other toxic contaminants contribute significantly to degradation of waters off the Atlantic coast. Changes in biological components are a consequence of long-term ocean disposal. Harmful human pathogens and parasites can be found in biota and sediments in the vicinity of ocean dump sites. In addition, shellfish harvesting grounds have been closed because of excessive concentrations of pathogenic and indicator species of bacteria.

Many of the above issues and concerns may also be germane to the dumping of fish and shellfish waste in the ocean. The closure of land based processing plants because of the inability to meet NPDES/SPDES effluent requirements encourages the attempts for at sea disposal. While fishery byproducts may be nutritive in value, problems of biological oxygen demand (BOD) increase excessive algal blooms, and concentrations of pathogenic bacteria, may all be associated with ocean disposal of fisheries products.

Measures for conservation and enhancement

Note: this threat was a major concern to NMFS habitat researchers and the Council members in the mid to the late 1980s. Through concerted efforts of numerous individuals and agencies, ocean disposal has presently ceased; however, discussions still persist relative to resuming dumping. Should ocean disposal ever become viable again, the Council policy (MAFMC 1990b) should be reviewed.

A). Under no circumstances should there be disposal of contaminated material in EFH (section 2.2.5.4.D). All of the other recommendations for dredging and disposal of dredged materials (section 2.2.5.4) apply here as well.

B). Ocean disposal of fresh fish waste (i.e., scallop shells and bodies, fish racks, etc.) shall be permitted in areas that are not environmentally at risk. Monitoring of the disposal area will be the responsibility of the discharger if there is credible scientific information that suggest the area is being negatively impacted by the discharge.

2.2.5.13 Introduced species

Over the past two decades there has been an increase in introductions of exotic species into aquatic habitats (Kohler and Courtenay 1988). Introductions can be intentional (e.g., for purpose of stocking or pest control) or unintentional (e.g., fouling organisms). Five types of negative impacts generally occur due to species introductions: (1) habitat alteration; (2) trophic alteration; (3) gene pool alteration; (4) spatial alteration; and (5) introduction of diseases. Habitat alteration includes the excessive vegetation of introduced aquatic plants (e.g. hydrilla, watermilfoil, and alligator weed (Kohler and Courtenay 1988). This overgrowth interferes with swimming and fishing activities, upsets predator-prey relationships, and causes water quality problems. The introduction of exotic species may alter community structure by predation on native species (e.g. brown trout on brook trout) or by population explosions of the introduced species (e.g. tilapias). Spatial alteration occurs when territorial introduced species compete with native species (e.g. displacement of brook trout by brown trout). Although hybridization is rare, gene pool deterioration may occur between native and introduced species (e.g. brown trout and brook trout). One of the most severe threats to a native fish community is the bacteria, viruses, and parasites that can be introduced with exotic species (Kohler and Courtenay 1988).

Escape of exotic species may result in a restructuring of the native ecosystem through such pathways as gene pool deterioration, trophic alteration, introduction of pathogens and disease, and displacement of native species through competition (Robinette *et al.* 1991). Cultured species may be genetically altered and/or have a less genetically diverse background than wild species. The release of the reared stock may have an adverse impact to the wild stock. For example, a reared stock may be less resistant to a disease than a wild stock. When the two stocks begin to mix it may lower the resistance of the native stock to the disease (Sindermann 1992).

Measures for conservation and enhancement

The following recommendations are taken from the AFS Position Statement on Introductions of Aquatic Species (Kohler and Courtenay 1986).

A). Fish importers, farmers, dealers, and hobbyists should prevent and discourage the accidental or purposeful introduction of aquatic species into their local ecosystems.

B). City, county, state or federal agencies should not introduce species into any waters within its jurisdiction which might contaminate any waters outside its jurisdiction.

C). Only ornamental aquarium fish dealers should be permitted to import such fishes for sale or distribution to hobbyists.

D). The importation of fishes for purposes of research not involving introduction into a natural ecosystem should be made with the responsible government agencies.

E). All species that are considered for release should be prohibited and considered undesirable for any purpose of introduction into any ecosystem unless found to be desirable by federal fisheries agencies, as well as neighboring state agencies .

2.2.5.14 Cumulative impact analysis

According to section 600.815 (a)(6), to the extent feasible and practicable, FMPs should analyze how fishing and non-fishing activities influence habitat function on an ecosystem or watershed scale.

"Cumulative impacts to the environment that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of who undertakes such actions." Several examples of cumulative impacts from non-fishing and fishing threats include wetland losses, nutrient enrichment, eutrophication, toxic algal blooms, and global climate change. These cumulative impacts generally occur in estuarine and inshore areas; the multiple effects can result in adverse impacts to dogfish EFH.

Estuaries provide the nation with highly productive habitats and important living resources. Intensive use of these ecosystems for industrial, residential, and recreational activities has had cumulative adverse effects on many estuarine resources. Fourteen estuaries have been designated as dogfish EFH (Table 7).

The Mid-Atlantic region extends from New York through North Carolina. However, Mid-Atlantic Fishery Management Council manages species throughout their range, which for dogfish includes the entire U.S. Atlantic coast. The National Estuarine Inventory defines 15 estuaries in the Mid-Atlantic States including Gardiner's Bay, Long Island Sound, Great South Bay, Hudson-Raritan Bay, Barnegat Bay, New Jersey Inland Bays, Delaware Bay, Delaware Inland Bays, Chincoteague Bay, Chesapeake Bay, Albemarele Sound, Pamlico Sound, Bogue Sound, New River, and Cape Fear River (USDC 1990). Mid-Atlantic estuaries account for 44% of the total freshwater discharge to coastal waters along the Atlantic coast. Yearly precipitation amounts to 40 to 48 inches per year. However, peak freshwater flow is a result of spring snow melt (USDC 1990).

Human use of estuaries in the Mid-Atlantic is extensive and described earlier in section 2.2.5. These problems have begun to be addressed. However, conclusions about the cumulative effects of contaminants is lacking on the ecosystem and the 14 estuaries (Table 8 and Figures 12 and 13) that were established as dogfish EFH, along with much of the inshore area of the Atlantic coast (Figures 17-19). Some of the dogfish prey species are estuarine dependent. Unquantified cumulative impacts to estuarine and inshore areas have potential impacts to the sustainability of the dogfish fishery.

2.2.5.14.1 Nutrient Loading

Land use intensification threatens efficient nutrient cycling in many watersheds. Excess nutrients from land based activities accumulate in the soil, pollute the atmosphere, pollute ground water, or move into streams. Healthy watersheds have a reasonable balance of nutrient imports and exports (Aschman *et al.* 1997). Physical characteristics and nutrient loadings of eight of the major mid-Atlantic estuaries are summarized in

Table 17. Five of eight of these estuaries have medium to high nutrient loadings. Nutrient inputs include a combination of urban and industrial sources (Mid-Atlantic Regional Research Program 1994). Nutrient to these mid-Atlantic estuaries include sewage input (septic systems and wastewater treatment), industrial wastewater, urban input, agricultural sources, and atmospheric inputs.

Of course while nutrient overloading is a significant problem in many areas, nutrients are necessary for overall productivity. It is speculated by some that chemosynthesis from deep sea trenches is perhaps the largest input of nutrients into the marine system. (Fletcher pers.comm.). While worldwide, chemosynthesis may be very important in the oceans' productivity, it does not appear that significant nutrients are contributed from deep sea trenches to areas currently designated as dogfish EFH.

Measures for conservation and enhancement

Nutrient loading is a cumulative impact that results from the individual threats of coastal development, nonpoint source pollution, marinas and recreational boating, sewage treatment and disposal, industrial wastewater and solid wastes, ocean disposal and aquaculture. Please refer to the above sections for individual measures for conservation and enhancement.

2.2.5.14.2 Eutrophication

Nutrient inputs are known to have a direct effect on water quality. For example, in extreme conditions excess nutrients can stimulate excessive algal blooms that can lead to increased metabolism and turbidity, decreased dissolved oxygen, and changes in community structure, a condition called eutrophication (USDC 1997d-f). Office of Ocean Resources Conservation and Assessment (ORCA) initiated the Estuarine Eutrophication Survey in 1992 to comprehensively assess the scale and scope of nutrient enrichment and eutrophication in the National Estuarine Inventory estuaries. Table 18 illustrates the results of the eutrophication survey for the Atlantic coast, collected through a series of surveys, interviews, and regional workshops. The surveys describe existing conditions and trends of 17 parameters that characterize nutrient enrichment (USDC 1997d-f).

Measures for conservation and enhancement

Eutrophication is a cumulative impact that results from the individual threats of coastal development, nonpoint source pollution, marinas and recreational boating, sewage treatment and disposal, industrial wastewater and solid wastes, ocean disposal and aquaculture. Please refer to the above sections for individual measures for conservation and enhancement.

2.2.5.14.3 Harmful algal blooms

It is believed that nutrient enrichment of estuarine waters has lead to blooms of noxious dinoflagellates and algae (Mid-Atlantic Regional Marine Research Program 1994). Examples of such dinoflagellates or algae include *Gynodinium breve*, the dinoflagellate that causes neurotoxic shellfish poisoning, dinoflagellates of the genus *Alexandrium*, which cause paralytic shellfish poisoning, *Aureococcus anophagefferens*, the algae which causes "Brown tide", and diatoms of the genus *Pseudo-nitzschia*, which cause amnesic shellfish poisoning (Boesch *et al.* 1997).

Brown tide has been a recurrent problem in Peconic/Flanders and South Shore Bays of Long Island, since 1985 (Suffolk County DOHS 1997). It has also occurred in Narragansett Bay, Rhode Island and Barnegat Bay, New Jersey. Among finfish and shellfish that have been impacted by brown tide, the scallop population in the Peconic Estuary has virtually eradicated (Suffolk County DOHS 1997). The causes of the impact of brown tide are still unknown and may be attributed to toxic, mechanical, and/or nutritional aspects of the organism. However, when brown tide blooms exist at concentrations greater than 200,000 to 250,000 cells per 0.06 cu. in. (1 ml), it reduces light penetration, adversely impacting eelgrass beds which are of critical importance to finfish and shellfish (Suffolk County DOHS 1997). Although macro-nutrients do not cause blooms, they may provide optimum conditions for it.

Pfiesteria piscicida is a recently-described toxic dinoflagellate that was originally isolated from North Carolina waters (FDEP 1998). It has been documented in the water column in Delaware, Maryland, and North Carolina. Another *Pfiesteria*-like organism has been documented in St. John's River, Florida. *P. piscicida* has been associated with fish kills in North Carolina and Maryland (FDEP 1997, Hughes Commission 1997). Although *Pfiesteria* has been documented in Maryland waters, and fish with lesions were found in those same waters, etiologies of those lesions is still unknown, and is currently being studied by state, federal, and university pathologists (Driscoll pers. comm.). Additionally, the role of nutrient runoff and other possible causes are being investigated (Driscoll pers. comm).

The role of nutrients in algal blooms around the world is well documented (Hughes Commission 1997). *Pfiesteria* has a complicated life cycle (Figure 22), and the role that nutrients play in that life cycle is still unknown. Dr. Joanne Burkholder, who is credited with the discovery of *Pfiesteria*, has demonstrated in the laboratory that the growth of non-toxic stages of *Pfiesteria* can be stimulated by the addition of inorganic and organic nutrients. Field studies conducted by Burkholder have demonstrated a correlation between phosphorous-rich waste outfalls and high concentrations of non-toxic *Pfiesteria* (Hughes Commission Report 1997). It is important to note that not all outbreaks of *Pfiesteria* occurred in nutrient-enriched waters. Currently, it is not known what triggers *Pfiesteria* to a toxic stage. High nutrient concentrations are not required for *Pfiesteria* or *Pfiesteria*-like dinoflagellates to turn toxic. In fact, if suitable concentrations are present, toxic outbreaks can occur even if nutrient concentrations are relatively low. It appears that excessive nutrient loadings can help to create an environment rich in microbial prey and organic matter that *Pfiesteria* uses as a food supply (Hughes Commission 1997). Some scientists hypothesize that the primary stimuli for the transformation of the dinoflagellate into toxic stages are chemical cues secreted or excreted by the fish. In other words, fish must be present for a toxic outbreak to occur (Hughes Commission 1997).

Measures for conservation and enhancement

A). Federal and state agencies should address the issue of harmful algal blooms and *Pfiesteria*-like toxins which cause adverse effects in dogfish EFH.

2.2.5.14.4 Wetland Loss

In the late 1970's and early 1980's the country was losing wetlands at an estimated rate of 300,000 acres per year. The Clean Water Act and state wetland protection programs have helped to decrease wetland losses to 117,000 acres per year, between 1985 and 1995 (Dahl *et al.* 1997). Estimates of wetlands loss differ according to agency. USDA estimates attributes 57% wetland loss to development, 20% to agriculture, 13% to deepwater habitat, and 10% to forest land, rangeland, and other uses (USDA 1995). Of the wetlands lost to uplands between 1985 and 1995, USFWS estimates that 79% wetlands were lost to upland agriculture. Urban development and "other" types of land use activities were responsible for 6% and 15%, respectively (Dahl *et al.* 1997). Strong wetland protection must continue to be a national priority; otherwise, fisheries that support more than a million jobs and contribute billions of dollars to the national economy are at risk (Stedman and Hanson 1997).

Despite the urbanized nature of the mid-Atlantic, it contains more than 3,500 square miles of wetlands (Stedman and Hanson 1997). The Chesapeake and Delaware Bays have the first and second highest areas of wetlands in the region, respectively. Forested wetlands are the most common type of wetland, accounting for nearly 58% of the region's wetlands, followed by salt marsh (28%; Stedman and Hanson 1997).

Measures for conservation and enhancement

Wetland loss is a cumulative impact that results from the individual threats of coastal development, dredging and dredge spoil placement, port development, marinas and recreational boating, sewage treatment and disposal, industrial wastewater and solid wastes, ocean disposal, marine mining, and aquaculture. Please refer to the above sections for individual measures for conservation and enhancement.

2.2.5.14.5 Global climate change

Global warming, an indirect impact of population growth, is an accumulation of carbon dioxide and other gases, such as methane, that trap solar infrared light in the atmosphere causing a warming trend. These gases originate from industrial and residential sources. Although the issue of global warming is controversial, all models predict some warming, especially in the higher latitudes in the northern hemisphere (Thorne-Miller and Catena 1991).

While the rise of the ocean temperature may not be as dramatic or as fast as the atmosphere, only a degree or two can have a dramatic effect on biological communities (Thorne-Miller and Catena 1991). Another potential affect will be sea level rise caused by the melting of the Arctic tundra and ice cap. Among the possible effects on sea life are: (1) a significant loss of coral reefs, salt marshes, and mangrove swamps unable to keep up with a rapid rise in sea level; (2) loss of species whose temperature tolerance range is exceeded (perhaps an even greater threat to corals than sea-level rise); (3) effects from Tundra runoff including runoff of nutrients and suspended sediments; and (4) saltwater intrusion that wreaks havoc with freshwater ecosystems, including rivers, freshwater marshes, and coastal lowland farm acreage (Thorne-Miller and Catena 1991). Other effects that may result from the melting of the Arctic tundra, include: (1) warmer water species would invade formerly cooler habitats confining cooler habitat species farther north; and (2) physical changes in the Arctic Seas that may have repercussions through oceans worldwide by altering the patterns of circulation, food chains that include valuable fisheries, and climate in other part of the world (Thorne-Miller and Catena 1991).

The Department of Commerce reports that human-generated increases in greenhouse gas concentrations have combined with natural forces to cause unprecedented warming in the Arctic in the 20th century, a phenomenon that could lead to significant changes in the earth's natural environment (USDC 1997b). Between 1840 and the mid-20th century, the Arctic warmed to the highest levels of the past four centuries, causing dramatic retreats of glaciers, thawing of permafrost and sea ice, and changes in terrestrial and lake ecosystems (USDC 1997b). Significant warming in the Arctic, particularly after 1920, may also be related to increased solar irradiance, decreased volcanic activity, and factors internal to the climate system (USDC 1997b).

As a result of changing meteorological conditions and sea level rise, fish habitats, fishery yields, and the industry's shoreline infrastructure could change dramatically (Bigford 1991). The projected average range of global sea level rise over the next century has been adjusted down since the mid-1980's, but still ranges from about 20 to 78 in. (50 to 200 cm). At least three factors will determine the severity of impacts from sea-level rise on natural resources and their habitat: (1) physical obstruction to inland habitat shifts from natural or human barriers; (2) resilience of species to withstand new environmental conditions during periods of erosion-induced transition; and (3) the rate of environmental change (Bigford 1991). Also sea-level rise could affect species distributions and abundance, particularly for estuarine-dependent or wetland dependent species.

Measures for conservation and enhancement

While the following recommendations made by Bigford (1991) would improve the prospects of dealing effectively with global warming and sea level rise, they may also apply to climatic fluctuations as well.

A). Resource and land use planners should include physical, ecological, and economic impacts of rising waters with respect to fish habitat and the fishing industry on a short-term and long-term basis.

B). Local, regional, state, and federal agencies should accommodate sea level rise in decisions related to permits and federal support.

C). All fishing industry sectors should familiarize themselves with the potential of sea level rise and possible impacts to their financial survival.

D). Responsible agencies should conduct studies, including engineering and ecological, on the implications of a range of sea levels on coastal ports and habitats.

2.2.5.15 Legislation and regulations that currently address habitat issues

Many federal laws are designed to regulate activities that have the potential to adversely affect the environment. Frequently, state programs complement those of the federal government. However, it is not the intent of this discussion to provide a comprehensive description of all these programs, but rather focus attention on those that most directly affect fisheries resources and their associated habitats. Those programs in which NMFS participate are emphasized because NMFS is specifically charged with conserving, enhancing, and managing living marine resources and, in concert with the Councils, implementing provisions of the MSFCMA.

Consultative authority is conferred to NMFS by several laws [e.g., Fish and Wildlife Coordination Act (FWCA), the National Environmental Policy Act (NEPA), the Marine Mammal Protection Act (MMPA), and the Endangered Species Act (ESA)]. These laws require federal agencies to consult with NMFS when proposing to construct, operate, authorize, or fund any activity that may affect resources within the purview of NMFS (e.g., fisheries resources, some marine mammals and endangered species, and their respective habitats). These mandates are essential to NMFS when reviewing proposals requiring permits to modify estuarine and marine habitats, such as those regulated by the Section 10/404 program.

Section 10 of the River and Harbor Act of 1899 authorizes the Army Corps of Engineers (COE) to regulate activities in navigable waters (to mean high water shoreline). Section 404 of the Clean Water Act (CWA), as amended, authorizes COE to regulate the discharge of dredged or fill materials in waters of the United States, including wetlands. EPA exercises oversight of the corps through establishment of guidelines under Section 404(b)(1) and the ability to veto permit decisions under section 404(c). The COE must consult with NMFS, and consider any recommendation made by them, before making a permit decision. It is through these recommendations that NMFS has the opportunity to alleviate potential adverse impacts associated with project implementation.

NMFS may also use its consultative authorities when reviewing other activities that can affect aquatic habitats. For example, Section 402 of CWA authorizes EPA, or delegated states with approved programs, to regulate the discharge of all industrial and municipal wastes (i.e., point source discharges). The EPA and COE also share regulatory responsibilities under the Marine Protection, Research, and Sanctuaries Act (MPRSA) for the discharge of wastes into ocean waters. The COE specifically regulates the discharge of dredged materials, while EPA regulates other discharges (e.g., municipal sewage sludge, industrial wastes). MPRSA also directs NOAA to conduct research and establish marine sanctuaries, which have habitat applications, as do elements of the Coastal Zone Management Act (CZMA).

Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) requires states with approved Coastal Zone Management Programs to address nonpoint pollution in coastal waters. States must submit Coastal Nonpoint Pollution Control Programs for approval to both the EPA and the NOAA. EPA published "Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters" to assist states to achieve compliance with CZARA. States failing to comply with Section 6217 may lose part of their federal funding under Section 306 of CZMA and Section 319 of CWA.

Other provisions of CWA enable NMFS to exercise its consultative authorities to conserve and enhance living marine resources and habitat. For example, Section 316 (a) and (b) require power plants to address and abate thermal pollution, and entrainment and impingement of organisms, respectively, and Section 303 requires states to address water quality holistically by watershed. Total Maximum Daily Loads (TMDLs) have been established for key pollutants (e.g., some heavy metals, nutrients) under Section 303. Stream segments within each watershed are then monitored, and abatement plans are developed so that each watershed can be brought into compliance with TMDLs.

Section 320 of the CWA authorizes the National Estuary Program (NEP). Currently, 28 estuaries are included in the NEP nationally; 8 in the Mid-Atlantic. Habitat loss and modification and eutrophication have been identified as major problems affecting Mid-Atlantic estuaries. Comprehensive Conservation and Management Plans (CCMPs) have been developed that address the problems affecting these estuaries, describe measures needed to resolve these problems, and provide implementation strategies. Plans are also developed to monitor the success of plan implementation. NMFS participates on the Scientific and Technical Committees (STACs) and Living Resources Subcommittees (LRSCs) of many of these estuaries recommending research needed to understand estuarine processes and problems, assisting in the development of CCMPs, and facilitating their implementation.

Some laws, such as the Federal Power Act, as amended, provide NMFS with the authority to prescribe mitigative measures (e.g., construction of fish passage facilities) for projects licensed by the Federal Energy Regulatory Commission. In the northeast, prescriptive authority is primarily used to retrofit facilities that injured resources resulting from past actions, such as requiring construction of fishways on existing hydroelectric plants during relicensing evaluations. Other legislation mandating NMFS to mitigate resource injuries through restoration or replacement of equivalent services are found in the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund) and Oil Pollution Act.

Additionally, NMFS is involved in programs (e.g., Saltonstall-Kennedy, Anadromous Fish Act) that provide grants for the implementation of studies that contribute to the conservation of fish and habitats, or improve fisheries management.

The MSFCMA interim final rule requires consultation between NMFS and other state and federal agencies regarding EFH. Federal agencies are required to respond to NMFS and Council comments on federal activities, including those that are federally authorized or funded. State and federal agencies are encouraged to coordinate with NMFS and the Council in the early stages of actions to identify potential impacts to EFH.

Other pertinent legislation affecting the protection, conservation, enhancement, and management of living marine resources and habitat can be found in *A Plan to Strengthen the National Marine Fisheries Service's National Habitat Program* (USDC 1996b).

2.2.6 Prey Species

According to section 600.815 (a)(8), actions that reduce the availability of a major prey species, either through direct harm or capture, or through adverse impacts to the prey species' habitat that are known to cause a reduction in the population of the prey species may be considered adverse effects on a managed species and its EFH. The bulk of this information can be found in section 2.1.3.5 Food and Feeding.

In summary, dogfish are non-selective predators, however some of their prey items are estuarine dependent. Conservation and enhancement recommendations (section 2.2.5) address degradation in estuarine areas for dogfish and their food sources.

2.2.7 Research and Information Needs

From section 600.815 (a)(10), it states that each FMP should contain recommendations for research efforts that the Councils and NMFS view as necessary for carrying out their EFH management mandate. There are two sets of recommendations included in this section.

In general, there is a necessity to review the unpublished "grey" literature from organizations such as Sea Grant, state and federal agencies, educational institutions, consulting firms, etc. where significant research has been performed on fisheries related contaminant data. However, the time frame imposed by Congress did not permit for a complete this data. Review of existing information should provide a logical first step for management and better define and prioritize research needs.

The two sets of recommendations in this section are simply a compilation of all existing data needs. The Council stands ready to work with NMFS to prioritize these needs on a coastwide basis. The Council is soliciting input from the public during the hearing process as to their view of prioritization.

The first set of recommendations comes from McMillan and Morse (1998) where it is stated that the following information is lacking on the biology of dogfish. For a more detailed register of research needs see NEFSC reference document 94-22 and the update, revised November 1997.

1. Update age and growth estimates;

2. Update length at maturity estimates;

3. Update/investigate food habits of young-of-year (<35cm) and recruits (>35cm);

4. Improve estimates of discards by non-directed fisheries;

5. Investigate potential databases from coastal states regarding estuarine use, particularly the ELMR mid-Atlantic region; and

6. Increase the frequency of sex determination for all surveys and seasons.

The second list comes from Auster and Langton (1998). A number of areas where primary data are lacking, which would allow better monitoring and improved experimentation, ultimately leading to improved predictive capabilities, are:

1. The spatial extent of fishing induced disturbance. While many observer programs collect data at the scale of single tows or sets, the fisheries reporting systems often lack this level of spatial resolution. The available data makes it difficult to make observations, along a gradient of fishing effort, in order to assess the effects of fishing effort on habitat, community, and ecosystem level processes.

2. The effects of specific gear types, along a gradient of effort, on specific habitat types. These data are the first order needs to allow an assessment of how much effort produces a measurable level of change in structural habitat components and the associated communities. Second order data should assess the effects of fishing disturbance in a gradient of type 1 and type 2 disturbance treatments.

3. The role of seafloor habitats on the population dynamics of harvested demersal species. While there is often good time series data on late-juvenile and adult populations, and larval abundance, there is a general lack of empirical information (except in coral reef, kelp bed, and for seagrass fishes) on linkages between EFH and survival, which would allow modeling and experimentation to predict outcomes of various levels of disturbance.

These data, and any resulting studies, should allow managers to regulate where, when, and how much fishing will be sustainable in regards to EFH. Conservation engineering should also play a large role in developing fishing gears which are both economical to operate and minimize impacts to environmental support functions.

2.2.8 Review and Revision of EFH Components of FMP

In section 600.815 (a)(11), it states that Councils and NMFS should periodically review the EFH components of FMPs, including an update of the fishing equipment assessment. Each EFH FMP amendment should include a provision requiring review and update of EFH information and preparation of a revised FMP amendment if new information becomes available.

The Council will amend its FMPs at least every five years as called for in this section, but is also including a habitat framework adjustment provision that can be included in each FMP. Due to the very rapid time constraints of meeting the October-MSFMCA deadline mandated by Congress (with very limited additional funds), it was impossible to include much of the state survey data that will be available in the future, as well as, much of the unpublished literature on contaminants etc. It is important to understand that this EFH is a "work in progress" and that the process will evolve. This framework provision is envisioned to work along the existing framework provisions established for the New England Multispecies FMP by the NEFMC. A similar process is proposed in this FMP for other non-EFH management measures.

The FMP contains definitions of essential fish habitat, estimates of gear impacts on essential fish habitat, and contains recommendations that describe options to avoid, minimize, or compensate for the adverse effects and promote the conservation and enhancement of EFH. In some cases those definitions, estimates, and recommendations are made in general terms because the necessary work on, for example, the specific content and concentrations of organic and inorganic (nutrient) compounds which have not as yet been compiled and/or specified by regulatory agencies, such as the Environmental Protection Agency, Fish and Wildlife Service, National Marine Fisheries Service, and/or appropriate state agencies. The purpose of this framework provision is to incorporate such specifics into the definitions, estimates, and recommendations as specifics are developed via existing data not available when the FMP was adopted. The framework provision is not to be used to add or delete the conservation and enhancement recommendations, but only to adjust definitions of EFH (boundaries) and revise gear management measures (such as degradable panels and lines).

The Council envisions creating a Habitat Monitoring Committee (HMC) made up of at least staff representatives from the NMFS Northeast Fisheries Science Center, the Northeast Regional Office Management and Habitat Sections, the Atlantic States Marine Fisheries Commission, and Chaired by the Council Executive Director or his/her designee. The HMC will meet at the call of the HMC Chair, to develop options for MAFMC consideration on any adjustment or elaboration of any FMP EFH definition or gear impacts of EFH recommendations necessary to achieve the habitat goals and objectives. Based on this review, the HMC will recommend specific measures to revise EFH definitions, revise gear specifications.

The MAFMC, through its Habitat Committee, will review the recommendations of the HMC and all of the options developed by the HMC and other relevant information, consider public comment, and develop a recommendation to meet the FMP's habitat goals and objectives. If the MAFMC does not submit a recommendation that meets the FMP's habitat goals and objectives and is consistent with other applicable law, the Regional Administrator may adopt by regulatory change any option developed by the HMC, unless rejected by the MAFMC or tabled by the MAFMC for additional consideration, provided the option meets the FMP's habitat goals and objective and is consistent with other applicable law. The frameworked process for developing EFH and/or gear impacts will follow the same overall process as that for other non-EFH management measures.

2.3. DESCRIPTION OF FISHING ACTIVITIES

2.3.1 COMMERCIAL FISHERY

United States fishermen have been landing spiny dogfish along the Northeastern coast of the US since the 1880's (Bigelow and Schroeder 1953). The early domestic fishery utilized long lines and otter trawls but was of relatively minor importance to the US fishery due to low market demand. In fact, spiny dogfish were generally avoided by US fishermen and remained lightly exploited during the late 19th and most of the 20th century. However, spiny dogfish have been a popular foodfish in various European markets and have also been the target of the foreign fishing fleets throughout the world (chiefly for reduction), including the east coast of North America (Soldat 1979).

The history of the US commercial fishery for spiny dogfish can be divided into three more or less distinct phases. In the first phase, prior to the passage of the Magnuson Act, reported US commercial landings of spiny dogfish were very small. Historical records dating back to 1931 indicate that US commercial landings of spiny dogfish were relatively minor, with less than 0.25 million pounds (100 mt) per year reported landed prior to 1960 (NMFS 1998). There was a modest increase in dogfish landings from 1962-1966, when an average of 1.2 million pounds was landed by US fishermen. The annual US domestic spiny dogfish landings from Maine to North Carolina averaged roughly 0.7 million pounds (359 mt) from 1962-1978 (Table 19). Following the passage of the Magnuson Act, a second phase characterized by moderate US spiny dogfish landings began, as reported landings increased with the cessation of foreign fishing for dogfish in the US EEZ . During 1979-1989, US commercial spiny dogfish landings ranged from 9-15 million pounds (4,000-6,800 mt). US commercial landings averaged 11.7 million pounds (5,300 mt) during this phase of moderate landings.

Beginning in 1990, the US commercial fishery for spiny dogfish began to expand dramatically. Landings increased six-fold from roughly 10 million pounds (4,500 mt) in 1989 to 60 million pounds (27,000 mt) in 1996. Spiny dogfish commercial landings declined to 45.2 million pounds (20,500 mt) in 1997. During this third phase of rapid fishery expansion (1990-1997), US commercial landings averaged about 40 million pounds (18,000 mt). Cumulative removals during this eight year period was roughly 340 million pounds (154,000 mt). In contrast, cumulative US landings for the period 1962-1989 (i.e., the previous 28 years) were only 118.6 million pounds (54,000 mt). Foreign landings during the during the period 1965-1977 were about 345 million pounds (156,000 mt). Thus, since 1990, the recently expanded US fishery has landed roughly the same weight of spiny dogfish in eight years that the foreign fishery removed in the 13 years prior to the passage of the Magnuson Act. However, although the reported weight of landings were similar, the recent US fishery generated significant discards and the landings were comprised almost exclusively of mature females. In contrast, the foreign fishery was prosecuted on all sizes of spiny dogfish with minimal discarding (NMFS 1998).

Spiny dogfish are landed in every state from Maine to North Carolina (Tables 20). However, prior to 1990, Massachusetts was responsible for the vast majority of commercial spiny dogfish landings. Beginning in 1989 (as the US fishery expansion began), the states of New Jersey, Maryland and Maine began to increase in importance. By 1996, the expansion of the spiny dogfish fishery had occurred in virtually every state, especially in North Carolina since 1992. Overall, Massachusetts and North Carolina recorded the highest landings of spiny dogfish during the period 1988-1997, followed by Maryland, Maine, New Jersey, Rhode Island, New Hampshire, and Virginia (Table 21).

Numerous gear types are reported as taking spiny dogfish based on NMFS weighout data (Table 22). However, two principal gear types, trawls and gill nets, accounted for the majority of spiny dogfish commercial landings historically (Table 22). From 1988-1990, roughly equal amounts of spiny dogfish were landed by trawls and gill nets. As the fishery expanded in the early 1990's, gill nets increased dramatically in importance (Table 23). In 1991, gill nets accounted for greater than 60% of the dogfish landed and increased to 75% of the landings by 1993. In 1996, gill nets accounted for greater than 80% of the 60 million pounds of spiny dogfish landed in that year. Thus, the dramatic increase in spiny dogfish landings in recent years is due to largely to an increase in gill net activity within the fishery. In addition, there has been a recent increase in dogfish landings by longline (Table 22). The landings of spiny dogfish by gear type by state, for the period 1988-1997, are given in Table 24.

Spiny dogfish are landed in all months of the year (Table 25) and throughout a broad area along the Atlantic coast, principally from Maine to North Carolina. However, the distribution of those landings vary by area and season. During the fall and winter months, spiny dogfish are landed principally in Mid-Atlantic waters and southward from New Jersey to North Carolina. During the spring and summer months, spiny dogfish are landed mainly in northern waters from New York to Maine (Table 25).

2.3.2 RECREATIONAL FISHERY

Estimates of recreational catch and landings of dogfish were obtained from the NMFS Marine Recreational Fishery Statistics Survey (MRFSS). Recreational catch data have been collected in a consistent fashion since 1981. Methodological differences between the current survey and intermittent surveys before 1981 preclude the use of the earlier data. The MRFSS consists of two complementary surveys of anglers *via* on-site interviews and households *via* telephone. The angler-intercept survey provides catch data and biological samples while the telephone survey provides a measure of overall effort. Surveys are stratified by state, type of fishing (mode), and sequential two-month periods (waves). Annual catches pooled over all waves and modes and grouped by subregion (Maine to Connecticut, New York to Virginia and North Carolina to Florida) were examined.

Catches are partitioned into three categories: A, B1 and B2. Type A catches represent landed fish enumerated by the interviewer, while B1 are landed catches reported by the angler. Type B2 catches are those fish caught and returned to the water. Inasmuch as dogfish are generally caught with live bait and are often mishandled by anglers, NMFS (1998) assumed 100% discard mortality. The MRFSS provides estimates of landings in terms of numbers of fish. Biological information on dogfish is generally poor, resulting in wide annual fluctuations in mean lengths and weights. As a result, to compute total catch in weight NMFS (1998) assumed an average weight of 5.5 pounds (2.5 kg) per fish for all years. This assumption was used to produce the estimates of recreational catch in weight in Table 19.

Excluding the recreational estimate for 1981, total recreational catches increased from about 150,000 pounds (70 mt) in 1982-83 to greater than 900,000 pounds in 1989 (Table 19). Since then the estimates of spiny dogfish recreational catch in weight have declined. The 1993 estimate was about 265,000 pounds (120 mt). Total catch in weight declined to less than 80,000 pounds (37 mt) in 1996, but increased to 146,000 pounds (66 mt) in1997.

Total catches in number (Type A + B1 + B2) increased nearly five fold from 1982-1989 (Table 26). In the North Atlantic subregion (Maine-Connecticut), catches peaked in 1988 at nearly 400,000 fish and declined to fewer than 250,000 in 1993 (Table 27). Peak catches of nearly 500,000 fish occurred in the Mid-Atlantic states (New York-Virginia) in 1990. The number caught in 1993 declined to about 250,000. Catches of spiny dogfish from North Carolina to Florida increased dramatically after 1979, but are an order of magnitude lower than observed in the Mid-Atlantic and New England states. Historically, less than 4 % of the spiny dogfish catch comes from North Carolina to Florida. Most dogfish are released after capture (Type B2) and the B2 proportion of the catch has increased to more than 90% in recent years. Most of the recreational spiny dogfish catch is taken from party/charter and private/ rental boats (Table 28) and in ocean waters >3 miles from shore (Table 29).

NMFS (1998) considered the possibility that recreational catches may simply reflect increased reporting by anglers. If so, there should be no relation between catch and fishery-independent indices of abundance. The log of total catch was significantly correlated ($r=0.62$, $P=0.015$) with the log of average weight per tow from the NEFSC spring research vessel survey. Thus, increases in recreational catches roughly parallel increases in abundance and the hypothesis of an increased reporting rate was not supported (NMFS 1998).

Even if all of the Type B2 catch is assumed to die after release, recreational catches have constituted only about 8% of the total landings. Therefore, any imprecision in the estimation of recreational landings is inconsequential relative to the commercial landings and discards, especially in recent years.

2.3.3. FOREIGN FISHING ACTIVITIES

As noted above, spiny dogfish were generally by avoided US fishermen and remained lightly exploited during the late 19th and most of the 20th century. However, spiny dogfish have been a popular foodfish in various European markets and have also been the target of the foreign fishing fleets throughout the world (chiefly for reduction), including the east coast of North America (Soldat 1979). Significant fishing effort directed at the spiny dogfish began in 1965 by vessels from the former Soviet Republic (USSR). By 1970, Poland, the former German Democratic Republic, Japan and Canada had also entered the fishery. Most of the foreign landings during the 1970's were attributable to vessels from the former USSR and originated from waters which later became regulated under the Magnuson Act (NAFO Areas 5 and 6). Reported foreign landings of spiny dogfish in NAFO Areas 2-6 (Figure 23) increased from about 0.5 million pounds (207 mt) in 1965 to a peak of 54.1 million pounds (24,549 mt) in 1974 (Table 19). Foreign spiny dogfish landings averaged 29.6 million pounds (12,059 mt) for the period 1965-1977. Cumulative landings for the same period were 346.5 million pounds (157,000 mt).

Foreign fishing for spiny dogfish began to be regulated with the advent of extended fishery jurisdiction in the US under the Magnuson Act in 1977. US regulations restricted foreign vessels fishing for squid and other species to certain areas and times (the so-called foreign fishing "windows"), primarily to reduce spatial conflicts with domestic fixed gear fishermen and minimize bycatch of non-target species. The result of these restrictions was an immediate reduction in the foreign landings of spiny dogfish from 37.4 million pounds (16,971 mt) in 1976 to 1.6 million pounds (706 mt) in 1978. Foreign landings from the US EEZ have remained sharply curtailed since the period of fishery expansion during the 1970's.

2.3.4 ECONOMIC CHARACTERISTICS OF THE FISHERY

As described above, spiny dogfish has become an increasingly important species to the commercial fishing sector from North Carolina to Maine over the past decade, while the recreational fishery for spiny dogfish is of little or no importance to the Atlantic coast recreational fisheries. For example, only 150,000 pounds (67 mt) of spiny dogfish was landed (catch type A + B1) by anglers in 1997 while the commercial landings in that same year was about 45 million pounds (20,000 mt). Thus, it is evident that dogfish play a much greater role in the commercial fishery than the recreational fishery.

The individual firms engaged in the commercial harvesting and marketing of spiny dogfish make expenditures and generate employment in the course of business activities. When considering the relative benefits of spiny dogfish between commercial and recreational fishing sectors, it is difficult to juxtapose the value and impacts of each sector. Recreational values are not easily measured and too often, economic impacts of recreational fishing are erroneously contrasted with ex-vessel value in the commercial sector.

2.3.4.1 COMMERCIAL FISHERY

In general, the commercial fishery is divided into three parts: producers, processors, and marketing. The following section examines these three components of the commercial spiny dogfish fishery in order to better understand this fishery.

Ex-vessel value and price for 1988-1997 is given in Table 30. The commercial landings increased almost tenfold from about 6 million pounds in 1987 to greater than 60 million pounds in 1996. Notably, the average ex-vessel price for spiny dogfish also increased 300% between 1988 and 1996. The combination of the increase in price and landings resulted in an increase in nominal ex-vessel value from $0.48 million in 1988 to $10.9 million in 1996.

Spiny dogfish are landed primarily from Maine to North Carolina. However, several states land the majority of spiny dogfish. Average landings for each state during 1987-1996 are broken down as follows: Massachusetts 55%, North Carolina 16%, Maryland and Maine with 7% each, and New Jersey with 5%. In total, these states landed 90% of the spiny dogfish from 1987-1996. Furthermore, there are several ports which landed a disproportionate amount of spiny dogfish in 1996. Notably, four ports comprise 44% of the 1996 spiny dogfish landings: Chatham, MA--14%; Plymouth, MA--12%; Ocean City, MD--12%; Gloucester, MA--6%. The ex-vessel value by state and year is given in Table 31.

At present, no permit is required for commercial fishing vessels landing spiny dogfish. As such, information on the total number of vessels landing spiny dogfish is can only be estimated. NMFS weighout data can be used to estimate the number of vessels involved in the spiny dogfish fishery, but these data do not constitute a complete census. Unpublished NMFS weighout data indicate that 642 vessels landed spiny dogfish in 1996 (using primarily gill nets and otter trawls). It is likely that most of the vessels that qualify for spiny dogfish permits (which will be required under the current FMP) will apply for them for two reasons: to maintain flexibility in the complex of species they fish and second, since the current management alternatives involve greatly reducing landing after the first year, there is little incentive not to fish in the first year of the FMP.

Based on the number of trips landing spiny dogfish in 1996 (13,632), the average ex-vessel value per trip was $807 (obtained by dividing the total 1996 ex-vessel value by the total number of trips landing spiny dogfish in 1996). This would indicate that the fishery is a mixed fishery where participants fish a complex of species. This is reinforced by the number of other permits vessels landing spiny dogfish hold. Table 32 contains the number of different permits held by the 642 vessels which landed spiny dogfish in 1996 (based on NMFS weighout data).

2.3.4.2 Recreational Fishery

In the recreational fishing sector, value and impacts are usually conceptualized as expenditures and revenues associated with fishing trips rather than the value of landings. Impacts and value for a particular species is best thought of in terms of expenditures and concomitant revenues derived from trips targeting that species of fish. The 1994 Marine Recreational Fisheries Statistics Survey (MRFSS) indicated that of the 33,279 intercept surveys conducted in New England and the Mid-Atlantic, 4 anglers were targeting spiny dogfish as their "primary" species. Although this number is not expanded to represent all anglers making trips during that year, it suggests that there a very limited directed recreational fishery for spiny dogfish.

Most of the catch of spiny dogfish in the recreational fishing sector appears to be incidental in the targeting of other species. Thus the value of spiny dogfish in the recreational fishing sector in terms of angler expenditures and revenues derived from those expenditures in the targeting of this species appears to be fairly low. Although a recreational demand curve for spiny dogfish is unavailable, based on the low level of interviewed anglers targeting spiny dogfish in recent years, there is likely to be very little lessening of demand for marine recreational fishing trips as a result of this catch restrictions on spiny dogfish.

2.3.4.3 FOREIGN MARKETS AND INTERNATIONAL TRADE

The increase in landings as well as the noticeable increase in average ex-vessel price in reportedly due to the development of export markets for spiny dogfish. In Great Britain and France, the portion of the fish commonly called the "back" is used in fish and chips. The market price depends largely on the availability of a competing product from Scotland. Belly flaps are used in Germany and France for a cured product called *schillerlocken*. Backs and bellies are commonly sold in two sizes, medium and large. These sizes are further divided into fresh and frozen categories. Fresh fish is air-freighted to awaiting European markets while frozen product is more apt to be sent by ship. In general, the fresh bellies and backs garner higher prices than frozen product.

Tails and fins (excluding the dorsal fin which is not exported and currently has no market) are exported primarily to Pacific Rim nations. Spiny dogfish skins are used in the production of "shark skin" products and the head is used in two ways: (1) it is sold as bait for other fisheries or the cartilage is dried and pulverized to service a market for medicinal uses (primarily exported to Pacific Rim nations).

2.3.4.4 Port and Community Description

The Mid-Atlantic Fishery Management Council commissioned a report to describe the people and communities involved in the region's fisheries in the early 1990's. The report titled "Part 2, Phase I, Fishery Impact Statement Project, Mid-Atlantic Fishery Management Council" by McCay *et al.* (1993) was developed to assist in describing the potential effects of management actions on the people and communities involved in fisheries throughout the region in the early 1990's. The results of McCay *et al.* 1993 and more recent NMFS weighout data for 1997 provide recent historical and current description of the reliance of various ports along the Atlantic coast on spiny dogfish.

The principal approaches employed to compile the information presented in McCay *et al.* (1993) were open-ended phone interviews, port visits, data analysis, and interviews of people involved in different aspects of the fishing industry. The report prepared by McCay *et al.* (1993), identified ports that appeared in the top 10, in terms of landed value, for any of the species that the Mid-Atlantic Fishery33 Management Council has full or shared responsibility for the preparation of Fishery Management Plans (tilefish, scup, black sea bass, summer flounder, dogfish, Atlantic mackerel, *Loligo* squid, *Illex* squid, butterfish, weakfish, bluefish, and angler or monkfish). The ports identified as relevant in the report covered ports from Chatham, Massachusetts, to Wanchese, North Carolina. Landing statistics and values were from the National Marine Fisheries Service weighout data. Information about the ports is from interviews with key informants and from earlier studies conducted by McCay's research team (McCay *et al.* 1993). The results of McCay et al. 1993 can be contrasted with more recent 1997 NMFS weighout data

The descriptive information that follows is excerpted and paraphrased from a report prepared for the Council by McCay *et al.* 1993 and is based on interviews conducted in the respective ports as described above:

Wanchese, North Carolina

"Wanchese has traditionally been a fishing community with commercial fishing operations since the late 1800s. Many of the current residents of Wanchese are descendants of people who settled here in the late 1600s and early 1700s." Many of the fishers are small, independent owner operators. "Informants have estimated that fifty percent of the men in Wanchese are in a marine related career." Wanchese has never developed the strong tourism sector seen in nearby areas. Because of the periodic shallowness of Oregon Inlet, many of its larger trawlers stay in Hampton, Virginia or New Bedford, Massachusetts during the winter. "Wanchese is also the site of the Wanchese Seafood Industrial Park (WSIP) which was developed in the 1970s to be a major site for seafood processing activities. However, because of the uncertain nature of Oregon Inlet and the general decline in fisheries since the 1970s, very few businesses actually operate in WSIP. The catch is either sold at retail markets locally or it is packed in ice and sent to other markets. At least one of the Wanchese commercial fishing and packing operations has expanded to other ports such as Hampton, Virginia and New Bedford, Massachusetts." In recent years, some New Bedford vessels have moved south to base in Wanchese in response to shortages of groundfish and scallops in New England.

Much of the ocean fishing occurs in the winter months (November-April). However, the boats in Wanchese fish all year round. Bluefish is predominantly caught with ocean gill nets which fish up to ten miles offshore and fish the area of Ocracoke to Currituck Light. Other species include weakfish, dogfish and Atlantic croaker between the first of November and the end of April. There are a half dozen fish houses and other marine-related businesses that handle species other than crabs, and a couple that handle crabs exclusively. McCay *et al.* (1993) reported that summer flounder (21%) was the most important species in Dare County in terms of landed value in 1991. The value of all species landed in Dare County was over $11 million in 1991. Blue crabs (hard) are second in importance (11%), followed by weakfish (9%). Other species of volume in Dare County in 1991 were bluefish (4.02%), sea basses (3.41%), dogfish (1.00%), tilefish (0.53%), scup (0.41%), butterfish (0.31%), squid (0.29%), and Atlantic mackerel (0.12%).

Generally, the boats that are owned by local companies are operated by hired captains. However, these boats may be operated by a relative in some instances. Independent boats are usually owner-operated, with family members often serving as crew. "The crew on these vessels are mostly local; 75-80 percent are from within the area. All are paid with some variation of a share system." The crews are mostly 18 to 40 years of age; captains are usually older, with some over 65. Most crew members are white, though there are some black fishers including black captains. Sometimes, members of a family will own boats and fish houses. In the fish houses, most of the work force is black women, except for the crab houses where Latino workers are more common."

"Recreational fishers use the inshore, offshore, and sound waters around Wanchese and Dare Counties." Those fishing from boats do not predominantly target bluefish. Bluefish are targeted by pier and surf fishers, who are primarily local residents and residents of nearby counties. Other species targeted by pier and surf fishers are: flounder, Kingfish or sea mullet, triggers, puffers, skates, rays, spot, pigfish, and pinfish.

Hampton/Hampton Roads, Virginia

The area in Virginia containing Hampton, Newport News, Seaford, and Virginia Beach is know as Hampton Roads. It is difficult to describe fishing in Hampton apart from the rest of the area. These ports have historically been fishing communities. The Hampton Roads area included five of the six major offloading ports in Virginia. However, the fishing industry is but one of the many industries in the Hampton Roads area. While Hampton itself is not a big tourist spot, the town is trying to emphasize its waterfront area and its tourism potential. There is an Air and Space Museum, a marina for pleasure boats, a number of military installations, and a large coal port in addition to other shipping."

Much of the landed fish in Virginia by weight is accounted for by menhaden, but other species are also important. Dogfish accounted for less than 0.01% of the total landed value in Hampton Roads in 1992, 100% of which was landed by sink gill nets. Overall, the fishers in this area are very opportunistic, targeting whatever is available and marketable.

Family ties are important in choosing crew members on the smaller vessels. These boats tend to have very stable crews. Larger vessels, especially scallopers have a much higher turnover rate among crew. Crew are paid on a share system. Most of the captains and some of the crew have been fishing for most of their lives. Educational levels vary. "There is a mix of age groups in commercial fishing in Hampton Roads. One informant said that for a while, there was concern that there were no younger people getting into this industry. A few younger people have joined fishing recently with the recession and the scale down in the military." There is a small but growing contingent of Vietnamese-owned boats, which is generating some resentment from longtime resident fishers. There are also a small number of Mexican-American fishers, most of whom are members of a single extended family.

"Trawlers unload at packing houses and these fish houses often serve as the wholesale buyer and distributor. One of the fish houses has government contracts and supplies the navy with all of its seafood. Bluefish are shipped north to Philadelphia or New York City. Two of the companies in Hampton own their own trucks and one of these is also a secondary buyer."

"Hampton Roads also has a large recreational fishery. Virginia Beach has a sports fishing center like Ocean City, Maryland but not as big as Oregon Inlet, North Carolina." Summer flounder is an important recreational species with hook and line, with the highest recreational landings in the spring near Chincoteague (eastern shore). Headboats go out for black sea bass, and some recreational fishers target scup. Other recreational species include bluefish and weakfish, with dogfish being an incidental catch. "Bluefish are a recreational fish in the early summer in inshore waters."

Ocean City, Maryland

"The principal ocean port in Maryland is Ocean City. Ocean City is a commercial fishing community with families that have been involved in fishing for at least sixty years. In the last [twenty] years, Ocean City has grown into its current status as a summer resort area. However, new development is not taking place at the same levels as it did in the past. In fact, fishers are also finding it hard to go into other industries such as crabbing or construction because these are depressed as well." Surf clams and ocean quahogs are the two most important species, but summer flounder, black sea bass, sea scallops, bigeye tuna, swordfish, spiny dogfish, and yellowfin tuna are also species of interest.

Draggers take a variety of species, but primarily summer flounder and spiny dogfish. They trawl year round for summer flounder, black sea bass, and scup. From April through September they target summer flounder almost exclusively. Black sea bass are important species for inshore handline fishers. There has also been a significant sea bass pot fishery, with black sea bass landed value being second only to summer flounder in many years though it has seen some decline recently. The black sea bass pot fishery runs from April to September. The top ten species by value (1992) landed in Ocean City are: surf clam (34.09%), ocean quahog (28.04), summer flounder (4.83%), black sea bass (4.69%), sea scallop (4.07%), bigeye tuna (3.94%) swordfish (3.78%), spiny dogfish (3.66%), yellowfin tuna (3.62%), and lobster (1.51%). Bluefish ranked 29th in importance, accounting for 0.10% of the total landed value in this port.

"Most of the vessels in Ocean City are owner-operated but a few hire captains. Most owners pay their crew by the share system. A few African-Americans are in the crews and at least one boat had an African-American captain." Captains range from age 23 and up.

"Businesses that serviced the surf clam and ocean quahog fishery such as trucking, fuel and ice have declined tremendously. There are unloading areas in Ocean City as well as local buyers. Fluke [summer founder] and black sea bass are taken to New York or Norfolk to bigger fish houses. During the summer, more summer flounder is sold locally and in Baltimore. Big-eye tuna and the best yellowfins go to Japan and bring a lot of money per pound."

"Ocean City is a well known recreational fishing port with many offshore charter boats." Pelagic boats target white marlin, as also tuna, bluefins and big eyes. Atlantic mackerel are also popular targets.

Belford/Pleasant Point/Barnegat Light/Long Beach, New Jersey

Belford's fleet is mostly in the 40-60 foot range and most vessels are older. This is a family based fishing port, with draggers, pound netters and lobster potters predominating. Most of the fish are handled by a local cooperative, with other firms handling lobster and shellfish. There is little or no tourism. Point Pleasant is more diverse and larger. It is less dominated by family businesses. There are half a dozen fish houses, including a cooperative. There are also a lot of marine-related industries and a strong tourist sector. Barnegat Light is heavily tourism oriented in the summer but becomes more dependant on fishing in the winter.

Most boats in these ports are owner-operated, and there are no freezer boats. Whiting is an important species, as are surf clams and ocean quahogs. There is a bluefish poundnet fishery in Sandy Hook Bay. In Belford, bluefish accounted for less than 2% of the total landed value for all species in 1992. In Belford, there is a sink gill-net fishery, which accounted for 0.6% of the total landed value in 1992. It is dominated by weakfish (50%) and bluefish (39%), and also includes butterfish, summer flounder, bluefish, black sea bass, and scup. Run-around gill nets are sometimes used for bluefish. In Point Pleasant, bluefish accounted for less than 1% of the total landed value by all species in 1992. In Point Pleasant, weakfish, bluefish, mackerel, little tunny, and scup are major species landed by gill net boats. Some bluefish are also landed by hand line gear. In Barnegat Light/Long Beach Island, bluefish accounted for less than 2% of the total landed value by all species in 1992. Captains tend to be aged 40-60. "Belford is a place where fishers have little other skilled work experience and thus are particularly dependent on fishing."

There is a charter boat fleet in Barnegat Light which targets mostly bluefish, summer flounder and tuna.

Cape May/Wildwood, New Jersey

Cape May "is noted for its tremendous tourist and beach economy during the summer. While there are marinas in town there is little conflict for space with commercial fishers because the commercial docks are separated from the rest of the community." The general outline of the area fisheries indicate that dogfish are caught by gill netters and they are a bycatch for draggers. There are only a few gill netters in Cape May. For the Cape May/Wildwood area the sink gill net fishery accounted for 0.69% of the total landed value in 1992. However, the gill-netters are almost totally dependent on few species: dogfish (41% landed value), weakfish (27%), and bluefish (11%) in 1992. Other species caught included angler, summer flounder, scup, Atlantic mackerel, and butterfish. The draggers are generally 50-75 feet long, steel hulled, and specialize in scup and summer flounder. "In addition to local boats, a large number of transient boats from North Carolina, Virginia and some northern states land here." The number of boats has been fairly stable recently, however, perhaps due to the great diversity of species landed here.

Brooklyn/Freeport, New York

Vessels originating from these ports are primarily draggers fishing for whiting, summer flounder, winter flounder, *Loligo* squid, and scup. There are also lobster boats in these ports. Most are day boats who take an occasional 48 hour trip for squid. Most boats are owner-operated. "According to one informant, the gill netters target bluefish, weakfish, butterfish, and mackerel." Pay is by the share system. There is also a substantial amount of tourism, with numerous charter boats based in Freeport.

Stonington, Connecticut

Species of importance in the area include lobster, quahog, summer flounder, winter flounder, and squid. Menhaden, bluefish, black sea bass, alewife, and weakfish are important components of the drift gill net fishery. The number of boats in Stonington is stable. Most fishers are of Portuguese descent. The share system is typically used. There are several fish dealers who sell to markets in Baltimore, Philadelphia, Boston and New York, or directly to local fish markets.

Newport/Other Washington County, Rhode Island

"Three ports make up the bulk of the landings in Rhode Island: Point Judith, Quonset Point, and Newport. Point Judith is generally a "wetfish" port, where the fish is most often landed on ice and packaged at port. Newport is similar. Quonset Point is strictly a large factory freezer vessel port. Newport traditionally landed groundfish and lobster, but in the early 1990s began targeting squid, mackerel, butterfish, scup and dogfish."

"Groundfishing boats, a few scallopers, gill-netters, and draggers make up the range of boats in Newport. While Newport's fish potters rely almost entirely on scup, they also catch a little tautog, small amounts of black sea bass, bluefish, and summer flounder, among other species"

"Newport's small gill-net fishery relies heavily on anglers, as well as its traditional cod, tautog, and bluefish catches. Newport's gill-netters also land the majority of spiny dogfish. They also land large amounts of weakfish and small amounts of *Loligo* squid." Newport's floating trap fishery targets among others: scup, bluefish, summer flounder, Atlantic mackerel, black sea bass, and *Loligo* squid.

Point Judith harbors some minor fisheries. Pot fisheries, besides lobster, are heavily reliant on scup, and pots catch a small percentage of black sea bass, as well as tautog, conger eel, and small amounts of bluefish. Point Judith's small gill net fishery depends heavily on angler, as well as cod, dogfish, tautog, and other species. Bluefish, Atlantic mackerel, summer flounder, black sea bass, weakfish, and butterfish in small quantities are landed in the gill-net fishery. Angler are caught predominantly by draggers, accounting for the bulk of the total landed value for the dragger fishery in 1992. Bluefish, butterfish, summer flounder, scup, black sea bass, squids and weakfish, are also landed by draggers.

Newport has several commercial fish packing and distributing firms, but is also heavily oriented to yachting and tourism. Few non-fishing jobs are available, however. Point Judith is almost exclusively a fishing town, though there is some summer tourism, mostly related to Block Island. The Point Judith coop employed some local labor as well, but is now closed.

New Bedford, Massachusetts

"The dominant gear types in new Bedford are scallop dredges and otter trawls." Angler, summer flounder, spiny dogfish, *Loligo* squid, and scup are among the most important species landed in New Bedford. Some bluefish is landed by draggers and gill netters.

Chatham, Massachusetts

"Chatham is a seasonal resort community. It is a wealthy community and property values are very high. Sportfishing and commercial fishing are important to the community. However they do not seem to be the mainstays of the community's economy. Chatham's fishing community is divided between two ports, Chatham Harbor on the east coast of town, and Stage Harbor on the south side of town. Scup, fluke, sea bass, mackerel, butterfish, weakfish and bluefish are caught as miscellaneous fish by Chatham Harbor boats. Chatham boats are all under 50 feet and are owner-operated. Most crew are paid by the share system and others are paid by the day or are wage workers."

Other North Carolina locations

In the work conducted by McCay *et al.* (1993), the only port described in North Carolina was Wanchese. This section further describes the general characteristics of fishing activities in North Carolina. The descriptive information that follows is excerpted and paraphrased from a report prepared by Griffith (1996), and is based on visits to fishing centers around the state, surveys, and in depth-interviews.

The information presented in this section is based on the following visited locations: Swan Quarter, Englehard, Rose Bay, Germantown, and Ocracoke in Hyde County; Belhaven, and Aurora in Beaufort County; Hatteras, Wanchese, and Alligator River in Dare County; Atlantic, Stacey, Beaufort and Salter Path in Carteret County; Vandamere and Paradise in Pamlico County; Sneads Ferry, and Hampstead in Oslow County; and Varnumtown in Brunswich County.

"First, most obviously, the busiest fishing season for almost all sites visited begins in the spring and lasts through summer, with December through February being relatively quiet in most locations. Exceptions to this are the fisheries of the Outer Banks, which tend to be net-based and to target winter species. Second, despite the fact that we find a number of extremely large vessels in the state, crews on most vessels tend to be small (<45'). Most crews consist of between one and three fishermen and many interviewed fishermen fish alone. The menhaden fishery, of course, is an exception to this (Garrite-Blake 1995). Third, relatively few sites we visited specialize in only one species, one type of gear, or one type of vessel. Crab pots and shrimp or otter trawls rank high among the principal gears used in the state, but others tend to be found in use alongside these either by the same fishermen or by others using the same docking and other facilities. Fourth, few full-time, owner-operator North Carolina fishermen rely on a single species or single gear for their livelihood, and many operate from more than one vessel; indeed, this diversity and flexibility constitutes one of the central defining characteristics of a full-time fishermen in North Carolina. Small crew sizes, especially those based on family and community relations, are adaptive under these conditions, where shifting among fishing gears and locations does not depend on mobilizing large numbers of crewmen. Fifth, this diversity and flexibility has some implications for managing the fisheries of the state. Although fishermen tend to be defined by the *primary* species they target and gear they use to capture those species, such as shrimpers using otter trawls or crabbers using crab pots, North Carolina fishermen become more alike one another, often, in the *secondary* species they target and, in particular, the gears they use for those species. Sixth, North Carolina fisheries are highly localized. Those sites with access to both inland and off-shore waters, such as fishermen based in Wanchese or the Outer Banks or Carteret County, have more options available to them to switch among fisheries and even between recreational and commercial sectors (such as operating as charter boat fishermen) than fishermen based along the Pamlico River or Albemarle Sound. Some fishermen, recognizing the advantages to these different locations, dock boats at more than one location or utilize more than one launching facility. However, several fishermen we interviewed had little or no idea about the character of fisheries fewer than fifty to sixty miles away. Seventh, regional differences occur among the fisheries as we move from North to South, yet are more pronounced as we move from East to West. For example, those fishermen who fish in the Albemarle Sound are more like fishermen of the Pamlico River than they are like those who operate out of Wanchese. Urban and rural distinctions also figure into these differences, fishing strategies of around the Nags Head/Manteo are more similar to Morehead City and Wilmington fishing strategies than they are toward those of Eastern Dare further down the Outer Banks. Finally, with the exception of crab processing plants, most shore sites are staffed by relatively few people on land; most of the work of off-loading, icing, and other handling of the catch is done by fishermen."

Regarding the present aspects of the fishery in the area, it was found that "North Carolina's principal fisheries have change considerably through time, yet certain historical continuities thread through the fishing lifestyles we find on the coast from prehistoric and colonial times to the present." Some families in the Tidewater area (Hyde County) still depend on combining commercial crabbing, eeling, gill net fishing, trapping, hunting, and hiring out as guides to hunters and sportfishermen. Individuals around the upper reaches of the Albemarle Sound still string together seasonal work in the herring fishery, hunting, logging, and from time to time, farming. "Two of the earliest fisheries in North Carolina provided an organizational template for fisheries that continue, in altered form, today. The early herring fisheries on the Chowan River and the Albemarle Sound were highly capitalized fisheries in which harvesting and processing were as tightly integrated as today's menhaden fishery."

According to the most recent weighout data (1997), several ports are extremely dependent on the spiny dogfish fishery and derived a large percent of landings value from spiny dogfish, as compared to the combined value of all other species landed in that port. For example, In Plymouth, MA, spiny dogfish accounted for 96% of the total pounds and 74% of the total value of all fish landed in this port. This phenomenon also manifests in several other ports. In Wachapreague, VA, spiny dogfish accounted for 90% of the total pounds and 76% of the total value of all fish landed in that port; in Scituate, MA, spiny dogfish accounted for 74% of the total pounds and 21% of the total value of all fish landed in this port; in Chatham, MA, spiny dogfish accounted for 47% of the total pounds and 14% of the total value of all fish landed in this port; in Ocean City, MD, spiny dogfish accounted for 32% of the total pounds and 11% of the total value of all fish landed in this port; and, in Dare County, NC, spiny dogfish accounted for 30% of the total pounds and 11% of the total value of all fish landed in this port (Table 32).

Clearly these ports are very dependent upon spiny dogfish landings and will be disproportionately affected by any proposed regulatory action. The extent to which local communities will be affected "materially" is unknown, but it is likely that some of the local businesses which support the commercial fishing industry in these areas will be adversely impacted by this FMP in the short-term.

3.0 ENVIRONMENTAL IMPACTS OF THE ALTERNATIVES

3.1 Management Alternatives

3.1.1 Preferred Measures to Attain Management Objectives

3.1.1.1 Specification of OY, DAH, DAP, JVP, and TALFF

Section 600.310 (b) states that the determination of OY is a decisional mechanism for resolving the Magnuson-Stevens Act's multiple purposes and policies, implementing an FMP's objectives, and balancing the various interests that comprise the national welfare. OY is to be based on MSY, or on MSY as it may be reduced for social, economic, or ecological reasons. The most important limitation on the specification of OY is that the choice of OY and the conservation and management measures proposed to achieve it must prevent overfishing.

OY is all spiny dogfish harvested pursuant to this FMP as determined by the overfishing definition and rebuilding schedule detailed in this FMP. OY will change as the fishing mortality rate target varies and is dependent on the level of adult stock biomass.

The Council has concluded that U.S. vessels have the capacity to, and will, harvest the OY on an annual basis, so DAH equals OY. The Council has also concluded that U.S. fish processors, on an annual basis, will process that portion of the OY that will be harvested by U.S. commercial fishing vessels, so DAP equals DAH and JVP equals zero. Since U.S. fishing vessels have the capacity and intent to harvest the entire OY, there is no portion of the OY that can be made available for foreign fishing, so TALFF also equals zero.

3.1.1.2. Rebuilding Schedule

The Sustainable Fisheries Act (SFA) requires the Councils to set the overfishing definition to meet a new standard (F_{MSY}) or a suitable proxy . In addition, the resource must be rebuilt to the biomass associated with MSY, B_{MSY} or a suitable proxy in as short a period as possible. The rebuilding period is not to exceed 10 years, except where biology, environmental conditions or international agreements dictate otherwise.

In the most recent assessment for spiny dogfish, NMFS (1998) found that current fishing mortality for spiny dogfish exceeds the threshold fishing mortality rate (F_{rep}, proxy for F_{msy}). In addition, total adult stock biomass of spiny dogfish is currently 67% of the target biomass (SSB_{max}, proxy for B_{MSY}). Thus, the spiny dogfish stock is considered overfished according to the new SFA overfishing guidelines and requires rebuilding. This FMP addresses the overfishing problem and plans to rebuild the resource to meet SFA requirements over a ten year planning horizon.

An additional requirement of the SFA is that stocks which are identified as overfished (i.e., stock biomass is less than minimum biomass threshold) must be rebuilt to the level that will produce maximum sustainable yield (B_{MSY}). The SFA guidelines advise that, in most cases, the stock rebuilding period may not exceed 10 years. The most recent stock assessment data presented by NMFS (1998) and the Dogfish Technical Committee indicate that total adult spiny dogfish stock biomass is currently about 280 million lbs (127,000 mt), well below the minimum adult stock biomass target of 440 million lbs (200,000 mt). As a result, the Councils propose to rebuild the spiny dogfish stock to the B_{MSY} level over a ten year rebuilding period through the implementation of this FMP.

The preferred alternative will eliminate overfishing and rebuild the spiny dogfish stock through a two step reduction in fishing mortality rate. The first step allows for a one year exit fishery of 22 million pounds (10,000 mt) to allow a phase out of the directed fishery. This approach was chosen to minimize the impact of the rebuilding program on both the harvest and processing sectors of the industry. For the first year of the rebuilding plan (1999-2000), F will be reduced to 0.2 and then F will be reduced to F=0.03 in the remaining nine years of the rebuilding plan (2000-2009). This schedule allows for stock rebuilding to the level which will support harvests at or near the MSY level in the year 2009.

3.1.1.3 Permit requirements for commercial vessels

Any owner of a vessel desiring to fish for spiny dogfish within the US EEZ for sale, or transport or deliver for sale, any spiny dogfish taken within the EEZ must obtain a federal commercial vessel permit from NMFS for that purpose.

The federal costs of implementing an annual permit system for the sale of spiny dogfish shall be charged to permit holders as authorized by section 303(b) (1) of the Magnuson-Stevens Act. In establishing the annual fee, the NMFS Regional Administrator will ensure that the fee does not exceed the administrative costs incurred in issuing the permit, as required by section 304(d) of the Magnuson-Stevens Act.

3.1.1.4 Dealer permits and fees

Any dealer of spiny dogfish must have a permit. A dealer of spiny dogfish is defined as a person or firm that receives spiny dogfish for a commercial purpose from a vessel possessing a commercial spiny dogfish permit pursuant to this FMP for other than transport.

An applicant must apply for a federal dealer permit in writing to the Regional Administrator. The application must be signed by the applicant and submitted to the Regional Administrator at least 30 days before the date upon which the applicant desires to have the permit made effective. Applications must contain the name, principal place of business, mailing address and telephone number of the applicant. The Regional Administrator will notify the applicant of any deficiency in the application. If the applicant fails to correct the deficiency within 15 days following the date of notification, the application will be considered abandoned. Except as provided in Subpart D of 15 CFR Part 904, the Regional Administrator will issue a permit within 30 days of the receipt of a completed application.

A permit expires on 31 December of each year or if the ownership or the dealer changes. Any permit issued under this section remains valid until it expires, is suspended, is revoked, or ownership changes. Any permit which is altered, erased, or mutilated is invalid. The Regional Administrator may issue replacement permits. Any application for a replacement permit shall be considered a new permit.

A permit is not transferable or assignable. It is valid only for the dealer to whom it is issued.

The permit must be displayed for inspection upon request by an authorized officer or any employee of NMFS designated by the Regional Administrator.

The Regional Administrator may suspend, revoke, or modify, any permit issued or sought under this section. Procedures governing permit sanctions or denials are found at Subpart D of 15 CFR Part 904. The Regional Administrator may, after publication of a notice in the *Federal Register*, charge a permit fee. Within 15 days after the change in the information contained in an application submitted under this section, the dealer issued the permit must report the change in writing to the Regional Administrator.

3.1.1.5 Operator permit and fees

Any individual who operates a vessel for the purpose of fishing commercially for spiny dogfish (i.e., possesses a valid commercial vessel permit spiny dogfish must obtain an operators permit. Any vessel fishing commercially for spiny dogfish must have on board at least one operator who holds an operators 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 federal permit program has the following requirements:

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

2. An operator is defined as the master or other individual on board a vessel who is in charge of that vessel (see 50 CFR 620.2).

3. The operator is required to submit an application, supplied by the Regional Administrator, for an Operator's Permit. The permit will be issued for a period of up to three years.

4. 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. In addition to this information, the applicant must provide two passport-size color photos.

5. The permit is not transferable.

6. 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.

7. The Regional Administrator may, after publication in the *Federal Register*, charge a permit fee.

3.1.1.6 Spiny dogfish FMP Monitoring Committee

The Spiny Dogfish Monitoring Committee is a joint committee made up of staff representatives of the Mid-Atlantic and New England Fishery Management Councils, the Northeast Regional Office, the Northeast Fisheries Center, and state representatives. The state representatives will include any individual designated by an interested state from Maine to North Carolina. The Mid-Atlantic Council Executive Director or his designee will chair the Committee.

The Spiny Dogfish Monitoring Committee will annually review the best available data including, but not limited to, commercial and recreational catch/landing statistics, current estimates of fishing mortality, stock status, the most recent estimates of recruitment, VPA results or length-based stock projection models, target mortality levels, beneficial impacts of size/mesh regulations, as well as the level of noncompliance by fishermen or states and recommend to the Councils' Joint Spiny Dogfish Committee commercial and recreational measures designed to assure that the target mortality level for spiny dogfish is not exceeded. The Committee will also review the gear used to catch spiny dogfish to determine whether gear other than otter trawls and gill nets need to be regulated to help ensure attainment of the fishing mortality rate target and propose such regulations as appropriate.

The Councils will receive the report of the Joint Spiny Dogfish Committee as well as appropriate public input. The Councils will consider this information and jointly determine the quota and framework adjustments for the following year. Next, the Councils will make its recommendations to the Regional Administrator. The Regional Administrator will receive the report of the Councils and publish a report in the *Federal Register* for public comment by the date specified in the regulations, which provides the Councils sufficient time to implement quotas and other management measures. Following the review period, the Regional Administrator will set the final quota and other management measure adjustments for the year. If each option has been rejected by one or the other Council, then the Regional Administrator may select any option that has not been rejected by both Councils.

In summary, the steps from the Monitoring Committee to action by the Councils and Regional Administrator are:

1. The Monitoring Committee reviews the data and makes recommendations to the Joint Spiny Dogfish Committee.

2. The Joint Spiny Dogfish Committee considers the recommendations of the Monitoring Committee in determining the annual quota and framework adjustments and makes recommendations to the Councils.

3. The Councils consider the recommendations of the Joint Spiny Dogfish Committee and make their recommendations to the Regional Administrator.

4. The Regional Administrator considers the recommendations of the Councils decision and publishes proposed measures in the *Federal Register*. If each option is rejected by one or the other Council, then the Regional Administrator may select any option that has not been rejected by both Councils.

3.1.1.7 Framework Adjustment Process

In addition to the annual review and modifications to management measures detailed in section 3.1.1.6, the Councils could add or modify management measures through a framework adjustment procedure. This adjustment procedure allows the Councils to add or modify management measures through a streamlined public review process. As such, management measures that have been identified in the plan could be implemented or adjusted at any time during the year.

The following management measures could be implemented or modified through framework adjustment procedures:

1. Minimum fish size.
2. Maximum fish size.
3. Gear requirements, restrictions or prohibitions (including, but not limited to, mesh size restrictions and net limits).
4. Regional gear restrictions.
5. Permitting restrictions and reporting requirements.
6. Recreational fishery measures including possession and size limits and season and area restrictions.
7. Commercial season and area restrictions.
8. Commercial trip or possession limits.
9. Fin weight to spiny dogfish landing weight restrictions.
10. Onboard observer requirements.
11. Commercial quota system including commercial quota allocation procedure and possible quota set asides to mitigate bycatch.
12. Recreational harvest limit.
13. Annual quota specification process.
14. FMP Monitoring Committee composition and process.

15. Designation of essential fish habitat.
16. Overfishing definition and related thresholds and targets.
17. Regional season restrictions (including option to split seasons).
18. Restrictions on vessel size (LOA and GRT) or shaft horsepower.
19. Target quotas.
20. Measures to mitigate marine mammal entanglements and interactions.
21. Any other management measures currently included in the FMP.
22. Any other commercial or recreational management measures.

The adjustment procedure would involve the following steps. If the Councils determine that an adjustment to management measures is necessary to meet the goals and objectives of the Spiny Dogfish FMP, it will recommend, develop and analyze appropriate management actions over the span of at least two Council meetings. The Councils will provide the public with advance notice of the availability of the recommendation, the appropriate justifications and economic and biological analyses, and opportunity to comment on the proposed adjustments prior to and at the second Council meeting. After developing management actions and receiving public testimony, the Councils will then submit the recommendation to the Regional Administrator. The Councils recommendation to the Regional Administrator must include supporting rationale, an analysis of impacts, and a recommendation to the Regional Administrator on whether to publish the management measures as a final rule.

If the Councils recommend that the management measures should be published as a final rule, the Councils must consider at least the following factors and provide support and analysis for each factor considered:

1. Whether the availability of data on which the recommended management measures are based allows for adequate time to publish a proposed rule.

2. Whether regulations have to be in place for an entire harvest/fishing season.

3. Whether there has been adequate notice and opportunity for participation by the public and members of the affected industry in the development of the Councils recommended management measures.

4. Whether there is an immediate need to protect the resource.

5. Whether there will be a continuing evaluation of management measures adopted following their promulgation as a final rule.

If, after reviewing the Councils recommendation and supporting information:

1. The Regional Administrator concurs with the Councils recommended management measures and determines that the recommended management measures may be published as a final rule, then the action will be published in the Federal Register as a final rule; or

2. The Regional Administrator concurs with the Councils recommendation and determines that the recommended measures should be published first as a proposed rule, the action will be published as a proposed rule in the Federal Register. After additional public comment, if the Regional Administrator concurs with the Council recommendation, the action will be published as a final rule in the Federal Register; or

3. The Regional Administrator does not concur, the Councils will be notified, in writing, of the reason for non-concurrence.

4. Framework actions can be taken only in the case where both Councils approve the proposed measure.

3.1.1.8 Commercial management measures

3.1.1.8.1 Commercial quota

The process used to set the quota is specified in 3.1.1.6. A quota would be allocated to the commercial fishery to control fishing mortality. The quota would be based on projected stock size estimates for that year as derived from the latest stock assessment information. Estimates of stock size coupled with the target fishing mortality rate would allow for a calculation of total allowable landings (TAL). The quota will be specified for the fishing year which will be defined as May 1- April 30.

During the first year of the FMP, the quota will be set at 22 million pounds (10,000 mt) to allow a phase out of the directed fishery. This on year "exit" approach was chosen to minimize the impact of the rebuilding program on both the harvest and processing sectors of the industry. For the first year of the rebuilding plan (1999-2000), F will be reduced to 0.2 and then F will be reduced to F=0.03 in the remaining nine years of the rebuilding plan (2000-2009). This schedule allows for stock rebuilding to the level which will support harvests at or near the MSY level in the year 2009. Assuming that F does not exceed 0.2 in year 1, The TALs in the remaining 9 years would of the rebuilding program are specified in Table 33.

A system to distribute and manage the annual commercial quota on a seasonal basis within the fishing year would be implemented by the Councils. Quotas would be distributed between seasons based on the percentage of commercial landings for the each semi-annual period during the years 1990-1997. These season specific quotas are specified in Table 34. The specification of the seasonal allocation may change under the framework procedure described in section 3.1.1.7.

After year one of the management program ,the annual commercial quota will be set at a range of between 0 and the maximum allowed by the adopted fishing mortality rate reduction strategy. The commercial quota includes all landings for sale by *any* gear. If a person or vessel does not have a commercial spiny dogfish permit, the fish may not be sold and any recreational rules on size, possession, and season apply.

The annual commercial quota would be based on the recommendations of the Spiny Dogfish FMP Monitoring Committee to the Councils. The commercial quota may change annually, if appropriate, following the Spiny dogfish Monitoring Committee process set forth in 3.1.1.6. However, the quota may be specified for a period of up to three years.

The quota will apply throughout the management unit, that is, in both state and federal waters. All spiny dogfish landed for sale in a state would be applied against commercial quota regardless of where the spiny dogfish were harvested. Using data collected through this FMP (section 3.1.1.11), NMFS will monitor the fishery to determine when a quota will be reached. The Regional Administrator shall prohibit landings of spiny dogfish by vessels with federal spiny dogfish permits when the quota has been landed. In addition, each state is encouraged to close state waters to take of spiny dogfish when the quota is landed.

3.1.1.9 Prohibition of finning

Finning, the act of removing the fins of spiny dogfish and discarding the carcass, will be prohibited. Vessels which land spiny dogfish must land fins in proportion to carcasses, with a maximum of three fins per carcass. Fins may not be stored aboard a vessel after the first point of landing.

3.1.1.10 Gill net limitations

Commercial gill net vessels fishing for spiny dogfish will be prohibited from fishing more than a total of 80 nets (50 fathoms each).

3.1.1.11 Other measures

Only persons with a dealer permit may buy spiny dogfish at the point of first sale landed by an individual that has a commercial spiny dogfish permit issued pursuant to this FMP. Only persons with a dealer permit may buy spiny dogfish landed by a vessel or individual that has a commercial permit issued pursuant to this FMP.

Individuals and owner/operators with commercial permits may sell spiny dogfish at the point of first sale only to a dealer that has a dealer permit issued pursuant to this FMP.

The amount of spiny dogfish on board a vessel using mesh sizes smaller than those specified for trawl or gill net gear may not exceed the minimum threshold as specified.

All spiny dogfish on vessels fishing with a mesh smaller than the legal minimum size (if one is specified) must have any spiny dogfish on board boxed in a manner that will facilitate enforcement personnel knowing whether the vessel has more than the level specified of spiny dogfish on board to meet the minimum mesh size criterion. Any unboxed spiny dogfish on board a vessel fishing with a net smaller that the legal minimum is considered a violation of this FMP. A box holds 100 lbs of spiny dogfish and is approximately 36" long, 15" wide, and 12" high (approximately 3.75 cubic feet).

The Regional Administrator may place sea samplers aboard vessels if he determines a voluntary sea sampling system is not giving a representative sample from the spiny dogfish fishery.

No foreign fishing vessel shall conduct a fishery for or retain any spiny dogfish. Foreign nations catching spiny dogfish shall be subject to the incidental catch regulations set forth in 50 CFR 611.13, 611.14, and 611.50.

The Regional Administrator, in consultation with the Executive Directors, may exempt any person or vessel from the requirements of this FMP for the conduct of experimental fishing beneficial to the management of the spiny dogfish resource or fishery.

The Regional Administrator may not grant such exemption unless it is determined that the purpose, design, and administration of the exemption is consistent with the objectives of the FMP, the provisions of the Magnuson Act, and other applicable law, and that granting the exemption will not:

1. have a detrimental effect on the spiny dogfish resource and/or fishery or cause any quota to be exceeded; or

2. create significant enforcement problems.

Each vessel participating in any exempted experimental fishing activity is subject to all provisions of this FMP except those necessarily relating to the purpose and nature of the exemption. The exemption will be specified in a letter issued by the Regional Administrator to each vessel participating in the exempted activity. This letter must be carried aboard the vessel seeking the benefit of such exemption.

All experimental activities must be consistent with the harvest rates in the FMP.

It is the Councils intention that experimental fisheries are short-term fisheries to answer specific management questions and are not to be used to resolve short-comings in existing fishery management plans.

3.1.1.12 Specification and sources of pertinent fishery data

3.1.1.12.1 Domestic and foreign fisheries

Section 303(a)(5) of the MSFCMA requires that Council specify the pertinent data which shall be submitted to the Secretary with respect to commercial, recreational, and charter/party fishing in the fishery, including, but not limited to, information regarding the type and quantity of fishing gear used, catch by species in numbers of fish or weight thereof, areas in which fishing was engaged in, time of fishing, number of hauls and the estimated processing capacity of, and actual processing capacity utilized by, United States fish processors. In order to achieve the objectives of this FMP and to manage the fishery for the maximum benefit of the U.S., it is necessary that, at a minimum, the Secretary collect on a continuing basis and make available to the Councils: (1) spiny dogfish catch, effort, and exvessel value and the catch and exvessel value of those species caught in conjunction with spiny dogfish for the commercial fishery provided in a form that analysis can be performed at the trip, water area, gear, month, year, principal (normal) landing port, landing port for trip, and state levels of aggregation; (2) catch, effort and discards for the recreational fishery; (3) biological (e.g., length, weight, age, and sex) samples from both the commercial and recreational fisheries; and (4) annual and fully comparable NMFS bottom trawl surveys for analyses of both CPUE and age/size frequency. The Secretary may implement necessary data collection procedures through amendments to the regulations. It is mandatory that these data be collected for the entire management unit on a compatible and comparable basis.

Commercial logbooks must be submitted on a monthly basis by federal commercial permit holders in order to monitor the fishery.

It is intended that the reports required by this section are the same as the reports required by the Summer Flounder FMP, the Northeast Multispecies FMP, and the Atlantic Sea Scallop FMP. That is, fishermen need to submit one logbook report, not one report for each FMP.

Foreign fishermen are subject to the reporting and record keeping requirements in 50 CFR 611.

3.1.1.12.2 Dealers

In order to monitor the fishery and enable the Regional Administrator and the states to forecast when a closure will be needed, dealers with permits issued pursuant to this FMP must submit weekly reports showing at least the quantity of spiny dogfish purchased (in pounds), and the name and permit number of the individuals from whom the spiny dogfish was purchased. Dealers having state permits are required to report to the state or NMFS all spiny dogfish purchased. States would report state landings weekly to NMFS.

Buyers that do not purchase directly from vessels are not required to submit reports under this provision. Dealers should report only those purchases from vessels with commercial permits for spiny dogfish.

3.1.1.12.3 Processors

Section 303(a)(5) of the MSFCMA requires that at least estimated processing capacity of, and the actual processing capacity utilized by U.S. fish processors, must be submitted to the Secretary. The Secretary may implement necessary data collection procedures through amendments to the regulations.

3.1.2 Alternatives to the Preferred Management Measures

3.1.2.1 Take no action at this time

This would mean that the spiny dogfish fishery would remain unregulated.

3.1.2.2 Alternative rebuilding schedules

3.1.2.2.1 Reduce fishing mortality to F=0.04 in year 1 and maintain to allow stock rebuilding in ten years to rebuild to biomass target (B_{MSY})

This option would require a reduction in fishing mortality to F=0.04 in years 1-10 and would allow for stock rebuilding over a 10 year planning horizon by maintaining a constant F. Total allowable landings (TAL) or quota would have to be reduced to 5.1 million pounds (2,300 mt) during the first three years of the management program (1999-2003). TAL would increase slightly towards the end of the rebuilding program (Table 33) .

3.1.2.2.2 Reduce fishing mortality in year 1 half way between $F_{current}$ and $F_{threshold}$, in year 2 reduce fishing mortality to $F_{threshold}$ and in year 3 reduce F to level required to rebuild stock in remaining 8 years of the rebuilding program.

This option would require a reduction in fishing mortality to F=0.204 in year 1 (half way between $F_{current}$ and $F_{threshold}$), in year 2 fishing mortality would be reduced to $F_{threshold}$ or F=0.11. Under this scenario, even if F was reduced to F=0.026 in ensuing eight years, the stock would not rebuild to the target SSB by the tenth year. In year 1 the TAL would be 22.5 million pounds (10,186 mt), in year 2 TAL would equal 11.3 million pounds (5,130 mt) and in the eight remaining years TAL would range from 2.8 - 3.4 million pounds (1,262 - 1,558 mt). This option would not meet the requirements of the SFA.

3.1.2.2.3 Reduce fishing mortality in year 1 to allow a harvest of 13.2 million pounds (6,000 mt) and in year 2 reduce F to allow for harvest of 8.8 million pounds (4,000 mt) then reduce F to the level required to rebuild stock in remaining 8 years of the rebuilding program.

This option would require a reduction in fishing mortality in year 1 to allow a harvest of 13.2 million pounds (6,000 mt) and in year 2 to allow for a harvest of 8.8 million pounds (4,000 mt), F would then be reduced to F=0.028 to rebuild the stock in the remaining 8 years of the rebuilding program. In the last eight years of the rebuilding program, TAL would range from 3.3 - 3.7 million pounds (1,509 - 1,685 mt).

3.1.2.2.4 Reduce fishing mortality to F=0.072 in year 1 and maintain to allow stock rebuilding in 15 years to rebuild to biomass target (B_{MSY})

This option would require a reduction in fishing mortality to F=0.072 in years 1-15 and would allow for stock rebuilding over a 15 year planning horizon by maintaining a constant F. This option would not meet the requirements of the SFA.

3.1.2.2.5 Reduce fishing mortality to F=0.078 in year 1 and maintain to allow stock rebuilding in 20 years to rebuild to biomass target (B_{MSY})

This option would require a reduction in fishing mortality to F=0.078 in years 1-20 and would allow for stock rebuilding over a 20 year planning horizon by maintaining a constant F. This option would not meet the requirements of the SFA.

3.1.2.2.5 Reduce fishing mortality to F=0.088 in year 1 and maintain to allow stock rebuilding in 30 years to rebuild to biomass target (B_{MSY})

This option would require a reduction in fishing mortality to F=0.088 in years 1-30 and would allow for stock rebuilding over a 30 year planning horizon by maintaining a constant F. This option would not meet the requirements of the SFA.

3.1.2.3. Establish a coastwide trip limit

This alternative would establish a system of uniform trip limits established on a coastwide basis in conjunction with the quota system. To estimate allowable trip limits under any of the scenarios requires an estimation of the number of trips likely to be taken during each year of the management program. For example, there are roughly 5,000 vessels which currently possess permits to fish in the EEZ from ME to NC. Assuming that each vessel makes 100 trips per year, and that half of those trips could land spiny dogfish, yields an estimate of 250,000 trips. If the annual TAL was 1,316 mt in the year 2000, the associated trip limit would be about 12 lbs. This analysis suggests that any trip limit specified on an annual basis would be very low. A trip limit could be specified for a limited season which might allow for a higher trip limit.

3.1.2.4 Minimum size limits

3.1.2.4.1 Establish a minimum size which corresponds to the length at which 50% of female spiny dogfish are sexually mature

This alternative would establish a minimum size for spiny dogfish which corresponds to the length at which 50% of female spiny dogfish are sexually mature. This would require a minimum size of 32 inches (80 cm).

3.1.2.4.2 Establish a minimum size which corresponds to the length at which 100% of female spiny dogfish are sexually mature

This alternative would establish a minimum size for spiny dogfish which corresponds to the length at which 100% of female spiny dogfish are sexually mature. This would require a minimum size of 36 inches (91 cm).

3.1.2.4.3 Establish minimum a size of 27.5 in (70 cm)

This alternative would establish a minimum size of 27.5 in, which is the current effective minimum size at capture for spiny dogfish in the commercial fishery.

3.1.2.4.4 Establish a slot size limit of 27.5 in to 32 in (70-80 cm)

Each of the stock rebuilding strategies which meet the SFA requirements could be implemented with a slot size limit of 27.5 in to 32 in (70-81 cm). This alternative would require that the F applied in any given year be applied fully to a slot limit of 27.5 in to 32 in (70-80 cm) and that a partial recruitment vector of 0.5 of that F was applied to dogfish greater than 80 cm. Under these scenarios only fish from 27-32 in (70-79 cm) could be retained, and it was assumed that fish greater than 32 in (80 cm) would continue to be caught and discarded, with an effective mortality rate of 50% of those landed in the slot. The results indicate that this strategy would result in lower yields and would not alter the rebuilding time frame.

3.1.2.5 Alternative seasonal allocation of the commercial quota

3.1.2.5.1 Allocate commercial quota on a quarterly basis

The process used to set the quota is specified in 3.1.1.6. A quota would be allocated to the commercial fishery to control fishing mortality. The quota would be based on projected stock size estimates for that year as derived from the latest stock assessment information. Estimates of stock size coupled with the target fishing mortality rate would allow for a calculation of total allowable landings (TAL).

A system to distribute and manage the annual commercial quota on a seasonal basis would be implemented by the Councils. Quotas would be distributed between seasons based on the percentage of commercial landings for the each quarterly period during the years 1990-1997. These season specific quotas are specified in Table 34.

3.1.2.5.2 Allocate commercial quota on a bi-monthly basis

The process used to set the quota is specified in 3.1.1.6. A quota would be allocated to the commercial fishery to control fishing mortality. The quota would be based on projected stock size estimates for that year as derived from the latest stock assessment information. Estimates of stock size coupled with the target fishing mortality rate would allow for a calculation of total allowable landings (TAL).

A system to distribute and manage the annual commercial quota on a seasonal basis would be implemented by the Councils. Quotas would be distributed between seasons based on the percentage of commercial landings for the each bi-monthly period during the years 1990-1997. These season specific quotas are specified in Table 34.

3.1.2.6 *Limit entry into the spiny dogfish fisheries*

Under this alternative, vessels would have to qualify for a limited access commercial permit for spiny dogfish. The qualifying criteria would be based on historical performance in the fishery at a level specified by the Councils. The intent of this action would be to limit the number of participants in the commercial fishery for spiny dogfish.

3.1.2.7 Specify a target commercial quota

Under this alternative, the Councils would specify a target commercial quota in place of the "hard" or fixed quota specified in the preferred alternative. This approach to managing the commercial fishery would require additional management measures which would control fishing effort (i.e., input controls). Under this system an annual target quota would be specified and a suite of effort controls would be specified such that the landings under the effort control system would be expected to approximate the target quota. The fishery would not necessarily be closed if the target quota is reached or exceeded. This system depends on fishing effort limitations primarily through limitations on the number of days that vessels may fish during the quota period.

3.1.3 The FMP Relative to the National Standards

3.1.3 The Amendment Relative to the National Standards

Section 301(a) of the MSFCMA states: "Any fishery management plan prepared, and any regulation promulgated to implement such plan pursuant to this title shall be consistent with the following national standards for fishery conservation and management." The following is a discussion of the standards and how this amendment meets them:

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

The Sustainable Fisheries Act (SFA), which reauthorized and amended the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) made a number of changes to the existing National Standards. With respect to National Standard 1, the SFA imposed new requirements concerning definitions of overfishing in fishery management plans. To comply with National Standard 1, the SFA requires that each Council FMP define overfishing as a rate or level of fishing mortality that jeopardizes a fisheries capacity to produce maximum sustainable yield (MSY) on a continuing basis.

Each FMP must specify objective and measurable status determination criteria for identifying when stocks or stock complexes covered by the FMP are overfished. To fulfill the requirements of the SFA, status determination criteria for spiny dogfish are comprised of two components: 1) a maximum fishing mortality threshold and 2) a minimum stock size threshold. The maximum F threshold for spiny dogfish is specified as F_{MSY}. The minimum biomass threshold is specified as ½ B_{MSY}.

For spiny dogfish, MSY could not be reliably estimated from a surplus production model, like other stocks that have better catch and effort data. This approach also gives results that are conditioned on the exploitation pattern, which appears to be changing (the fishery has targeted smaller fish with time). In lieu of this approach, the Dogfish technical Committee and Overfishing Definition Panel recommended using yield-per-recruit biological reference points that maximize yield and protect against declines in total recruitment. Yield-per-recruit analyses do not give any advice on the amount of recruitment or how it changes with stock size. To estimate a stock size that would maximize recruitment, a stock-recruitment model was fitted to spawning stock biomass and recruitment observations. The stock size that would maximize average recruitment is knows as the SSB_{max} and was recommended as a proxy value for B_{MSY}. This value is estimated to be 440 million pounds (200,000 mt) and was measured as a swept-area biomass index.

A length-based projection model, using the fitted Ricker stock-recruitment equation, estimated the fishing mortality rate that would allow the stock biomass to fluctuate around the SSBmax value to be equal to 0.11. As a maximum fishing mortality threshold that would serve as a proxy for F_{MSY}, Applegate *et al.* 1998 this fishing mortality value, which was estimated to stabilize the female population at SSB_{max} while maximizing yield per recruit. To set a risk adverse fishing mortality target that ensures adequate recruitment while maximizing yield-per-recruit, Applegate *et al.* 1998 recommended a fishing mortality rate target that would produce an average of 1.5 pups-per-recruit. Based on the yield-per-recruit analysis conducted by SAW 26, the fishing mortality target would be 0.082 with a size-at-entry in the fishery of 27.5 in (70 cm) and 0.118 at 32 in (80 cm).

Recommended biological reference points that would define overfishing and overfished conditions for spiny dogfish (from Applegate *et al.* 1998).

Reference point	Basis	Estimated value
Biomass target	SSB_{max} (the spawning stock biomass calculated to produce maximum recruitment on the Ricker S/R function).	440 million pounds (200,000 mt) spawning stock biomass
Biomass threshold	1/2 SSB_{max} - defines a 10 year rebuilding program when SSB > 1/2 SSB_{max} and a 5 year rebuilding program when SSB < 1/2 SSB_{max}.	220 million pounds (100,000 mt) spawning stock biomass.
Total swept-area adult female biomass - 1995-1997	Status quo value.	279 million pounds (127,000 mt) (64% of the biomass target).
Fishing mortality target	Defined by the fishing mortality rate that would allow stock production at 1.5 pups per recruit.	0.082 with a 27.5 in (70 cm) size-at-entry to the fishery and 0.118 at 80 cm.
Fishing mortality threshold	The fishing mortality rate that stabilizes the population at the SSB_{max} when recruitment @ 70 cm.	0.11 (51 percent of current fishing mortality).
Current fishing mortality - three-year smoothed average.	Status quo value.	0.297

The female spawning stock, SSB_{max} is the point on the Ricker stock-recruitment curve that would produce the highest average recruitment over time, if spawning stock biomass remains constant. Applegate *et al.* (1998) recommended using this total female biomass level as a proxy for B_{MSY}, because it maximizes average recruitment. The reader is cautioned that this does not represent the maximum level of female biomass observed for spiny dogfish. When a fishing mortality rate that maximizes yield-per-recruit is applied, this biomass approximates a level that would maximize total yield. Using a swept-area method for calculating total biomass from a survey index, the Ricker equation gives a SSB_{max} value of 200,000 mt.

Whenever biomass is low, potentially jeopardizing recruitment success, management should take immediate and significant steps to reduce mortality and rebuild spawning biomass as quickly as possible. Applegate *et al.* (1998) and the Spiny Dogfish Technical Committee panel used a length projection model to estimate rebuilding potential from equilibrium conditions. Since spiny dogfish appear to be less resilient than other fish, a more aggressive rebuilding strategy was recommended for a control law, or fishing mortality management strategy. In general, slower growth rates and lower fecundity make elasmobranchs, like spiny dogfish, less resilient than teleost fish and rebuilding times are much longer for equivalent biomass levels.

Due to this low resiliency and the long rebuilding times needed for recovery, Applegate *et al.* (1998) recommended using l/2 of the SSB_{max} as a minimum biomass threshold. If total female biomass is above the minimum biomass threshold, then the Councils should not permit mortality to exceed levels that would require rebuilding to SSB_{max} over periods greater than 10 years. When total female biomass is below 1/2 of the SSB_{max}, then fishing mortality should not exceed a rate that would allow rebuilding to the SSB_{max} in five years. If female biomass is between 1/2 of the SSB_{max} and the SSB_{max} values, fishing mortality rates that would allow recovery to the biomass target within 10 years would define overfishing. Whenever biomass is less than 1/2 of the SSB_{max} value, fishing mortality above a level that is would allow rebuilding in 5 years would define overfishing. If female biomass is above the target level, then the fishing mortality rate that would allow the stock to fluctuate around SSBmax would define overfishing.

The SFA requires that stocks which are identified as overfished (i.e., stock biomass is less than minimum biomass threshold) must rebuilt to the level that will produce maximum sustainable yield (B_{MSY}). The SFA guidelines advise that, in most cases, the stock rebuilding period may not exceed 10 years. The most recent stock assessment data presented by NMFS (1998) and the Dogfish Technical Committee indicate that total adult spiny dogfish stock biomass is currently about 280 million lbs (127,000 mt), well below the minimum stock biomass target of 440 million lbs (200,000 mt). As a result, the Councils propose to rebuild the spiny dogfish stock to the B_{MSY} level (as represented by the proxy of SSB_{max}) over a ten year rebuilding period through the implementation of this FMP.

The preferred alternative will eliminate overfishing and rebuild the spiny dogfish stock through a two step reduction in fishing mortality rate. The first step allows for a one year exit fishery of 22 million lbs (10,000 mt) to allow a phase out of the directed fishery. This approach was chosen to minimize the impact of the rebuilding program on both the harvest and processing sectors of the industry. For the first year of the rebuilding plan (1999-2000), F will be reduced to 0.2 and then will be reduced to F=0.03 in the remaining nine years of the rebuilding plan (2000-2009). This schedule allows for stock rebuilding to the level which will support harvests at or near the SSB_{max} level in the year 2009.

3.1.3.2 Conservation and management measures shall be based upon the best scientific information available.

This Amendment is based on the best and most recent scientific information available. Future dogfish research should be devoted toward both data collection and analysis in order to evaluate the effectiveness of this FMP. Future research to determine the level of post-release mortality of spiny dogfish discarded in non-directed fisheries by gear type is of particular importance. This species should be reviewed periodically by the NEFSC Stock Assessment Workshop process.

3.1.3.3 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 in close coordination.

The FMP's management unit is spiny dogfish throughout their range on the Atlantic coast from Maine through Florida, including the EEZ, territorial sea, and internal waters. This specification is consistent with

National Standard 3.

3.1.3.4 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 a manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

The FMP does not discriminate among residents of different states. It does not differentiate among U.S. citizens, nationals, resident aliens, or corporations on the basis of their state of residence. It does not incorporate or rely on a state statute or regulation that discriminates against residents of another state.

Since the quota is based on stock size and will be determined annually to assure that the target mortality rate is not exceeded, National Standard 4B is met.

In the commercial fishery, the commercial quota will be applied coastwide. In addition, any recreational measures would be applied coastwide. These provisions are, therefore, "fair and equitable to all fishermen." The management measures included in this FMP are all specified so they may be adjusted annually following procedures set forth in Section 3.1.1.7 to assure that the fishing mortality target is achieved. These provisions are, therefore, "reasonably calculated to promote conservation."

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

The management regime is intended to allow the fishery to operate at the lowest possible cost (e.g., fishing effort, administration, and enforcement) given the FMP's objectives. The objectives focus on the issue of administrative and enforcement costs. The FMP places no restrictions on processing or marketing.

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

The management measures in this FMP are all specified so that they may be adjusted annually following procedures set forth in the FMP to assure that the fishing mortality reduction strategy is followed. The definition of overfishing is based upon a fishing mortality rate strategy. As such, the annual quota will fluctuate to reflect changes in spiny dogfish stock conditions.

3.1.3.7 Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

The FMP is consistent with and complements, but does not duplicate, management measures contained in other FMPs and PMPs.

3.1.3.8 Conservation and management measures shall, consistent with the conservation requirements of the Magnuson-Stevens Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities.

The Sustainable Fisheries Act (SFA), which reauthorized and amended the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) made a number of changes to the existing National Standards, as well as to definitions and other provisions an the Magnuson-Stevens Act. In regard to National Standard 8, the SFA requires that the importance of the fishery resources to fishing communities must be taken into account when implementing conservation and management measures.

One area which may be significantly affected is employment. Several industry advisors have indicated that due to the low TALs mandated by the plan, and the labor-intensive nature of hand-processing spiny dogfish, employment reductions in the processing sector may be needed. The extent of these employment reductions will most likely be determined by whether or not processors can find an alternative species which requires hand processing. If this does not occur, it is likely that seasonal or permanent reductions in employment may occur as a result of this action. However, specific data needed to quantify the extent of these potential reductions are unavailable.

Another area of concern is the preferred alternatives affect on certain ports. According to the most recent NMFS weighout data (1997), several ports are extremely dependent on the spiny dogfish fishery and derived a large percent of landings value from spiny dogfish, as compared to the combined value of all other species landed in that port. For example, In Plymouth, MA, spiny dogfish accounted for 96% of the total pounds and 74% of the total value of all fish landed in this port.

This phenomenon also manifests in several other ports. In Wachapreague, VA, spiny dogfish accounted for 90% of the total pounds and 76% of the total value of all fish landed in that port; in Scituate, MA, spiny dogfish accounted for 74% of the total pounds and 21% of the total value of all fish landed in this port; in Chatham, MA, spiny dogfish accounted for 47% of the total pounds and 14% of the total value of all fish landed in this port; in Ocean City, MD, spiny dogfish accounted for 32% of the total pounds and 11% of the total value of all fish landed in this port; and, in Dare County, NC, spiny dogfish accounted for 30% of the total pounds and 11% of the total value of all fish landed in this port (Table 35).

Clearly these ports are very dependent upon spiny dogfish landings and will be disproportionately affected by the proposed regulatory action. The extent to which local communities will be affected "materially" is unknown, but it is likely that local businesses which support the commercial fishing industry will be adversely impacted by this FMP.

The proper management of the spiny dogfish stock through implementation of the management measures described above will be beneficial to the commercial and recreational fishing communities of the Atlantic coast in long term once the stock is rebuilt. By preventing overfishing and allowing stock rebuilding, benefits to the fishing communities will be realized through increased spiny abundance and subsequent harvests at sustainable levels. However, to meet the conservation objectives embodied in National Standard 1 of the SFA, short term reductions in catch and revenue from the spiny dogfish fisheries are necessary and unavoidable.

3.1.3.9 Conservation and management measures shall, to the extend practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.

The Sustainable Fisheries Act (SFA), which reauthorized and amended the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) made a number of changes to the existing National Standards, as well as to definitions and other provisions an the Magnuson-Stevens Act. In regard to National Standard 9, the SFA requires that bycatch issues must be considered when implementing conservation and management measures.

This national standard requires Councils to consider the bycatch effects of existing and planned conservation and management measures. Bycatch can, in two ways, impede efforts to protect marine ecosystems and achieve sustainable fisheries and the full benefits they can provide to the Nation. First, bycatch can increase substantially the uncertainty concerning total fishing-related mortality, which makes it more difficult to assess the status of stocks, to set the appropriate optimal yield (OY) and define overfishing levels, and to ensure that OYs are attained and overfishing levels are not exceeded. Second, bycatch may also preclude other more productive uses of fishery resources.

The term "bycatch" means fish that are harvested in a fishery, but that are not sold or kept for personal use. Bycatch includes the discard of whole fish at sea or elsewhere, including economic discards and regulatory discards, and fishing mortality due to an encounter with fishing gear that does not result in capture of fish (i.e., unobserved fishing mortality). Bycatch does not include any fish that legally are retained in a fishery and kept for personal, tribal, or cultural use, or that enter commerce through sale, barter, or trade. Bycatch does not include fish released alive under a recreational catch-and-release fishery management program. A catch-and-release fishery management program is one in which the retention of a particular species is prohibited. In such a program, those fish released alive would not be considered bycatch.

Virtually all of the spiny dogfish taken as bycatch in the mixed- and multi-species gillnet and otter trawl fisheries in the Northwest Atlantic Ocean were discarded based on sea sample data from 1991-1993 (NMFS 1998). The primary reason for discarding of dogfish taken in these fisheries is small size or lack of market. The result of this activity is to reduce the mean size/age of selection. Since these animals are discarded, they represent economic and biological waste.

Any future harvest policy developed for spiny dogfish must take into account the background mortality that results from discarding of dogfish from these fisheries. The issue of discards is a particularly important issue in the management of spiny dogfish, especially given the new National Standard 7, which mandates that regulations within FMPs developed under the SFA must minimize the level of discards and the mortality of discards which are unavoidable.

Estimates of discards of spiny dogfish were updated by the Spiny Dogfish Technical Committee using the Domestic Sea Sampling Program (DSSP) database for 1989-1997. The data were pooled across years to increase the number of observations in each cell. For each trip observed, the primary species caught (> 50% of the total pounds on board) and the number of pounds of spiny dogfish discarded were calculated. These were summed over all trips grouped by primary species caught. A discard rate was calculated by dividing the total pounds of dogfish subsampled by the total pounds of the primary species. To calculate total dogfish discarded by year, these rates were multiplied by the pounds of the primary species caught from the NEFSC weighout database where the primary species comprised more than 50% of the trip.

The results of the analysis are provide in Tables 36a-c. The major fisheries which discard dogfish are the cod, goosefish, flatfish, mackerel, scup, butterfish, silver hake, *Loligo*, skate and spiny dogfish otter trawl directed fisheries and groundfish and spiny dogfish sink gill net fisheries. The total amount of dogfish discarded over the time period varied from a low of 15.4 million pounds (7,000 mt) in 1995 to a high of 25.6 million pounds (11,600 mt) in 1989. Discard mortality was assumed to be 50% for otter trawls and 75% for sink gill nets.

During the development of this FMP, the Joint Dogfish Committee requested that the Technical Committee re-evaluate the discard mortality estimates by gear provided by SARC 26. During the evaluation of this assumption, the Technical Committee discussed the apparent mismatch between the predicted yield from the swept area estimates of biomass and the observed yields in the fishery. The Technical Committee contacted researchers conducting tagging studies on spiny dogfish in recent years. The committee was unable to obtain any data to address the issue of discard mortality. In addition, the committee contacted the NC Division of Marine Fisheries, whose biologists have been obtaining sea sample data from the spiny dogfish fishery off the state of North Carolina. No data were made available to the Technical Committee. None of the other committee members were aware of any additional data relative to discard mortality of spiny dogfish. During discussions about post release mortality of spiny dogfish, it was noted that there appears to be some portion of total mortality of spiny dogfish not currently being accounted for in the analysis. Two possible sources of this uncertainty include unreported catch and discard mortality. Since the bulk of the spiny dogfish landings are handled by a small number of processors which are adequately covered in the weighout data system, the committee concluded that the most likely source would be that losses due to discarding are underestimated in the current analysis. This would imply that the current estimates of discard mortality are realistic. If discard mortality was low, then we would be over-estimating mortality, which does not appear to be the case. The committee concluded that there is no basis to change the SARC assumptions about discard mortality at the current time, especially lacking any new information.

The Technical Committee also considered the issue of what the level of losses due to discards are expected to be during the recovery period (after the year one exit fishery occurs). The question is, will expected losses due to discards exceed the levels assumed under the rebuilding plan? The answer to that question depends on how fishermen will adapt to a fishery closure. The Technical Committee concluded that given the current inability to predict the behavior of the fishing fleet of the Northwest Atlantic Ocean, they were unable to predict the absolute level of discard mortality of spiny dogfish in the future. The Committee decided on another approach, which was to consider a range of possible achievable reductions in F. These scenarios were developed to allow the Councils to compare the various stock rebuilding options relative to one another. That is, the alternatives presented can be compared in a relative sense. Once the rebuilding program is implemented, the stock will have to be monitored to determine the sources and magnitude of fishing mortality for spiny dogfish. All of the stock rebuilding scenarios considered by the Technical Committee and presented in this FMP assume that current levels of background discard mortality losses will continue in the future.

The discard mortality issue is significant. The Technical Committee recommended that the fisheries which take dogfish as bycatch be monitored through collection of sea sample data after the plan goes into effect. Research into the post release survivorship by gear type should also be conducted. With respect to increased levels of bycatch of spiny dogfish, any of the proposed management measures will likely result in the discard of spiny dogfish which could otherwise be kept under current regulations. These measures include quotas, trip limits, size limits, season or area closures and recreational measures. The FMP includes framework provisions to deal with future discard problems. Specifically, if a discard problems become so severe as to compromise the conservation objectives of the FMP, then gear, season and area restrictions could be implemented to reduce discard mortality. All of these factors will result in the minimization of bycatch and discard mortality of spiny dogfish in the commercial fishery, to the extent practicable. Therefore, National Standard 9 is satisfied, to the extent practicable.

3.1.3.10 Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.

The Sustainable Fisheries Act (SFA), which reauthorized and amended the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), made a number of changes to the existing National Standards, as well as to definitions and other provisions in the Magnuson-Stevens Act. In regard to National Standard 10, the SFA requires that the safety of human life at sea must be promoted when implementing conservation and management measures.

National Standard 10 recognizes that fishery regulations by definition place constraints on fishing that would not otherwise exist. It's purpose is to ensure that fishery regulations do not create pressures on fishermen to fish under conditions they would otherwise avoid. None of the management measures in this amendment will promote or result in increased levels of unsafe behavior at sea relative to the status quo.

The management measures in this FMP should not alter the behavior or fishing practices of fishermen to extent that they would engage in fishing practices that they would otherwise avoid. None of the measures should affect the vessel operating environment or gear loading requirements. In order to minimize the creation of derby style fisheries, the Councils are implementing the commercial quota on a seasonal basis. The Council developed this FMP in consultation with industry advisors to help ensure that this was the case. In summary, the Council has concluded that the proposed amendment will not impact or affect the safety of human life at sea. Therefore, National Standard 10 is met.

3.1.4 Environmental Impacts of the Proposed and Alternative Management Measures

3.1.4.1 Analysis of the Proposed Management Measures

This section presents an analysis of the impacts of the preferred management measurers considered by the Council on the environment. These actions were described in section 3.1.1 above. In this section each management measure is be analyzed in terms of biological, economic, and social impacts, and its effects to marine mammals, turtles, and sea birds.

3.1.4.1.1. Rebuilding Schedule and Commercial Quota Management Strategy

The Sustainable Fisheries Act (SFA) requires the Councils to set the overfishing definition to meet a new standard (F_{MSY}) or a suitable proxy . In addition, the resource must be rebuilt to the biomass associated with MSY, B_{MSY}, or a suitable proxy in as short a period as possible. The rebuilding period is not to exceed 10 years, except where biology, environmental conditions, or international agreements dictate otherwise.

In the most recent assessment for spiny dogfish, NMFS (1998) found that current fishing mortality for spiny dogfish exceeds the threshold fishing mortality rate (F_{rep} , proxy for F_{msy}). In addition, total adult stock biomass of spiny dogfish is currently 67% of the target biomass (SSB_{max}, proxy for B_{MSY}). Thus, the spiny dogfish stock is considered overfished according to the new SFA overfishing guidelines and requires rebuilding. This FMP addresses the overfishing problem and plans to rebuild the resource to meet SFA requirements over a ten year planning horizon.

An additional requirement of the SFA is that stocks which are identified as overfished (i.e., stock biomass is less than minimum biomass threshold) must be rebuilt to the level that will produce maximum sustainable yield (B_{MSY}). The SFA guidelines advise that, in most cases, the stock rebuilding period may not exceed 10 years. The most recent stock assessment data presented by NMFS (1998) and the Dogfish Technical Committee indicate that total adult spiny dogfish stock biomass is currently about 280 million lbs (127,000 mt), well below the minimum adult stock biomass target of 440 million lbs (200,000 mt). As a result, the Councils propose to rebuild the spiny dogfish stock to the B_{MSY} level over a ten year rebuilding period through the implementation of this FMP.

Biological Impacts

Spiny dogfish are long lived and slow growing (see Section 2.1.3.2). This life history strategy (long lived with low reproductive potential) makes the species particularly vulnerable to overfishing. Holden (1973) noted the limited ability of sharks and other elasmobranchs to maintain the levels of exploitation sustainable in fisheries for teleost or bony fish. This is because stock and recruitment are directly related and reductions in adult stock size result in reduced recruitment. In addition, the limited reproductive potential of spiny dogfish offers little flexibility in compensating for increased exploitation.

The relationship between stock and recruitment in spiny dogfish, like other elasmobranchs, is direct, owing to their reproductive strategy of low fecundity combined with few, well-developed offspring (Hoenig and Gruber 1990). Although Holden (1977) provides some evidence that fecundity of sharks can increase as stock size declines, size of the female body cavity and energy considerations combine to create an upper limit on pup production per adult female. As a result, recruitment to the stock in spiny dogfish is directly related to and dependent upon the number of adult females in the stock. The direct relationship between adult stock and recruitment is the most critical factor in the development of a rational strategy of exploitation of elasmobranch stocks (Hoenig and Gruber 1990), including spiny dogfish.

The preferred alternative will eliminate overfishing and rebuild the spiny dogfish stock through a two step reduction in fishing mortality rate. The first step allows for a one year exit fishery of 22 million pounds (10,000 mt) to allow a phase out of the directed fishery. This approach was chosen to minimize the impact of the rebuilding program on both the harvest and processing sectors of the industry. For the first year of the rebuilding plan (1999-2000), F will be reduced to 0.2, and then F will be reduced to $F=0.03$ in the remaining nine years of the rebuilding plan (2000-2009). This schedule allows for stock rebuilding to the level which will support harvests at or near the MSY level in the year 2009.

The rebuilding plan proposed in this FMP recognizes the unique biological characteristics of spiny dogfish relative to other marine species subject to exploitation (i.e, the marine teleosts). The primary goal of the rebuilding plan is to allow the adult female biomass of spiny dogfish to a level that will maximize average recruitment and in turn allow sustainable harvests. Thus, the biological impacts of the management program in general, and the rebuilding strategy in particular, will be positive.

Economic impacts

The preferred alternative will eliminate overfishing and rebuild the spiny dogfish stock while allowing a one year "exit fishery". This step allows for a one year fishery of 22 million pounds (10,006 mt) to allow a phase out of the directed fishery. This approach was chosen to minimize the impacts of the rebuilding program on both the harvesting and processing sectors of the industry. Landings will be reduced to 3.0 million pounds (1316 mt) in year 2 and be maintained at under 4.5 million ponds (2000 mt) for the duration of the rebuilding period. This alternative is expected to rebuild spiny dogfish stocks in the shortest possible time while still meeting the requirements of the Sustainable Fisheries Act. In 1999, commercial landings would be reduced by 37,992,279 pounds ($6,838,610.20) relative to 1996 landings levels.

Based upon projected status quo total landings (i.e. total predicted landings if no management measures were imposed) this reduction would be 9,234,540 pounds ($1,662,217) in 1999. Based upon projected status quo total landings in relation to proposed TALs, ex-vessel gross revenue declines reach a high of $4,184,576.28 in year two as landings are reduced to 2,901,780 lbs (1316 metric tons) (Tables 37 and 38). Pack-out facility gross revenue declines reach a high of $1,015,170.98 in year two (Table 39). Gross revenue losses decline from this point as projected landings increase.

The cumulative discounted impacts of this action are illustrated in Figure 25 (see Figure 24 for non-discounted impacts). Notably, the discounted projected impacts of the preferred management action and its alternatives do not reach status quo levels (the *x* axis) within the shown 30 year time-frame (Figure 25). The discounted loss of gross ex-vessel revenues is fairly dramatic until the year 2009 when the benefits of harvest reductions begin to be realized as projected TALs increase dramatically. This characterization, however, has several shortcomings, the greatest of which is that it does not account for elasticity of demand. Potentially, price could increase as supply declines causing these curves to rise (i.e., toward the *x* axis). This characterization also does not account for changes in costs and introductions of new, potentially more efficient harvest technologies.

An additional area of uncertainty are the effects of low TALs upon markets. Processors have indicated that the ability to process spiny dogfish in a cost-effective manner is dependent upon volume. The proposed low TAL may cause processors to cease processing spiny dogfish and thus cause established U.S. based markets for this species to collapse. Since currently, most spiny dogfish are processed and exported, the implications of management upon both foreign and domestic markets are hard to predict. Two scenarios are: 1) the demand for spiny dogfish by foreign markets may decline as this species is replaced by a more readily available alternative; and conversely, 2) the lessening of supply in light of a static demand could cause price to rise and allow for a modified fishery to exist while landings remain at low levels.

These scenarios would also affect harvesters: if markets for spiny dogfish cease, there will not be an outlet to sell their catch. Conversely, if prices rise, harvesters will be able to receive greater ex-vessel prices for spiny dogfish (assuming a market exists). Even if prices increase, however, due to the extremely low TALs, this would probably do little to mitigate the economic impacts caused by the preferred alternative (this is true for both harvesters and processors).

The preferred alternative is not likely to affect the recreational fishery for spiny dogfish. The 1996 landings of spiny dogfish by the recreational fishing sector was 14,408 lbs (catch type A + B1), and discards were estimated at 143,130 lbs (catch type B2). The 1994 MRFSS survey indicated that of the 33,279 intercept surveys conducted in New England and the Mid-Atlantic, 4 anglers were targeting spiny dogfish as their "primary" species. Although this number is not expanded to represent all anglers making trips during that year, it suggests that there is not a substantial directed recreational fishery for spiny dogfish. In light of this, there is expected to be no lessening of demand for recreational fishing trips due to this proposed action.

Social Impacts

The proposed rebuilding schedule will achieve the total biomass target (B_{MSY}) in nine years while allowing for stability in projected yields during the recovery period. Furthermore, it provides the industry with an adjustment period during the early years of the recovery program which will minimize social impacts.

Long-term benefits should be realized though a sustainable spiny dogfish fishery which can continue to capitalize on existing markets or take advantage of new markets. One caveat to this is that if the U.S. based export market does cease for the duration of the rebuilding plan, the level of demand for a product that has been unavailable for many year may be adversely affected.

The commercial quota is allocated between two six month seasons based on the seasonal distribution of landings during the period 1990-1997. This is intended to preserve the traditional distribution of landings, both geographically and seasonally. By allocating the quota on a seasonal basis, the Councils are attempting to ensure that the harvest is allocated in a fair and equitable manner. This should have positive benefits for the communities that have traditionally depended on spiny dogfish for employment and income.

Effects on Marine Mammals, Sea Turtles, and Seabirds

Activities conducted under this FMP have not yet been considered for their impacts on endangered species in order to do a Section 7 of the Endangered Species Act consultation. NMFS will be performing a Section 7 consultation while the FMP is out for public review during the next few months. The Fish and Wildlife Service may also perform a Section 7 consultation on any seabirds that may be impacted by this FMP. The following background information is provided to facilitate evaluations of the alternatives relative to the order of magnitude these spiny dogfish fisheries may have on these threatened or endangered species.

Numerous species of marine mammals and sea turtles occur in the northwest Atlantic Ocean. The most recent comprehensive survey in this region was done from 1979-1982 by the Cetacean and Turtle Assessment Program (CETAP) at the University of Rhode Island (University of Rhode Island 1982) under contract to the Minerals Management Service (MMS), Department of the Interior. The following is a summary of the information gathered in that study, which covered the area from Cape Sable, Nova Scotia, to Cape Hatteras, North Carolina, from the coastline to 5 nautical miles seaward of the 1000 fathom isobath.

Four hundred and seventy one large whale sightings, 1,547 small whale sightings and 1,172 sea turtles were encountered in the surveys. The "estimated minimum population number" for each mammal and turtle in the area, as well as those species currently included under the Endangered Species Act, were also tabulated.

CETAP concluded that both large and small cetaceans were widely distributed throughout the study area in all four seasons and grouped the 13 most commonly seen species into three categories based on geographical distribution. The first group contained only the harbor porpoise, which is distributed only over the shelf and throughout the Gulf of Maine, Cape Cod, and Georges Bank, but probably not southwest of Nantucket. The second group contained the most frequently encountered baleen whales (fin, humpback, minke, and right whales) and the white-sided dolphin. These were found in the same areas as the harbor porpoise and also occasionally over the shelf at least to Cape Hatteras or out to the shelf edge. The third group indicated a "strong tendency for association with the shelf edge" and included the grampus, striped, spotted, saddleback, and bottlenose dolphins, and the sperm and pilot whales.

Loggerhead turtles were found throughout the study area, but appeared to migrate north to about Massachusetts in summer and south in winter. Leatherbacks appeared to have had a more northerly distribution. CETAP hypothesized a northward migration of both species in the Gulf Stream with a southward return in continental shelf waters nearer to shore. Both species usually were found over the shoreward half of the slope and in depths less than 200 feet. The northwest Atlantic may be important for sea turtle feeding or migrations, but the nesting areas for these species generally are in the South Atlantic and Gulf of Mexico.

This problem may become acute when climatic conditions result in concentration of turtles and fish in the same area at the same time. These conditions apparently are met when temperatures are cool in October but then remain moderate into mid-December and result in a concentration of turtles between Oregon Inlet and Cape Hatteras, North Carolina. In most years sea turtles leave Chesapeake Bay and filter through the area a few weeks before the bluefish becomes concentrated. Efforts are currently under way (by VIMS and the U.S. Fish and Wildlife Service refuges at Back Bay, Virginia, and Pea Island, North Carolina) to more closely monitor these mortalities due to trawls. Fishermen are encouraged to carefully release turtles captured incidentally and to attempt resuscitation of unconscious turtles as recommended in the 1981 *Federal Register* (pages 43976 and 43977).

The only endangered species of fish occurring in the northwest Atlantic is the shortnose sturgeon (*Acipenser brevirostrum*). The Councils urge fishermen to report any incidental catches of this species to the Regional Administrator, NMFS, One Blackburn Drive, Gloucester, Massachusetts 01930, who will forward the information to persons responsible for the active sturgeon data base.

The range of spiny dogfish and the above mentioned marine mammals and endangered species overlap and there always exists a potential for an incidental kill. Under the proposed recovery schedule and the resultant decline in fishing effort for spiny dogfish, such accidental catches should have a negligible impact on marine mammal or abundances of endangered species, and the Councils believe that implementation of this FMP will have a positive impact upon these populations.

Attempts were made to put these fisheries/sea turtle interaction into perspective of other sources of mortality for these endangered turtle species. The Congressionally mandated report *Decline of the Sea Turtles: Causes and Prevention* (NRC 1990) states that "Of all the known factors, by far the most important source of deaths was the incidental capture of turtles (especially loggerheads and Kemp's ridleys) in shrimp trawling. This factor acts on the life stages with the greatest reproductive value for the recovery of sea turtle populations."

Mortality associated with other fisheries and with lost or discarded fishing gear is much more difficult to estimate than that associated with shrimp trawling, and there is a need to improve these estimates (NRC 1990). This report identified possible turtle losses from the winter trawl fishery north of Cape Hatteras (about 50-200 turtles per year), the historical Atlantic sturgeon fishery, now closed, off the Carolinas (about 200 to 800 turtles per year), and the Chesapeake Bay passive-gear fisheries (about 25 turtles per year). Considering the large numbers of fisheries from Maine to Texas that have not been evaluated and the problems of estimating the numbers of turtles entangled in the 135,000 metric tons of plastic nets, lines, and buoys lost or discarded annually, it seems likely that more than 500 loggerheads and 50 Kemp's ridleys are killed annually by nonshrimp fisheries (NRC 1990). These other fishery operations, lost fishing gear, and marine debris are known to kill sea turtles, but the reported deaths are only about 10% of those caused by shrimp trawling. Dredging, entrainment in power-plants intake pipes, collisions with boats, and the effects of petroleum-platform removal all are potentially and locally serious causes of sea turtle deaths. However these collectively amount to less than 5% of the mortality caused by shrimp trawling (NRC 1990).

The NRC report (1990) concludes that all species of marine turtles need increased protection under the Endangered Species Act and other relevant legislation. While the report does not recommend specific conservation measures for these fisheries, the recommendations for the shrimp trawling are germane. The NRC report (1990) recommended TEDs, 60 minute winter tow-time limits, and limited time/area closure for turtle "hot spots". Currently, there are 5 sea turtle recovery plans in place these include plans for the loggerhead (1991), the green sea turtle (1991), the leatherback (1992), the Kemp's ridley sea turtle (1992), and the hawksbill sea turtle (1993). Of the six "Actions Needed" that are identified by the Recovery Plan to achieve recovery of loggerheads is item 5: "minimize mortality from commercial fisheries."

Shortnose sturgeon (*Acipenser brevirostrum*) is an additional endangered species that may be caught incidentally in trawl fisheries. Sturgeon will be included in the Incidental Take Statement of the pending

Biological Opinion. As shortnose sturgeon are generally associated with the estuarine environment, rather than the truly marine environment, it is anticipated that the gear and fishing locations of these dogfish fisheries will rarely encounter shortnose sturgeon.

Marine mammals are managed under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973. Marine mammals have been historically important in the U.S. both as targets for commercial harvests and in ecological interactions with commercial fisheries. An excellent description of the historical importance of marine mammals is described in USDC 1993b.

The results of this earlier work were addressed in 1979 when the U.S. Marine Mammal Commission sponsored a workshop to help define research needed for the study of marine mammals on the U.S. east and Gulf coasts and in 1989 at a NMFS-sponsored workshop on Gulf of Mexico marine mammal research needs (USDC 1993b). These workshops set a research agenda that was immediately addressed by agencies such as the Minerals Management Service and NMFS. During the 1980's, several institutions in the northeast developed active research programs which have resulted in a body of knowledge that is being drawn upon in developing management approaches for several critical marine mammal issues in the region. In the 1990's, increased attention has been focused on the characterization of marine mammal fauna of the U.S. Gulf of Mexico and the Mid-Atlantic Bight (USDC 1993b).

Thirty-five species of marine mammals range the U.S. Atlantic and Gulf of Mexico waters (32 whales, dolphins and porpoises, two seal species, and one manatee). Their status, in general, is poorly known, but some, like the right whale, Mid-Atlantic coastal bottlenose dolphin, and harbor porpoise, are under stresses that may affect their survival (USDC 1993b).

The gears managed under this FMP are under several categories listed for the final List of Fisheries for 1997 for the taking of marine mammals by commercial fishing operations under section 114 of the Marine Mammal Protection Act (MMPA) of 1972. Section 114 of the MMPA establishes an interim exemption for the taking of marine mammals incidental to commercial fishing operations and requires NMFS to publish and annually update the List of Fisheries, along with the marine mammals and the number of vessels or persons involved in each fishery, arranging them according to categories, as follows:

1. A fishery that has a frequent incidental taking of marine mammals;

2. A fishery that has an occasional incidental taking of marine mammals; or

3. A fishery that has a remote likelihood, or no known incidental taking, of marine mammals.

In Category I, there is documented information indicating a "frequent" incidental taking of marine mammals in the fishery. "Frequent" means that it is highly likely that more than one marine mammal will be incidentally taken by a randomly selected vessel in the fishery during a 20-day period. Some of the spiny dogfish gill net fisheries are in this category. With the mandatory reductions in spiny dogfish fishing mortality in the preferred alternative, there should be an overwhelming beneficial impact from the preferred alternative management measures on the marine mammal populations of the east coast.

In Category II, there is documented information indicating an "occasional" incidental taking of marine mammals in the fishery, or in the absence of information indicating the frequency of incidental taking of marine mammals, other factors such as fishing techniques, gear used, methods used to deter marine mammals, target species, seasons and areas fished, and species and distribution of marine mammals in the area suggest there is a likelihood of at least an "occasional" incidental taking in the fishery. "Occasional" means that there is some likelihood that one marine mammal will be incidentally taken by a randomly selected vessel in the fishery during a 20-day period, but that there is little likelihood that more than one marine mammal will be incidentally taken. Some of the spiny dogfish gill net fisheries are in this category.

In Category III, there is information indicating no more than a "remote likelihood" of an incidental taking of a marine mammal in the fishery or, in the absence of information indicating the frequency of incidental taking of marine mammals, other factors such as fishing techniques, gear used, methods used to deter marine mammals, target species, seasons and areas fished, and species and distribution of marine mammals in the area suggest there is no more than a remote likelihood of an incidental take in the fishery. "Remote likelihood" means that it is highly unlikely that any marine mammal will be incidentally taken by a randomly selected vessel in the fishery during a 20-day period. The spiny dogfish trawl and demersal longline fisheries are considered Category III fisheries. With the mandatory reductions in spiny dogfish fishing mortality in the preferred alternative, there should be an overwhelming beneficial impact from the preferred alternative management measures on the marine mammal populations of the east coast.

The 1994 amendments to the Marine Mammal Protection Act (MMPA) require the preparation and implementation of Take Reduction Plans (TLP's) for strategic marine mammal stocks that interact with Category I or II fisheries. The 1996 Stock Assessment Report (SAR) (Waring et al., 1997) states that harbor porpoise bycatch has been observed by the NMFS Sea Sampling program in the following fisheries: (1) the Northeast (NE) multispecies sink gillnet, (2) the mid-Atlantic coastal gillnet, (3) the Atlantic drift gillnet, (4) the North Atlantic bottom trawl fisheries, and (5) the Canadian Bay of Fundy sink gillnet fishery. The fisheries of greatest concern, and the subject of this TRP, are the NE multispecies sink gillnet fishery (Category I), and the Mid-Atlantic coastal gillnet fishery (Category II).

The NMFS recently announced in 50 CFR 229, the availability of a proposed harbor porpoise take reduction plan (HPTRP) to reduce the bycatch of harbor porpoise (*Phocoena phocoena*) in gillnet fisheries throughout the stock's U.S. range. NMFS also proposes regulations to implement the HPTRP. The proposed plan, including a discussion of the recommendations of the Gulf of Maine Take Reduction Team (GOMTRT) and the Mid-Atlantic Take Reduction Team (MATRT). The potential biological removal (PBR) level for Gulf of Maine harbor porpoise throughout their range is 483 animals (62 FR 3005, January 21, 1997). The incidental bycatch of harbor porpoise in the Gulf of Maine (GOM) and Mid-Atlantic gillnet fisheries exceeds the PBR level. The proposed HPTRP would use a wide range of management measures to reduce the bycatch and mortality of harbor porpoise. In the GOM, the HPTRP proposes time and area closures and time/area periods during which pinger use would be required in the Northeast, Mid-coast, Massachusetts Bay, Cape Cod South and Offshore Closure Areas. In the Mid-Atlantic area, the HPTRP proposes time/area closures and modifications to gear characteristics, including floatline length, twine size, tie downs, and number of nets, in the large mesh and small mesh fisheries.

As noted above, the stock recovery schedule in this FMP specifies mandatory reductions in spiny dogfish fishing mortality which will result in reductions in fishing effort directed at spiny dogfish in excess of 90% of current levels in years 2-10 of the rebuilding period through elimination of the directed fishery. As a result, there should be an overwhelming beneficial impact from the preferred alternative management measures on certain marine mammal populations of the east coast.

Pelagic seabirds are not likely to come into contact with spiny dogfish fisheries. Most of the following information is taken from the Mid-Atlantic Regional Marine Research Program (1994) and Peterson (1963). Fulmars occur as far south as Virginia in late winter and early spring. Shearwaters, storm petrels (both Leach's and Wilson's), jaegers, skuas, and some terns pass through this region in their annual migrations. Gannets and phalaropes occur in the Mid-Atlantic during winter months. Eight gulls breed in eastern North America and occur in shelf waters off the northeastern U.S. These gulls include: glaucous, Iceland, great black-backed, herring, laughing, ring-billed, Bonaparte's and Sabine's gulls, and black-legged caduceus. Royal and sandwich terns are coastal inhabitants from Chesapeake Bay south to the Gulf of Mexico. The Roseate tern is listed as endangered under the ESA, while the Least tern is considered threatened (Safina pers. comm.). Of course, our national symbol, the bald eagle is listed as endangered under the ESA and is a bird of aquatic ecosystems. Literally translated, its Latin name, *Haliaeetus leucocephalus*, means white-headed sea eagle (*Federal Register* 1994, 35584).

Spiny dogfish are not important prey for the Common and Roseate terns (Safina 1987, Safina *et al.* 1988, and Safina *et al.* 1990). Safina *et al.* (1988) note that few other seabird studies have measured ambient food levels among foraging birds, but many studies which have examined food provisioning to chicks and reproductive performance in seabirds have found results similar to theirs. Laying dates, clutch sizes, growth, and fledgling success of seabirds have been linked to food availability by a number of workers. Safina *et al.* (1988) recorded that prey fish were more abundant in 1984 than it was in 1985 and noted that reproductive productivity of terns was greater in 1984 for most parameters measured. Although they studied productivity for only two seasons, the results suggest that prey population fluctuations may limit reproductive success in the terns they studied.

Safina *et al.* (1990) noted that observing prey deliveries at nests cannot address the question of how foraging birds select prey or foraging habitat from the range of possibilities. However, the variability they found shows that either prey availability or birds' selection criteria changes, and that prey availability or selection varies differently between the two tern species, Common and Roseate, they studied. Some prey species may have their own consistent internal rhythms (or influencing factors) which make them differentially susceptible to tern predation on a daily time scale.

The stock recovery schedule proposed in this amendment will reduce fishing mortality over a ten year period. As such, these reductions in fishing mortality will result in reduced fishing effort that in turn will reduce interactions with marine mammals, sea turtles, shortnose sturgeon, and seabirds. Preventing overfishing of spiny dogfish thus will be beneficial to some seabirds and certain species of marine mammals.

3.1.4.1.2 Impacts of Permit and Reporting Requirements Under the Preferred Alternative

Biological Impacts

Actions two through four implement permit requirements for commercial vessels, dealers, and operators. Given the current status of the stocks and the uncertainties regarding discard rates for spiny dogfish, mechanisms which account for all activities in the fishery are necessary to enforce provisions of the FMP and ensure overfishing is prevented. Permits issued to all sectors which harvest, process, or sell spiny dogfish provide the foundation for effective monitoring and enforcement of regulations.

There are no direct biological impacts associated with the implementation of this management alternative. However, this alternative will help track the quota and therefore reduce the chance that the quota is exceeded, and as such, reduce the chance of overfishing. A commercial permit to sell is essential for a quota based management system. The dealer permitting and reporting requirements are also very important in tracking the quota and forecasting necessary closures.

Economic Impacts

It is estimated that 642 vessels landed spiny dogfish in 1996 along the Atlantic coast.. Under the preferred alternative, any vessel desiring to fish commercially for spiny dogfish must obtain a federal vessel spiny dogfish permit. It is estimated that 87% of commercial vessels landing spiny dogfish in 1996 possess a NMFS vessel permit for at least one or more fisheries. Therefore, approximately 83 new applicants would be required to apply for a federal spiny dogfish permit using the initial application form. The remainder would use the renewal form and would not likely incur an additional burden. It is estimated that owner/operators of all 83 vessels would apply for a spiny dogfish permit. The total burden cost associated with public requirements is $623 ($7.50 per vessel) and the total burden cost associated with federal requirements is estimated at $2,739.

The calculation of public and federal costs applies to the new respondents only. It is highly unlikely that under the preferred management alternative, there will be any new applicants for dealer permits. If there were new dealer permits issued, the total burden costs associated with the public requirement for new applicants is $1.25 per applicant. Thereafter, the public annual estimate of submitting weekly reports will be $26 per dealer per year. Thereafter, the annual estimate of processing weekly reports for the NMFS will be $43 per dealer.

Licensed commercial vessels pursuant to this Amendment must submit monthly logbooks. It was estimated that 87% of all commercial vessels participating in the spiny dogfish fishery hold one or more permits for fisheries that require logbook submission (e.g., multispecies, summer flounder, black sea bass, scup, snapper grouper complex, etc.). As such, the only 83 additional vessels would be required to submit a report to meet the reporting requirements for the spiny dogfish fishery. The total burden cost associated with public requirements is $1,660 ($20 per vessel).

Social Impacts

The issuance of permits and reporting requirements are essential ingredients in the management of fishery resources. Section 303(b)(1) of the MSFCMA specifically recognized the need for permit issuance. Almost every international, federal, state, and local fishery management authority recognizes the value of permits and uses permits as part of their management systems. The purpose and use of permits is to: 1) register fishermen, fishing vessels, fish dealers and processors, 2) list the characteristics of fishing vessels and/or dealer/processor operations, 3) exercise influence over compliance (e.g., withhold issuance pending collection of unpaid penalties), 4) provide a mailing list for the dissemination of important information to the industry, and 5) provide a universe for data collection purposes.

Commercial fishing permit information can be used by enforcement officials to check for regulatory infractions and by NOAA scientists and economists as a basis for analysis. The commercial fishing permit requirement ensures more complete reporting from the fishery. Commercial fishing permits will increase compliance with commercial quota management. With the implementation of a commercial fishing permit, the quota system should be tracked more accurately. Therefore, permit requirements will enhance enforcement.

Effects on Marine Mammals, Sea Turtles, and Seabirds

The various permitting processes preferred for this FMP for the commercial fishery, dealers, and operators will not have any significant impact on marine mammals, sea turtles, shortnose sturgeon, and seabirds.

3.1.4.1.3 Prohibition of finning

Finning, the act of removing the fins of spiny dogfish and discarding the carcass, will be prohibited. Vessels which land spiny dogfish must land fins in proportion to carcasses, with a maximum of three fins per carcass. Fins may not be stored aboard a vessel after the first point of landing.

Biological Impacts

This management measure is intended to eliminate the wasteful practice of finning. The Councils intend to ensure that, to the extent practical, the entire fish be utilized when harvested. This will have positive biological impacts for the spiny dogfish stock by reducing the wasteful discard of spiny dogfish carcasses.

Economic Impacts

During the course of development of this FMP, the issue of finning and discard of the carcass at sea of spiny dogfish has been discussed. Industry advisors testified that this practice occurs only on a very limited basis. Therefore, no negative economic impacts as a result of this management measure are expected.

Social Impacts

As noted above, during the course of development of this FMP, the issue of finning and discard of the carcass at sea of spiny dogfish has been discussed. The response of the public and industry was overwhelmingly in favor of a prohibition on the practice of finning. Because of its universal acceptance by the public, this measure is not expected to have any negative social consequences.

Effects on Marine Mammals, Sea Turtles, and Seabirds

This measure will not have any significant impact on marine mammals, sea turtles, shortnose sturgeon, and seabirds.

3.1.4.1.4 Gill net limitations

Biological Impacts

Commercial gill net vessels fishing for spiny dogfish will be prohibited from fishing more than a total of 80 nets (50 fathoms each). The purpose of this measure is to attempt to cap overall fishing effort during the first year exit fishery. It is intended to prevent a derby style fishery during the first year when a directed fishery will be prosecuted. This measure should have positive biological impacts since it will place an overall limitation on gill nets in the directed spiny dogfish fishery, thereby reducing the chance that the quota will be exceeded.

Economic Impacts

Since no regulations specific to the spiny dogfish gill net fishery currently exist, little or no information exits on the amount of fishing effort in the directed fishery. However, anecdotal reports from industry indicate few if any spiny dogfish gill netters fish in excess of the proposed net limit. As a result, there are no economic impacts expected from this measure.

Social Impacts

Since no regulations specific to the spiny dogfish gill net fishery currently exist, little or no information exits on fishing effort in the directed fishery. However, anecdotal reports from industry indicate few if any spiny dogfish gill netters fish in excess of the proposed net limit. As a result, there are no social impacts expected from this measure.

Effects on Marine Mammals, Sea Turtles, and Seabirds

The effect of this measure is to place an overall cap on fishing effort in the spiny dogfish gill net fishery. Since these are classified as Category 1 fisheries, this measure is may have a positive impact on marine mammals since it will limit the amount of fishing gear that can be used to take spiny dogfish.

3.1.5 Analysis of the Alternatives to the Preferred Management Measures

3.1.5.1 Take no action at this time

Biological Impacts

With the implementation of this alternative, the spiny dogfish fishery would remain unregulated. The no action alternative would not address the problems and objectives identified in sections 1.1.2 and 1.1.3, respectively. Overfishing would continue to occur and the stock would be expected to continue to decline.

Economic impacts

The implementation of this alternative would not reduce overfishing or rebuild the stock. As a result, economic benefits will not accrue in the long-term.

Social Impacts

With the implementation of this alternative, the Council will not address the requirements of the Magnuson-Stevens Act. A sustainable spiny dogfish fishery will not be developed, and negative social and economic impacts may develop if the stock is not rebuilt.

Effects on Marine Mammals, Sea Turtles, and Seabirds

No action may jeopardize the continued existence of the threatened or endangered species mentioned above because there will be uncontrolled, unlimited fishing pressures on the species managed by the FMP. As noted earlier, the spiny dogfish gill net fisheries are designated as Category 1 fisheries. The reductions in fishing mortality necessary to rebuild the spiny dogfish stock will require significant reductions in fishing effort. This will be beneficial to certain species of marine mammals.

3.1.5.2 Alternative rebuilding schedules

3.1.5.2.1 Reduce fishing mortality to F=0.04 in year 1 and maintain to allow stock rebuilding in ten years to rebuild to biomass target (B_{MSY})

Biological Impacts

This option would require a reduction in fishing mortality to F=0.04 in years 1-10 and would allow for stock rebuilding over a 10 year planning horizon by maintaining a constant F. Total allowable landings (TAL) or quota would have to be reduced to 5.1 million pounds (2300 mt) during the first three years of the management program (1999-2003). TAL would increase slightly towards the end of the rebuilding program (Table 33) .

Spiny dogfish are long lived and slow growing (see Section 2.1.3.2). This life history strategy (long lived with low reproductive potential) makes the species particularly vulnerable to overfishing. Holden (1973) noted the limited ability of sharks and other elasmobranchs to maintain the levels of exploitation sustainable in fisheries for teleost or bony fish. This is because stock and recruitment are directly related and reductions in adult stock size result in reduced recruitment. In addition, the limited reproductive potential of spiny dogfish offers little flexibility in compensating for increased exploitation.

The relationship between stock and recruitment in spiny dogfish, like other elasmobranchs, is direct, owing to their reproductive strategy of low fecundity combined with few, well-developed offspring (Hoenig and Gruber 1990). Although Holden (1977) provides some evidence that fecundity of sharks can increase as stock size declines, size of the female body cavity and energy considerations combine to create an upper limit on pup production per adult female. As a result, recruitment to the stock in spiny dogfish is directly related to and dependent upon the number of adult females in the stock. The direct relationship between adult stock and recruitment is the most critical factor in the development of a rational strategy of exploitation of elasmobranch stocks (Hoenig and Gruber 1990), including spiny dogfish.

This alternative would eliminate overfishing and rebuild the spiny dogfish stock through a one step reduction in fishing mortality rate. F would be reduced to F=0.04 for the ten years of the rebuilding plan (1999-2009). This schedule allows for stock rebuilding to the level which will support harvests at or near the MSY level in the year 2009.

This rebuilding plan recognizes the unique biological characteristics of spiny dogfish relative to other marine species subject to exploitation (i.e, the marine teleosts). The primary goal of the rebuilding plan is to allow the adult female biomass of spiny dogfish to a level that will maximize average recruitment and in turn allow sustainable harvests. Thus, the biological impacts of this rebuilding strategy will be positive.

Economic Impacts

This alternative would reduce landings to 2,162 metric tons in year one and maintain mortality at under 3,000 metric tons to allow the stock to rebuild in 10 years. This alternative will reduce gross ex-vessel revenues by $4,921,202.40 in year one (1999), and this impact will decrease as expected TALs increase. Successive revenue losses are projected to continue until 2009, although at a decreasing rate (Table 37).

Figure 24 shows that cumulative gross revenues (not discounted) exceed status quo levels in 2221. Pack-out facilities will see gross revenues decline in year one (1999) by $1,193,875.20 (See Table 39).

Social Impacts

This alternative reduces landings to a consistent level of approximately 5.5 million pounds (2500 mt) over ten years. Although this will reduce gross revenues for all sectors, the reduction of supply in light of demand may cause prices for spiny dogfish to increase. This point is complicated, however, by the low allowable landings. At approximately 5.5 million pounds (2500 mt), a directed fishery for spiny dogfish is unlikely, and the affect that a by-catch fishery may have on markets is currently unknown.
This alternative is likely to have greater negative social consequences than the preferred alternative since the directed dogfish fishery and associated processing sector would be eliminated immediately in year one of the management program. This would have negative social consequences, especially during the first year of the management program.

Effects on Marine Mammals, Sea Turtles, and Seabirds

As noted earlier, the spiny dogfish gill net fisheries are designated as Category 1 fisheries. The reductions in fishing mortality necessary to rebuild the spiny dogfish stock will require significant reductions in fishing effort. These reductions in gill net fishing effort would be very beneficial to certain species of marine mammals.

3.1.5.2.2 Reduce fishing mortality in year 1 half way between $F_{current}$ and $F_{threshold}$, in year 2 reduce fishing mortality to $F_{threshold}$ and in year 3 reduce F to level required to rebuild stock in remaining 8 years of the rebuilding program

Biological Impacts

This option would require a reduction in fishing mortality to F=0.204 in year 1 (half way between $F_{current}$ and $F_{threshold}$), in year 2 fishing mortality would be reduced to $F_{threshold}$ or F=0.11. Under this scenario, even if F was reduced to F=0.026 in ensuing eight years, the stock would not rebuild to the target SSB by the tenth year. In year 1, the TAL would be 22.5 million pounds (10,186 mt) in year 2 TAL would equal 11.3 million pounds (5,130 mt), and in the eight remaining years TAL would range from 2.8 - 3.4 million pounds (1,262 - 1,558 mt). This option would not meet the requirements of the SFA. As a result, negative biological consequences are expected because the stock will not be rebuilt in 10 years.

Economic Impacts

The third non-preferred management alternative would reduce landings by over one-third in year one (1999), by 75% in year two (2000), and then limit landings to a level which would ensure the rebuilding of the stocks within a ten year time-frame. Gross revenue declines reach a high of $3,436,497.89 in year three (2001;Table 37). Figure 24 shows that cumulative gross revenues exceed status quo levels in 2221. Similarly, gross revenue declines for pack-out facilities reach a high of $833,688.45 in year three (2001) (Table 39). Impacts decline from this point as projected landings decline. This alternative, however, fails to meet the requirement of the SFA.

Social Impacts

Both non-preferred management alternatives two and three allow for landings at slightly more than one-third of current landings rates for year one followed by large reductions in landing necessary to rebuild stocks. Like the preferred alternative, the graduated reduction in landings should allow producers and processors to transition to other fisheries in light of the low allowable landings in years two through eight. However, the benefits of these alternatives do not exceed the preferred alternative which allows for the largest TAL exit fishery.

Effects on Marine Mammals, Sea Turtles, and Seabirds

As noted above, the spiny dogfish gill net fisheries are designated as Category 1 fisheries. The reductions in fishing mortality necessary to rebuild the spiny dogfish stock will require significant reductions in fishing effort. These reductions in gill net fishing effort would be very beneficial to certain species of marine mammals.

3.1.5.2.3 Reduce fishing mortality in year 1 to allow a harvest of 13.2 million pounds (6,000 mt) and in year 2 reduce F to allow for harvest of 8.8 million pounds (4,000 mt) then reduce F to the level required to rebuild stock in remaining 8 years of the rebuilding program

Biological Impacts

This option would require a reduction in fishing mortality in year 1 to allow a harvest of 13.2 million pounds (6,000 mt) and in year 2 to allow for a harvest of 8.8 million pounds (4,000 mt), F would then be reduced to F=0.028 to rebuild the stock in the remaining 8 years of the rebuilding program. In the last eight years of the rebuilding program, TAL would range from 3.3 - 3.7 million pounds (1,509 - 1,685 mt).

Economic Impacts

This alternative allows for a graduated reduction in landings in years one and two. Landings for the remaining 8 years are reduced to such a level as to allow the stock to be rebuilt in the required 10 year time-frame. Year one gross ex-vessel revenue declines are $3,254,079.65 (Table 37). Pack-out facility gross revenue declines are $789,434.10 in year one (Table 39). These impacts will decline throughout the time-span of the management plan as projected landings decline. This option consists of a graduated restriction of landings.

Social Impacts

This alternative allows for gradually reduced landings for years one and two followed by large reductions in landing necessary to rebuild stocks. Like the preferred alternative, the graduated reduction in landings should allow producers and processors to transition to other fisheries in light of the low allowable landings in years three through ten. However, the benefits of these alternatives do not exceed the preferred alternative which allows for the largest TAL exit fishery

Effects on Marine Mammals, Sea Turtles, and Seabirds

As noted above, the spiny dogfish gill net fisheries are designated as Category 1 fisheries. The reductions in fishing mortality necessary to rebuild the spiny dogfish stock will require significant reductions in fishing effort. These reductions in gill net fishing effort would be very beneficial to certain species of marine mammals.

3.1.5.2.4 Reduce fishing mortality to F=0.072 in year 1 and maintain to allow stock rebuilding in 15 years to rebuild to biomass target (B_{MSY})

Biological Impacts

This option would require a reduction in fishing mortality to F=0.072 in years 1-15 and would allow for stock rebuilding over a 15 year planning horizon by maintaining a constant F. This option would not meet the requirements of the SFA. As a result, negative biological consequences are expected because the stock will not be rebuilt in 10 years.

Economic Impacts

These options may spread economic impacts over a greater time period, but do not meet the requirements of the SFA.

Social Impacts

These options may spread social impacts over a greater time period, but do not meet the requirements of the SFA.

Effects on Marine Mammals, Sea Turtles, and Seabirds

As noted above, the spiny dogfish gill net fisheries are designated as Category 1 fisheries. The reductions in fishing mortality necessary to rebuild the spiny dogfish stock will require significant reductions in fishing effort. These reductions in gill net fishing effort would be very beneficial to certain species of marine mammals.

3.1.5.2.5 Reduce fishing mortality to F=0.078 in year 1 and maintain to allow stock rebuilding in 20 years to rebuild to biomass target (B_{MSY})

Biological Impacts

This option would require a reduction in fishing mortality to F=0.078 in years 1-20 and would allow for stock rebuilding over a 20 year planning horizon by maintaining a constant F. This option would not meet the requirements of the SFA. As a result, negative biological consequences are expected because the stock will not be rebuilt in 10 years.

Economic Impacts

These options may spread economic impacts over a greater time period, but do not meet the requirements of the SFA.

Social Impacts

These options may spread social impacts over a greater time period, but do not meet the requirements of the SFA.

Effects on Marine Mammals, Sea Turtles, and Seabirds

As noted above, the spiny dogfish gill net fisheries are designated as Category 1 fisheries. The reductions in fishing mortality necessary to rebuild the spiny dogfish stock will require significant reductions in fishing effort. These reductions in gill net fishing effort would be very beneficial to certain species of marine mammals.

3.1.5.2.6 Reduce fishing mortality to F=0.088 in year 1 and maintain to allow stock rebuilding in 30 years to rebuild to biomass target (B_{MSY})

Biological Impacts

This option would require a reduction in fishing mortality to F=0.088 in years 1-30 and would allow for stock rebuilding over a 30 year planning horizon by maintaining a constant F. This option would not meet the requirements of the SFA. As a result, negative biological consequences are expected because the stock will not be rebuilt in 10 years.

Economic Impacts

These options may spread economic impacts over a greater time period, but do not meet the requirements of the SFA.

Social Impacts

These options may spread social impacts over a greater time period, but do not meet the requirements of the SFA.

Effects on Marine Mammals, Sea Turtles, and Seabirds

As noted above, the spiny dogfish gill net fisheries are designated as Category 1 fisheries. The reductions in fishing mortality necessary to rebuild the spiny dogfish stock will require significant reductions in fishing effort. These reductions in gill net fishing effort would be very beneficial to certain species of marine mammals.

3.1.5.3. Establish a coastwide trip limit

Biological Impacts

This alternative would establish a system of uniform trip limits established on a coastwide basis in conjunction with the quota system. To estimate allowable trip limits under any of the scenarios requires an estimation of the number of trips likely to be taken during each year of the management program. For example, there are roughly 5,000 vessels which currently possess permits to fish in the EEZ from ME to NC. Assuming that each vessel makes 100 trips per year, and that half of those trips could land spiny dogfish, yields an estimate of 250,000 trips. If the annual TAL was 1,316 mt in the year 2000, the associated trip limit would be about 12 lbs. This analysis suggests that any trip limit specified on an annual basis would be very low. A trip limit could be specified for a limited season which might allow for a higher trip limit. The biological impacts would be the same as those identified in the sections describing the commercial quota.

Economic Impacts

Under this alternative, the Councils may establish trip limits and seasons to insure that the annual quota is not exceeded. Thus, the Councils would be required to implement a uniform trip limit which would apply coastwide. A coastwide uniform trip limit system will not likely ensure equitable distribution for all areas, gears, and seasons.

This alternative would establish a system of uniform trip limits in conjunction with the quota system. Section 3.1.3 of this document describes the low projected trip limits per vessel, potentially as low as 12 lbs. per trip. This would seem to preclude any targeted fishery for spiny dogfish and would create mostly a by-catch fishery. Given that the average commercial fishing trip in 1996 landed 4,405 lbs, this low trip limit would preclude a viable directed fishery. Conceivably, there would be fewer participants involved in the commercial spiny dogfish fishery which may allow larger trip limits. However, a uniform trip limit system may not ensure an equitable distribution for all areas, gears, and seasons (if implemented). Therefore, positive long-term benefits may be fettered by this management option. Table 40 illustrates the potential affects of trip limits under the preferred and non-preferred management alternatives.

Social Impacts

The advantage of this alternative is that a uniform trip limit would be relatively easy to enforce because all individuals would be subject to the same trip limit regardless of origin or location of fishing. The drawback to this alternative is that a uniform trip limit would not be appropriate for all areas, gears, and seasons.

Effects on Marine Mammals, Sea Turtles, and Seabirds

The trip limit options considered in this Amendment would not have any significant impact on marine mammals, sea turtles, shortnose sturgeon, and seabirds.

3.1.5.4 Minimum size limits

3.1.5.4.1 Establish a minimum size which corresponds to the length at which 50% of female spiny dogfish are sexually mature

This alternative would establish a minimum size for spiny dogfish which corresponds to the length at which 50% of female spiny dogfish are sexually mature. This would require a minimum size of 32 inches (80 cm).

3.1.5.4.2 Establish a minimum size which corresponds to the length at which 100% of female spiny dogfish are sexually mature

This alternative would establish a minimum size for spiny dogfish which corresponds to the length at which 100% of female spiny dogfish are sexually mature. This would require a minimum size of 36 inches (91 cm).

3.1.5.4.3 Establish minimum a size of 27.5 in (70 cm)

This alternative would establish a minimum size of 27.5 in, which is the current effective minimum size at capture for spiny dogfish in the commercial fishery.

3.1.5.4.4 Establish a slot size limit of 27.5 in to 32 in (70-80 cm)

Each of the stock rebuilding strategies which meet the SFA requirements could be implemented with a slot size limit of 27.5 in to 32 in (70-81 cm). This alternative would require that the F applied in any given year be applied fully to a slot limit of 27.5 in to 32 in (70-80 cm), and that a partial recruitment vector of 0.5 of that F was applied to dogfish greater than 80 cm. Under these scenarios, only fish from 27-32 in (70-79 cm) could be retained, and it was assumed that fish greater than 32 in (80 cm) would continue to be caught and discarded, with an effective mortality rate of 50% of those landed in the slot. The results indicate that this strategy would result in lower yields and would not alter the rebuilding time frame.

Biological Impacts

Assuming that undersized fish are not caught and discarded, minimum size regulations would have positive impacts on the stock. In general, because minimum sizes increase the size at full recruitment, yields are increased as fishermen catch larger, heavier fish. In addition, minimum size regulations can increase the resilience of the stock to overfishing, i.e., the biological reference points (F_{MSY}) can increase. Finally, minimum size regulations can increase spawning stock biomass by allowing more fish to spawn.

However, negative biological consequences of minimum and slot size restrictions in the spiny dogfish fishery would result from increased discarding. It is unlikely that spiny dogfish fishermen could avoid catching sub-legal fish, and, as a result, increased levels of discards are expected given the current size composition of the stock.

Economic Impacts

The economic impact on the commercial sector from the implementation of these alternatives would vary between regions and gears employed. In general terms, reduction in revenues in the short-term would be expected. The degree of long term economic consequences would depend on the level and extent of discarding as the stock rebuilds.

Overall, these alternatives are expected to have a significant adverse economic effect on the spiny dogfish fishery, at least in the short term. However, benefits of a size restrictions in the fishery could result from increased catches of fish in future years. Gains will accrue to fishermen through protecting small fish until they reach legal size. This management measure will result in a short-term reduction in the marketable catch and long-term benefits as more fish mature and increase the size of the spawning stock. In addition, a reduction in the mortality of small fish will allow for an increase in yield or harvest as small fish that were previously killed grow larger and add weight to the stock.

Social Impacts

The proposed commercial fish size limitations would reduce the commercial catch and increase discards. If commercial fishermen can substitute the potential income loss by landing another species without additional effort then they may see no negative impact. However, if this is not possible, short-term impacts could occur. Nevertheless, given the analysis conducted under economic impacts above, it is not anticipated that commercial fishermen will be faced with substantial income loss as the result of the minimum size limit.

Effects on Marine Mammals, Sea Turtles and Seabirds

Size restrictions in the spiny dogfish fishery will not have any significant impact on marine mammals, sea turtles, shortnose sturgeon, and seabirds.

3.1.5.5 Alternative seasonal allocation of the commercial quota

3.1.5.5.1 Allocate commercial quota on a quarterly basis

The process used to set the quota is specified in 3.1.1.6. A quota would be allocated to the commercial fishery to control fishing mortality. The quota would be based on projected stock size estimates for that year as derived from the latest stock assessment information. Estimates of stock size coupled with the target fishing mortality rate would allow for a calculation of total allowable landings (TAL).

A system to distribute and manage the annual commercial quota on a seasonal basis would be implemented by the Councils. Quotas would be distributed between seasons based on the percentage of commercial landings for the each quarterly period during the years 1990-1997. These season specific quotas are specified in Table 34.

3.1.5.5.2 Allocate commercial quota on a bi-monthly basis

The process used to set the quota is specified in 3.1.1.6. A quota would be allocated to the commercial fishery to control fishing mortality. The quota would be based on projected stock size estimates for that year as derived from the latest stock assessment information. Estimates of stock size coupled with the target fishing mortality rate would allow for a calculation of total allowable landings (TAL).

A system to distribute and manage the annual commercial quota on a seasonal basis would be implemented by the Councils. Quotas would be distributed between seasons based on the percentage of commercial landings for the each bi-monthly period during the years 1990-1997. These season specific quotas are specified in Table 34.

Biological Impacts

The alternative seasonal allocations described above could be expected to have positive or negative biological impacts for the spiny dogfish stock, depending on fishermen behavior in reaction to the imposition of various seasons. In general, the shorter the season, the greater the assurance that the quota will be taken throughout the year. However, increased discarding could occur once the seasonal quota is reached, resulting in negative biological consequences for the stock.

Economic Impacts

These alternatives would establish an annual quota distributed seasonally and bi-monthly, as implemented by the Councils. The effects of these alternatives would depend largely upon the distributional system set up by the Councils. Quotas should be allocated so as to ensure an equitable distribution of the TAL based on historical landing data. Since there is a northern and southern fishery, consideration should be given to reducing economic impacts associated with seasonal price variations for spiny dogfish. An equitable allocation of quotas should ensure the maximization of long-term benefits through a rebuilt spiny dogfish fishery.

Social Impacts

As noted above, seasonal quota allocations of quotas should ensure the maximization of long-term benefits through a rebuilt spiny dogfish fishery. Quotas should be allocated so as to ensure an equitable distribution of the TAL based on historical landing data. The effects of these alternatives would depend largely upon the distributional system set up by the Councils.

Effects on Marine Mammals, Sea Turtles, and Seabirds

Alternative seasonal allocations of the quota in the spiny dogfish fishery will not have any significant impact on marine mammals, sea turtles, shortnose sturgeon, and seabirds.

3.1.5.6 Limit entry into the spiny dogfish fisheries

Biological Impacts

Under this alternative, vessels would have to qualify for a limited access commercial permit for spiny dogfish. The qualifying criteria would be based on historical performance in the fishery at a level specified by the Councils. The intent of this action would be to limit the number of participants in the commercial fishery for spiny dogfish. As such, this measure would not be expected to have and biological impacts.

Economic Impacts

The level of economic impacts of this alternative would depend on the qualifying criteria that the Councils choose to obtain a limited access permit. The stricter the requirements, the fewer the number of vessels that would qualify for a limited access permit. The economic consequences of any limited access program would have to be evaluated based on the requirements of the program. However, in general the economic consequences would be positive for the historical participants who qualify since they will be assured of the economic benefits derived from the stock rebuilding program.

Social Impacts

The level of social impact of this alternative would depend on the qualifying criteria that the Councils choose to obtain a limited access permit. The stricter the requirements, the fewer the number of vessels that would qualify for a limited access permit. The social consequences of any limited access program would have to be evaluated based on the requirements of the program. However, in general the social consequences would be positive for the historical participants who qualify since they will be assured of the benefits derived from the stock rebuilding program.

Effects on Marine Mammals, Sea Turtles, and Seabirds

Limiting entry into the spiny dogfish fishery will not have any significant impact on marine mammals, sea turtles, shortnose sturgeon, and seabirds.

3.1.5.7 Specify a target commercial quota

Biological Impacts

Under this alternative, the Councils would specify a target commercial quota in place of the "hard" or fixed quota specified in the preferred alternative. This approach to managing the commercial fishery would require additional management measures which would control fishing effort (i.e., input controls). Under this system an annual target quota would be specified and a suite of effort controls would be specified such that the landings under the effort control system would be expected to approximate the target quota. The fishery would not necessarily be closed if the target quota is reached or exceeded. This system depends on fishing effort limitations primarily through limitations on the number of days that vessels may fish during the quota period.

Spiny dogfish are long lived and slow growing (see Section 2.1.3.2). This life history strategy (long lived with low reproductive potential) makes the species particularly vulnerable to overfishing. Holden (1973) noted the limited ability of sharks and other elasmobranchs to maintain the levels of exploitation sustainable in fisheries for teleost or bony fish. This is because stock and recruitment are directly related and reductions in adult stock size result in reduced recruitment. In addition, the limited reproductive potential of spiny dogfish offers little flexibility in compensating for increased exploitation.

Given the vulnerability of this species to overfishing, this system of management could have negative biological consequences if it fails to dramatically reduce fishing mortality. The spiny dogfish stock is designated as overfished and under the SFA the stock must be rebuilt in ten years. If an effort control system fails to end overfishing and allow stock rebuilding, yield would be foregone and thus optimum yield would not be obtained.

Economic Impacts

If an effort control system fails to end overfishing and allow stock rebuilding, yield would be foregone and thus, optimum yield would not be obtained. As a result, economic inefficiency and lost revenue to the spiny dogfish fishery, in terms of both the harvesting and processing sector, would be expected.

Social Impacts

If effort controls fail to end overfishing, the resulting economic inefficiency and lost revenue to the spiny dogfish fishery, in terms of both the harvesting and processing sector, would be expected to have negative social impacts. These impacts would be especially acute in the ports and the associated communities which depend heavily on spiny dogfish.

Effects on Marine Mammals, Sea Turtles, and Seabirds

The impact of this measure on marine mammals, sea turtles and seabirds would depend on the degree to which the measures implemented would reduce fishing effort in the spiny dogfish gill net fisheries. Assuming that the effort control program was successful in reducing effort in these gill net fisheries, then they would be expected to have a positive impact on some species of marine mammals.

4.0 DRAFT REGULATORY IMPACT REVIEW AND REGULATORY FLEXIBILITY ANALYSIS

4.1 INTRODUCTION

The National Marine Fisheries Service requires the preparation of a Regulatory Impact Review (RIR) for all regulatory actions that either implement a new Fishery Management Plan (FMP) or significantly amend an existing plan. The RIR is prepared by the Regional Fishery Management Councils with assistance from the National Marine Fisheries Service (NMFS), as necessary. The RIR is part of the process of preparing and reviewing FMPs and provides a comprehensive review of the economic impacts associated with proposed regulatory actions.

The National Marine Fisheries Service requires a RIR for all regulatory actions that are part of the "public interest." The RIR does three things: 1) it provides a comprehensive review of the level and incidence of economic impacts associated with proposed regulatory actions; 2) it provides a review of the problems and policy objectives prompting the regulatory proposals and an evaluation of the major alternatives that could be used to meet these objectives; and, (3) it ensures that the regulatory agency systematically and comprehensively considers all available alternatives so that the public welfare can be enhanced in the most efficient and cost effective manner.

The RIR addresses many items in the regulatory philosophy and principles of Executive Order (E.O.) 12866. The RIR also serves as the basis for determining whether any proposed regulation is a "significant regulatory action" under certain criteria provided in E.O. 12866. The RIR also determines whether the proposed regulations will have a significant economic impact on a substantial number of small entities in compliance with the Regulatory Flexibility Act (RFA) of 1980 as amended by Public Law 104-121. The purpose of the RFA is to relieve small businesses, small organization, and small government agencies from burdensome regulations and record-keeping requirements, to the extent possible.

4.2 PROBLEMS AND OBJECTIVES

The description of the spiny dogfish fishery can be found in section 2.3 of this document. The problems for resolution and management objectives are outlined in sections 1.1.2 and 1.1.3 of this document, respectively.

4.3 METHODOLOGY AND FRAMEWORK FOR ANALYSIS

The basic approach adopted in the RIR is an assessment of management measures from the standpoint of determining the resulting changes in costs and benefits to society. The net effects should be stated in terms of producer and consumer surplus for the harvesting, processor/dealer sectors, and for consumers. Ideally, the expected present value of net yield streams over time associated with different management alternatives should be compared in evaluating the benefits. However, lack of data precludes this type of analysis. The approach taken in analyzing the alternative management actions is to describe and/or quantify to the extent possible the changes in net benefits by looking at changes in gross revenues for different industry sectors.

4.4 IMPACTS OF THE PROPOSED ACTION AND ALTERNATIVES

Changes in gross revenues were estimated relative to the projected status quo levels for each alternative. Impacts were calculated using the projected status quo landings by taking the average 1996 ex-vessel price for spiny dogfish (per pound) and multiplying this value by the proposed change in landings (per pound prices are from 1996 weighout data). It is important to note that the ex-vessel price for spiny dogfish, given the proposed reductions in landings, would depend on the elasticity of demand for this species. Since no studies have determined a demand function for spiny dogfish, revenue changes which account for varying levels of demand could not be calculated. In addition, changes in costs and market trends are not reflected in the analysis due to lack of data.

Pack-out facilities are usually compensated based on the number of pounds off-loaded and prepared for transport. Many different types of arrangement exist; for example, in some instances the pack-out facility only packs the fish in ice and prepares it for transport. In other situations the pack-out facility may act as a broker between the producers and processors. Since no formal database is maintained on this sector, primary information from pack-out businesses was used to determine the economic impacts of the proposed management alternatives. These individuals generally receive 4-5 cents per pound of fish handled. For all management options it was assumed that 100% of spiny dogfish landed was dealt with by a pack-out facility at 4.5 cents per pound. This assumption represents the upper bound for this sector since it could be argued that not all dogfish are handled in this manner. This assumption is based on the desire to include the dealer/transport sector as part of the spiny dogfish fisheries system.

No formal database on the gross revenues of processors is maintained; therefore the losses of gross revenues for this sector could not be calculated. Information on the percent of spiny dogfish revenues to total gross revenues was obtained to conduct a Regulatory Flexibility Act (RFA) Analysis (see Section 4.6.3).

4.4.1 SUMMARY OF IMPACTS OF PROPOSED ACTIONS

4.4.1.2 Preferred Alternative

The preferred alternative will eliminate overfishing and rebuild the spiny dogfish stock while allowing a one year "exit fishery." This step allows for a one year fishery of 22 million pounds (10,006 mt) to allow a phase out of the directed fishery. This approach was chosen to minimize the impacts of the rebuilding program on both the harvesting and processing sectors of the industry. Landings will be reduced to 3.0 million pounds (1316 mt) in year 2 and be maintained at under 4.5 million ponds (2000 mt) for the duration of the rebuilding period.

4.4.1.3 Impacts of the Preferred Alternative on Commercial Fishing, Processors, and Pack-out Facilities

This alternative is expected to rebuild spiny dogfish stocks in the shortest possible time while still meeting the requirements of the Sustainable Fisheries Act. In 1999, commercial landings would be reduced by 37,992,279 pounds ($6,838,610.20) relative to 1996 landings levels.

Based upon projected status quo total landings (i.e. total predicted landings if no management measures were imposed) this reduction would be 9,234,540 pounds ($1,662,217) in 1999. Based upon projected status quo total landings in relation to proposed TALs, ex-vessel gross revenue declines reach a high of $4,184,576.28 in year two as landings are reduced to 2,901,780 lbs (1316 metric tons) (Tables 37 and 38). Pack-out facility gross revenue declines reach a high of $1,015,170.98 in year two (Table 39). Gross revenue losses decline from this point as projected landings increase.

The cumulative discounted impacts of this action are illustrated in Figure 25 (see Figure 24 for non-discounted impacts). Notably, the discounted projected impacts of the preferred management action and its alternatives do not reach status quo levels (the *x* axis) within the shown 30 year time-frame (Figure 25). The discounted loss of gross ex-vessel revenues is fairly dramatic until the year 2009 when the benefits of harvest reductions begin to be realized as projected TALs increase dramatically. This characterization, however, has several shortcomings, the greatest of which is that it does not account for elasticity of demand. Potentially, price could increase as supply declines causing these curves to rise (i.e., toward the *x* axis). This characterization also does not account for changes in costs and introductions of new, potentially more efficient harvest technologies.

An additional area of uncertainty are the effects of low TALs upon markets. Processors have indicated that the ability to process spiny dogfish in a cost-effective manner is dependent upon volume. The proposed low TAL may cause processors to cease processing spiny dogfish and thus cause established U.S. based markets for this species to collapse. Since currently, most spiny dogfish are processed and exported, the implications of management upon both foreign and domestic markets are hard to predict. Two scenarios are: 1) the demand for spiny dogfish by foreign markets may decline as this species is replaced by a more readily available alternative; and conversely, 2) the lessening of supply in light of a static demand could cause price to rise and allow for a modified fishery to exist while landings remain at low levels.

These scenarios would also affect harvesters: if markets for spiny dogfish cease, there will not be an outlet to sell their catch. Conversely, if prices rise, harvesters will be able to receive greater ex-vessel prices for spiny dogfish (assuming a market exists). Even if prices increase, however, due to the extremely low TALs, this would probably do little to mitigate the economic impacts caused by the preferred alternative (this is true for both harvesters and processors).

Long-term benefits should be realized though a sustainable spiny dogfish fishery which can continue to capitalize on existing markets or take advantage of new markets. One caveat to this is that if the U.S. based export market does cease for the duration of the rebuilding plan, the level of demand for a product that has been unavailable for many year may be adversely affected.

4.4.1.4 Impacts of the Preferred Alternative on Recreational Fishing

The preferred alternative is not likely to affect the recreational fishery for spiny dogfish. The 1996 landings of spiny dogfish by the recreational fishing sector was 14,408 lbs (catch type A + B1) and discards were estimated at 143,130 lbs (catch type B2). The 1994 MRFSS survey indicated that of the 33,279 intercept surveys conducted in New England and the Mid-Atlantic, 4 anglers were targeting spiny dogfish as their "primary" species. Although this number is not expanded to represent all anglers making trips during that year, it suggests that there is not a substantial directed recreational fishery for spiny dogfish. In light of this, there is expected to be no lessening of demand for recreational fishing trips due to this proposed action.

4.4.1.5 Impacts of Permit and Reporting Requirements Under the Preferred Alternative

Actions two through four implement permit requirements for commercial vessels, dealers, and operators. Given the current status of the stocks and the uncertainties regarding discard rates for spiny dogfish, mechanisms which account for all activities in the fishery are necessary to enforce provisions of the FMP and ensure overfishing is prevented. Permits issued to all sectors which harvest, process, or sell spiny dogfish provides the foundation for effective monitoring and enforcement of regulations.

It is estimated that 642 vessels landed spiny dogfish in 1996 along the Atlantic coast. Under the all of the alternatives, any vessel desiring to fish commercially for spiny dogfish must obtain a federal vessel/owner spiny dogfish permit. It is estimated that 87% of commercial vessels landing spiny dogfish in 1996 possess a NMFS permit for at least one or more fisheries. Therefore, approximately 83 new applicants would be required to apply for a federal spiny dogfish permit using the initial application form. The remainder would use the renewal form and would not likely incur an additional burden. It is estimated that owner/operators of all 83 vessels would apply for a spiny dogfish permit. The total burden cost associated with public requirements is $623 ($7.50 per vessel) and the total burden cost associated with federal requirements is estimated at $2,739.

The calculation of public and federal costs applies to the new respondents only. It is highly unlikely that under the preferred management alternative there will be any new applicants for dealer permits. If there were new dealer permits issued, the total burden costs associated with the public requirement for new applicants is $1.25 per applicant. Thereafter the public annual estimate of submitting weekly reports will be $26 per dealer per year. Thereafter, the annual estimate of processing weekly reports for the NMFS will be $43 per dealer.

4.4.1.6 Impacts of Framework Adjustment Measures Under the Preferred Alternative

The next regulatory action establishes the framework adjustment process which enables the modification of management measures through a framework adjustment procedure. This adjustment procedure allows the Councils to add or modify management measure through a streamlined public review process.

The following management measures could be implemented or modified through framework adjustment procedures.

1. Minimum fish size.
2. Maximum fish size.
3. Gear requirements, restrictions or prohibitions (including, but not limited to, mesh size restrictions and net limits).
4. Regional gear restrictions.

5. Permitting restrictions and reporting requirements.
6. Recreational fishery measures including possession and size limits and season and area restrictions.
7. Commercial season and area restrictions.
8. Commercial trip or possession limits.
9. Fin weight to spiny dogfish landing weight restrictions.
10. Onboard observer requirements.
11. Commercial quota system including commercial quota allocation procedure and possible quota set asides to mitigate bycatch.
12. Recreational harvest limit.
13. Annual quota specification process.
14. FMP Monitoring Committee composition and process.
15. Designation of essential fish habitat.
16. Overfishing definition and related thresholds and targets.
17. Regional season restrictions (including option to split seasons).
18. Restrictions on vessel size (LOA and GRT) or shaft horsepower.
19. Target quotas.
20. Measures to mitigate marine mammal entanglements and interactions.
21. Any other management measures currently included in the FMP.
22. Any other commercial or recreational management measures.

The framework adjustment procedures listed above may be used to modify the FMP to ensure the objective of rebuilding spiny dogfish stocks. The maximum and minimum size limit would likely do little to constrain the harvesting of spiny dogfish beyond the proposed restrictions. These provisions may add flexibility to the method of managing spiny dogfish as well as ensuring the timely rebuilding of fish stocks (refer to section 3.1.4.5 for a discussion of slot limits). Section 3.1.4.4 discusses gear restrictions and minimum mesh sizes and permitting requirements are discussed in section 4.4.1. As previously stated, there is no known directed recreational fishery for spiny dogfish and, as such, neither possession and size limits, nor seasons is likely to have a significant impact on the demand for recreational fishing trips. Section 3.1.5.1 discusses season and area restrictions. A prohibition on finning (removing the fins at sea and disposing of the carcass) is likely to have no economic impact as industry advisors have indicated that this practice is very rare. Similarly, fin weight to spiny dogfish landing weight restrictions are likely to have no economic impacts as this has historically not been an issue in the spiny dogfish fishery. Trip and/or possession limits are discussed in section 4.4.2. The likely impacts of onboard observer requirements and measures to mitigate marine mammal entanglements and interactions are hard to predict. These measures may be necessary to ensure adherence to the FMP and other laws, respectively. The impact of all of the framework measures listed above will be evaluated at the time that they are considered for implementation.

4.4.1.7 Impacts of Commercial Quotas Under the Preferred Alternative

The next regulatory action would establish a seasonally allocated commercial fishing quota. The quota would be based on projected stock size estimates for that year as derived by the latest stock assessment information. The annual commercial quota would be distributed between seasons based on the percentage of commercial landings for each semi-annual period during the years 1990-1997. This quota should succeed in reducing mortality rates to the point where spiny dogfish stocks can be rebuilt within the legally mandated 10 year time-frame.

A seasonally allocated commercial fishing quota would also likely ensure that spiny dogfish landings are equitably distributed between northern and southern areas. Figures 24 and 25 as well as Tables 37 and 38 illustrated the likely impacts on gross ex-vessel revenues of the preferred option as well as the alternative rebuilding strategies. The benefits of this action will be realized at the terminus of the management plan through a productive spiny dogfish fishery.

4.4.1.8 Impacts of Prohibition on Finning

Finning, the act of removing the fins of spiny dogfish and discarding the carcass, will be prohibited. Vessels which land spiny dogfish must land fins in proportion to carcasses, with a maximum of three fins per carcass. Fins may not be stored aboard a vessel after the first point of landing. As noted above, a prohibition on finning (removing the fin at sea and disposing of the carcass) is likely to have no economic impact as industry advisors have indicated that this practice is very rare.

4.4.1.9 *Gill net limitations*

Commercial gill net vessels fishing for spiny dogfish will be prohibited from fishing more than a total of 80 nets (50 fathoms each). Since no regulations specific to the spiny dogfish gill net fishery currently exist, little or no information exits on fishing effort in the directed fishery. However, anecdotal reports from industry indicate few if any spiny dogfish gill netters fish in excess of the proposed net limit. As a result, there are no economic impacts expected from this measure.

4.4.2 SUMMARY OF IMPACTS OF ALTERNATIVES

4.4.2.1 Alternative 1 (non-preferred)

Non-preferred alternative 1 (take no action or status quo) will not allow for the problems identified in section 1.1.2 of this document to be solved. The implementation of this alternative is projected to cause landings to decline precipitously: by the year 2001 landing would be less than half of what they were in 1997. This alternative would not meet the requirements of the Sustainable Fisheries Act nor capture long-term economic benefits of rebuilt spiny dogfish stocks.

4.4.2.2 Alternative 2 (non-preferred)

The second non-preferred alternative would reduce landings to 2,162 metric tons in year one and maintain mortality at under 3,000 metric tons to allow the stock to rebuild in 10 years. This alternative will reduce gross ex-vessel revenues by $4,921,202.40 in year one (1999) and this impact will decrease as expected TALs increase. Successive revenue losses are projected to continue until 2009, although at a decreasing rate (Table 37). Figure 24 shows that cumulative gross revenues (not discounted) exceed status quo levels in 2221. Pack-out facilities will see gross revenues decline in year one (1999) by $1,193,875.20 (See Table 39).

This alternative reduces landings to a consistent level of approximately 5.5 million pounds (2500 mt) over ten years. Although this will reduce gross revenues for all sectors, the reduction of supply in light of demand may cause prices for spiny dogfish to increase. This point is complicated, however, by the low allowable landings. At approximately 5.5 million pounds (2,500 mt), a directed fishery for spiny dogfish is unlikely and the affect that a by-catch fishery may have on markets is currently unknown.

4.4.2.3 Alternative 3 (non-preferred)

The third non-preferred management alternative would reduce landings by over one-third in year one (1999), by 75% in year two (2000), and then limit landings to a level which would ensure the rebuilding of the stocks within a ten year time-frame. Gross revenue declines reach a high of $3,436,497.89 in year three (2001) (Table 37). Figure 24 shows that cumulative gross revenues exceed status quo levels in 2221. Similarly, gross revenue declines for pack-out facilities reach a high of $833,688.45 in year three (2001) (Table 39). Impacts decline from this point as projected landings decline. This alternative, however, fails to meet the requirement of the SFA

Both non-preferred management alternatives two and three allow for landings at slightly more than one-third of current landings rates for year one followed by large reductions in landing necessary to rebuild stocks. Like the preferred alternative, the graduated reduction in landings should allow producers and processors to transition to other fisheries in light of the low allowable landings in years two through eight. However, the benefits of these alternatives do not exceed the preferred alternative which allows for the largest TAL exit fishery.

4.4.2.4 Alternative 4 (non-preferred)

Non-preferred alternative four allows for a reduction to 13.8 million pounds (6238 mt) and 9.0 million pounds (4117 mt) in years one and two. Landings for the remaining 8 years are reduced to such a level as to allow the stock to be rebuilt in the required 10 year time-frame. Year one gross ex-vessel revenue declines are $3,254,079.65 (Table 37). Pack-out facility gross revenue declines are $789,434.10 in year one (Table 39). These impacts will decline throughout the time-span of the management plan as projected landings decline. This option consists of a graduated restriction of landings.

4.4.2.5 Alternatives 5, 6, and 7 (non-preferred)

Alternatives five, six, and seven all reduce mortality to levels that are necessary to rebuild spiny dogfish stocks within a 15, 20, and 30 year time frame, respectively. These options may spread economic impacts over a greater time period, but do not meet the requirements of the SFA.

4.4.2.6 Alternative 8 (non-preferred)

Alternative eight would establish a system of uniform trip limits in conjunction with the quota system. Section 3.1.3 of this document describes the low projected trip limits per vessel, potentially as low as 12 lbs. per trip. This would seem to preclude any targeted fishery for spiny dogfish and would create mostly a by-catch fishery. Given that the average commercial fishing trip in 1996 landed 4,405 lbs, this low trip limit would preclude a viable directed fishery. Conceivably, there would be fewer participants involved in the commercial spiny dogfish fishery which may allow larger trip limits. However, a uniform trip limit system may not ensure an equitable distribution for all areas, gears, and seasons (if implemented). Therefore positive long-term benefits may be fettered by this management option. Table 40 illustrates the potential affects of trip limits under the preferred and non-preferred management alternatives.

4.4.2.7 Alternatives 9 and 10 (non-preferred)

Alternative nine and ten would establish a minimum size limit for spiny dogfish which corresponds to the length at which 50% of female spiny dogfish are sexually mature (32 inches) and the length at which 100% of female spiny dogfish are sexually mature (36 inches), respectively. This is likely to have little economic impact on recreational fishing. There are likely to be negative short-term economic impacts on the commercial harvesting sector, which will correspondingly be incurred by processors and dealers. Any short-term losses should be off-set by long-term benefits of a productive fishery comprised of more abundant, larger spiny dogfish.

4.4.2.8 Alternative 11 (non-preferred)

Alternative eleven would establish a slot size limit of 27.5 inches to 32 inches. The results of projected TAL under this scenario indicate that this strategy would result in lower overall yields and not quicken the pace of the rebuilding period. Thus the potential benefits under this scenario are less than the preferred alternative in the same time-frame.

4.4.2.9 Alternatives 12 and 13 (non-preferred)

The twelve and thirteen alternatives would establish an annual quota distributed seasonally and bi-monthly, as implemented by the councils. The effects of these alternatives would depend largely upon the distributional system set up by the council. Quotas should be allocated so as to ensure an equitable distribution of the TAL based on historical landing data. Since there is a northern and southern fishery, consideration should be given to reducing economic impacts associated with seasonal price variations for spiny dogfish. An equitable allocation of quotas should ensure the maximization of long-term benefits through a rebuilt spiny dogfish fishery.

4.4.2.10 Alternative 14 (non-preferred)

Under this alternative, the Councils would specify a target commercial quota in place of the "hard" or fixed quota specified in the preferred alternative. This approach to managing the commercial fishery would require additional management measures which would control fishing effort (i.e., input controls). Under this system an annual target quota would be specified and a suite of effort controls would be specified such that the landings under the effort control system would be expected to approximate the target quota. The fishery would not necessarily be closed if the target quota is reached or exceeded. This system depends on fishing effort limitations primarily through limitations on the number of days that vessels may fish during the quota period.

Given the vulnerability of this species to overfishing, this system of management could have negative consequences if it fails to dramatically reduce fishing mortality. The spiny dogfish stock is designated as overfished and under the SFA the stock must be rebuilt in ten years. If an effort control system fails to end overfishing and allow stock rebuilding, yield would be foregone and thus optimum yield would not be obtained. As a result, economic inefficiency and lost revenue to the spiny dogfish fishery, in terms of both the harvesting and processing sector, would be expected.

4.5 DETERMINANTS OF A SIGNIFICANT REGULATORY ACTION

Pursuant to E.O. 12866 a regulation is considered a "significant regulatory action" if it is likely to: (1) have an annual effect on the economy of $100 million dollars or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local, or tribal governments or communities; (2) create a serious inconsistency or otherwise interfere with an action taken or planned by another agency; (3) materially alter the budgetary impact of entitlements, grants, user fees, or loan programs of the rights and obligations of recipients thereof; or, (4) raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in E.O. 12866.

In 1996, the commercial harvesting sector landed spiny dogfish valued at just above 11 million dollars and therefore it is unlikely that the proposed rule will result in an annual economic effect of 100 million dollars.

One area which may be significantly affected is employment. Several industry advisors have indicated that due to the low TALs mandated by the plan, and the labor-intensive nature of hand-processing spiny dogfish, employment reductions in the processing sector may be needed. The extent of these employment reductions will most likely be determined by whether or not processors can find an alternative species which requires hand processing. If this does not occur, it is likely that seasonal or permanent reductions in employment may occur as a result of this action. However, specific data needed to quantify the extent of these potential reductions are unavailable.

Another area of concern is the preferred alternatives affect on certain ports. According to the most recent weighout data (1997), several ports are extremely dependent on the spiny dogfish fishery and derived a large percent of landings value from spiny dogfish, as compared to the combined value of all other species landed in that port. For example, In Plymouth, MA, spiny dogfish accounted for 96% of the total pounds and 74% of the total value of all fish landed in this port.

This phenomenon also manifests in several other ports. In Wachapreague, VA, spiny dogfish accounted for 90% of the total pounds and 76% of the total value of all fish landed in that port; in Scituate, MA, spiny dogfish accounted for 74% of the total pounds and 21% of the total value of all fish landed in this port; in Chatham, MA, spiny dogfish accounted for 47% of the total pounds and 14% of the total value of all fish landed in this port; in Ocean City, MD, spiny dogfish accounted for 32% of the total pounds and 11% of the total value of all fish landed in this port; and, in Dare County, NC, spiny dogfish accounted for 30% of the total pounds and 11% of the total value of all fish landed in this port (See Table 35).

Clearly these ports are very dependent upon spiny dogfish landings and will be disproportionately affected by the proposed regulatory action. The extent to which local communities will be affected "materially" is unknown, but it is likely that local businesses which support the commercial fishing industry will be adversely impacted by this FMP.

It is unlikely that this regulatory action will create a serious inconsistency or otherwise interfere with an action taken or planned by another agency; materially alter the budgetary impact of entitlements, grants, user fees, or loan programs of the rights and obligations of recipients thereof; or, raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in E.O. 12866.

Although the annual effect on the economy is unlikely to near the 100 million dollar mark, the expected affects upon employment and the disproportionate impacts upon certain ports require further consideration. Since data needed to assess the extent of affects on employment and certain ports are currently unavailable, based upon the preceding information and the impacts on entities directly impacted by the proposed action, it is concluded that this regulation, if enacted, would not likely constitute a "significant regulatory action."

4.6 REVIEW OF IMPACTS RELATIVE TO THE REGULATORY FLEXIBILITY ACT

4.6.1 Regulatory Flexibility Analysis

4.6.1.1 Introduction

The purpose of the Regulatory Flexibility Act (RFA) is to minimize the adverse impacts from burdensome regulations and record keeping requirements on small businesses, small organizations, and small government entities. The category of small entities likely to be affected by the proposed plan is that of commercial entities harvesting spiny dogfish and entities processing spiny dogfish. The following discussion of impacts centers specifically on the effects of the proposed actions on the mentioned small business entities.

4.6.1.2 Determination of a Significant Economic Impact on a Substantial number of Small Entities

The Small Business Administration (SBA) considers any business a small business if it is independently owned and operated and not dominant in its field of operations and if it has annual receipts not in excess of $3,000,000. For related industries (processing) involved in canned and cured fish and seafood or prepared fish or frozen fish and seafoods, a small business is one that employs 500 employees or less. In the spiny dogfish fishery, the 642 boats and 5 major processors are small business entities (the number and size of pack-out facilities is currently unknown).

According to the guidelines on regulatory analysis of fishery management actions, a "substantial number" of small entities is more that 20 percent of those small entities engaged in the fishery. Since the proposed action will directly and indirectly affect most of the vessels and processors involved in the spiny dogfish fishery, the "substantial number" criterion will be met.

The 20 percent is calculated by dividing the number of small entities affected by the regulations by the total number of small entities in a particular industry or segment of that industry. If the effects fall primarily on a distinct segment, or portion thereof, of the industry that segment would be considered the class for the purposes of this determination.

Economic impacts on small business entities are considered to be "significant" if the proposed action would result in any of the following: a) a reduction in annual gross revenues by more that 5 percent; b) an increase in total costs of production by more than 5 percent as a result of an increase in compliance costs; c) an increase in compliance costs as a percent of sales for large entities; d) capital internal cash flow and external financing capabilities; or e) 2 percent of small business entities being forced to cease business operations.

4.6.1.3 Analysis of Economic Impacts

(a) Does this action result in a reduction in annual gross revenues by more that 5 percent for more than 20 percent of small entities:

The projected reductions in landings is expected to cause substantial ex-vessel declines for harvesters. Notably, 26% of the vessels landing spiny dogfish in 1996 (167) landed 42% of total pounds. This suggests that certain boats are dependent upon harvesting spiny dogfish. What is not known is the percent of gross revenues derived from spiny dogfish in comparison to other species of fish that these boats landed. Permit files show that vessels landing spiny dogfish in 1996 possess an array of permits allowing them to harvest other, usually more valuable species of fish. Therefore it appears that spiny dogfish fulfill a role within the targeting of an array of other species. Whether or not increased fishing for alternative species can compensate for the loss of ex-vessel revenues caused by this management plan is unknown. However, given the declines in many other species of fish, whether or not an alternative species of fish could be a viable alternative to spiny dogfish is questionable. It seems unlikely, however, that for the harvesting sector the proposed rule will meet this threshold

The entities that are most likely to be affected in the greatest number are the processors. There are known to be less then six major processors of spiny dogfish (representing a "distinct segment"). The percent of gross revenues that these processors derive from spiny dogfish ranges from 10-60%. Given the proposed 75% reduction in the TAL in 1999 (relative to the most recent 1997 landings data) it is estimated that 80% of the processors will incur a lessening of gross revenues of greater than 5%. This is determined by considering the reductions in landings in relation to reductions in gross revenues derived from dogfish, as a percent of total revenues. This is calculated by the following:

$$1-\left[\frac{x-y}{x}\right]=z$$

Where x = % of total gross revenues derived from spiny dogfish.
y = % of gross revenues that, when exceeded, constitutes a significant regulatory action (6% was used because the law states "greater than 5% of total gross revenues").
z = % decline in landing that will lead to the exceeding of this threshold for processors (multiply by 100 for percent).

For example, if a processor derived 25% of their gross revenues from dogfish, a proposed 24% reduction in landings would most likely meet this threshold. The proposed 75% reductions of landings in year 1 (relative to 1997) and further restrictions in following years combined with dependence of several processors on spiny dogfish, will have a significant economic impact. Even if using the difference between projected 1999 status quo landings and the 1999 proposed TAL (a 30% reduction in landings) this threshold is still met.

(b) Does this action result in an increase in compliance costs (annualized capital, operating, reporting, etc.) of greater than 5 percent for 20 percent or more of the participants:

Compliance costs for participants were described in section 4.4.1. The total burden cost associated with public requirements is $1,868 and the total burden cost associated with federal requirements is estimated at $8,217. It is highly unlikely that under the preferred management alternative there will be any new applicants for dealer permits. If there were new dealer permits issued, the total burden costs associated with the public requirement for new applicants is $1.25 per applicant. Thereafter the public annual estimate of submitting weekly reports will be $26 per dealer per year. Thereafter, the annual estimate of processing weekly reports for the NMFS will be $43 per dealer. It in not expected that these burden costs will substantially increase compliance costs for the affected entities. Thus, it is likely that this threshold is not met.

(c) Does this action result in 2 percent of the entities ceasing operations:

It is not known whether this management plan will cause 2% of the small entities to cease operation. It appears that a certain portion of the vessels landing spiny dogfish in 1996 are dependent upon this species. Therefore, some may go out of business as a result of this management action. Whether this number will reach 2%, however, is unknown.

Given that most processors devote a large amount of processing capacity to spiny dogfish, it is likely that one or more will cease business operations as a result of this actions. Thus this threshold will most likely be met.

Based upon the preceding information it is concluded that this regulation, if enacted, would have a significant economic impact on a substantial number of small entities.

5.0 OTHER APPLICABLE LAWS

5.1 RELATION OF RECOMMENDED MEASURES TO EXISTING APPLICABLE LAWS AND POLICIES

5.1.1 FMPs

This FMP is related to other plans to the extent that all fisheries of the northwest Atlantic are part of the same general geophysical, biological, social, and economic setting. U.S. fishermen usually are active in more than a single fishery. Thus regulations implemented to govern harvesting of one species or a group of related species may impact on other fisheries by causing transfers of fishing effort.

5.1.2 Treaties or International Agreements

No treaties or international agreements, other than GIFAs entered into pursuant to the MSFCMA, relate to this fishery.

5.1.3 Federal Law and Policies

5.1.3.1 Marine mammals and endangered species

Activities conducted under this FMP have not yet been considered for their impacts on endangered species in order to do a Section 7 of the Endangered Species Act consultation. NMFS will be performing a Section 7 consultation while the FMP is out for public review during the next few months. The Fish and Wildlife Service may also perform a Section 7 consultation on any seabirds that may be impacted by this FMP. The following background information is provided to facilitate evaluations of the alternatives relative to the order of magnitude these spiny dogfish fisheries may have on these threatened or endangered species.

Numerous species of marine mammals and sea turtles occur in the northwest Atlantic Ocean. The most recent comprehensive survey in this region was done from 1979-1982 by the Cetacean and Turtle Assessment Program (CETAP) at the University of Rhode Island (University of Rhode Island 1982) under contract to the Minerals Management Service (MMS), Department of the Interior. The following is a summary of the information gathered in that study, which covered the area from Cape Sable, Nova Scotia, to Cape Hatteras, North Carolina, from the coastline to 5 nautical miles seaward of the 1000 fathom isobath.

Four hundred and seventy one large whale sightings, 1,547 small whale sightings and 1,172 sea turtles were encountered in the surveys. The "estimated minimum population number" for each mammal and turtle in the area, as well as those species currently included under the Endangered Species Act, were also tabulated.

CETAP concluded that both large and small cetaceans were widely distributed throughout the study area in all four seasons and grouped the 13 most commonly seen species into three categories based on geographical distribution. The first group contained only the harbor porpoise, which is distributed only over the shelf and throughout the Gulf of Maine, Cape Cod, and Georges Bank, but probably not southwest of Nantucket. The second group contained the most frequently encountered baleen whales (fin, humpback, minke, and right whales) and the white-sided dolphin. These were found in the same areas as the harbor porpoise and also occasionally over the shelf at least to Cape Hatteras or out to the shelf edge. The third group indicated a "strong tendency for association with the shelf edge" and included the grampus, striped, spotted, saddleback, and bottlenose dolphins, and the sperm and pilot whales.

Loggerhead turtles were found throughout the study area, but appeared to migrate north to about Massachusetts in summer and south in winter. Leatherbacks appeared to have had a more northerly distribution. CETAP hypothesized a northward migration of both species in the Gulf Stream with a southward return in continental shelf waters nearer to shore. Both species usually were found over the shoreward half of the slope and in depths less than 200 feet. The northwest Atlantic may be important for sea turtle feeding or migrations, but the nesting areas for these species generally are in the South Atlantic and Gulf of Mexico.

This problem may become acute when climatic conditions result in concentration of turtles and fish in the same area at the same time. These conditions apparently are met when temperatures are cool in October but then remain moderate into mid-December and result in a concentration of turtles between Oregon Inlet and Cape Hatteras, North Carolina. In most years sea turtles leave Chesapeake Bay and filter through the area a few weeks before the bluefish becomes concentrated. Efforts are currently under way (by VIMS and the U.S. Fish and Wildlife Service refuges at Back Bay, Virginia, and Pea Island, North Carolina) to more closely monitor these mortalities due to trawls. Fishermen are encouraged to carefully release turtles captured incidentally and to attempt resuscitation of unconscious turtles as recommended in the 1981 *Federal Register* (pages 43976 and 43977).

The only endangered species of fish occurring in the northwest Atlantic is the shortnose sturgeon (*Acipenser brevirostrum*). The Councils urge fishermen to report any incidental catches of this species to the Regional Administrator, NMFS, One Blackburn Drive, Gloucester, Massachusetts 01930, who will forward the information to persons responsible for the active sturgeon data base.

The range of spiny dogfish and the above mentioned marine mammals and endangered species overlap and there always exists a potential for an incidental kill. Under the proposed recovery schedule and the resultant decline in fishing effort for spiny dogfish, such accidental catches should have a negligible impact on marine mammal or abundances of endangered species, and the Councils believe that implementation of this FMP will have a positive impact upon these populations.

Attempts were made to put these fisheries/sea turtle interaction into perspective of other sources of mortality for these endangered turtle species. The Congressionally mandated report *Decline of the Sea Turtles: Causes and Prevention* (NRC 1990) states that "Of all the known factors, by far the most important source of deaths was the incidental capture of turtles (especially loggerheads and Kemp's ridleys) in shrimp trawling. This factor acts on the life stages with the greatest reproductive value for the recovery of sea turtle populations."

Mortality associated with other fisheries and with lost or discarded fishing gear is much more difficult to estimate than that associated with shrimp trawling, and there is a need to improve these estimates (NRC 1990). This report identified possible turtle losses from the winter trawl fishery north of Cape Hatteras (about 50-200 turtles per year), the historical Atlantic sturgeon fishery, now closed, off the Carolinas (about 200 to 800 turtles per year), and the Chesapeake Bay passive-gear fisheries (about 25 turtles per year). Considering the large numbers of fisheries from Maine to Texas that have not been evaluated and the problems of estimating the numbers of turtles entangled in the 135,000 metric tons of plastic nets, lines, and buoys lost or discarded annually, it seems likely that more than 500 loggerheads and 50 Kemp's ridleys are killed annually by nonshrimp fisheries (NRC 1990). These other fishery operations, lost fishing gear, and marine debris are known to kill sea turtles, but the reported deaths are only about 10% of those caused by shrimp trawling. Dredging, entrainment in power-plants intake pipes, collisions with boats, and the effects of petroleum-platform removal all are potentially and locally serious causes of sea turtle deaths. However these collectively amount to less than 5% of the mortality caused by shrimp trawling (NRC 1990).

The NRC report (1990) concludes that all species of marine turtles need increased protection under the Endangered Species Act and other relevant legislation. While the report does not recommend specific conservation measures for these fisheries, the recommendations for the shrimp trawling are germane. The NRC report (1990) recommended TEDs, 60 minute winter tow-time limits, and limited time/area closure for turtle "hot spots". Currently, there are 5 sea turtle recovery plans in place these include plans for the loggerhead (1991), the green sea turtle (1991), the leatherback (1992), the Kemp's ridley sea turtle (1992), and the hawksbill sea turtle (1993). Of the six "Actions Needed" that are identified by the Recovery Plan to achieve recovery of loggerheads is item 5: "minimize mortality from commercial fisheries."

Shortnose sturgeon (*Acipenser brevirostrum*) is an additional endangered species that may be caught incidentally in trawl fisheries. Sturgeon will be included in the Incidental Take Statement of the pending Biological Opinion. As shortnose sturgeon are generally associated with the estuarine environment, rather than the truly marine environment, it is anticipated that the gear and fishing locations of these dogfish fisheries will rarely encounter shortnose sturgeon.

Marine mammals are managed under the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973. Marine mammals have been historically important in the U.S. both as targets for commercial harvests and in ecological interactions with commercial fisheries. An excellent description of the historical importance of marine mammals is described in USDC 1993b.

The results of this earlier work were addressed in 1979 when the U.S. Marine Mammal Commission sponsored a workshop to help define research needed for the study of marine mammals on the U.S. east and Gulf coasts and in 1989 at a NMFS-sponsored workshop on Gulf of Mexico marine mammal research needs (USDC 1993b). These workshops set a research agenda that was immediately addressed by agencies such as the Minerals Management Service and NMFS. During the 1980's, several institutions in the northeast developed active research programs which have resulted in a body of knowledge that is being drawn upon in developing management approaches for several critical marine mammal issues in the region. In the 1990's, increased attention has been focused on the characterization of marine mammal fauna of the U.S. Gulf of Mexico and the Mid-Atlantic Bight (USDC 1993b).

Thirty-five species of marine mammals range the U.S. Atlantic and Gulf of Mexico waters (32 whales, dolphins and porpoises, two seal species, and one manatee). Their status, in general, is poorly known, but some, like the right whale, Mid-Atlantic coastal bottlenose dolphin, and harbor porpoise, are under stresses that may affect their survival (USDC 1993b).

The gears managed under this FMP are under several categories listed for the final List of Fisheries for 1997 for the taking of marine mammals by commercial fishing operations under section 114 of the Marine Mammal Protection Act (MMPA) of 1972. Section 114 of the MMPA establishes an interim exemption for the taking of marine mammals incidental to commercial fishing operations and requires NMFS to publish and annually update the List of Fisheries, along with the marine mammals and the number of vessels or persons involved in each fishery, arranging them according to categories, as follows:

1. A fishery that has a frequent incidental taking of marine mammals;

2. A fishery that has an occasional incidental taking of marine mammals; or

3. A fishery that has a remote likelihood, or no known incidental taking, of marine mammals.

In Category I, there is documented information indicating a "frequent" incidental taking of marine mammals in the fishery. "Frequent" means that it is highly likely that more than one marine mammal will be incidentally taken by a randomly selected vessel in the fishery during a 20-day period. Some of the spiny dogfish gill net fisheries are in this category. With the mandatory reductions in spiny dogfish fishing mortality in the preferred alternative, there should be an overwhelming beneficial impact from the preferred alternative management measures on the marine mammal populations of the east coast.

In Category II, there is documented information indicating an "occasional" incidental taking of marine mammals in the fishery, or in the absence of information indicating the frequency of incidental taking of marine mammals, other factors such as fishing techniques, gear used, methods used to deter marine mammals, target species, seasons and areas fished, and species and distribution of marine mammals in the area suggest there is a likelihood of at least an "occasional" incidental taking in the fishery. "Occasional" means that there is some likelihood that one marine mammal will be incidentally taken by a randomly selected vessel in the fishery during a 20-day period, but that there is little likelihood that more than one marine mammal will be incidentally taken. Some of the spiny dogfish gill net fisheries are in this category.

In Category III, there is information indicating no more than a "remote likelihood" of an incidental taking of a marine mammal in the fishery or, in the absence of information indicating the frequency of incidental taking of marine mammals, other factors such as fishing techniques, gear used, methods used to deter marine mammals, target species, seasons and areas fished, and species and distribution of marine mammals in the area suggest there is no more than a remote likelihood of an incidental take in the fishery. "Remote likelihood" means that it is highly unlikely that any marine mammal will be incidentally taken by a randomly selected vessel in the fishery during a 20-day period. The spiny dogfish trawl and demersal longline fisheries are considered Category III fisheries. With the mandatory reductions in spiny dogfish fishing mortality in the preferred alternative, there should be an overwhelming beneficial impact from the preferred alternative management measures on the marine mammal populations of the east coast.

The 1994 amendments to the Marine Mammal Protection Act (MMPA) require the preparation and implementation of Take Reduction Plans (TLP's) for strategic marine mammal stocks that interact with Category I or II fisheries. The 1996 Stock Assessment Report (SAR) (Waring et al., 1997) states that harbor porpoise bycatch has been observed by the NMFS Sea Sampling program in the following fisheries: (1) the Northeast (NE) multispecies sink gillnet, (2) the mid-Atlantic coastal gillnet, (3) the Atlantic drift gillnet, (4) the North Atlantic bottom trawl fisheries, and (5) the Canadian Bay of Fundy sink gillnet fishery. The fisheries of greatest concern, and the subject of this TRP, are the NE multispecies sink gillnet fishery (Category I), and the Mid-Atlantic coastal gillnet fishery (Category II).

The NMFS recently announced in 50 CFR 229, the availability of a proposed harbor porpoise take reduction plan (HPTRP) to reduce the bycatch of harbor porpoise (*Phocoena phocoena*) in gillnet fisheries throughout the stock's U.S. range. NMFS also proposes regulations to implement the HPTRP. The proposed plan, including a discussion of the recommendations of the Gulf of Maine Take Reduction Team (GOMTRT) and the Mid-Atlantic Take Reduction Team (MATRT). The potential biological removal (PBR) level for Gulf of Maine harbor porpoise throughout their range is 483 animals (62 FR 3005, January 21, 1997). The incidental bycatch of harbor porpoise in the Gulf of Maine (GOM) and Mid-Atlantic gillnet fisheries exceeds the PBR level. The proposed HPTRP would use a wide range of management measures to reduce the bycatch and mortality of harbor porpoise. In the GOM, the HPTRP proposes time and area closures and time/area periods during which pinger use would be required in the Northeast, Mid-coast, Massachusetts Bay, Cape Cod South and Offshore Closure Areas. In the Mid-Atlantic area, the HPTRP proposes time/area closures and modifications to gear characteristics, including floatline length, twine size, tie downs, and number of nets, in the large mesh and small mesh fisheries.

As noted above, the stock recovery schedule in this FMP specifies mandatory reductions in spiny dogfish fishing mortality which will result in reductions in fishing effort directed at spiny dogfish in excess of 90% of current levels in years 2-10 of the rebuilding period through elimination of the directed fishery. As a result, there should be an overwhelming beneficial impact from the preferred alternative management measures on certain marine mammal populations of the east coast.

The stock recovery schedule proposed in this amendment will reduce fishing mortality over a ten year period. As such, these reductions in fishing mortality will result in reduced fishing effort that in turn will reduce interactions with marine mammals, sea turtles, shortnose sturgeon, and seabirds. Preventing overfishing of spiny dogfish thus will be beneficial to certain species of marine mammals.

5.1.3.2 Marine sanctuaries

National marine sanctuaries are allowed to be established under the National Marine Sanctuaries Act of 1973. Currently there are 12 designated marine sanctuaries that creates a system that protects over 14,000 square miles (National Marine Sanctuary Program 1993).

There are four designated national marine sanctuaries in the area covered by the FMP: the *Monitor* National Marine Sanctuary off North Carolina, and the Stellwagen Bank National Marine Sanctuary off Massachusetts, Gray's Reef off Georgia and the Florida Keys National Marine Sanctuary . There is currently one additional proposed sanctuary on the east coast, the Norfolk Canyon.

The *Monitor* National Marine Sanctuary was designated on 30 January 1975, under Title III of the Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA). Implementing regulations (15 CFR 924) prohibit deploying any equipment in the Sanctuary, fishing activities which involve "anchoring in any manner, stopping, remaining, or drifting without power at any time" (924.3 (a)), and "trawling" (924.3 (h)). The Sanctuary is clearly designated on all National Ocean Service (NOS) charts by the caption "protected area." This minimizes the potential for damage to the Sanctuary by fishing operations. Correspondence for this sanctuary should be addressed to: *Monitor* NMS, NOAA, Building 1519, Fort Ousts, Virginia 23604.

Gray's Reef was designated a National Marine Sanctuary in January 1981. Located 17 miles off the coast of Georgia, Gray's Reef is one of the largest nearshore sandstone reefs in the southeastern United States. The sanctuary encompasses 17 nm^2 of live-bottom habitat. Implementing regulations (15 CFR 922.90) permit recreational fishing and commercial fishing is restricted. Specifically, wire fish traps and bottom tending fishing gears (dredges, trawls etc.) are prohibited. Correspondence for this sanctuary should be addressed to: Gray's Reef Sanctuary Manager, 10 Ocean Science Circle, Savannah, Georgia 31411.

NOAA/NOS issued a proposed rule on 8 February 1991 (56 FR 5282) proposing designation under MPRSA of the Stellwagen Bank National Marine Sanctuary, in federal waters between Cape Cod and Cape May, Massachusetts. On 4 November 1992, the Sanctuary was Congressionally designated. Implementing regulations (15 CFR 940) became effective March 1994. Commercial fishing is not specifically regulated by Stellwagen Bank regulations. The regulations do however call for consultation between federal agencies and the Secretary of Commerce on proposed agency actions in the vicinity of the Sanctuary that "may affect" sanctuary resources. The process for consultation is currently (late 1995) being worked out between the Regional office of NMFS, the Sanctuary, and NEFMC for Amendment 7 to groundfish. Correspondence for this sanctuary should be addressed to: Stellwagen Bank NMS, 14 Union Street, Plymouth, Massachusetts 02360.

The United States Congress passed the Florida Keys National Marine Sanctuary and Protection Act of 1990 designating the Florida Keys a National Marine Sanctuary. The act required NOAA to develop a comprehensive management plan with implementing regulations to govern the overall management of the Sanctuary and to protect and conserve it's resources. The Sanctuary consists of 2,800 nm^2 of coastal and oceanic waters, and the associated submerged lands surrounding the Florida Keys, extending westward to include the Dry Tortugas, but excluding the Dry Tortugas National Park. The sanctuary prohibits the taking of coral or live rock, except as permitted by the NMFS or the state of Florida. The sanctuary contains designated Sanctuary Preservation Areas and Replenishment Reserves where the taking or disturbance of sanctuary resources is prohibited. Fishing is prohibited in these non-consumptive areas. Correspondence for this sanctuary should be addressed to Superintendent, NOAA/Florida Keys National Marine Sanctuary, P.O. Box 500368, Marathon, Florida 33050.

Details on sanctuary regulations may be obtained from the Chief, Sanctuaries and Reserves Division (SSMC4) Office of Ocean and Coastal Resource Management, NOAA, 1305 East-West Highway, Silver Spring, Maryland 20910.

5.1.3.3 Indian treaty fishing rights

No Indian treaty fishing rights are known to exist in the fishery.

5.1.3.4 Oil, gas, mineral, and deep water port development

While Outer Continental Shelf (OCS) development plans may involve areas overlapping those contemplated for offshore fishery management, no major conflicts have been identified to date. The Councils, through involvement in the Intergovernmental Planning Program of the MMS, monitor OCS activities and have opportunity to comment and to advise MMS of the Councils' activities. Certainly, the potential for conflict exists if communication between interests is not maintained or appreciation of each other's efforts is lacking. Potential conflicts include, from a fishery management position: (1) exclusion areas, (2) adverse impacts to sensitive biologically important areas, (3) oil contamination, (4) substrate hazards to conventional fishing gear, and (5) competition for crews and harbor space. The Councils are unaware of pending deep water port plans which would directly impact offshore fishery management goals in the areas under consideration, and are unaware of potential effects of offshore FMPs upon future development of deep water port facilities.

5.1.3.5 Paper work reduction act of 1995

The Paperwork Reduction Act concerns the collection of information. The intent of the Act is to minimize the Federal paperwork burden for individuals, small businesses, state and local governments, and other persons as well as to maximize the usefulness of information collected by the Federal government.

Since this FMP proposes new reporting requirements which solicit facts from "10 or more persons," the collection will have to be cleared through the Office of Management and Budget. The sponsor agency (NMFS) must submit an information collection budget, containing a listing of all new information collections planned for the upcoming fiscal year.

5.1.3.6 Impacts of the plan relative to federalism

The Amendment does not contain policies with federalism implications sufficient to warrant preparation of a federalism assessment under Executive Order 12612.

5.1.4 State, Local, and Other Applicable Law and Policies

5.1.4.1 State management activities

This plan will apply to all states from Florida to Maine. This includes Florida, Georgia, South Carolina, North Carolina, Virginia, Maryland, Delaware, New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine. There are currently no state management activities specific to spiny dogfish.

5.1.4.2 Impact of federal regulations on state management activities

There are currently no state management activities specific to spiny dogfish.

5.1.4.3 Coastal zone management program consistency

The CZM Act of 1972, as amended, provides measures for ensuring stability of productive fishery habitat while striving to balance development pressures with social, economic, cultural, and other impacts on the coastal zone. It is recognized that responsible management of both coastal zones and fish stocks must involve mutually supportive goals.

The Council must determine whether the FMP will affect a state's coastal zone. If it will, the FMP must be evaluated relative to the state's approved CZM program to determine whether it is consistent to the maximum extent practicable. The states have 45 days in which to agree or disagree with the Councils' evaluation. If a state fails to respond within 45 days, the state's agreement may be presumed. If a state disagrees, the issue may be resolved through negotiation or, if that fails, by the Secretary.

The FMP was reviewed relative to CZM programs of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, and Florida. Letters will be sent to all of the states listed along with a hearing draft of the FMP. The letters to all of the states will state that the Council concluded that the FMP would not affect the state's coastal zone and was consistent to the maximum extent practicable with the state's CZM program as understood by the Council.

6.0 COUNCIL REVIEW AND MONITORING OF THE FMP

The Councils and Commission will monitor the fishery using the best available data, including that specified in section 3.1.1.11. The commercial, recreational, biological, and survey data specified in section 3.1.1.11 are critical to the evaluation of the management measures adjustment mechanism. It is necessary that NMFS incorporate all of the above data types from all spiny dogfish fisheries into the overall NEFSC data bases. Additionally, improved stock assessments are necessary for FMP monitoring. As a result of that monitoring, the Councils will determine whether it is necessary to amend the FMP.

The primary organization in the review and monitoring process will be the Spiny Dogfish FMP Monitoring Committee (section 3.1.1.6).

7.0 LIST OF PREPARERS

This Amendment was prepared by the following members of the MAFMC staff - Dr. Christopher M. Moore, Richard J. Seagraves, Dr. Thomas B. Hoff, and Valerie M. Whalon- and Timothy Goodger (NMFS) and Jonathan O'Neil (Rutgers University Ecopolicy Center).

8.0 AGENCIES AND ORGANIZATIONS

In preparing the Amendment, the Councils consulted with the NMFS, the South Atlantic Fishery Management Council, the Fish and Wildlife Service, the Department of State, and the States of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and North Carolina through their membership on the Council and the following committees - Mid-Atlantic EFH Technical Committee, Northeast Region Steering Committee, MAFMC Habitat Committee, MAFMC Habitat Advisory Panel and the Joint MAFMC and NEFMC Dogfish Committee. In addition to the states that are members of the Councils, South Carolina, Georgia and Florida were also consulted through the Coastal Zone Management Program consistency process.

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Table 1. Biological characteristics of US commercial landings of spiny dogfish, 1982 - 1996.

	Commercial landings (million lbs.)					Mean Weight (kg)		Total Number Caught				Mean Length (cm)	
Year	Total	Females	Males	Female%	Male%	Females	Males	Females	Males	Female%	Male%	Females	Males
1982	11.9	11.7	0.2	98.30%	1.70%	4.44	2.17	1,199,204	42,325	96.59%	3.41%	97.0	84.8
1983	10.8	10.8	-	100.0%	-	4.09	-	1,197,182	-	100.00%	0.00%	94.7	-
1984	9.8	9.8	<0.1	99.76%	0.24%	4.42	1.76	1,004,315	6,030	99.40%	0.60%	96.7	79.4
1985	8.9	8.8	<0.1	99.48%	0.52%	4.10	1.68	976,479	12,375	98.75%	1.25%	94.8	78.1
1986	6.0	5.9	0.1	97.82%	2.18%	4.01	1.63	670,564	36,838	94.79%	5.21%	93.7	77.6
1987	6.0	5.9	<0.1	99.31%	0.69%	3.78	1.70	711,085	11,022	98.47%	1.53%	92.3	78.8
1988	6.8	6.8	<0.1	99.80%	0.20%	4.29	2.11	722,972	2,869	99.60%	0.40%	96.0	84.6
1989	9.9	9.8	0.1	98.79%	1.21%	4.02	1.93	1,103,734	28,095	97.52%	2.48%	94.2	82.0
1990	32.5	32.4	0.1	99.62%	0.38%	4.00	1.77	3,669,820	31,268	99.16%	0.84%	94.1	79.8
1991	29.0	28.9	0.2	99.36%	0.64%	3.90	1.08	3,354,707	77,348	97.75%	2.25%	93.4	77.9
1992	37.2	37.1	<0.1	99.82%	0.18%	3.82	1.86	4,402,269	16,576	99.62%	0.38%	92.9	81.1
1993	45.5	45.2	0.4	99.22%	0.78%	3.58	1.87	5,721,367	86,687	98.51%	1.49%	91.5	81.2
1994	41.4	40.9	0.5	98.71%	1.29%	3.17	1.84	5,846,452	131,350	97.80%	2.20%	88.1	80.9
1995	50.1	49.8	0.3	99.42%	0.58%	2.95	1.55	7,662,456	84,537	98.91%	1.09%	86.3	76.4
1996	60.1	50.0	10.1	83.22%	16.78%	2.65	1.56	8,567,153	2,933,039	74.50%	25.50%	84.1	76.4

Table 2. Weight per tow (lbs.) indices for spiny dogfish from NEFSC spring (1968-1997) and autumn (1967-1996) bottom trawl surveys (offshore strata 1-30, 33-40, 61-76; Footnotes A-C).

	Spring				Autumn			
Year	Unsexed	Male	Female	Total	Unsexed	Male	Female	Total
1967	-	-	-	-	76.8	-	-	76.8
1968	56.8	-	-	56.8	49.3	-	-	49.3
1969	35.4	-	-	35.4	121.7	-	-	121.7
1970	29.3	-	-	29.3	52.4	-	-	52.4
1971	52.8	-	-	52.8	34.1	-	-	34.1
1972	107.8	-	-	107.8	35.4	-	-	35.4
1973	125.6	-	-	125.6	47.7	-	-	47.7
1974	147.4	-	-	147.4	17.8	-	-	17.8
1975	100.3	-	-	100.3	46.0	-	-	46.0
1976	81.4	-	-	81.4	43.6	-	-	43.6
1977	53.0	-	-	53.0	35.4	-	-	35.4
1978	79.9	-	-	79.9	42.5	-	-	42.5
1979	29.5	-	-	29.5	58.5	-	-	58.5
1980	29.5	75.2	3.52	108.0	-	8.8	33.2	42.0
1981	1.3	44.9	106.0	152.2	-	27.9	76.8	104.7
1982	-	68.4	189.2	257.4	-	11.4	21.3	32.8
1983	-	46.4	38.9	85.6	-	30.1	48.6	78.8
1984	-	42.5	50.6	93.3	-	19.1	30.6	49.5
1985	-	220.9	146.7	367.6	-	32.1	55.0	87.3
1986	-	12.8	85.8	98.8	-	29.5	52.1	81.6
1987	-	89.3	135.7	225.1	-	23.3	24.6	48.0
1988	-	59.2	170.3	229.7	-	33.7	53.5	87.1
1989	-	76.6	94.8	171.2	-	13.4	12.1	25.3
1990	-	133.3	196.2	329.6	-	32.8	32.8	65.6
1991	-	80.3	116.6	196.9	-	54.1	58.7	112.9
1992	-	98.6	154.2	252.8	-	31.0	91.5	122.5
1993	-	78.5	114.8	193.4	-	11.2	4.6	15.8
1994	-	109.8	77.66	187.2	-	40.7	32.2	72.2
1995	-	76.6	88.0	164.6	-	36.7	25.1	61.6
1996	-	129.8	133.1	262.9	-	31.7	58.7	90.4
1997	-	82.5	98.78	181.3	-	-	-	-

A. During 1963-1984, BMV oval doors were used in the spring and autumn surveys; since 1985, Portuguese polyvalent doors have been used in both surveys. No adjustments have been made because no significant difference was found between the two types of doors for spiny dogfish (NEFSC 1991).

B. Spring surveys from 1973-1981 were accomplished with a '41 Yankee' trawl; in all other years, spring surveys were accomplished with a '36 Yankee' trawl. A factor of 0.69 was applied to all tows in these years (Sissenwine and Bowman, 1978).

C. During the fall of 1970, 1975, 1978, 1979, 1980, 1981, 1985, 1986, 1988, 1989, 1990, 1991, an 1993 and the springs of 1973, 1976, 1977, 1979, 1980, 1981, 1982, 1987, 1989, 1990, 1991, and 1994, the *Delaware II* was used entirely or in part to conduct the survey. All other years, the *Albatross IV* was the only vessel used for the survey. A factor of 0.81 was applied to all *Delaware II* tows (NEFSC 1991).

Table 3. Minimum biomass estimates (millions of lbs.) based on area swept by NEFSC trawl during spring surveys.

	Lengths ≥ 80 cm			Lengths 36-79 cm			Lengths ≤ 35 cm			
Year	Females	Males	Total	Females	Males	Total	Females	Males	Total	All Lengths
1968	-	-	91.3	-	-	243.4	-	-	3.4	338.0
1969	-	-	60.4	-	-	152.8	-	-	1.5	214.5
1970	-	-	80.9	-	-	72.8	-	-	7.0	160.7
1971	-	-	228.8	-	-	60.8	-	-	6.1	295.9
1972	-	-	279.1	-	-	321.7	-	-	3.4	604.3
1973	-	-	394.0	-	-	364.4	-	-	5.7	763.9
1974	-	-	489.2	-	-	395.9	-	-	5.9	890.9
1975	-	-	231.7	-	-	275.6	-	-	8.8	515.9
1976	-	-	212.3	-	-	266.3	-	-	2.6	481.3
1977	-	-	170.4	-	-	149.9	-	-	1.2	321.7
1978	-	-	192.7	-	-	289.2	-	-	2.7	484.6
1979	-	-	115.3	-	-	41.0	-	-	4.0	160.3
1980	230.8	33.7	370.6	37.0	159.2	272.3	0.7	0.9	1.9	644.6
1981	587.5	53.8	647.7	56.2	165.6	221.8	4.7	6.2	11.2	880.7
1982	1,000.9	76.3	1,077.2	135.8	315.9	451.7	1.1	1.5	2.6	1,531.3
1983	171.3	66.4	237.7	80.9	217.2	298.3	6.8	8.7	15.5	551.4
1984	254.9	60.6	315.5	73.6	194.0	267.6	0.3	0.5	0.8	584.0
1985	698.9	276.7	975.8	226.0	1,107.8	1,333.8	8.8	11.2	20.1	2,329.6
1986	421.7	7.7	429.5	114.4	65.3	179.7	1.9	2.4	4.3	613.3
1987	483.0	199.5	682.5	135.6	378.5	513.9	5.4	10.5	15.9	1,212.5
1988	954.8	57.8	1,012.8	205.7	338.6	544.5	2.0	2.4	4.4	1,561.7
1989	357.4	89.3	446.7	221.3	348.8	570.1	2.5	3.4	5.9	1,022.7
1990	882.5	155.9	1,038.4	360.5	668.2	1,028.7	1.5	2.3	3.8	2,070.8
1991	485.9	66.1	551.8	239.0	410.7	649.7	2.2	3.2	5.3	1,206.8
1992	618.4	92.4	710.8	396.6	511.2	907.9	1.6	2.2	3.8	1,622.4
1993	517.2	61.3	578.7	229.5	437.6	667.1	1.2	1.4	2.7	1,248.5
1994	232.1	81.8	313.9	238.8	560.4	799.2	9.4	12.2	21.6	1,134.9
1995	225.8	65.0	290.8	339.5	384.7	724.2	0.6	0.8	1.3	1,016.1
1996	433.2	73.6	506.8	444.7	738.1	1,182.6	2.2	2.5	4.7	1,694.2
1997	184.5	38.6	223.1	452.4	461.0	913.4	0.1	0.1	0.2	1,136.5

Notes: Total equals sum of males and females plus unsexed dogfish. Data for dogfish prior to 1980 are currently not available by sex.

Table 4. Distribution and habitat use for spiny dogfish.

Study	Area	Spatial & Temporal Distribution	Bottom Temp (°C)	Salinity (ppt)	Bottom Depth (m) Bottom Type	Estuarine Use	Prey/Predator
Biglow & Schroeder 1953	Gulf of Maine	Seasonally transient. Cape Cod to Cape Sable. Common on offshore banks as well as along the coast. As early as mid May in Penobscot Bay. Autumnal departure by October-November.	Appear coastally when temperature warms to 6°, and disappear when temp increases to 15°. Preferred range on offshore wintering grounds seems to be 6° to 11°.		Occur at depths anywhere from surface to bottom. Deep water preferred in winter, moving to schoaler water summer-fall.	See spatial column	Prey: Mostly fish, in particular, herrings and mackerel. Practically all species of Gulf of Maine fish smaller than themselves. Squid among regula article found in stomachs. Also known to eat worms, shrimps, and crabs. Upon May arrival in Woods Hole, often found full of Ctenophores.
Jensen, *et al.* 1961, 1965	Northwest Atlantic	Coastal waters from Cape Lookout, NC, northward around Nova Scotia, along both the northern and southern shores of the Gulf of Lawrence, past the Strait of Belle Isle to southeast Labrador. Appear early on Georges Bank (Mar-Apr), New Jersey (Mar). Spring and autumn transients in their southern range, from New York to North Carolina. General migration northward in spring, moving south in fall.	Prefer 7.2° - 12.8° range.		Deep water in winter, shallower water in summer. Average depth at which 100+ dogfish per haul obtained Jan-Jun 1948-1960 = 137 m. Avg. Depth for Jul-Dec same period = 87 m.		Prey: Primarily a fish eater but will also feed on invertebrates, both swimming and bottom-dwelling forms. Clupeoids are important part of diet, but undoubtedly feeds on whatever species are abundant and not too difficult to capture. Predator: Sharks (Mackerel, Great White, Tiger, Blue), Barndoor skate, Lancetfish, Bluefin tuna, Tilefish, Goosefish.
Cohen, 1982	Northwest Atlantic	Labrador to Florida, most abundant from Nova Scotia to Cape Hatteras, NC. As far south as Florida in winter, chiefly north of Cape Cod in summer. Begin southward migration in October, begin returning north in spring.	In Mid-Atlantic and New England areas inhabit waters with bottom temp ranging from 4° to 18°. Preferred temp range seems to be between 7.2° and 12.8°				Prey: Voracious, opportunistic feeders. Most species of fish smaller than themselves, primarily mackerel, herring, scup, flatfish, cod haddock, shrimp, crabs, squid, siphonophores, and sipunculid worms, ctenophores. Predator: Shark (other)
Nammack, *et al.* 1985	Northwest Altantic	Greeland to Southern Florida and Cuba; more typically from Newfoundland to Georgia. Offshore and south in the winter.					
Silva, 1993	Northwest Atlantic	Exhibit extensive seasonal migrations between *winter pupping/mating grounds* (Cape Hatteras to New Jersey) and summer feeding grounds (Gulf of Maine and Georges Bank to Newfoundland).	7° to 13°.		1968-1990. Juveniles prin. found along 100m contour, adult fem. shallower and inwards from 100m in south, deeper water in north. Adult males sim. to adult females.		
Rago, *et al.* 1994	Northwest Atlantic	Mid-Atlantic waters in winter and spring. Summer movement towards Canadian waters including bays and estuaries. Autumnal migration to the south.	7.2° to 12.8° (Jensen, 1965)			See spatial column	Prey: Herring, Atlantic mackerel, and squid.
Wilk, *et al.* 1997	Hudson-Raritan Estuary, NJ	Nov.-Dec. 1994-1997. Found on Romer Shoals, East Bank, and in Ambrose Channel.	Occurred at: range 7.1° - 11.3°.	Occurred at: range 30.7 - 32.2 ppt	Occurred at: range 12 - 18 m.	See Appendix #1	Prey: Crabs American eel, small fish

Table 4. (continued) Distribution and habitat use for spiny dogfish.

Study	Area	Spatial & Temporal Distribution	Bottom Temp (°C)	Salinity (ppt)	Bottom Depth (m) Bottom Type	Estuarine Use	Prey/Predator
NMFS, NEFC Juveniles (see Figures 5-8 for season and dates)	Northwest Atlantic	Winter: Across shelf from North Carolina to Georges Bank (GB). Spring: Across shelf from NC to GB, more abundant offshore. Summer: Inadequate sampling. Autumn: Nantucket Is., Georges Bank, between Lucher Shoal and German Bank.	OR = observed range OA = occurred at PR = preferred range Spring OR: 1 - 22 OA: 3 - 17 PR: 8 - 13 Autumn OR: 5 - 28 OA: 5 - 20 PR: 10 - 15		Spring OR: 5 - 439 AR: 7 - 390 PR. 50 - 150 Autumn OR: 5 - 481 AR: 12 - 366 PR: 25 - 75		Major predators on some commercially important species, mainly herring, Atl. Mackerel, and squid, and to a lesser extent, haddock and cod.
NMFS, NEFC Adults (see Figures 13-16 for season and dates)	Northwest Atlantic	Winter: Across shelf from NC to GB. Spring: Outer shelf from MC to northeast peak of GB, Browns Bank. Summer: Inadequate sampling. Autumn: Nantucket Shoals, eastern C. Cop, Cape Cod & Mass. Bays.	Spring: OR: 1 - 22 OA: 3 - 17 PR: 7 - 11 Autumn: OR: 5 - 28 OA: 5 - 19 PR: 10 - 15		Spring: OR: 5 - 439 AR: 7 - 439 PR: 50 - 149 Autumn: OR: 5 - 481 AR: 12 - 344 PR: 10 - 49		See Above
Mass. Inshore trawl survey 1980-1996 Juveniles	Inshore from Vineyard Sound to Cape Ann	Spring: SW Martha's V., Southern Nantucket I., NE Cape Cod, No. Cape Cod Bay. Autumn: NE Nantucket I., Cape Cod and C. Cod Bay, Cape Ann	Spring: OR: 1 - 15 OA: 2 - 14 PR: 7 - 10 Autumn: OR: 4 - 23 OA: 4 - 20 PR: 8 - 10* 13 - 16* *Bimodal preference		Spring: OR: 5 - 82 AR: 7 - 64 PR: 10 - 44 Autumn: OR: 4 - 82 AR: 8 - 82 PR: 15 - 34		
Mass. Inshore trawl survey 1980-1996 Adults	Inshore from Vineyard Sound to Cape Ann	Spring: So. Nantucket I., NE Cape Co, C. Cod Bay, Absent in GOM. Autumn: Eastern C. Cod, No. C. Cod, C. Cod Bay, Cape Ann, Ipswich Bay, Plum I.	Spring: OR: 1 - 15 AR: 1 - 14 PR: 6 - 12 Autumn: OR: 4 - 23 AR: 4 - 20 PR: 9 - 15		Spring: OR: 4 - 82 AR: 6 - 64 PR: < 45 Autumn: OR: 4 - 82 AR: 6 - 82 PR: 10 - 34		
Gottschall, *et al.* In review. Connecticut Bur. Maine Resources Apr-Jun 1984-1994 Jul-Aug 1984-1990	Long Island Sound	Enter the Sound in May and June and depart by early August. Return in September-November with highest numbers in November.			May-June: Prefer waters > 27m, and sand to transitional bottom type September-November: Prefer waters > 27m, and mud to transitional bottom.		

Table 4. (continued) Distribution and habitat use for spiny dogfish.

Study	Area	Spatial & Temporal Distribution	Bottom Temp (°C)	Salinity (ppt)	Bottom Depth (m) Bottom Type	Estuarine Use	Prey/Predator
Scott, 1982 (two publications)	Scotian Shelf & Bay of Fundy	Summer intruder to Bay of Fundy and Fundian channel. Occas large catches on the Scotian Shelf. *Always associated with* warm water.	Temp range = 3 - 11 *Prefer Temp* = 7 - 9	Sal range = 31 - 34 Prefer sal = 31 - 34	Depth range = 37 - 363 *Prefer ranges* = 20 - 29 70 - 79 90 - 99 pref. 1)For Scotian Shelf drift: glacial till 2)Sambro basin sand 3)Emerald basin salt 4)LaHave basin clay 5)Sable Is. sand & gravel		
Schwartz, 1964	Isle of Wight, Assawoman, Sinepauxent, & Chincoteague Bays, Ocean City, MD	April-June: S. Doglish from 70 to 90 can *occur in the harbor and inlet area of Ocean* City, MD	Range during summer: Bays: 20 - 38 Inlet: 23 - 24	Sal range = *26 - 32*	Inlet = 7 - 10 m *Bays* = *2 - 3 m* Assawoman: western 3/4 = mud eastern 1/4 = sand	See "Area"	
Sameoto, *et al.*, 1994	Nova Scotia Shelf	Emerald and LaHave basins, more abundant in June than October.	Emerald basin June: 8.3, October: 8.6	Emer. Bas. June: 34.3	Emerald and LaHave > 200	n/a	Prey: Zooplankton, namely *Calanus finmarchicus & Meganyctiphanes norvegica.*
Azarovitz, *et al.*, 1980	Middle Atlantic Bight	Spring: Larger catches offshore, inshore south of Delaware Bay but have not reaches coastal NJ or NY. Autumn: *Southern movement from the northern* (summer) grounds has begun. Young of the Year (≤ 32 cm) rarely occur inshore. Pupping is an exclusive offshore event.	Inhabit waters 4 - 18 prefer waters 7.2 - 12.8				See Bigelow & Schroeder, 1953
Woodhead, *et al.*, 1976	Frenchman Bay and surrounding waters, ME	Early June: 89% ♀ caught Flanders Bay. Late June/Early July: 95% ♂ caught off Stave Island. Late July/Early Aug.: Males plentiful around Ironbound Island. Late August: Mostly males caught in Bar Harbor.			All sets made in 16 - 32 m on muddy or sandy bottoms.	See spatial	Bait used = aged salted herring
Soldat, 1979	Northwest Atlantic	Migratory, thermally induced. Dense aggreg during winter off Norfolk, VA, Nantucket I, and southern slopes Georges. Diurnal vertical migrations.	Overall range: 4 - 17 prefer: 6 - 14 Winter: 7 - 10 Summer: 8 - 12		Winter: 200 - 300, as well as 40 - 80. Summer: 60 - 150 on Georges		Feeds mainly on fish, with squid being an important prey item also.

Table 5. Spatial distribution and relative abundance of dogfish in North Atlantic estuaries.

North Atlantic Estuaries

	Passamaquoddy Bay			Englishman Machias Bays			Narraguagus Bay			Blue Hill Bay			Penobscot Bay			Muscongus Bay		
Life Stage	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S
A		●	■		●	■		●	■		●	■		●	■		●	●
M			na			na			na			na			na			na
J		●	■		●	■		●	■		●	■		●	●		●	●
P			na			na			na			na			na			na

	Damariscotta River			Sheepscot River			Kennebec/ Androscoggin Rivers			Casco Bay			Saco Bay			Wells Harbor		
Life Stage	T	M	S	T	M	S	T	M	S	T	M	S	T	M	S	*	M	S
A		●	●		●	●		●	●		▼	●		▼	●			
M			na			na			na									
J		●	●		●	●		●	●		▼	●		▼	●			
P			na			na			na									

	Great Bay			Merrimack River			Massachusetts Bay			Boston Harbor			Cape Cod Bay		
Life Stage	T	M	S	T	M	*	*	*	S	*	M	S	*	M	S
A									■		▼	▼		▼	■
M									na						na
J									■		▼	▼		▼	■
P									na						na

Relative Abundance

▲ - Highly Abundant
■ - Abundant
● - Common
▼ - Rare
Blank - Not present

Salinity Zone

T - Tidal Fresh
M - Mixing
S - Seawater
* - Salinity Zone not present

Life stage

A - Adults
M - Mating
J - Juveniles
P - Parturition

Source: Jury *et al.* 1994.

Table 6. Temporal distribution and relative abundance of dogfish in North Atlantic estuaries.

Estuary (North Atlantic estuaries)	Life Stage	J	F	M	A	M	J	J	A	S	O	N	D
Passamaquoddy Bay	A						*C*	*C*	*C*	*A*	*A*		
	M						n a						
	J						*C*	*C*	*C*	*A*	*A*		
	P						n a						
Englishman / Machias Bays	A						*C*	*C*	*A*	*A*	*A*	*R*	
	M						n a						
	J						*C*	*C*	*A*	*A*	*A*	*R*	
	P						n a						
Narraguagus Bay	A						*C*	*C*	*A*	*A*	*A*	*C*	
	M						n a						
	J						*C*	*C*	*A*	*A*	*A*	*C*	
	P						n a						
Blue Hill Bay	A						*C*	*C*	*A*	*A*	*A*	*C*	
	M						n a						
	J						*C*	*C*	*A*	*A*	*A*	*C*	
	P						n a						
Penobscot Bay	A						*C*	*A*	*A*	*C*	*C*	*R*	
	M						n a						
	J						*C*	*C*	*C*	*C*	*C*	*R*	
	P						n a						
Muscongus Bay	A					*R*	*C*	*C*	*C*	*C*	*R*	*R*	
	M						n a						
	J					*R*	*C*	*C*	*C*	*C*	*R*	*R*	
	P						n a						
Damariscotta River	A					*R*	*C*	*C*	*C*	*C*	*R*	*R*	
	M						n a						
	J					*R*	*C*	*C*	*C*	*C*	*R*	*R*	
	P						n a						
Sheepscot River	A					*R*	*C*	*C*	*C*	*C*	*R*	*R*	
	M						n a						
	J					*R*	*C*	*C*	*C*	*C*	*R*	*R*	
	P						n a						
Kennebec / Androscoggin Rivers	A					*R*	*C*	*C*	*C*	*C*	*R*	*R*	
	M						n a						
	J					*R*	*C*	*C*	*C*	*C*	*R*	*R*	
	P						n a						
Casco Bay	A					*R*	*C*	*C*	*C*	*C*	*C*	*R*	
	M												
	J					*R*	*C*	*C*	*C*	*C*	*C*	*R*	
	P												
Saco Bay	A					*R*	*C*	*C*	*C*	*C*	*C*	*R*	*R*
	M												
	J					*R*	*C*	*C*	*C*	*C*	*C*	*R*	*R*
	P												
Wells Harbor	A												
	M												
	J												
	P												
Great Bay	A												
	M												
	J												
	P												
Merrimack River	A												
	M												
	J												
	P												
Massachusetts Bay	A					*R*	*C*	*A*	*A*	*A*	*C*	*R*	
	M						n a						
	J					*R*	*C*	*A*	*A*	*A*	*C*	*R*	
	P						n a						
Boston Harbor	A					*R*	*R*	*R*	*R*	*R*	*R*	*R*	
	M												
	J					*R*	*R*	*R*	*R*	*R*	*R*	*R*	
	P												
Cape Cod Bay	A					*R*	*C*	*A*	*A*	*A*	*A*	*R*	
	M						n a						
	J					*R*	*C*	*C*	*A*	*A*	*A*	*R*	
	P						n a						

Relative Abundance

H - Highly Abundant
A - Abundant
C - Common
R - Rare
Blank - Not Present
na - No data available

Life Stage

A - Adults
M - Mating
J - Juveniles
P - Parturition

Source: Jury *et al.* 1994

Table 7a. Approximate area (percent and number of 10 minute squares) for the dogfish catch and area EFH alternatives, for male and female juvenile dogfish caught in the NEFSC bottom trawl survey. The logged catch alternative was not presented because the percent area and number of squares consistently fall between the catch and area alternatives. The preferred alternative is 90% of the area.

Female juvenile dogfish

% Area	% Catch	Number of 10" squares
0	0	0
4	50	40
12	75	117
30	90	293
50	92	488
75	95	731
90	98	878
100	100	850

Male juvenile dogfish

% Area	% Catch	Number of 10" squares
0	0	0
2	50	15
7	75	50
17	90	131
50	93	363
75	96	544
90	99	653
100	100	725

Table 7b. Approximate area (percent and number of 10 minute squares) for dogfish catch and area EFH alternatives, for male and female dogfish caught in the NEFSC trawl survey. The logged catch alternative was not presented because the percent area and number of squares consistently fall between the catch and area alternatives. The preferred alternative is 90% of the area.

Female adult dogfish

% Area	% Catch	Number of 10" squares
0	0	0
6	50	50
12	75	102
28	90	238
50	93	425
75	96	638
90	98	765
100	100	850

Male adult dogfish

% Area	% Catch	Number of 10" squares
0	0	0
6	50	50
15	75	125
28	90	238
50	92	425
75	95	638
90	98	765
100	100	850

Table 8. Estuaries designated as essential fish habitat for juvenile and adult dogfish (seawater portions only).

Estuaries	Adults	Juveniles
Passamaquoddy Bay	X	X
Englishman / Machias Bays	X	X
Narraguagus Bay	X	X
Blue Hill Bay	X	X
Penobscot Bay	X	X
Muscongus Bay	X	X
Damariscotta Bay	X	X
Sheepscot Bay	X	X
Kennebec / Androscoggin Rivers	X	X
Casco Bay	X	X
Saco Bay	X	X
Massachusetts Bay	X	X
Cape Cod Bay	X	X

Table 9. Comparisons of intensity and severity of various sources of physical disturbance to the seafloor (based on Hall 1994, Watling and Norse MS1997). Intensity is a measure of the force of physical disturbance and severity is the impact on the benthic community.

Source	Intensity	Severity
ABIOTIC		
Waves	Low during long temporal periods but high during storm events (to 70-80 m depth)	Low over long temporal periods since taxa adapted to these events but high locally depending on storm behavior
Currents	Low since bed shear normally lower than critical velocities for large volume and rapid sediment movement	Low since benthic stages rarely lost due to currents
Iceberg Scour	High locally since scouring results in significant sediment movement but low regionally	High locally due to high mortality of animals but low regionally
BIOTIC		
Bioturbation	Low since sediment movement rates are small	Low since infauna have time to repair tubes and burrows
Predation	Low on a regional scale but high locally due to patchy foraging	Low on a regional scale but high locally due to small spatial scales of high mortality
HUMAN		
Dredging	Low on a regional scale but high locally due to large volumes of sediment removal	Low on a regional scale but high locally due to high mortality of animals
Land Alteration (Causing silt laden runoff)	Low since sediment laden runoff per se does not exert a strong physical force	Low on a regional scale but high locally where siltation over coarser sediments causes shifts in associated communities
Fishing	High due to region wide fishing effort	High due to region wide disturbance of most types of habitat

Source: Auster and Langton 1998.

Table 10. Studies of the impacts of fishing gear on the structural components of fish habitat.

Habitat	Gear Type	Location	Results	Reference(s)
Eelgrass	Scallop dredge	North Carolina	Comparison of reference quadrats with treatments of 15 and 30 dredgings in hard sand and soft mud substrates within eelgrass meadows. Eelgrass biomass was significantly greater in hard sand than soft mud sites. Increased dredging resulted in significant reductions in eelgrass biomass and number of shoots.	Fonesca et al. (1984)
Eelgrass and shoalgrass	Clam rake and "clam kicking"	North Carolina	Comparison of effect of two fishing methods. Raking and "light" clam kicking treatments, biomass of seagrass was reduced approximately 25% below reference sites but recovered within one year. In "intense" clam kicking treatments, biomass of seagrass declined approximately 65% below reference sites. Recovery did not begin until more than 2 years after impact and biomass was still 35% below the level predicted from controls to show no effect.	Peterson et al. (1987)
Eelgrass and shoalgrass	Clam rakes (pea digger and bull rake)	North Carolina	Compared impacts of two clam rake types on removal of seagrass biomass. The bull rake removed 89% of shoots and 83% of roots and rhizomes in a completely raked 1 m2 area. The pea digger removed 55% of shoots and 37% of roots and rhizomes.	Peterson et al. (1983)
Seagrass	Trawl	western Mediter-ranean	Noted loss of *Posidonia* meadows due to trawling; 45% of study area. Monitored recovery of the meadows after installing artificial reefs to stop trawling. After 3 years plant density has increased by a factor of 6.	Guillen et al. (1994)
Sponge-coral hard-bottom	Roller-rigged trawl	off Georgia coast	Assessed effect of single tow. Damage to all species of sponge and coral observed; 31.7% of sponges, 30.4% of stony corals, and 3.9% of octocorals. Only density of barrel sponges (*Cliona* spp.) significantly reduced. Percent of stony coral damage high because of low abundance. Damage to other sponges, octocorals, and hard corals varied but changes in density not significantly different. No significant differences between trawled and reference sites after 12 months.	Van Dolah et al. (1987)
Sponge-coral hard-bottom	roller-frame shrimp trawl	Biscayne Bay, Florida	Damage to approximately 50% of sponges, 80% of stony corals, and 38% of soft corals.	Tilmant (1979) (cited in Van Dolah et al. 1987)

Source: Auster and Langton 1998.

Table 10 (continued). Studies of the impacts of fishing gear on the structural components of fish habitat.

Habitat	Gear Type	Location	Results	Reference(s)
Various tropical emergent benthos	Trawl	North West Shelf, Australia	Catch rates of all fish and large and small benthos show that in closed areas fish and small benthos abundance increased over 5 years while large benthos (>25 cm) stayed the same or increased slightly. In trawled areas all groups of animals declined. Found that settlement rate and growth to 25 cm was on the order of 15 years for the benthos.	Sainsbury et al. (In press)
Gravel pavement	Scallop dredge	Georges Bank	Assessed cumulative impact of fishing. Undredged sites had significantly higher percent cover of the tube-dwelling polychaete *Filograna implexa* and other emergent epifauna than dredged sites. Undredged sites had higher numbers of organisms, biomass, species richness, and species diversity than dredged sites. Undredged sites were characterized by bushy epifauna (bryozoans, hydroids, worm tubes) while dredged sites were dominated by hard-shelled molluscs, crabs, and echinoderms.	Collie et al. (1996, 1997)
Gravel-boulder	Assumed roller-rigged trawl	Gulf of Maine	Comparison of site surveyed in 1987 and revisited in 1993. Initially mud draped boulders and high density patches of diverse sponge fauna. In 1993, evidence of moved boulders, reduced densities of epifauna and extreme truncation of high density patches.	Auster et al. (1996)
Cobble-shell	Assumed trawl and scallop dredge	Gulf of Maine	Comparison of fished site and adjacent closed area. Statistically significant reduction in cover provided by emergent epifauna (e.g., hydroids, bryozoans, sponges, serpulid worms) and sea cucumbers.	Auster et al. (1996)
Gravel	Beam trawl	Irish Sea	An experimental area was towed 10 times. Density of epifauna (e.g., hydroids; soft corals, *Alcyonium digitatum*) was decreased approximately 50%.	Kaiser and Spencer (1996a)
Boulder-Gravel	Roller-rigged trawl	Gulf of Alaska	Comparisons of single tow trawled lane with adjacent reference lane. Significant reductions in density of structural components of habitat (two types of large sponges and anthozoans). No significant differences in densities of a small sponge and mobile invertebrate fauna. 20.1% boulders moved or dragged. 25% of ophiuroids (*Amphiophiura ponderosa*) in trawled lanes were crushed or damaged compared to 2% in reference lanes.	Freese et al. (In prep.)
Gravel over sand	Scallop dredge	Gulf of St. Lawrence	Assessed effects of single tows. Suspended fine sediments and buried gravel below the sediment-water interface. Overturns boulders.	Caddy (1973)

Source: Auster and Langton 1998.

Table 10 (continued). Studies of the impacts of fishing gear on the structural components of fish habitat.

Habitat	Gear Type	Location	Results	Reference(s)
Bryozoan beds (on sand and cobble)	Otter trawl and roller-rigged trawl	New Zealand	Qualitative comparison of closed and open areas. Two bryozoans produce "coral-like" forms and provide shelter for fishes and their prey. Comparisons of fished site with reference sites and prior observations from fishers show reduced density and size of colonies.	Bradstock and Gordon (1983)
Mussel bed	Otter trawl	Strangford Lough, Northern Ireland	Comparison of characteristics of trawled and untrawled *Modiolus modiolus* beds as pre and post impacts of a trawl. Trawled areas, confirmed with sidescan sonar, showed mussel beds disconnected with reductions in attached epibenthos. The most impacted sites were characterized by few or no intact clumps, mostly shell debris, and sparse epifauna. Trawling resulted in a gradient of complexity with flattened regions at the extreme. Immigration of *Nephrops* into areas previously dominated by *Modiolus* may result in burial of new recruits due to burrowing activities; precluding a return to a functional mussel bed habitat.	Magorrian (1995)
Sand-mud	Trawl and scallop dredge	Hauraki Gulf, New Zealand	Comparisons of 18 sites along a gradient of fishing effort (i.e., heavily fished sites through unfished reference sites). A gradient of increasing large epifaunal cover correlated with decreasing fishing effort.	Thrush et al. (In press)
Soft sediment	Scallop dredge	Port Phillip Bay, Australia	Compared reference and experimentally towed sites in BACI designed experiment. Bedforms consisted of cone shaped callianasid mounds and depressions prior to impact. Depressions often contained detached seagrasses and macroalgae. Only dredged plot changed after dredging. Eight days after dredging the area was flattened; mounds were removed and depressions filled. Most callianasids survived and density did not change in 3 mo following dredging. One month post impact, seafloor remained flat and dredge tracks distinguishable. Six months post impact mounds and depressions were present but only at 11 months did the impacted plot return to control plot conditions.	Currie and Parry (1996)
Sand	Beam trawl	North Sea	Observations of effects of gear. As pertains to habitat, trawl removed high numbers of the hydroid *Tubularia.*	DeGroot (1984)

Source: Auster and Langton 1998.

Table 10 (continued). Studies of the impacts of fishing gear on the structural components of fish habitat.

Habitat	Gear Type	Location	Results	Reference(s)
Gravel-sand-mud	Trawl	Monterey Bay	Comparison of heavily trawled (HT) and lightly trawled (LT) sites. The seafloor in the HT area had significantly higher densities of trawl tracks while the LT area had significantly greater densities of rocks >5 cm and mounds. The HT area had shell debris on the surface while the LT area had a cover of flocculent material. Emergent epifauna density was significantly higher for all taxa (anenomes, sea pens, sea whips) in the LT area.	Engel and Kvitek (MS1997)
Sand	Otter trawl	North Sea	Observations of direct effects of gear. Well buried boulders removed and displaced from sediment. Trawl doors smoothed sand waves. Penetrated seabed 0-40 mm (sand and mud).	Bridger (1970, 1972)
Sand-shell	Assumed trawl and scallop dredge	Gulf of Maine	Comparison of fished site and adjacent closed area. Statically significant reduction of habitat complexity based on reduced cover provided by biogenic depressions and sea cucumbers. Observations at another site showed multiple scallop dredge paths resulting in smoothed bedforms. Scallop dredge paths removed cover provided by hydrozoans which reduced local densities of associated shrimp species. Evidence of shell aggregates dispersed by scallop dredge.	Auster et al. (1996)
Sand-silt to mud	Otter trawl with chain sweep and roller gear	Long Island Sound	Diver observations showed doors produced continuous furrows. Chain gear in wing areas disrupted amphipod tube mats and bounced on bottom around mouth of net, leaving small scoured depressions. In areas with drifting macroalgae, the algae draped over grounder of net during tows and buffered effects on the seafloor. Roller gear also created scoured depressions. Spacers between discs lessened impacts.	Smith et al. 1985

Source: Auster and Langton 1998.

Table 11. Studies of short-term impacts of fishing on benthic communities.

Taxa	Gear and Sediment Type	Region	Results	Reference(s)
Infauna	beam trawl; megaripples and flat substrate	Irish Sea, U.K.	Assessed at the immediate effects of beam trawling and found a reduction in diversity and abundance of some taxa in the more stable sediments of the northeast sector of their experimental site but could not find similar effects in the more mobile sediments. Out of the top 20 species 19 had lower abundance levels at the fished site and nine showed a statistically significant decrease. Coefficient of variation for numbers and abundance was higher in the fished area of the NW sector supporting the hypothesis that heterogeneity increases with physical disturbance. Measured a 58% decrease in mean abundance and a 50% reduction in the mean number of species per sample in the sector resulting from removal of the most common species. Less dramatic change in the sector where sediments are more mobile.	Kaiser and Spencer (1996a)
Starfish	beam trawl; coarse sand, gravel and shell, muddy sand, mud	Irish Sea, U.K.	Evaluated damage to starfish at three sites in the Irish sea that experienced different degrees of trawling intensity. Used ICES data to select sites and used side scan to confirm trawling intensity. Found a significant correlation between starfish damage (arm regeneration) and trawling intensity.	Kaiser (1996)
Horse mussels	otter trawl; horse mussel beds,	Strangford Lough; N. Ireland	Used video/rov, side scan and benthic grabs to characterize the effect of otter trawling and scallop dredging on the benthic community. There was special concern over the impact on *Modiolus* beds in the Lough. Plotted the known fishing areas and graded impacts based on a subjective 6 point scale; found significant trawl impacts. Side scan supported video observations and showed areas of greatest impact. Found that in otter trawl areas that the otter boards did the most damage. Side scan suggested that sediment characteristics had changed in heavily trawled areas.	Industrial Science Division. (1990)
Benthic fauna	beam trawl; mobile megaripples structure and stable uniform sediment	Irish Sea, U.K.	Sampled trawled areas 24 hours after trawling and 6 months later. On stable sediment found significant difference immediately after trawling. Reduction in polychaetes but increase in hermit crabs. After six months there was no detectable impact. On megaripples substrate no significant differences were observed immediately after trawling or 6 months later.	Kaiser et al MS 1997

Source: Auster and Langton 1998.

Table 11 (continued). Studies of short-term impacts of fishing on benthic communities.

Taxa	Gear and Sediment Type	Region	Results	Reference(s)
Bivalves, sea scallop, surf clams, ocean quahog	scallop dredge, hydraulic clam dredge; various substrate types	Mid-Atlantic Bight, USA	Submersible study of bivalve harvest operations. Scallops harvested on soft sediment (sand or mud) had low dredge induced mortality for uncaught animals (<5%). Culling mortality (discarded bycatch) was low, approx. 10%. Over 90% of the quahogs that were discarded reburrowed and survived whereas 50% of the surf clams died. Predators crabs, starfish, fish and skates, moved in on the quahogs and clams in the predator density 10 items control area levels within 8 hours post dredging. Noted numerous "minute" predators feeding in trawl tracks. Non-harvested animals, sand dollars, crustaceans and worms significantly disrupted but sand dollars suffered little apparent mortality.	Murawski and Serchuck (1989)
Ocean quahog	hydraulic clam dredge;	Long Island, N.Y., USA	Evaluated clam dredge efficiency over a transect and changed up to 24 hours later. After dredge fills it creates a "windrow of clams". Dredge penetrates up to 30 cm and pushes sediment into track shoulders. After 24 hours track looks like a shallow depression. Clams can be cut or crushed by dredge with mortality ranging from 7 to 92 %, being dependent on size and location along dredge path. Smaller clams survive better and are capable of reburrowing in a few minutes. Predators, crabs, starfish and snails, move in rapidly and depart within 24 hours.	Meyer et al. (1981)
Macro-benthos	scallop dredge; coarse sand	Mercury Bay, New Zealand	Benthic community composed of small short-lived animals at two experimental and adjacent control sites. Sampling before and after dredging and three months later. Dredging caused an immediate decrease in density of common macrofauna. Three months later some populations had not recovered. Immediate post-trawling snails, hermit crabs and starfish were feeding on damaged and exposed animals	Thrush et al. (1995)
Scallops and associated fauna	scallop dredge; "soft sediment"	Port Phillip Bay, Australia	Sampled twice before dredging and three times afterwards, up to 88 days later. The mean difference in species number increased from 3 to 18 after trawling. The total number of individuals increased over the sampling time on both experimental and control primarily as a result of amphipod recruitment, but the number of individuals at the dredged sites were always lower than the control. Dissimilarity increased significantly, as a result of dredging, because of a decrease in species numbers and abundance.	Currie and Parry (1994)

Source: Auster and Langton 1998.

Table 11 (continued). Studies of short-term impacts of fishing on benthic communities.

Taxa	Gear and Sediment Type	Region	Results	Reference(s)
Sea Scallops and associated fauna	otter trawl and scallop dredge; gravel and sand	Gulf of St. Lawrence, Canada	Observed physical change to sea floor from otter doors and scallop dredge and lethal and nonlethal damage to the scallops. Noted an increase in the most active predators within the trawl tracks compared to outside; winter flounder, sculpins and rock crabs. No increase in starfish or other sedentary forms within in an hour of dredging.	Caddy (1973)
Macrofauna	beam trawl; hard-sandy substrate	North Sea, coast of Holland	Sampling before and after beam trawling (*hrs, 16 hrs and 2 weeks) showed species specific changes in macrofaunal abundance. Decreasing density ranged from 10 to 65% for species of echinoderms (starfish and sea urchins but not brittle stars), tube dwelling polychaetes and molluscs at the two week sampling period. Density of some animals did not change others increased but these were not significant after 2 weeks.	Bergman and Hup (1992)
Benthic fauna	beam trawl and shrimp trawl; hard sandy bottom, shell debris and sandy-mud	North Sea, German coast	Preliminary report using video and photographs comparing trawled and untrawled areas. Presence and density of brittle stars, hermit crabs, other "large" crustaceans and flatfish was higher in the controls than the beam trawl site. Difference in sand ripple formation in trawled areas was also noted, looking disturbed not round and well developed. Found a positive correlation with damage to benthic animals and individual animal size. Found less impact with the shrimp trawl, diver observations confirmed low level of impact although the net was "festooned" with worms. Noted large megafauna, mainly crabs, in trawl tracks.	Rumhor et al. (1994)
Soft bottom macrofauna	beam trawl; very fine sand	North Sea, Dutch Sector	Compared animal densities before and after trawling and looked at fish stomach contents. Found that total mortality due to trawling varied between species and size class of fish, ranging from 4 to 139% of pretrawling values. (values> 100% indicate animals moving into the trawled area). Mortality for echinoderms was low, 3 to 19%, undetectable for some molluscs, esp. solid shells or small animals, while larger molluscs had a 12 to 85% mortality. Burrowing crustaceans had low mortality but epifaunal crustaceans approximated 30 % but ranged as high as 74%. *Annelids were generally unaffected except for Pectinaria, a tube building* animal. Generally mortality increased with number of times the area was trawled (once or twice). Dab were found to be the major savager, immigrating into the area and eating damaged animals.	Santbrink and Bergman (1994)

Source: Auster and Langton 1998.

Table 11 (continued). Studies of short-term impacts of fishing on benthic communities.

Taxa	Gear and Sediment Type	Region	Results	Reference(s)
Hermit Crabs	beam trawl	Irish Sea, U.K.	Compared the catch and diet of two species of hermit crab on trawled and control sites. Found significant increases in abundance on the trawl lines two to four days after trawling for both species but also no change for one species on one of two dates. Found a general size shift towards larger animals after trawling. Stomach contents weight was higher post-trawling for one species. Diets of the crabs were similar but proportions differed.	Ramsey et al. (1996)
Sand macrofauna and infauna	scallop dredge	Irish Sea	Compared experimental treatments based frequency of tows (i.e., 2,4,12,25). Bottom topography changes did not change grain size distribution, organic carbon, or chlorophyll content. Bivalve molluscs and peracarid crustaceans did not show significant changes in abundance or biomass. Polychaetes and urchins showed significant declines. Large molluscs, crustaceans and sand eels were also damaged. In general, there was selective elimination of fragile and sedentary components of the infauna as well as large epifaunal taxa.	Eleftheriou and Robertson (1992)

Source: Auster and Langton 1998.

Table 12. Studies of long-term impacts of fishing on benthic communities.

Habitat Type and Taxa Present	Time Period	Location	Effect	Reference
Sand; macrobenthos and meiofauna	2-7 months	Bay of Fundy	Experimental trawling in high energy area. Otter trawl doors dug up to 5 cm deep and marks were visible for 2 to 7 months. Initial significant effects on benthic diatoms and nematodes but no significant impact on macrofauna. No significant longterm effects.	Brylinsky et al. (1994)
Quartz sand; benthic infauna	5months	South Carolina Estuary	Compared benthic community in two areas, one open to trawling one closed, before and after shrimp season. Found variation with time but no relationship between variations and trawling per se.	Van Dolah et al. (1991)
Sandy; ocean quahogs	----	Western Baltic	Observed otter board damage to bivalves, especially ocean quahogs, and found an inverse relation between shell thickness and damage and a positive correlation between shell length and damage.	Rumhor and Krost (1991)
Subtidal shallows and channel; macrobenthos	100 years	Wadden Sea	Reviewed changes in benthic community documented over 100 years. Considered 101species. No long term trends in changing abundance for 42 common species, with 11 showing considerable variation. Sponges, coelenterates and bivalves suffered greatest losses while polychaetes showed the largest gains. Decrease subtidally for common species from 53 to 44 and increase intertidally from 24 to 38.	Reise (1982)
Intertidal sand; lug worms	4 years	Wadden Sea	Studied impact of lugworm harvesting versus control site. Machine digs 40 cm gullies. Immediate impact is a reduction in several benthic species and slow recovery for some the larger long-lived species like soft shelled clams. With one exception, a polychaete, the shorter-lived macrobenthic animals showed no decline. It took several years for the area to recover to prefishing conditions.	Beukema (1995)
Various habitat types; all species	---	North Sea	Review of fishing effects on the North Sea based primarily on ICES North Sea Task Force reports. Starfish, sea urchins and several polychaetes showed a 40 to 60 % reduction in density after beam trawling but some less abundant animals showed no change and one polychaete increased. At the scale of the North Sea the effect of trawling on the benthos is unclear.	Gislason (1994)

Source: Auster and Langton 1998.

Table 12 (continued). Studies of long-term impacts of fishing on benthic communities.

Habitat Type and Taxa Present	Time Period	Location	Effect	Reference
Sand; macrofauna	73 years	Kattegatt	Compared benthic surveys form 1911-1912 with 1984. Community composition has changed with only approximately 30% similarity between years at most stations. Primary change was a decrease in sea urchins and increase in brittle stars. Animals were also smaller in 1984. Deposit feeders have decreased while suspension feeders and carnivores have increased.	Pearson et al. (1985)
Subtidal shallows and channels; Macrofauna	55 years	Wadden Sea, Germany	Documented increase in mussel beds and associated species such as polychaetes and barnacles when comparing benthic survey data. Noted loss of oyster banks, *Sabellaria* reefs and subtidal sea grass beds. Oysters were overexploited and replaced by mussels; *Zostera* lost to disease. Conclude that major habitat shifts are the result of human influence.	Riesen and Reise (1982)
146 stations; Ocean Quahogs	---	Southern North Sea, Europe	Arctica valves were collected from 146 stations in 1991 and the scars on the valve surface were dated, using internal growth bands, as an indicator of the frequency of beam trawl damage between 1959 and 1991. Numbers of scars varied regionally and temporally and correlated with fishing.	Witbaard and Klein (1994)
Various habitats; Macrofauna	85 years	Western English Channel, UK	Discusses change and causes of change observed in benthic community based on historic records and collections. Discusses effects of fishing gear on dislodging hydroid and bryozoan colonies, and speculates that effects reduce settlement sites for queen scallops.	Holme (1983)
Gravel/sand; Macrofauna	3 years	Central California, USA	Compared heavily trawled area with lightly trawled (closed) area using Smith MacIntyre grab samples and video transect data collected over three years. Trawl tracks and shell debris were more numerous in heavily trawled area, as were amphinomid polychaetes and oligochaetes in most years. Rocks, mounds and flocculent material were more numerous at the lightly trawled station. Commercial fish were more common in the lightly trawled area as were epifaunal invertebrates. No significant differences were found between stations in term of biomass of most other invertebrates.	Engel and Kvitek (MS 1997)
Fine sand; razor clam	----	Barrinha, Southern Portugal	Evaluated disturbance lines in shell matrix of the razor clam and found an increase in number of disturbance lines with length and age of the clams. Sand grains were often incorporated into the shell suggestive of a major disturbance , such as trawling damage, and subsequent recovery and repair of the shell.	Gaspar et al. (1994)

Source: Auster and Langton 1998.

Table 12 (continued). Studies of long-term impacts of fishing on benthic communities.

Habitat Type and Taxa Present	Time Period	Location	Effect	Reference
Fine to medium sand; ocean quahogs	----	Southern New Jersey, USA	Compared areas unfished, recently fished and currently fished for ocean quahogs using hydraulic dredges. Sampled invertebrates with a Smith MacIntyre grab. Few significant differences in numbers of individuals or species were noted, no pattern suggesting any relationship to dredging.	MacKenzie (1982)
Gravel, shell debris and fine mud; Horse mussel community	8 years	Strangford Lough, Northern Ireland	Review paper of effects of queen scallop fishery on the horse mussel community. Compared benthic survey from the 1975-80 period with work in 1988. Scallop fishery began in 1980. *Modiolus* community has remained unchanged essentially from 1857 to 1980. The scallop fishery has a large benthic faunal bycatch, including horse mussels. Changes in the horse mussel community are directly related to the initiation of the scallop fishery and there is concern about the extended period it will take for this community to recover.	Brown (1989)
Shallow muddy sand; scallops	6 months	Maine, USA	Sampled site before, immediately after and up to 6 months after trawling. Loss of surficial sediments and lowered food quality of sediments, measured as microbial populations, enzyme hydrolyzable amino acids and chlorophyll *a*, was observed. Variable recovery by benthic community. Correlation with returning fauna and food quality of sediment.	Watling et al. (MS 1997)
Sand and seagrass; hard shelled clams and bay scallops	4 years	North Carolina, USA	Evaluated effects of clam raking and mechanical harvesting on hard clams, bay scallops, macroinvertebrates and seagrass biomass. In sand, harvesting adults showed no clear pattern of effect. With light harvesting seagrass biomass dropped 25% immediately but recovered in a year. In heavy harvesting seagrass biomass fell 65% and recovery did not start for >2 years and did not recover up to 4 years later. Clam harvesting showed no effect on macroinvertebrates. Scallop densities correlated with seagrass biomass.	Peterson et al. (1987)
Gravel pavement; benthic magafauna	Not known	Northern Georges Bank, USA	Used side scan, video and naturalist dredge sampling to characterize disturbed and undisturbed sites based on fishing activity records. Documented a gradient of community structure from deep, undisturbed to shallow disturbed sites. Undisturbed sites had more individual organisms, greater biomass, greater species richness and diversity and were characterized by an abundant bushy epifauna. Disturbed sites were dominated by hard-shelled molluscs, crabs and echinoderms.	Collie et al. (1997)

Source: Auster and Langton 1998.

Table 12 (continued). **Studies of long-term impacts of fishing on benthic communities.**

Habitat Type and Taxa Present	Time Period	Location	Effect	Reference
Sand; epifauna	3 year	Grand Banks, Canada	Experimentally trawled site 12 times each year within 31 to 34 hours for three years. Total invertebrate bycatch biomass declined over the three year study in trawls. Epibenthic sled samples showed lower biomass, averaging 25%, in trawled areas than reference sites. Scavenging crabs were observed in trawl tracks after first 6 hours and trawl damage to brittle stars and sea urchins was noted. No significant effects of trawling were found for four dominant species of mollusc.	Prena et al. (MS 1997)
Sand, shrimp and macrobenthos	7 months	New South Wales, Australia	Sampled macrofauna, pretrawling, after trawling and after commercial shrimp season using Smith McIntyre grab at experimental and control sites. Under water observation of trawl gear were also made. No detectable changes in macrobenthos was found or observed.	Gibbs et al. (1980)
Soft sediment; scallops and associated fauna	17 months	Port Phillip Bay, Australia	Sampled 3 months before trawling and 14 months after trawling. Most species showed a 20 to 30% decrease in abundance immediately after trawling. Dredging effects generally were not detectable following the next recruitment within 6 months but some animals had not returned to the trawling site 14 months post trawling.	Currie and Parry (1996)
Bryozoans; fish and associated fauna	----	Tasman Bay, New Zealand	Review of ecology of the coral-like bryozoan community and changes in fishing gear and practices since the 1950s. Points out the interdependence of fish with this benthic community and that the area was closed to fishing in 1980 because gear had developed which could fish in and destroy the benthic community thereby destroying the fishery.	Bradstock and Gordon (1983)
Various habitat types; diverse tropical fauna	5 + years, ongoing	North West Shelf, Australia	Describes a habitat dependent fishery and an adaptive management approach to sustaining the fishery. Catch rates of all fish and large and small benthos show that in closed areas fish and small benthos abundance increased over 5 years while large benthos (>25 cm) stayed the same or increased slightly. In trawled areas all groups of animals declined. Found that settlement rate and growth to 25 cm was on the order of 15 years for the benthos.	Sainsbury et al. (In press)

Source: Auster and Langton 1998.

Table 12 (continued). Studies of long-term impacts of fishing on benthic communities.

Habitat Type and Taxa Present	Time Period	Location	Effect	Reference
Mudflat; commercial clam cultivation and benthos	7 months	South-east England	Sampled benthic community on a commercial clam culture site and control area at the end of a two year growing period, immediately after sampling, and again 7 months later. Infaunal abundance was greatest under the clam culture protective netting but species composition was similar to controls. Harvesting with a suction dredge changed the sediment characteristics and reduced the numbers of individual animals and species. Seven months later the site had essentially returned to the unharvested condition.	Kaiser et al. (1996a)
Sand; razor clam and benthos	40 days	Loch Gairloch, Scotland	Compared control and experimentally harvested areas using a hydraulic dredge at 1 day and 40 days after dredging. On day one a non-selective reduction in the total numbers of all infaunal species was apparent but no differences were observed after forty days.	Hall et al. (1990)
Sand and muddy areas; Macro-zoobenthos	3years; ongoing	German Bite, Germany	Investigated macro-zoobenthos communities around a sunken ship that had been "closed" to fishing for three years. Compared this site with a heavily fished area. Preliminary results show an increase in polychaetes and the bivalve Tellina in the fished, sandy, area. The data does not yet allow for a firm conclusion regarding the unfished area but there is some (nonsignificant) increase in species numbers and some delicate, sensitive species occurred within the protected zone.	Arntz et al. (1994)

Source: Auster and Langton 1998.

Table 13. Total commercial landings in millions of pounds by gear type from Maine to Virginia, in 1995.

GEAR TYPE	X 10^6 POUNDS	% OF TOTAL
PURSE SEINE, MENHADEN	739	44.90%
TRAWL, OTTER, BOTTOM	249	15.12%
UNKNOWN	142	8.60%
DREDGE, CLAM	118	7.17%
PURSE SEINE, HERRING	76	4.63%
POT/TRAP, LOBSTER	71	4.32%
TRAWL, OTTER, MIDWATER	69	4.25%
GILL NET, SINK, OTHER	58	3.55%
DIVING GEAR	28	1.70%
DREDGE, SCALLOP, SEA	22	1.32%
POTS + TRAPS, OTHER	21	1.28%
DREDGE, OTHER	17	1.02%
OTHER	14	0.82%
LONGLINE, BOTTOM	10	0.62%
LONGLINE, PELAGIC	6	0.36%
GILL NET, OTHER	3	0.19%
POUND NET	2	0.13%
PURSE SEINE, OTHER	1	0.04%
GRAND TOTAL	1650	100.00%

Source: USDC weighout file 1995.

Table 14. Fishing gear managed by South Atlantic Fishery Management Council.

Gear Impacts and Council Action
Gear Used in Fisheries Under South Atlantic Council Fishery Management Plans

The following is a list of gear currently in use (or regulated) in fisheries managed under the South Atlantic Council fishery management plans. In general, if gear is not listed, it is prohibited or not commonly used in the fishery:

Snapper Grouper Fishery Management Plan

1. Vertical hook-and-line gear, including hand-held rod and manual or electric reel or "bandit gear" with manual, electric or hydraulic reel (recreational and commercial).

2. Spear fishing gear including powerheads (recreational and commercial).

3. Bottom longlines (commercial).
   - Prohibited south of a line running east of St. Lucie Inlet, Florida and in depths less than 50 fathoms north of that line.
   - May not be used to fish for wreckfish.

4. Sea bass pots (commercial).
   - May not be used or possessed in multiple configurations.
   - Pot size, wire mesh size and construction restrictions.
   - May not be used in the EEZ south of a line running due east of the NASA Vehicle Assembly Building, Cape Canaveral, Florida.

5. Special Management Zones (created under the Snapper Grouper FMP).
   - Sea bass pots are prohibited in all Special Management Zones.
   - Fishing may only be conducted with hand-held hook-and-line gear (including manual, electric, or hydraulic rod and reel) and spearfishing gear in specified Special Management Zones, however, and other specified Special Management Zones a hydraulic or electric real that is permanent affixed to a vessel ("bandit gear") and or spear fishing gear (or only powerheads) are prohibited.

Shrimp Fishery Management Plan

1. Shrimp trawls -- wide-ranging types including otter trawls, mongoose trawls, rock shrimp trawls, etc. (commercial).
   - Specified areas are closed to trawling for rock shrimp.

Red Drum Fishery Management Plan

1. No harvest or possession is allowed in or from the EEZ (no gear specified).

Golden Crab Fishery Management Plan

1. Crab traps (commercial).
   - May not be fished in water depths less than 900 feet in the northern zone and 700 feet in the middle and southern zones.
   - Trap size, wire mesh size, and construction restrictions.

Coral, Coral Reefs, and Live/Hard Bottom Habitat

1. Hand harvest only for allowable species (recreational and commercial).
2. Oculina Bank Habitat Area of particular concern.
   - Fishing with bottom longlines, bottom trawls, dredges, ports, or traps is prohibited.
   - Fishing vessels may not anchor, use and anchor and chain, or use a grapple and chain.

Coastal Migratory Pelagic Resource Fishery Management Plan

1. Hook-and-line gear, usually rod and reel or bandit gear, hand lines, flat lines, etc. (recreational and commercial).
2. Run-around gillnets or sink nets (commercial).
   - A gillnet must have a float line less than 1,000 yards in length to fish for coastal migratory pelagic species.
   - Gillnets must be at least 4-3/4 inch stretch mesh.
3. Purse seines for other coastal migratory species (commercial) with an incedental catch allowance for Spanish mackerel (10%) and king mackerel (1%).
4. Surface longlines primarily for dolphin.

Table 15. Proposed impact of fishing gear on dogfish EFH.

GEAR TYPE	KNOWN	POTENTIAL	NO EXPECTED
PURSE SEINE, MENHADEN			X
TRAWL, OTTER, BOTTOM		X	
UNKNOWN			X
DREDGE, CLAM		X	
PURSE SEINE, HERRING			X
POT/TRAP, LOBSTER		X	
TRAWL, OTTER, MIDWATER			X
GILL NET, SINK, OTHER		X	
DIVING GEAR			X
DREDGE, SCALLOP, SEA		X	
POTS + TRAPS, OTHER		X	
DREDGE, OTHER		X	
OTHER			X
LONGLINE, BOTTOM			X
LONGLINE, PELAGIC			X
GILL NET, OTHER		X	
POUND NET			X
PURSE SEINE, OTHER			X

Table 16. Matrix of prioritized threats in regards to their potential impact to dogfish EFH along the Atlantic coast.

	IMPACTS																								
Threat	A. Change in Topography	B. Fish Blockage	C. Wetland alteration	D. Loss of SAV	E. Loss of riparian habitat	F. Erosion	G. Change in nature of substratight	H. Suspended sediments, turbidity	I. Change in temperature regime	J. Change in salinity regime	K. Change in circulation pattern	L. Hypoxia / Anoxia	M. Nutrient loading, Eutrophication	N. Change in photosynthesis regime	O. Water contamination	P. Sediment contamination	Q. Litter	R. Atmospheric Deposition	S. Loss in benthic organisms	T. Physical damage to organism	U. Gene pool deterioration	V. Trophic alteration	W. Pathogens, disease	X. Displacement of Species	Y. Introduction of exotic species
1.0 Coastal Development	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*					*	
2.0 Nonpoint Source Pollution	*			*			*	*	*	*	*	*	*	*	*	*	*	*	*				*	*	
3.0 Dredging and Dredge Spoil Placement	*		*	*			*	*			*	*		*	*	*			*	*			*	*	
4.0 Port Development, Utilization, and Shipping	*		*				*	*				*		*	*	*		*	*	*				*	*
5.0 Marinas and Recreational Boating			*	*		*	*	*	*	*		*			*	*	*	*	*	*			*	*	*
6.0 Energy Production and Transport		*	*				*	*	*	*	*				*	*		*		*				*	
7.0 Sewage Treatment and Disposal			*				*	*	*			*	*	*	*	*			*				*	*	
8.0 Industrial Wastewater and Solid Wastes		*	*				*		*	*			*	*	*	*				*				*	
9.0 Marine Mining	*		*	*		*	*	*				*		*					*					*	
10.0 Aquaculture	*	*	*	*		*	*						*								*		*	*	*
11.0 Ocean Disposal							*	*				*	*	*	*	*							*	*	
12.0 Introduced Species	*			*				*													*	*	*	*	

Table 17. **Physical characteristics and nutrient loadings for eight major Mid-Atlantic estuaries.**

Location	Volume (cubic ft.)	Surface Area (sq. mi.)	Average Daily Inflow (cfs)	Total Drainage Area (sq. mi.)	Estimated Nitrogen Loadings (tons/yr.)	Estimated Phosphoru s Loadings (tons/yr.)
Delaware Bay	4.48×10^{11}	768	19,800	13,450	50,199 (High)	13,109 (High)
Delaware Inland Bays*	3.85×10^{9}	33.3	300	292	1,425 (Med-High)	82 (Med.)
Chincoteague Bay	2.25×10^{10}	137	400	300	292 (Low)	84 (Low)
Chesapeake Bay	2.59×10^{12}	3,830	85,800	69,280	119,929 (High)	16,813 (High)
Albemarle-Pamlico Sound	1.08×10^{12}	2,949	46,000	29,574	28,224 (High)	3,565 (High)
Bogue Sound	1.31×10^{10}	102	1,300	680	710 (Low)	56 (Low)
New River	5.18×10^{9}	32	800	470	616 (Low)	112 (Med.)
Cape Fear River	1.22×10^{10}	38	10,100	9,090	8,102 (Med.)	1,486 (High)

Source: Cooper and Lipton 1994

Table 18. Recent trends in selected parameters characterizing eutropication, by estuary.

Parameter	St. Croix R./Cobscook Bay		Englishman Bay		Narraguagus Bay		Blue Hill Bay		Penobscot Bay			Muscongus Bay		Damadscotta River		Sheepscot Bay			Kennebec/Andro River			Casco Bay		Saco Bay		Great Bay		Hampton Harbor		Merdmack River		Plum Island Sound		Massachusetts Bay	Boston Harbor		Cape Cod Bay
	M	S	M	S	M	S	M	S	T	M	S	M	S	M	S	T	M	S	T	M	S	M	S	M	S	M	S	M	S	T	M	M	S	S	M	S	S
CHLOROPHYLL *A* (pg/l)	●	●	?	?	?	?	?	●	?	?	?	?	●	?	●	?	●	●	?	?	?	●	●	●	●	●	●	?	?	?	?	●	●	●	?	●	●
TURBIDITY	V•	●	?	∧	?	?	?	●	?	?	?	?	?	?	●	●	●	●	?	?	?	V	●	?	?	●	●	?	?	?	?	●	●	●	●	●	●
NUISANCE ALGAE — *event duration*	●	●	?	?	?	?	?	?	?	●	●	?	?	?	●	●	●	●	?	?	?	●	●	●	●	●	●	●	●	?	?	●	●	●	?	?	●
frequency of occurrence	●	●	?	?	?	?	?	?	?	●	●	?	?	●	●	●	●	●	?	?	?	●	●	●	●	●	●	●	●	?	?	●	●	●	?	?	●
TOXIC ALGAE — *event duration*	●	●	?	●	?	●	?	●	?	●	●	?	?	?	●	●	●	●	?	?	?	●	●	●	●	●	●	●	●	?	?	●	●	●	?	?	●
frequency of occurrence	●	●	?	●	?	?	?	●	?	●	●	?	?	●	●	●	●	●	?	?	?	●	●	●	●	●	●	●	●	?	?	●	●	●	?	?	●
MACROALGAL	∧		?	∧	?	?	?	●	?	?	?	●	●	?	●	●	●	●	?	?	?	●	∧•	?	?	∧•	∧•	●	●	?	?	?	?	∧	?	∧•	∧
EPIPHYTE ABUNDANCE	?	●	?	?	?	?	?	?	?	?	?	●	●	●	●	●	●	●	?	?	?	●	●	?	?	●•	●•	●	●	?	?	?	?	●	?	?	●
NITROGEN (mg/l)	●	●	?	●	?	?	●	●	?	V•	●	?	●	●	●	●	●	●	?	?	?	●	●	●	●	●	●	?	?	?	?	●	●	●	?	●	∧•
PHOSPHORUS (mg/l)	●	●	?	?	?	?	●	●	●	●	●	?	●	●	●	●	●	●	?	?	?	●	●	●	●	V	●	?	?	?	?	●	●	●	?	●	●
BOTTOM DO (mg/l)	∧	●	?		?	?	●	●	∧	∧	●	●	●	●	●	∧•	?	●	?	?	?	∧	∧	∧	●	●	●	?	?	?	?	●	●	●	?	●	V•
ANOXIA — *event duration*	?	●	?	?	?	?	●	●	V	V	●	●•	?	●	●	?	?	●	?	?	?	?	V	?	?	●	●	?	?	?	?	●	●	●	?	?	●
frequency of occurrence	?	●	?	?	?	?	●	●	V	V	●	●•	?	●	●	?	?	?	?	?	?	?	V	?	?	●	●	?	?	?	?	●	●	●	?	●	●
spatial coverage	?	●	?	?	?	?	●	●	V	V	●	●•	?	●	●	?	?	●	?	?	?	?	V	?	?	●	●	?	?	?	?	●	●	●	?	●	●
HYPOXIA — *event duration*	?	●	?	?	?	?	●	●	V	V	●	●•	?	●	●	?	?	●	?	?	?	V	V	?	?	●	●	?	?	?	?	●	●	●	?	?	●
frequency of occurrence	?	●	?	?	?	?	●	●	V	V	●	●•	?	●	●	?	?	?	?	?	?	V	V	?	?	●	●	?	?	?	?	●	●	●	?	●	●
spatial coverage	?	●	?	?	?	?	●	●	V	V	●	●•	?	●	●	?	?	●	?	?	?	V	V	?	?	●	●	?	?	?	?	●	●	●	?	●	●
BIOLOGICAL STRESS — *event duration*	?	●	?	?	?	?	●	●	V	V	●	●•	?	●	●	?	?	●	?	?	?	V	V	?	?	●	●	?	?	?	?	●	●	●	?	?	●
frequency of occurrence	?	●	?	?	?	?	●	●	V	V	●	●•	?	●	●	?	?	?	?	?	?	?	V	?	?	●	●	?	?	?	?	●	●	●	?	●	●
spatial coverage	?	●	?	?	?	?	●	●	V	V	?	●•	?	●	●	?	?	●	?	?	?	V	V	?	?	●	●	?	?	?	?	●	●	●	?	●	●
PRIMARY PRODUCTIVITY	●•	●•	?	?	?	?	●	●	?	?	?	?	?	●•	●•	?	●	●	●•	●•		?	?	?	?	●	●	?	?	?	?	●	●	●	?	●	●
PLANKTONIC COMMUNITY	?	●	?		?	?	?	●	?	?	?	?	?	●	●	?	●	●	●•	●•		?	●	?	?	?	●	?	?	?	?	●	●	●	?	●	●
BENTHIC COMMUNITY	?	●	?		?	?	?	●	?	●	●	?	?	●	●	●	●	●	●•	●•		●	●	?	?	●	●	?	?	?	?	●	●	①	●	②	●
SAV (spatial coverage)	●	∧	?	?	?	?	●	●	?	?	?	?	?	●	●•	?	?	?	●•	●•		●	V	?	?	∧	∧	●	●	?	V	●	●	V	●	V	V

? - unknown V - decreasing trend • - speculative response ● - no trend or shift ∧ - increasing trend ① - shift from annelids to diverse ② - shift from a mixture of annelids and and crustaceans to crustaceans to crustaceans

Source: USDC 1997d

Table 18 (continued). Recent trends in selected parameters characterizing eutropication, by estuary.

	Buzzards Bay	Narragansett Bay	Gardiners Bay	Long Island Sound	Connecticut River	Great South Bay	Hudson R./Raritan Bay	Barnegat Bay	N. J. Inland Bays	Delaware Bay	DE Inland Bays	MD Inland Bays	Chincoteague Bay	Chesapeake Bay	Patuxent River	Potomac River	Rappahannock River	York River	James River	Chester River	Choptank River	Tan.Poc. Sounds
	M S	T M S	M S	T M S	T M	M S	T M S	M S	M S	T M S	M S	M S	S	T M S	T M	T M	T M	T M	T M	T M	T M	T M
CHLOROPHYLL *A* (pg/1)	? Λ•	● ● ●	● ●	● ● ●	? ?	● ●	? ● ●•	● ●	Λ• Λ•	● ● ●	● ●	V• ●	?	● ● ●	Λ ●	● V	Λ Λ	Λ Λ	Λ Λ	● ●	● ●	Λ Λ
TURBIDITY (concentration)	? ?	● ● ●	● ●	●• V V	? ?	● ●	? ? ?	? ?	? ?	● ● ●	● ●	● ?	●	● ● ●	● ●	● V	● ●	● ●	● ●	● ●	● V	● V
NUISANCE ALGAE — *event duration*	? ?	Λ Λ Λ	● ?	? Λ Λ	? ?	? ?	? ●• ●•	● ●	● Λ•	● ● ●	● ●	● ●	?	● ● ●	● ?	V ●	● ●	● ●	● ●	? ?	● ●	? ●
frequency of occurrence	? ?	Λ Λ Λ	● ?	? Λ Λ	? ?	? ?	? ●• ●•	● ●	● Λ•	● ● ●	● ●	● ●	?	● ● ●	● ●	V V	● ●	● ●	● ●	? ?	● ●	? ●
TOXIC ALGAE — *event duration*	? ?	? ? ?	? ?	● ● ●	? ?	● ●	? ●• ●•	● ●	● ●	● ● ●	? ?	? ?	?	● ● ●	? ?	● ●	● ●	● ●	● ●	? ?	● ●	? ●
frequency of occurrence	? ?	? ? ?	? ?	● ● ●	? ?	● ●	? ? ?	● ●	● ●	● ● ●	? ?	? ?	?	● ● ●	? ?	● ●	● ●	● ●	● ●	? ?	● ●	? ●
MACROALGAL ABUNDANCE	? ?	Λ Λ ?	Λ V	? Λ ●	? ?	● ●	? ? ?	? ?	? ?	● ● ●	? ?	? ?	?	● ● ●	● ●	V ●	● ●	● ●	● ●	? ?	● ●	? Λ
EPIPHYTE ABUNDANCE	? ?	? ? ?	? ?	? Λ ●	? ?	● ●	? ? ?	? ?	? ?	● ● ●	● ●	? ?	?	● ? ●	? ?	? ?	● ●	● ●	● ●	? ?	● V	? Λ
NITROGEN (mg/1)	? Λ•	● ● ●	● V	● Λ• ●	● ?	● ●	V ● ●	? ?	? ?	V V V	● ●	V• ?	V•	● Λ• ●	V V	● ●	● ●	● ●	● ●	● ●	● ●	? V
PHOSPHORUS (mg/1)	? ?	● ● ●	● V	● Λ ●	● ?	● ●	● V V	? ?	? ?	Λ Λ Λ	● ●	V ●	V•	● V• ●	V V	V ●	Λ ●	Λ ●	● ●	● ●	● V	? V
BOTTOM DO (mg/1)	? ?	Λ Λ ●	● ●	Λ Λ V	? ?	● ●	? Λ V	? ?	? ?	Λ Λ ●	● ●	● ●	●	● ● ●	Λ ●	Λ ●	● V	● ●	● V	● ●	● ●	● ●
ANOXIA — *event duration*	? ?	V V ●	● ●	● ● Λ	? ?	● ●	? V ●	? ?	? ?	V V ●	? ?	● ?	?	● ● ●	● ●	● ●	? ?	● ●	● ?	● ●	● ●	● ●
frequency of occurrence	? ?	V• V• ?	? ?	? ? Λ	? ?	? ?	? V ?	? ?	? ?	? ? ?	? ?	? ?	?	● ● ?	● ●	● ●	? ?	? ?	? ?	● ●	● Λ	● ●
spatial coverage	? ?	V V ●	● ●	● ● Λ	? ?	● ●	? V ●	? ?	? ?	● V ●	? ?	● ●	?	● Λ ●	● ●	? ●	? ?	● ●	● ?	● ●	● ●	● ●
HYPOXIA — *event duration*	? ?	V V ●	● ●	● ● Λ	V ?	● ●	? V Λ	? ?	? ?	V V ●	● ●	● ?	?	● ● ●	● ●	● ●	? ?	● ●	● ?	● ●	● ●	● ●
frequency of occurrence	? ?	V• V• V•	? ?	? ? Λ	? ?	? ?	? V ?	? ?	? ?	? ? ?	? ?	? ?	?	● ● ?	● ●	● ●	? ?	? ?	? ?	● ●	● Λ	● ●
spatial coverage	? ?	V V ●	● ●	● ● Λ	V ?	● ●	? V ●	? ?	? ?	● V ●	● ●	● ●	?	● Λ ●	● ●	Λ ●	? ?	● ●	● ?	● ●	● ●	● ●
BIOLOGICAL STRESS — *event duration*	? ?	V V ●	● ●	● ● Λ	? ?	● ●	? V ●	? ?	? ?	V V ●	● ●	● ●	?	● ● ●	V ●	● ●	● ?	● ●	● ?	● ●	● ●	● ●
frequency of occurrence	? ?	V• V• V•	? ?	? ? Λ	? ?	? ?	? ? ?	? ?	? ?	? ? ?	? ?	? ?	?	● ● ?	? ●	● V	? ?	? ?	? ?	● ●	● Λ	● ●
spatial coverage	? ?	V V ●	● ●	● ● Λ	? ?	● ●	? V ●	? ?	? ?	V V ●	● ●	● ●	?	● Λ ●	V ●	V ●	● ?	● ●	● ?	● ●	● ●	● ●
PRIMARY PRODUCTIVITY	? ③	? ? ?	● ●	? ●• ●	? ?	● ●	? ③ ③	? ?	? ●•	● ● ●	● ●	? ?	?	● ● ?	? ?	? ?	? ?	? ?	? ?	? ?	? ?	? ?
PLANKTONIC COMMUNITY	? ?	④ ● ④	● ●	? ● ●	? ?	● ●	? ● ●	●• ●•	? ●•	● ③④	① ●	● ●	?	● ● ●	● ●	● ●	● ●	● ●	● ●	? ●	● ●	? ?
BENTHIC COMMUNITY	? ?	① ● ●	? ?	● ● ●	? ?	● ●	③ ● ①	●• ●•	? ?	? ? ②	● ●	● ●	?	● ● ●	● ●	● ●	● ●	● ●	● ●	● ●	● ●	? ?
SAV (spatial coverage)	V V	● ● ●	Λ Λ	V V V	? ?	V V	? V V	? ?	? ?	● ● ●	● ●	● ?	Λ	● Λ Λ	Λ ●	Λ Λ	● Λ	● ●	● Λ	● Λ	● Λ	? Λ

? - unknown   V - decreasing trend   • - speculative response   Λ - increasing trend   ① - shift to diverse mixture   ② - shift to annelids and crustaceans   ③ - shift to pelagic   ④ - shift to diatoms   ⑤ - shift to mollusks

Source: USDC 1997e

Table 18 (continued). Recent trends in selected parameters characterizing eutropication, by estuary.

Parameter		Albemarle/Pamlico Sounds T	Albemarle/Pamlico Sounds M	Albemarle/Pamlico Sounds S	Pamlico River M	Neuse River T	Neuse River M	Bogue Sound M	Bogue Sound S	New River M	New River S	Cape Fear River T	Cape Fear River M	Cape Fear River S	Winyah Bay T	Winyah Bay M	Winyah Bay S
CHLOROPHYLL *A* (pg/1)		?	?	●*	Λ	●	Λ	?	●	?	?	?	?	●	?	?	●
TURBIDITY (concentrations)		V	?	?	?	●	?	?	●	?	?	Λ	?	?	Λ	Λ	●
NUISANCE ALGAE	*event duration*	?	●	?	?	V	Λ	●	●	?	?	?	?	?	●*	●*	●*
	frequency of occurrence	?	●	?	?	V	Λ	●	●	?	?	?	?	?	●*	●*	●*
TOXIC ALGAE	*event duration*	?	●	?	?	V	Λ	●	?	?	?	?	?	?	●*	●*	●*
	frequency of occurrence	?	●	?	?	V	Λ	●	●	?	?	?	?	?	●*	●*	●*
MACROALGAL ABUNDANCE		V	?	?	?	?	●	?	●	?	?	●	●	●	?	?	?
EPIPHYTE ABUNDANCE		?	?	?	?	?	●	?	?	?	?	●	●	●	?	?	?
NITROGEN (mg/1)		?	●	?	●	Λ	Λ	●	●	?	?	?	?	?	V	V	V
PHOSPHORUS (mg/1)		?	●	?	V	●	●	●	●	?	?	?	?	?	V	V	V
BOTTOM DO (mg/1)		?	?	?	V	V	V	●*	●	?	?	?	?	?	?	?	?
ANOXIA	*event duration*	?	?	?	●	?	Λ	●	●	?	?	?	?	?	?	?	?
	frequency of occurrence	?	?	?	●	?	Λ	●	●	?	?	?	?	?	?	?	?
	spatial coverage	?	?	?	●	Λ	Λ	●	●	?	?	?	?	?	?	?	?
HYPOXIA	*event duration*	?	?	?	●	Λ	Λ	●	●	?	?	?	?	?	?	?	?
	frequency of occurrence	?	?	?	●	Λ	Λ	●	●	?	?	?	?	?	?	?	?
	spatial coverage	?	?	?	●	Λ	Λ	●	●	?	?	?	?	?	?	?	?
BIOLOGICAL STRESS	*event duration*	?	?	?	●	Λ	Λ	●	●	?	?	?	?	?	?	?	?
	frequency of occurrence	?	?	?	●	Λ	Λ	●	●	?	?	?	?	?	?	?	?
	spatial coverage	?	?	?	●	Λ	Λ	●	●	?	?	?	?	?	?	?	?
PRIMARY PRODUCTIVITY		●	?	?	●	●*	●	?	?	?	?	?	?	?	?	?	●
PLANKTONIC COMMUNITY		●	?	?	●	①	●	●	●	?	?	?	?	?	?	?	●
BENTHIC COMMUNITY		?	?	?	?	?	?	?	●*	?	?	?	?	?	?	?	●
SAV (spatial coverage)		V	V	?	V	●	V	?	?	?	?	?	?	?	?	?	●
WETLANDS (spatial coverage)		●	●	?	●	●	●	●	●	?	?	?	?	?	?	●	●

Parameter		N & S Santee River T	N & S Santee River M	Charleston Harbor T	Charleston Harbor M	Charleston Harbor S	Stono/N. Edisto River M	Stono/N. Edisto River S	St. Helena Sound M	St. Helena Sound S	Broad River M	Broad River S	Savannah River T	Savannah River M	Savannah River S	Ossabaw Sound T	Ossabaw Sound M	Ossabaw Sound S
CHLOROPHYLL *A* (pg/1)		?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	●*	?
TURBIDITY (concentrations)		V	V	?	Λ	Λ	Λ	Λ	●	?	Λ	●	Λ	●	?	?	?	?
NUISANCE ALGAE	*event duration*	●*	●*	?	●	●*	?	?	?	?	?	?	?	●	●	?	●	●
	frequency of occurrence	●*	●*	?	●	●*	?	?	?	?	?	?	?	●	●	?	●	●
TOXIC ALGAE	*event duration*	●*	●*	?	●	●*	?	?	?	?	?	?	?	●	●	?	●	●
	frequency of occurrence	●*	●*	?	●	●*	?	?	?	?	?	?	?	●	●	?	●	●
MACROALGAL ABUNDANCE		●*	●*	Λ	?	?	●	●	?	?	?	?	?	●	●	?	?	?
EPIPHYTE ABUNDANCE		●*	●*	?	?	?	●	●	?	?	?	?	?	●	●	?	?	?
NITROGEN (mg/1)		V	V	V	V	V	V	?	V	?	●	?	●	●	●	●	●	?
PHOSPHORUS (mg/1)		V	V	V	V	V	V	V	●	?	●	●	●	●	●	●	●	?
BOTTOM DO (mg/1)		?	?	?	?	?	?	?	?	?	?	?	?	Λ	?	?	?	?
ANOXIA	*event duration*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	frequency of occurrence	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	spatial coverage	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
HYPOXIA	*event duration*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	frequency of occurrence	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	spatial coverage	?	?	?	?	?	?	?	?	?	?	?	?	Λ	?	?	?	?
BIOLOGICAL STRESS	*event duration*	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	frequency of occurrence	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	spatial coverage	?	?	?	?	?	?	?	?	?	?	?	?	Λ	?	?	?	?
PRIMARY PRODUCTIVITY		?	?	?	?	?	?	?	●	?	?	?	?	?	?	?	?	?
PLANKTONIC COMMUNITY		?	?	●	?	?	?	?	?	?	?	?	?	?	?	?	?	?
BENTHIC COMMUNITY		?	?	?	●	●	●	●	?	?	?	?	?	●	?	?	?	?
SAV (spatial coverage)		?	?	?	Λ	?	●	●	?	?	?	?	?	●	●	?	?	?
WETLANDS (spatial coverage)		●	●	?	●	●	●	●	●	●	●	●	?	V*	V*	?	?	?

Parameter		St. Catherine/Sapelo Sound M	St. Catherine/Sapelo Sound S	Altamaha River T	Altamaha River M	Altamaha River S	St. Andrews/ St. Simon Sound T	St. Andrews/ St. Simon Sound M	St. Andrews/ St. Simon Sound S	St. Marys/Cumberland Sound M	St. Marys/Cumberland Sound S	St. Johns River T	St. Johns River M	St. Johns River S	Indian River S	Biscayne Bay M	Biscayne Bay S
CHLOROPHYLL *A* (pg/1)		?	?	?	?	?	?	?	?	?	?	●	●	●	Λ*	●	●
TURBIDITY (concentrations)		?	?	?	●	?	?	?	?	?	?	●	●	●	●	●	V
NUISANCE ALGAE	*event duration*	●	●	?	●	?	?	●	●	●	●	●	●	●	●	●*	●*
	frequency of occurrence	●	●	?	●	●	?	●	●	●	●	●	●	●	●	●*	●*
TOXIC ALGAE	*event duration*	●	●	?	●	●	?	●	●	●	●	●	●	●	●	●*	●*
	frequency of occurrence	●	●	?	●	●	?	●	●	●	●	●	●	●	●	●*	●*
MACROALGAL ABUNDANCE		●	●	?	●	●	●	●	●	●	●	●	●	●	●	●	●
EPIPHYTE ABUNDANCE		●	●	?	●	●	●	●	●	●	●	●	●	●	?	●	●
NITROGEN (mg/1)		Λ*	?	V	V	?	Λ*	Λ*	?	●	?	●	●	●	●*	V	Λ
PHOSPHORUS (mg/1)		Λ*	?	●	●	?	Λ*	Λ*	?	●	?	●	●	●	●*	●	V
BOTTOM DO (mg/1)		?	?	?	?	?	?	?	?	?	?	●	●	●	●	V	V
ANOXIA	*event duration*	?	?	?	?	?	?	?	?	?	?	●	●	●	●	●	●
	frequency of occurrence	?	?	?	?	?	?	?	?	?	?	●	●	●	●	●	●
	spatial coverage	?	?	?	?	?	?	?	?	?	?	●	●	●	●	●	●
HYPOXIA	*event duration*	?	?	?	?	?	?	?	?	?	?	●	●	●	●	●	●
	frequency of occurrence	?	?	?	?	?	?	?	?	?	?	●	●	●	●	●	●
	spatial coverage	?	?	?	?	?	?	?	?	?	?	●	●	●	●	●	●
BIOLOGICAL STRESS	*event duration*	●*	?	●*	●*	?	●*	●*	?	●*	?	●	●	●	●	●	●
	frequency of occurrence	●*	?	●	●	?	●*	●*	?	●*	?	●	●	●	●	●	●
	spatial coverage	●*	?	●*	●*	?	●*	●*	?	●*	?	●	●	●	●	●	●
PRIMARY PRODUCTIVITY		?	?	?	?	?	?	?	?	?	?	?	?	?	●*	?	●
PLANKTONIC COMMUNITY		?	?	?	?	?	?	?	?	?	?	●	●	●	?	?	●
BENTHIC COMMUNITY		?	?	?	?	?	?	?	?	?	?	●	●	●	②	?	●
SAV (spatial coverage)		●	●	?	●	●	?	●	●	●	●	V	V	●	V*	●	Λ
WETLANDS (spatial coverage)		?	?	?	?	?	?	?	?	?	?	?	?	?	V*	V	V

? - unknown V - decreasing trend * - speculative response ● - no trend or shift Λ - increasing trend ① - shift from annelids to diverse mixture ② - shift from a mixture of annelids and crustaceans to crustaceans

Source: USDC 1997f

Table 19. **Landings of spiny dogfish (pounds) in the Northwest Atlantic Ocean based on NMFS weighout data, NMFS South Atlantic General Canvas Data and SAW-26.**

YEAR	CANADA	US COMM	US REC	US TOTAL	USSR	OTHER	TOTAL (Stock)
1962	0	518,081	0	518,081	0	0	518,081
1963	0	1,344,806	0	1,644,806	0	2,205	1,347,011
1964	0	1,609,358	0	1,609,358	0	35,274	1,644,632
1965	19,841	1,075,845	0	1,075,845	41,465	22,046	1,532,197
1966	85,979	1,274,259	0	1,274,259	20,698,989	0	22,059,228
1967	0	612,879	0	612,879	5,370,406	0	5,983,284
1968	0	38,327	0	348,327	9,709,058	0	10,057,385
1969	0	249,120	0	249,120	19,460,004	800,270	20,509,394
1970	41,887	233,688	0	233,688	10,855,450	1,578,494	12,709,519
1971	8,818	160,936	0	160,936	23,814,089	1,684,314	25,668,158
1972	6,614	152,117	0	152,117	51,371,589	1,518,969	53,049,290
1973	44,092	196,209	0	196,209	31,347,207	10,083,840	41,671,349
1974	79,366	279,984	0	279,984	45,070,842	8,970,517	54,400,710
1975	2,205	324,076	0	324,076	49,230,923	423,283	49,980,487
1976	6,614	1,212,530	0	1,212,530	36,774,933	235,892	38,229,969
1977	2,205	2,052,483	0	2,052,483	15,304,333	566,582	17,925,603
1978	185,186	1,825,409	0	1,825,409	1,272,054	99,207	3,381,856
1979	2,934,323	10,597,512	0	10,597,512	231,483	180,777	13,944,095
1980	1,477,082	9,027,837	0	9,027,837	773,815	546,741	11,825,474
1981	1,243,394	15,282,287	3,284,837	18,567,124	1,137,574	1,009,707	21,957,799
1982	2,100,984	11,929,091	154,946	12,084,037	59,524	742,950	14,987,495
1983	0	10,795,926	147,565	10,943,491	791,451	231,483	11,966,426
1984	8,818	9,810,470	200,888	10,011,358	641,539	220,460	1,082,175
1985	28,660	8,880,129	196,174	9,076,303	1,529,992	701,063	11,336,018
1986	46,297	6,058,241	403,073	6,461,314	471,784	339,508	7,318,903
1987	617,288	5,959,034	673,514	6,632,548	255,734	50,706	7,556,275
1988	0	6,845,283	792,385	7,637,668	1,265,440	160,936	9,064,044
1989	365,964	9,903,063	921,481	10,824,544	372,577	191,800	11,754,885
1990	2,901,254	32,475,963	392,750	32,868,713	844,362	22,046	36,636,374
1991	643,743	29,050,014	287,892	29,337,906	480,603	35,274	30,497,526
1992	1,827,613	37,165,147	534,798	37,699,945	57,320	90,389	39,675,266
1993	3,156,987	45,509,558	263,373	45,772,931	0	0	48,929,918
1994	4,010,167	41,446,480	340,692	41,787,172	0	0	45,797,339
1995	2,107,598	50,068,671	141,818	50,210,489	0	0	52,318,086
1996	950,183	60,055,509	79,244	60,134,753	0	0	61,084,935
1997	na	45,188,361	145,976	45,334,337	0	0	45,334,337

Table 20. Commercial landings of Spiny Dogfish by year and state.

	YEAR									
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	1000 LBS	1000 LBS	1000 LBS	1000 LBS	1000 LBS	1000 LBS	1000 LBS	1000 LBS	1000 LBS	1000 LBS
STATE										
ME	481	4,879	6,365	2,016	1,719	3,524	1,813	1,663	911	448
NH	.	.	185	.	402	1,641	2,375	2,106	1,079	1,009
MA	5,827	4,924	17,806	14,488	18,375	26,830	23,214	28,760	26,959	21,820
RI	.	4	1,300	3,160	2,027	1,924	530	573	1,128	1,013
CT	.	.	24	8	22	9	170	293	705	347
NY	86	48	18	77	155	95	237	934	1,327	487
NJ	10	22	4,543	2,715	2,534	770	1,129	2,388	4,635	3,950
DE	.	.	.	5	.	.	.	62	.	.
MD	23	3	2,181	4,939	3,063	1,795	1,428	3,117	7,151	4,227
VA	3	19	6	173	229	106	457	809	2,483	4,274
NC	301	.	41	1,463	8,634	8,806	9,877	7,174	13,210	7,608

Source: Unpublished NMFS Weighout Data.

Table 21. Commercial landings Spiny Dogfish average annual landings by state, 1988 - 1997.

State	1000 lbs	Percent
ME	2,382	6
NH	879	2
MA	18,900	53
RI	1,166	3
CT	158	-
NY	346	-
NJ	2,270	6
DE	6	-
MD	2,793	7
VA	856	2
NC	5,711	16
ALL STATES	35,473	100

Source: Unpublished NMFS Weighout Data.

Table 22. Spiny Dogfish commercial landings by gear, Maine to Florida, 1988 - 1997 combined.

Gear	1000 Pounds	Percent
Haul Seines, Beach	67	-
Haul Seines, Long	6	-
Danish Seine	-	-
Purse Seines, Menhaden	-	-
Otter Trawl Bottom, Crab	-	-
Otter Trawl Bottom, Fish	76,367	21
Otter Trawl Bottom, Scallop	8	-
Otter Trawl Bottom, Shrimp	7	-
Otter Trawl Bottom, Other	73	-
Trawl Midwater, Paired	444	-
Trawl Bottom, Paired	-	-
Scottish Seine	68	-
Pound Nets, Fish	65	-
Pound Nets, Other	4	-
Floating Traps (Shallow)	7	-
Fyke and Hoop Nets, Fish	-	-
Pots and Traps, Crab, Blue	-	-
Pots and Traps, Fish	1	-
Pots and Traps, Lobster Inshore	40	-
Pots and Traps, Lobster, Offshore	-	-
Gill Nets, Set, Salmon	-	-
Gill Nets, Sea Bass	9	-
Gill Nets, Other	55,585	15
Gill Nets, Sink, Other	202,945	57
Gill Net, Shad	-	-
Gill Nets, Drift, Other	6,528	1
Gill Nets, Drift, Runaround	47	-
Gill Nets, Stake	-	-
Trammel Nets	4	-
Lines Hand, Other	166	-
Lines Troll, Other	-	-
Lines Long Set with Hooks	10,690	3
Unk. Combined Gears	1,572	-
Dredge, Surf Clam	1	-
Dredges Scallop, Sea	4	-
Dredge, Urchin	1	-
ALL GEAR	354,731	100

Source: Unpublished NMFS Weighout Data.

Table 23. Spiny Dogfish commercial landings by year and gear type, Maine to Florida.

Gear	1988 % of Total	1989 % of Total	1990 % of Total	1991 % of Total	1992 % of Total	1993 % of Total	1994 % of Total	1995 % of Total	1996 % of Total	1997 % of Total
Haul Seines, Beach	.	0.0	0.0	0.0	0.0	.	0.1	0.0	0.0	0.0
Haul Seines, Long	.	.	.	0.0	.	.	0.0	.	0.0	.
Danish Seine	.	.	.	.	.	.	.	0.0	.	.
Purse Seines, Menhaden	.	.	.	.	.	.	.	0.0	.	.
Otter Trawl Bottom, Crab	.	.	.	.	.	.	.	0.0	.	.
Otter Trawl Bottom, Fish	50.6	10.8	47.6	39.5	28.4	24.7	15.6	12.1	11.8	8.7
Otter Trawl Bottom, Scallop	.	.	.	.	.	0.0	0.0	0.0	.	.
Otter Trawl Bottom, Shrimp	0.0	0.0	.	0.0	0.0	.	0.0	0.0	0.0	.
Otter Trawl Bottom, Other	.	.	.	.	.	.	.	0.0	0.1	.
Trawl Midwater, Paired	.	.	.	.	1.2	.	.	.	.	.
Trawl Bottom, Paired	.	.	.	0.0	0.0	.	.	.	.	.
Scottish Seine	.	.	.	.	.	0.0	0.0	0.0	0.0	0.1
Pound Nets, Fish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pound Nets, Other	.	.	.	.	.	0.0	.	0.0	.	.
Floating Traps (Shallow)	.	.	0.0	.	0.0	0.0	0.0	0.0	0.0	0.0
Fyke and Hoop Nets, Fish	.	.	.	.	.	.	.	.	0.0	.
Pots and Traps, Crab, Blue	.	.	.	.	.	.	0.0	0.0	.	.
Pots and Traps, Fish	.	0.0	0.0	0.0	.	.	0.0	.	0.0	0.0
Pots and Traps, Lobster Inshore	.	.	.	0.1	.	0.0	.	0.0	.	.
Pots and Traps, Lobster, Offshore	.	.	.	.	.	.	0.0	0.0	0.0	.
Gill Nets, Set, Salmon	.	.	.	.	.	.	.	0.0	.	.
Gill Nets, Sea Bass	.	.	.	.	.	.	0.0	.	.	.
Gill Nets, Other	0.0	0.0	0.1	4.4	22.8	18.8	23.4	14.9	21.7	16.7
Gill Nets, Sink, Other	48.7	85.5	52.1	54.8	46.3	55.1	57.0	62.9	56.3	64.0
Gill Net, Shad	.	.	.	.	.	.	.	.	0.0	.
Gill Nets, Drift, Other	0.2	0.2	0.1	0.8	1.0	0.0	0.1	1.6	4.7	5.0
Gill Nets, Drift, Runaround	0.2	0.3	0.0	0.0	.	0.0	.	.	.	.
Gill Nets, Stake	.	.	.	.	.	.	.	.	0.0	0.0
Trammel Nets	.	.	.	.	.	0.0	.	.	.	.
Lines Hand, Other	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1
Lines Troll, Other	.	.	.	.	.	.	0.0	0.0	0.0	0.0
Lines Long Set with Hooks	0.2	3.1	0.1	0.2	0.1	1.2	2.6	6.9	4.9	5.3
Unk. Combined Gears	.	.	.	.	0.1	0.0	1.3	1.5	0.3	0.1
Dredge, Surf Clam	.	.	.	.	.	.	.	.	0.0	0.0
Dredges Scallop, Sea	.	.	.	.	0.0	.	.	.	0.0	.
Dredge, Urchin	.	.	.	.	.	0.0	.	.	.	.
ALL GEAR	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Unpublished NMFS Weighout Data.

Table 24. Spiny Dogfish commercial landings by state and gear type, 1988 - 1997 combined.

Gear	ME % of Total	NH % of Total	MA % of Total	RI % of Total	CT % of Total	NY % of Total	NJ % of Total	DE % of Total	MD % of Total	VA % of Total	NC % of Total
Haul Seines, Beach	.	.	.	.	.	0.0	.	.	.	0.1	.
Haul Seines, Long	.	.	.	.	.	.	.	.	.	.	0.1
Danish Seine	.	.	0.0	.	.	.	.	.	.	.	0.0
Purse Seines, Menhaden	.	.	.	.	.	.	0.0	.	.	.	.
Otter Trawl Bottom, Crab	.	.	.	.	.	.	.	.	.	.	.
Otter Trawl Bottom, Fish	1.5	5.9	22.6	18.3	61.9	84.2	56.3	.	38.0	24.6	0.0
Otter Trawl Bottom, Scallop	.	.	.	.	.	.	0.0	.	.	0.0	2.3
Otter Trawl Bottom, Shrimp	0.0	.	0.0	.	.	.	.	.	.	.	.
Otter Trawl Bottom, Other	.	.	.	.	.	.	.	.	0.3	.	0.0
Trawl Midwater, Paired	.	.	0.2	.	.	.	.	.	.	.	.
Trawl Bottom, Paired	.	.	.	0.0	.	0.0	.	.	.	.	.
Scottish Seine	.	.	0.0	.	.	.	.	.	.	.	.
Pound Nets, Fish	.	.	.	.	0.1	1.6	0.0	.	.	0.0	.
Pound Nets, Other	.	.	.	.	.	0.1	.	.	.	.	.0
Floating Traps (Shallow)	.	.	.	0.1	.	.	.	.	.	.	.
Fyke and Hoop Nets, Fish	.	.	.	.	.	0.0	.	.	.	.	.
Pots and Traps, Crab, Blue	.	.	.	.	.	.	.	.	.	.	.
Pots and Traps, Fish	.	.	0.0	.	.	0.0	0.0	.	0.0	.	0.0
Pots and Traps, Lobster Inshore	.	0.0	0.0	0.0	.	.	0.2	.	.	.	0.0
Pots and Traps, Lobster, Offshore	.	0.0	.	.	0.0	.	0.0	.	.	.	.
Gill Nets, Set, Salmon	.	.	.	.	.	0.0	.	.	.	.	.
Gill Nets, Sea Bass	.	.	0.0	.	.	.	.	.	.	.	.
Gill Nets, Other	.	.	.	.	0.1	.	.	22.6	.	.	.
Gill Nets, Sink, Other	96.6	93.5	71.7	81.2	5.1	9.7	17.7	.	59.5	67.1	97.3
Gill Net, Shad	.	.	.	.	.	.	.	.	0.0	.	.
Gill Nets, Drift, Other	.	.	0.0	.	.	0.3	24.6	77.4	1.9	4.0	.
Gill Nets, Drift, Runaround	.	.	0.0	.	.	.	0.1	.	.	.	.
Gill Nets, Stake	.	.	.	.	0.0	.	.	.	.	.	.
Trammel Nets	.	.	.	.	.	.	0.0	.	.	.	.
Lines Hand, Other	0.1	0.2	0.1	0.0	.	0.3	0.0	.	0.0	0.1	0.0
Lines Troll, Other	.	.	.	.	.	.	.	.	.	.	0.0
Lines Long Set with Hooks	1.9	0.4	5.2	0.0	2.9	3.7	0.6	.	0.2	.	0.1
Unk. Combined Gears	.	.	0.3	0.4	29.9	.	0.4	.	.	4.2	0.2
Dredge, Surf Clam	.	.	.	.	.	.	0.0	.	.	.	.
Dredges Scallop, Sea	.	.	0.0	0.0	.	.	0.0	.	.	.	.
Dredge, Urchin	.	.	0.0	.	.	.	.	.	.	.	.
ALL GEAR	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Unpublished NMFS Weighout Data.

Table 25. Commercial landings of Spiny Dogfish by state and month, 1988 - 1997 combined.

	MONTH												
	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ALL
STATE	1000 LBS	1000 LBS	1000 LBS	1000 LBS	1000 LBS	1000 LBS	1000 LBS	1000 LBS	1000 LBS	1000 LBS	1000 LBS	1000 LBS	1000 LBS
ME	.	2	1	34	83	542	731	568	307	99	10	.	2,382
NH	.	.	.	5	15	199	303	241	68	39	6	.	879
MA	99	24	27	338	1,268	2,667	4,443	3,738	2,733	2,100	916	359	18,718
RI	241	22	28	78	62	104	41	21	9	142	191	221	1,166
CT	9	5	8	15	7	15	9	3	8	22	23	5	134
NY	23	17	16	23	16	27	15	11	12	56	60	61	342
NJ	240	183	186	168	54	15	5	6	12	172	686	538	2,270
DE	.	.	.	.	.	.	.	.	.	.	.	.	.
MD	722	439	580	325	4	8	.	.	.	.	229	481	2,793
VA	224	105	139	53	11	1	.	.	.	1	59	240	836
NC	1,370	1,809	1,390	209	2	.	.	.	.	.	41	886	5,711
ALL	2,932	2,609	2,380	1,252	1,526	3,582	5,551	4,592	3,152	2,634	2,225	2,796	35,236

Source: Unpublished NMFS Weighout Data.

Table 26. Spiny dogfish recreational catch, landings and discards based on NMFS MRFSS data, 1981-1997.

Year	Catch (A + B1 + B2)	Landings (A + B1)	Discards (B2)
1981	715,683	597,243	118,440
1982	167,902	28,172	139,730
1983	242,803	26,830	215,973
1984	206,099	36,525	169,574
1985	421,412	35,668	385,745
1986	548,216	73,286	474,930
1987	544,844	122,457	422,387
1988	494,480	144,070	350,410
1989	707,273	167,542	539,731
1990	539,494	71,409	468,085
1991	592,227	52,344	539,883
1992	504,721	9,236	407,485
1993	491,963	47,886	444,077
1994	449,218	61,944	387,274
1995	276,922	25,785	251,137
1996	157,538	14,408	143,130
1997	363,459	26,541	336,918

Table 27. Spiny dogfish recreational catch (number) by sub-region, based on NMFS MRFSS data, 1981-1997.

	REGION		
Year	North Atlantic	Mid-Atlantic	South Atlantic
1981	77,564	638,119	-
1982	57,322	110,580	-
1983	58,732	184,071	-
1984	105,940	100,159	-
1985	239,651	169,657	12,104
1986	305,614	242,246	356
1987	304,740	238,866	1,238
1988	368,514	125,373	594
1989	261,193	299,969	146,110
1990	79,968	442,243	17,284
1991	121,137	448,591	22,499
1992	228,611	230,215	45,895
1993	246,488	244,493	982
1994	151,856	296,592	771
1995	143,611	131,659	1,652
1996	100,102	55,728	1,708
1997	137079	223,882	2,498

Table 28. Spiny dogfish recreational catch (number) by mode based on NMFS MRFSS data, 1981-1997.

Year	Man Made	Beach/Bank	Shore	Party/Charter	Private Rental
1981	11,955	14,506	-	115,318	573,907
1982	-	-	-	140,126	27,776
1983	1,825	6,667	-	171,929	62,382
1984	409	4,611	-	57,833	143,247
1985	13,408	3,451	-	387,255	17,298
1986	-	-	5,615	245,549	297,052
1987	-	-	3,454	367,400	173,990
1988	-	-	1,539	232,669	260,272
1989	709	138,533	9,465	162,761	395,805
1990	3,058	13,856	11,254	358,819	152,507
1991	1,139	15,070	62,715	139,937	373,366
1992	2,459	21,291	11,268	216,659	252,839
1993	511	264	21,826	210,052	259,273
1994	343	428	21,003	124,467	302,977
1995	-	1,539	5,658	144,036	125,576
1996	289	909	9,940	63,429	82,971
1997	-	-	5,317	174,672	183,471

Table 29. Spiny dogfish recreational catch (number) by area based on NMFS MRFSS data, 1981-1997.

Year	Area: Ocean ≤ 3 mi.	Ocean > 3 mi.	Inland
1981	24,264	673,742	17,677
1982	62,427	96,457	9,018
1983	28,195	179,610	34,997
1984	7,896	187,768	10,435
1985	16,607	398,392	6,413
1986	112,669	336,658	98,889
1987	206,544	276,364	61,936
1988	67,130	386,593	40,757
1989	183,651	418,097	105,525
1990	63,044	403,039	73,411
1991	240,587	256,437	95,203
1992	126,871	290,597	87,253
1993	187,960	232,035	71,968
1994	109,850	240,145	99,223
1995	62,988	163,050	50,884
1996	46,961	71,104	39,472
1997	111,991	195,740	55,728

Table 30. Exvessel value of Spiny Dogfish commercial landings value by year, Maine - Florida.

Year	Nominal Value ($1000)	Nominal Price (Mean)	1997 Adjusted (Mean)
1988	483	0.07	0.06
1989	860	0.09	0.07
1990	3,313	0.10	0.09
1991	2,692	0.09	0.09
1992	3,943	0.11	0.10
1993	5,567	0.12	0.12
1994	5,588	0.14	0.13
1995	9,138	0.19	0.19
1996	10,921	0.18	0.18
1997	6,807	0.15	0.15

Source: Unpublished NMFS Weighout Data.

Table 31. Commercial landings of Spiny Dogfish value by year and state.

	YEAR									
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	VAL 1000 $	VAL 1000 $	VAL 1000 $	VAL 1000 $	VAL 1000 $	VAL 1000 $	VAL 1000 $	VAL 1000 $	VAL 1000 $	VAL 1000 $
STATE										
ME	59	430	745	188	203	509	264	338	169	67
NH	.	.	21	.	50	252	365	397	189	145
MA	359	405	1,597	1,145	2,186	3,541	3,394	5,413	4,934	3,119
RI	.	.	115	292	226	213	68	109	211	141
CT	.	.	2	.	1	1	10	19	133	47
NY	21	14	3	16	27	24	64	187	257	96
NJ	1	2	582	428	243	90	174	502	939	696
DE	.	.	.	4	.	.	.	12	.	.
MD	4	1	238	476	294	188	192	883	1,539	781
VA	1	6	2	17	19	9	40	125	400	725
NC	36	.	3	122	691	735	1,011	1,147	2,145	984

Source: Unpublished NMFS Weighout Data.

Table 32. Commercial Fishing Permits Held by Vessels Landing Spiny Dogfish in 1996.

Type of Permit	Number
Multispecies permit	562
Limited access multispecies permit	487
Summer flounder permit	295
Squid, mackerel, butterfish permits	527
Lobster permit	448
Scallop permits	40
Tuna permits	542

Table 33. Estimated total allowable landings (thousands of lbs.) of spiny dogfish under preferred alternative.

Year	TAL	%SSB
1999-2000	22,059.2	69.2
2000-2001	2,901.3	69.0
2001-2002	3,148.2	74.9
2002-2003	3,198.9	80.2
2003-2004	3,176.8	92.1
2004-2005	3,192.3	92.7
2005-2006	3,262.8	91.4
2006-2007	3,395.1	89.5
2007-2008	3,556.1	94.3
2008-2009	3,734.6	99.5
Total	51,625.2	

Table 34. Estimated total allowable landings of spiny dogfish in 1999 under preferred stock rebuilding alternative for semi-annual, quarterly, and bimonthly quota periods. Seasonal quota allocations based on seasonal distribution of spiny dogfish landings from NMFS weighout data, 1990-1997.

Period	1999 TAL (million lbs.)	1997 (million lbs.)	1990-1997 (million lbs.)
May-Oct.	12.8	22.8	194.3
Nov.-April	9.3	22.4	141.5

Period	1999 TAL (million lbs.)	1997 (million lbs.)	1990-1997 (million lbs.)
Quarter 1 (May - July)	6.5	13.7	98.6
Quarter 2 (Aug. - Oct.)	6.3	9.1	95.7
Quarter 3 (Nov. - Jan.)	5.2	11.5	79.4
Quarter 4 (Feb. - Apr.)	4.1	10.9	62.0

Period	1999 TAL (million lbs.)	1997 (million lbs.)	1990-1997 (million lbs.)
Jan. - Feb.	3.6	11.5	55.2
March - April	2.4	5.8	36.2
May - June	3.0	7.8	45.8
July - Aug.	6.3	10.2	95.5
Sept. - Oct.	3.5	4.8	52.9
Nov. - Dec.	3.3	5.1	50.1

Table 35. Percent of total for spiny dogfish and value, by port for 1997.

Port	Percent of Total $ from Dogfish	Percent of Total lbs. from Dogfish
Wachapreague, VA	76%	91%
Plymouth, MA	74%	96%
Scituate, MA	21%	74%
Chatham, MA	14%	47%
Ocean City, MD	11%	32%
Other Dare, NC	11%	30%
Marblehead, VA	10%	48%
Chincoteague, VA	6%	27%
Norfolk, VA	5%	22%
Long Beach, NJ	3%	26%
Camp Ellis, ME	3%	16%
Gloucester, MA	3%	8%
Rye, NH	3%	27%
Newport News, VA	3%	34%

Source: Unpublished NMFS Weighout Data.

Table 36a. Estimates of spiny dogfish discards and mortality (thousands of lbs.) based on 1989-1997 NMFS Sea sampling data.

Year	OT	GN	Total	OTD	GND	Total Dead
1989	12,619.1	4,900.8	17,520.0	6,309.6	3,675.1	9,984.6
1990	21,016.5	4,623.0	25,641.7	10,509.3	3,467.8	13,977.2
1991	18,452.5	3,970.5	22,423.0	9,226.3	2,978.4	12,202.5
1992	16,307.4	4,069.7	20,374.9	8,152.6	3,051.2	11,2056.0
1993	16,166.3	4,131.4	20,297.8	8,084.3	3,097.5	11,181.7
1994	12,367.8	3,582.5	15,950.3	6,183.9	2,687.4	8,871.3
1995	11,014.2	4,261.5	15,275.7	5,507.1	3,196.7	8,703.8
1996	14,995.7	4,506.2	19,499.7	7,497.8	3,379.7	10,877.5
1997	12,894.7	4,649.5	17,544.2	6,446.3	3,487.7	9,933.9

OTD - Otter Trawl Dead
GND - Gill Net Dead

Table 36b. Estimates of spiny dogfish discards for otter trawl by primary species landed.

Species	Number of Trips	Discard Rate	Dogfish Discards (Thousands of lbs) 1989	1990	1991	1992	1993	1994	1995	1996	1997
Goosefish	31	0.0579	140.8	60.1	279.5	311.4	337.4	309.3	468.7	589.5	594.2
Butterfish	12	0.1580	153.3	145.7	231.8	224.9	822.0	569.0	220.1	402.3	357.2
Cod	101	0.1631	1,429.5	2,673.3	1,630.7	788.4	633.6	486.3	209.4	395.4	290.9
Atlantic Croaker	8	0.0000	<1,000 lbs	0	0	0	<1,000 lbs	<1,000 lbs	<1,000 lbs	<1,000 lbs	<1,000 lbs
Blueback Herring	1	0.0151	0	0.2	0	9.2	0	0.2	<1,000 lbs	0	1.4
Winter Flounder	26	0.3248	510.3	539.4	618.9	484.4	282.3	308.8	645.5	798.9	1,239.9
Summer Flounder	116	0.5445	704.0	273.3	383.1	632.2	637.6	888.4	1,002.4	1,010.1	1,463.8
Witch Flounder	1	4.5455	321.9	11.0	34.3	406.7	278.0	250.4	301.4	411.9	268.8
Yellowtail Flounder	46	0.1779	511.0	2,206.2	606.9	405.1	145.1	332.8	80.9	140.4	312.7
American Plaice	11	0.0376	3.5	1.1	5.3	11.4	4.8	5.5	5.5	8.2	7.7
Windowpane Flounder	2	0.0141	21.1	7.2	43.7	13.4	11.9	1.3	9.8	75.1	2.4
Other Flounders	1	2.7348	105.2	40.7	87.5	112.8	85.7	16.4	0.6	4.5	7.8
Haddock	1	0.0026	<1,000 lbs	0.2	0.4	1.1	0.1	<1,000 lbs	<1,000 lbs	<1,000 lbs	0.1
Red Hake	12	0.0095	4.2	3.9	3.7	5.4	4.4	7.5	2.2	7.1	5.5
White Hake	1	0.3570	29.0	187.1	231.0	345.1	114.0	8.6	32.1	39.7	4.6
Atlantic Herring	19	0.0235	25.2	33.9	81.5	211.3	110.5	141.0	121.5	109.5	67.2
Atlantic Mackerel	19	0.0628	914.8	1,062.0	1,925.2	1,045.2	273.8	862.3	912.3	1,248.6	825.6
Ocean Pout	3	0.1585	345.5	360.6	371.4	60.8	41.2	43.4	5.4	11.3	4.5
Pollock	7	0.0321	114.2	100.0	52.4	33.4	12.5	4.9	6.5	8.3	16.6
Scup	15	0.4152	402.5	239.1	902.9	806.9	741.4	569.2	362.1	574.0	636.4
Black Sea Bass	1	1.8766	36.8	90.8	24.6	1.2	115.3	152.4	5.8	236.2	69.4
Weakfish	17	0.0340	30.7	35.3	6.2	12.0	5.7	5.7	19.3	15.7	17.2
Spiny Dogfish	32	0.3979	308.9	5,903.8	4,191.4	3,459.9	3,952.0	2,286.8	2,037.0	2,409.0	1,263.3
Skates	26	0.1192	1,431.1	2,350.3	2,184.5	2,466.7	2,353.0	1,342.1	1,062.2	2,922.2	1,659.7
Little Skates	18	0.2682	0	0	0.3	0	0	0	77.8	0	0
Tautog	7	0.0011	<1,000 lbs	<1,000 lbs	<1,000 lbs	<1,000 lbs	0.1	<1,000 lbs	<1,000 lbs	<1,000 lbs	<1,000 lbs
Silver Hake	219	0.1001	2,857.3	3,350.4	2,418.6	2,237.5	2,631.2	1,656.7	1,739.5	2,643.0	2,286.6
Other Groundfish	1	0.0459	0	<1,000 lbs	0	0.2	0	0	0	0	0
664	1	1.4577	0	0	0	0	0	0	0	0	0
Unclassified Crab	2	0.0004	0	0	0	0	0	<1,000 lbs	<1,000 lbs	<1,000 lbs	<1,000 lbs
Horseshoe Crab	51	0.0010	0.7	0.5	0.6	0.8	1.5	0.7	0.7	1.1	0.8
Northern Shrimp	476	0.0006	4.3	5.3	4.0	3.9	2.8	4.4	8.3	11.5	7.8
Conchs	2	0.0080	1.5	1.4	0.7	0.1	1.2	2.5	0.5	0.4	0.6
Loligo	147	0.0692	2,193.7	1,243.7	1,999.1	1,795.4	2,445.7	2,047.2	1,602.0	885.5	1,438.9
Illex	30	0.0009	13.1	21.5	22.8	34.1	34.4	33.5	26.1	28.2	24.2
Unclassified Squid	7	0.0561	3.7	69.2	109.1	96.1	87.8	30.5	48.1	7.5	18.7

Table 36c. Estimates of spiny dogfish discards for sink gill net by primary species landed.

Species	Number of Trips	Discard Rate	Dogfish Discards (Thousands of lbs) 1989	1990	1991	1992	1993	1994	1995	1996	1997
Goosefish	611	0.0385	0.5	0.8	21.3	64.9	120.5	193.1	310.2	268.2	292.0
Bluefish	114	0.1157	103.2	143.8	100.5	159.4	156.4	184.7	110.9	118.4	257.8
Bonito	8	0.0047	0	0	0	0.1	<1,000 lbs	0.1	0.1	<1,000 lbs	<1,000 lbs
Cod	2200	0.3015	1,908.5	1,620.9	1,606.5	1,028.0	759.7	850.9	884.2	921.5	481.5
Atlantic Croaker	170	0.0022	0.2	<1,000 lbs	<1,000 lbs	0.5	3.8	4.5	4.2	5.8	2.5
Red Drum	1	0.3333	0	0	<1,000 lbs	0.2	1.0	<1,000 lbs	0.2	0.1	0
Winter Flounder	118	0.0151	1.0	0.8	0.5	0.9	0.9	0.5	1.4	0.6	0.7
Witch Flounder	10	1.5964	0.9	0.8	3.2	0.3	0	0.2	0.1	0.2	0.7
Yellowtail Flounder	148	0.0067	0.1	0.5	0.7	0.5	0.2	0.4	1.7	1.4	0.8
White Hake	269	0.5741	999.8	739.3	326.7	1,123.1	589.7	146.4	267.4	173.0	84.9
Hickory Shad	2	0.0888	0	0	0	<1,000 lbs	0.1	<1,000 lbs	<1,000 lbs	<1,000 lbs	2.6
King Mackerel	5	0.0025	0	0	0	<1,000 lbs	<1,000 lbs	<1,000 lbs	<1,000 lbs	<1,000 lbs	0.1
Atlantic Mackerel	37	0.0660	3.5	19.1	6.4	10.5	2.8	4.9	6.5	18.0	9.3
Menhaden	23	0.0054	0.7	1.9	3.7	0.6	6.1	6.0	2.0	2.1	0.9
Pollock	470	0.1773	1,113.3	596.0	252.9	212.9	256.6	104.6	95.5	63.7	96.5
Scup	1	0.3529	0	0	0	0.1	0.4	0.5	2.3	2.7	0.9
Sea Robins	1	0.0716	0	0	0	0	<1,000 lbs	0	5.6	<1,000 lbs	0.1
Weakfish	80	0.1262	15.8	20.0	24.2	10.9	47.1	53.6	33.4	48.7	42.6
American Shad	10	0.0068	5.7	4.6	3.2	4.2	4.0	3.2	1.7	3.9	0.6
Smooth Dogfish	85	0.0020	0	0	0.5	1.3	0.9	0.8	0.9	1.5	1.0
Spiny Dogfish	1399	0.0853	741.1	1,400.0	1,323.1	1,395.8	2,149.9	1,969.8	2,479.2	2,737.9	2,463.0
Skates	12	0.0123	<1,000 lbs	<1,000 lbs	0.5	1.7	9.8	14.5	6.4	12.1	27.2
Little Skates	8	0.0152	0	0	0	0	0	0	0.2	0	0
Winter Skates	25	0.0002	0	0	0	0	0	0	0	0	0
Striped Bass	7	0.0561	0	15.4	11.4	20.7	16.2	18.7	26.0	90.9	9.7
Atlantic Sturgeon	1	0.3763	0	0	0	0	0	<1,000 lbs	0.1	0.1	0
Tautog	36	0.0613	0.7	1.9	3.9	4.7	1.1	2.1	1.2	1.4	0.3
Little Tuna	6	0.0006	0	0	0	<1,000 lbs	<1,000 lbs	<1,000 lbs	<1,000 lbs	<1,000 lbs	<1,000 lbs
Porbeagle Shark	3	0.0940	0	0	0.1	0	<1,000 lbs	0	<1,000 lbs	0	0.1
Wolffish	1	125.0000	6.0	57.8	280.5	27.8	4.5	23.9	21.8	34.3	869.4
660	2	0.6308	0	0	0	0	0	0	0	0	0
Horseshoe Crab	2	0.0796	0	0	0	0	0	0.1	1.5	1.3	5.1
American Lobster	14	0.0012	<1,000 lbs	0	0	<1,000 lbs	<1,000 lbs	<1,000 lbs	<1,000 lbs	0.1	<1,000 lbs

Table 37. Projected gross exvessel revenues for status quo and management options (not discounted).

Year	Status quo (NP-alt. 1)	NP-alt. 2	NP-alt. 3	Preferred	NP-alt. 4
1999	$5,805,480.96	$884,278.56	$4,166,170.85	$4,092,549.14	$2,551,401.31
2000	$4,722,832.79	$930,087.62	$2,098,218.78	$538,256.51	$1,683,892.14
2001	$3,952,667.89	$980,804.80	$516,170.00	$584,065.58	$617,195.35
2002	$3,123,196.60	$977,123.71	$526,804.25	$593,472.80	$625,375.54
2003	$2,428,289.45	$953,401.16	$525,168.21	$589,382.70	$619,649.40
2004	$1,986,968.19	$940,721.87	$530,485.33	$592,245.77	$621,285.44
2005	$1,753,423.76	$942,766.92	$545,618.68	$605,334.07	$633,555.73
2006	$1,688,391.25	$962,399.37	$572,613.31	$629,874.64	$658,096.30
2007	$1,684,710.16	$994,711.12	$604,107.04	$659,732.34	$689,181.02
2008	$1,667,531.76	$1,038,066.13	$637,236.81	$692,862.11	$725,173.86
2009	$1,617,223.59	$2,195,563.04	$2,067,134.05	$2,163,251.29	$2,186,564.83
2010	$1,528,468.53	$2,230,737.86	$2,069,997.12	$2,170,613.46	$2,198,426.11
2011	$1,407,810.73	$2,278,591.97	$2,084,721.46	$2,193,517.99	$2,224,602.71
2012	$1,267,111.46	$2,334,217.26	$2,111,716.09	$2,229,510.83	$2,262,231.59
2013	$1,116,186.95	$2,388,615.53	$2,143,618.83	$2,270,411.78	$2,303,541.55
2014	$968,125.51	$2,436,878.65	$2,178,384.64	$2,312,539.76	$2,345,260.52

Table 38. Projected gross exvessel revenues for status quo and management options (7% discount rate).

Year	Status quo (NP-alt. 1)	NP-alt. 2	NP-alt. 3	Preferred	NP-alt. 4
1999	$5,425,683.14	$826,428.56	$3,893,617.62	$3,824,812.00	$2,384,487.00
2000	$4,125,105.07	$812,374.55	$1,832,665.54	$470,134.10	$1,470,777.00
2001	$3,226,554.40	$800,628.88	$421,348.47	$476,771.50	$503,815.30
2002	$2,382,671.74	$745,443.00	$401,896.44	$452,757.60	$477,096.00
2003	$1,731,336.82	$679,761.85	$374,437.67	$420,221.70	$441,801.50
2004	$1,324,000.80	$626,842.70	$353,484.78	$394,638.40	$413,988.70
2005	$1,091,944.20	$587,107.85	$339,783.89	$376,971.60	$394,546.70
2006	$982,659.08	$560,125.20	$333,266.16	$366,592.80	$383,018.00
2007	$916,370.70	$541,056.94	$328,594.21	$358,850.70	$374,868.80
2008	$847,688.59	$527,700.18	$323,938.88	$352,216.00	$368,641.60
2009	$768,331.28	$1,043,096.18	$982,080.50	$1,027,745.00	$1,038,821.00
2010	$678,658.31	$990,474.29	$919,103.48	$963,778.30	$976,127.50
2011	$584,191.40	$945,534.66	$865,085.29	$910,232.00	$923,131.00
2012	$491,407.67	$905,249.70	$818,959.91	$864,642.70	$877,332.40
2013	$404,557.52	$865,744.19	$776,946.11	$822,901.70	$834,909.50
2014	$327,937.60	$825,455.11	$737,894.24	$783,337.20	$794,420.90

Table 39. Projected pack-out facility gross revenues for management options and status quo (not discounted).

Year	Status quo (NP-alt. 1)	NP-alt. 2	NP-alt. 3	Preferred	NP-alt. 4
1999	$1,408,399.65	$214,524.45	$1,010,705.85	$992,845.35	$618,965.55
2000	$1,145,751.08	$225,637.65	509,024.25	$130,580.10	$408,509.33
2001	$958,910.40	$237,941.55	125,221.95	$141,693.30	$149,730.53
2002	$757,682.10	$237,048.53	127,801.80	$143,975.48	$151,715.03
2003	$589,098.83	$231,293.48	127,404.90	$142,983.23	$150,325.88
2004	$482,035.05	$228,217.50	128,694.83	$143,677.80	$150,722.78
2005	$425,377.58	$228,713.63	132,366.15	$146,853.00	$153,699.53
2006	$409,600.80	$233,476.43	138,915.00	$152,806.50	$159,653.03
2007	$408,707.78	$241,315.20	146,555.33	$160,049.93	$167,194.13
2008	$404,540.33	$251,833.05	154,592.55	$168,087.15	$175,925.93
2009	$392,335.65	$532,639.80	501,483.15	$524,801.03	$530,456.85
2010	$370,803.83	$541,173.15	502,177.73	$526,587.08	$533,334.38
2011	$341,532.45	$552,782.48	505,749.83	$532,143.68	$539,684.78
2012	$307,399.05	$566,277.08	512,298.68	$540,875.48	$548,813.48
2013	$270,785.03	$579,474.00	520,038.23	$550,797.98	$558,835.20
2014	$234,865.58	$591,182.55	528,472.35	$561,018.15	$568,956.15

Table 40. Projected gross exvessel value under trip limits scenario (price per lb based on 1996 weighout data).

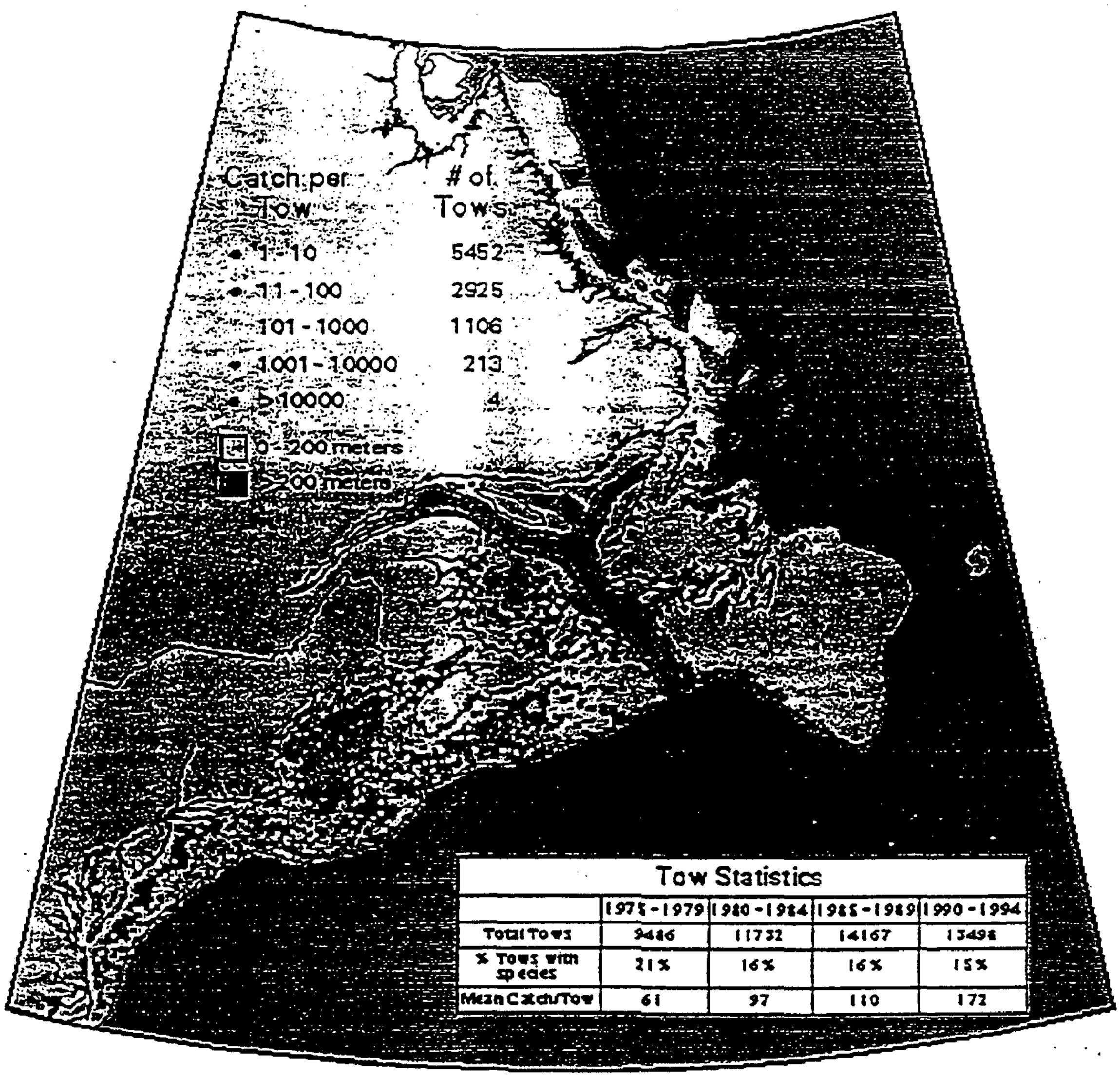
	Preferred action				Non-preferred alt. 4			
Year	Thousand lbs.	Per trip lbs.	Per trip lbs. (Disc = 7%)	Nominal per trip $	Thousand lbs.	Per trip lbs.	Per trip lbs. (Disc = 7%)	Nominal per trip $
1999	2,217.8	1618	$272	$291	13,752.3	1009	$170	$182
2000	2,901.3	213	$36	$38	9,076.3	666	$112	$120
2001	3,148.2	231	$39	$42	3,326.7	244	$41	$44
2002	3,198.9	235	$39	$42	3,370.8	247	$42	$45
2003	3,176.8	233	$39	$42	3,340.0	245	$41	$44
2004	3,192.3	234	$39	$42	3,348.8	246	$41	$44
2005	3,262.8	239	$40	$43	3,414.9	251	$42	$45
2006	3,395.1	249	$42	$45	3,547.2	260	$44	$47
2007	3,556.0	261	$44	$47	3,714.8	273	$46	$49
2008	3,734.6	274	$46	$49	3,908.8	287	$48	$52
2009	11,660.1	856	$144	$154	11,785.8	865	$145	$156
2010	11,699.8	858	$144	$155	11,849.7	869	$146	$156
2011	11,823.3	867	$146	$156	11,990.8	880	$148	$158
2012	12,017.3	882	$148	$159	12,193.6	895	$151	$161
2013	12,337.7	898	$151	$162	12,416.3	911	$153	$164
2014	12,464.8	915	$154	$165	12,641.2	927	$156	$167

Table 40 (continued). Projected gross exvessel value under trip limits scenario (price per lb based on 1996 weighout data).

	Non-preferred alt. 1 (SQ)				Non-preferred alt. 2				Non-preferred alt. 3			
Year	Thousand lbs.	Per trip lbs.	Per trip lbs. (Disc = 7%)	Nominal per trip $	Thousand lbs.	Per trip lbs.	Per trip lbs. (Disc = 7%)	Nominal per trip $	Thousand lbs.	Per trip lbs.	Per trip lbs. (Disc = 7%)	Nominal per trip $
1999	31,292.1	2243	$377.40	$403.81	4,766.3	350	$59	$63	22,456.1	1648	$277	$297
2000	25,456.5	1825	$307.02	$328.51	5,013.3	368	$62	$66	11,309.6	830	$140	$149
2001	21,305.3	1527	$256.95	$274.94	5,286.6	388	$65	$70	2,782.2	204	$34	$37
2002	17,495.7	1207	$203.03	$217.24	5,266.8	386	$65	$70	2,839.5	208	$35	$38
2003	13,088.7	938	$157.86	$168.91	5,138.9	377	$63	$68	2,830.7	208	$35	$37
2004	10,709.9	768	$129.17	$138.21	5,070.6	372	$63	$67	2,859.4	210	$35	$38
2005	9,451.1	678	$113.98	$121.96	5,081.6	373	$63	$67	2,940.9	216	$36	$39
2006	9,100.6	652	$109.76	$117.44	5,187.4	381	$64	$69	3,086.4	226	$38	$41
2007	9,080.7	651	$109.52	$117.18	5,361.6	393	$66	$71	3,256.2	239	$40	$43
2008	8,988.2	644	$108.40	$115.99	5,595.3	411	$69	$74	3,434.8	252	$42	$45
2009	8,717.0	625	$105.13	$112.49	11,834.3	868	$146	$156	11,142.0	817	$138	$147
2010	8,238.6	591	$99.36	$106.32	12,023.9	882	$148	$159	11,157.5	819	$138	$147
2011	7,588.2	544	$91.52	$97.92	12,281.8	901	$152	$162	11,236.8	824	$139	$148
2012	6,829.9	490	$82.37	$88.14	12,581.7	923	$155	$166	11,382.3	835	$140	$150
2013	6,016.4	431	$72.56	$77.64	12,874.9	945	$159	$170	11,554.3	848	$143	$153
2014	5,218.3	374	$62.93	$67.34	13,135.0	964	$162	$173	11,741.7	861	$145	$155

East Coast of North America Strategic Assessment Project

Distribution of Spiny dogfish (*Squalus acanthias*)



Tow Statistics				
	1975 - 1979	1980 - 1984	1985 - 1989	1990 - 1994
Total Tows	9486	11732	14167	13498
% Tows with species	21%	16%	16%	15%
Mean Catch/Tow	61	97	110	172

Projection: Lambert Conformal Conic

Science Sector,
Department of Fisheries and Oceans (Canada)
Office of Ocean Resources Conservation and Assessment,
National Oceanic and Atmospheric Administration (USA)

Figure 1. Distribution and relative abundance of spiny dogfish in the northwest Atlantic Ocean, 1975 - 1994, from the Department of Fisheries and Oceans (DFO Canada) and the National Oceanic & Atmospheric Administration (NOAA USA).
Source: McMillan and Morse 1998.

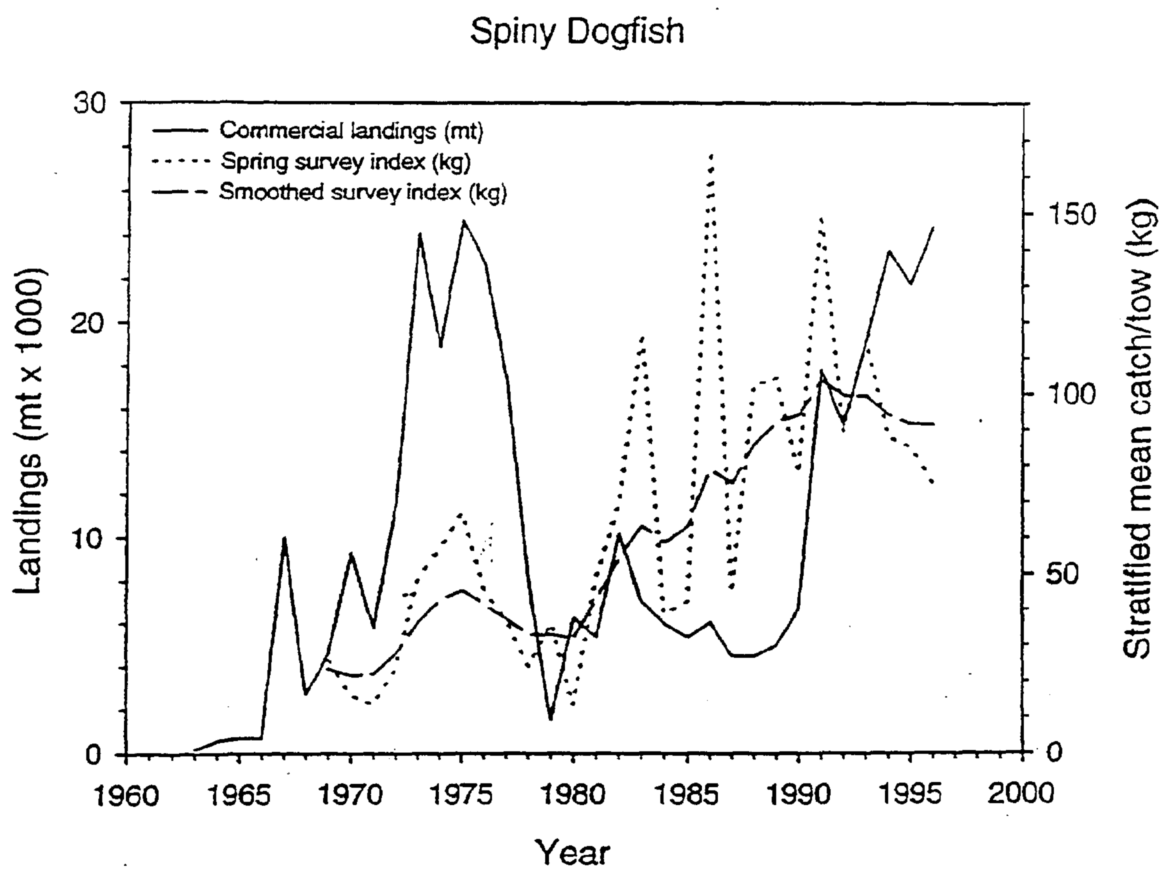


Figure 2. Commercial landings (US, Foreign, US Recreational) and NMFS bottom trawl data (stratified mean catch/tow) of spiny dogfish, 1963 - 1996.
Note: 1,000 metric tons = 2.205 million lbs.
Source: McMillan and Morse 1998.

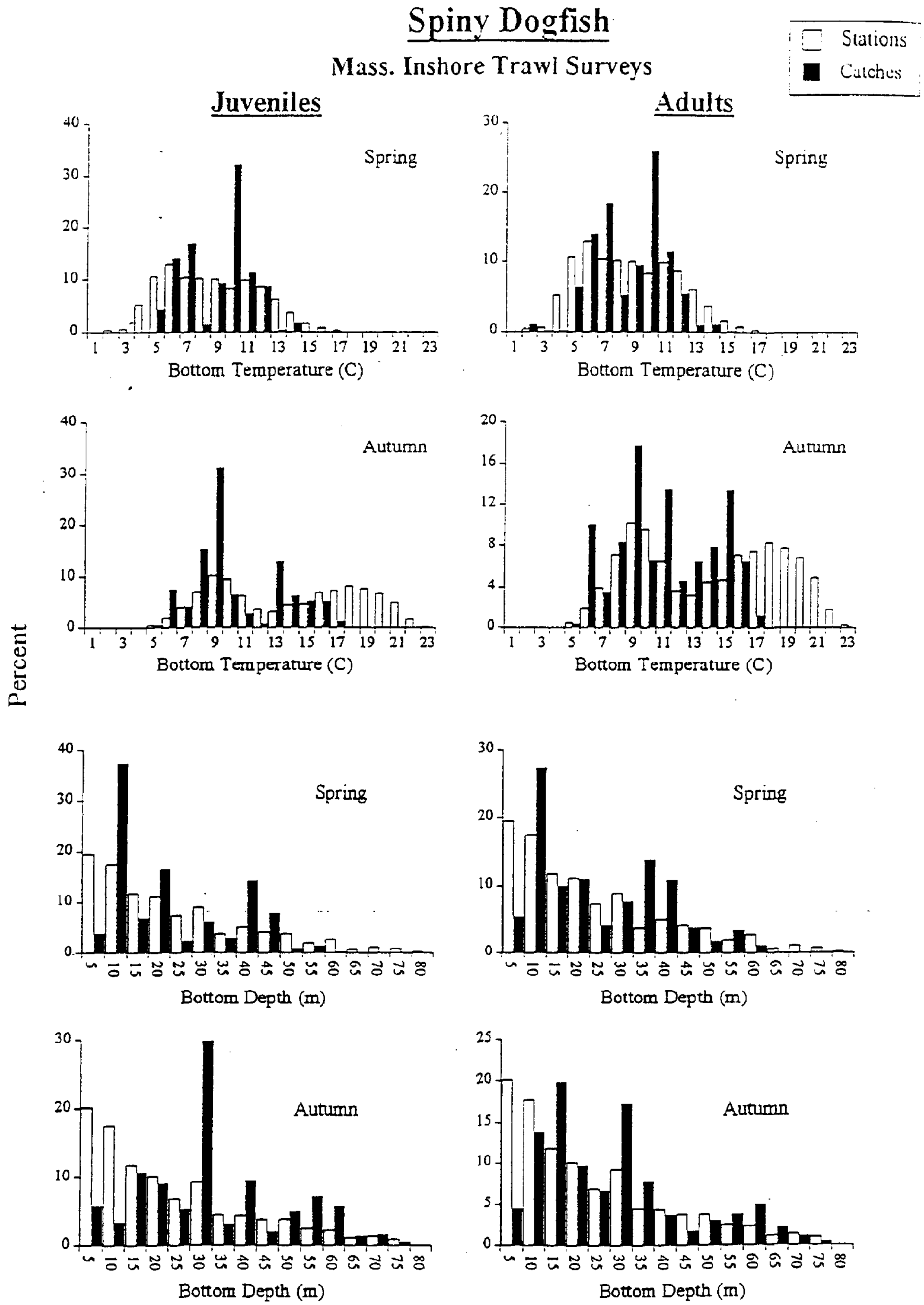


Figure 3. Percent frequencies for spring and autumn bottom temperature and bottom depth intervals for all stations sampled and for stations weighted by the number of spiny dogfish captured from NMFS, NEFSC bottom trawl surveys.
Source: McMillan and Morse 1998.

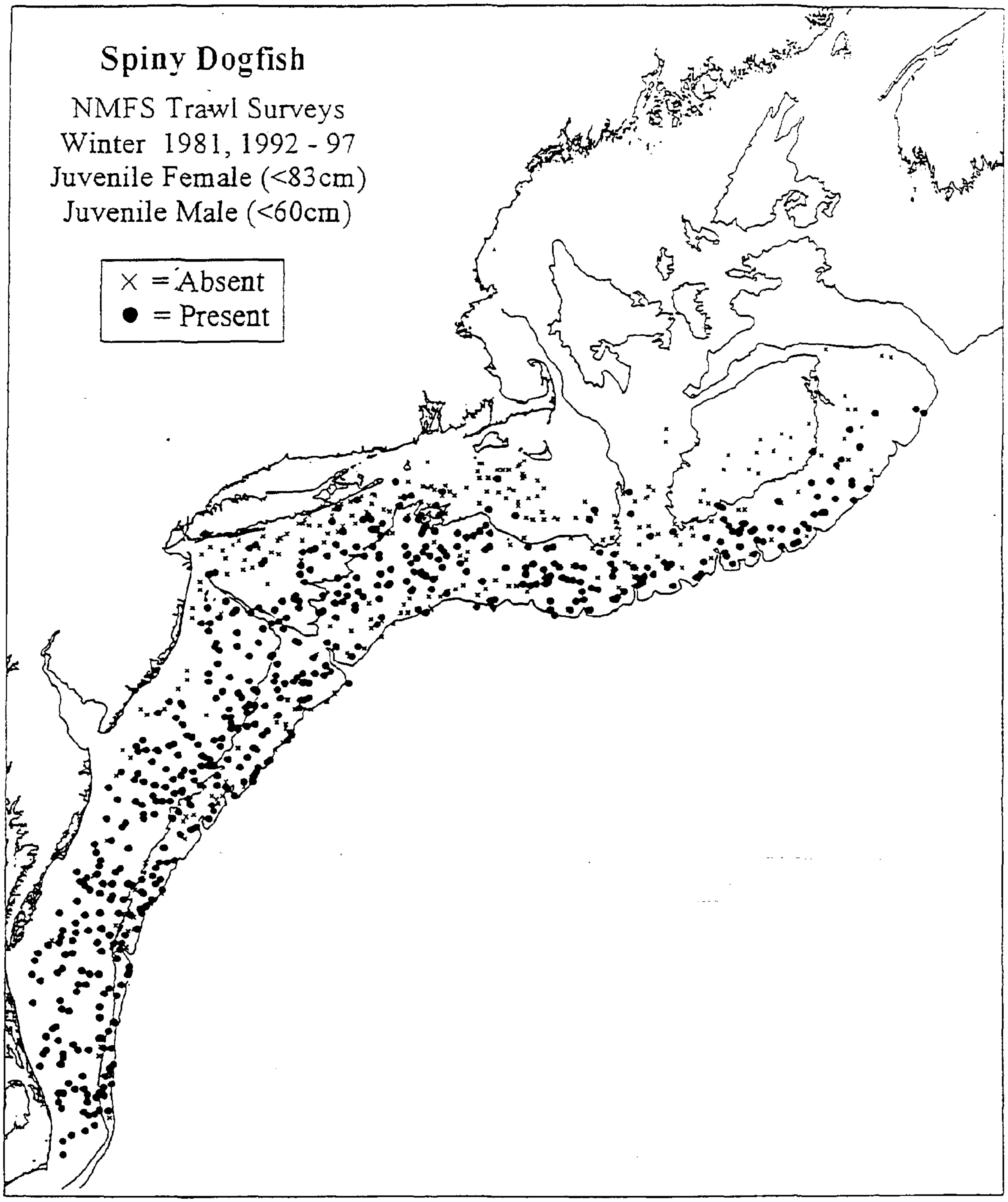


Figure 4. Distribution of stations sampled and stations where spiny dogfish were captured from NMFS, NEFSC bottom trawl surveys.
Source: McMillan and Morse 1998.

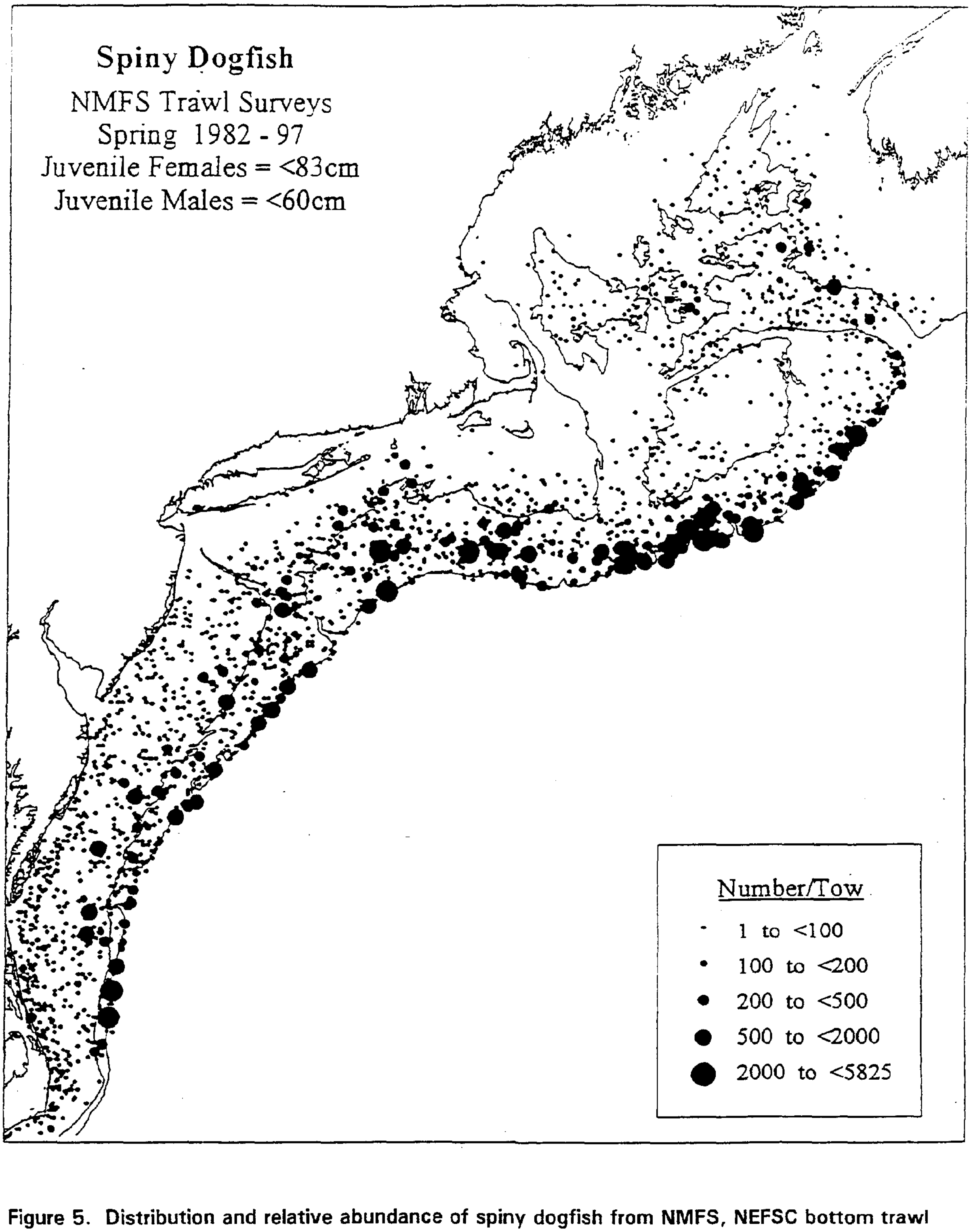


Figure 5. Distribution and relative abundance of spiny dogfish from NMFS, NEFSC bottom trawl surveys.
Source: McMillan and Morse 1998.

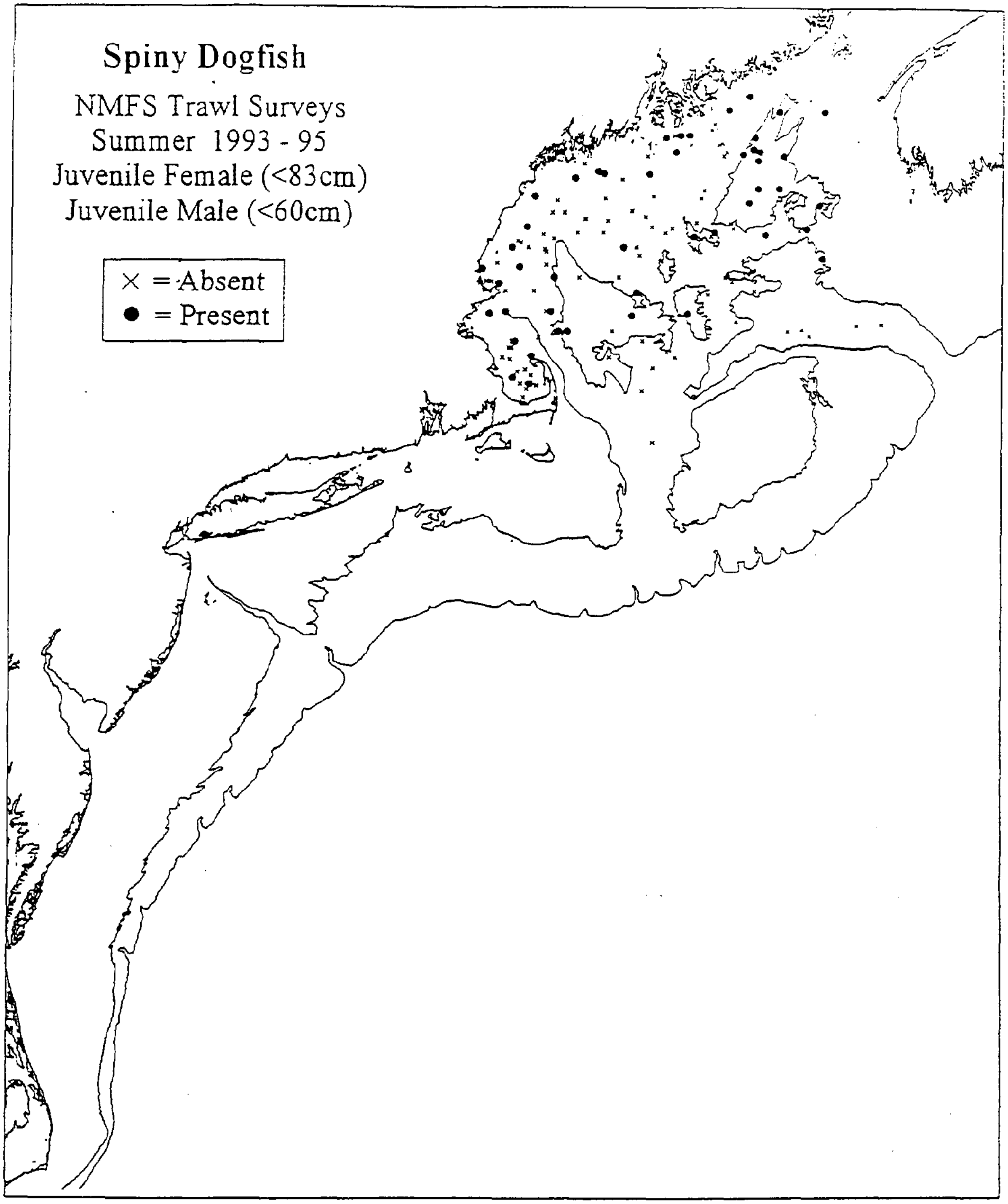


Figure 6. Distribution of stations sampled and stations where spiny dogfish were captured from NMFS, NEFSC bottom trawl surveys.
Source: McMillan and Morse 1998.

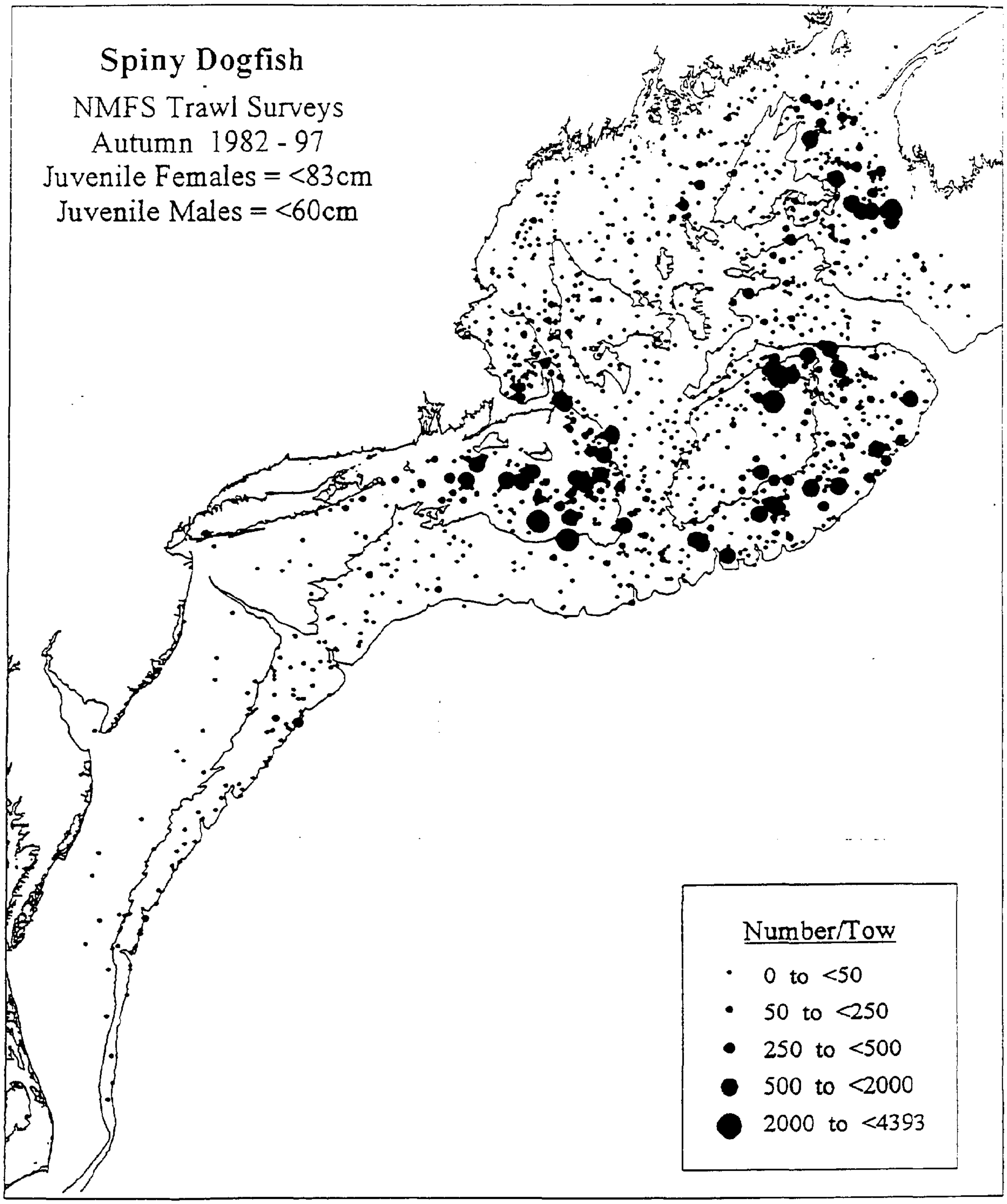


Figure 7. Distribution and relative abundance of spiny dogfish from NMFS, NEFSC bottom trawl surveys.
Source: McMillan and Morse 1998.

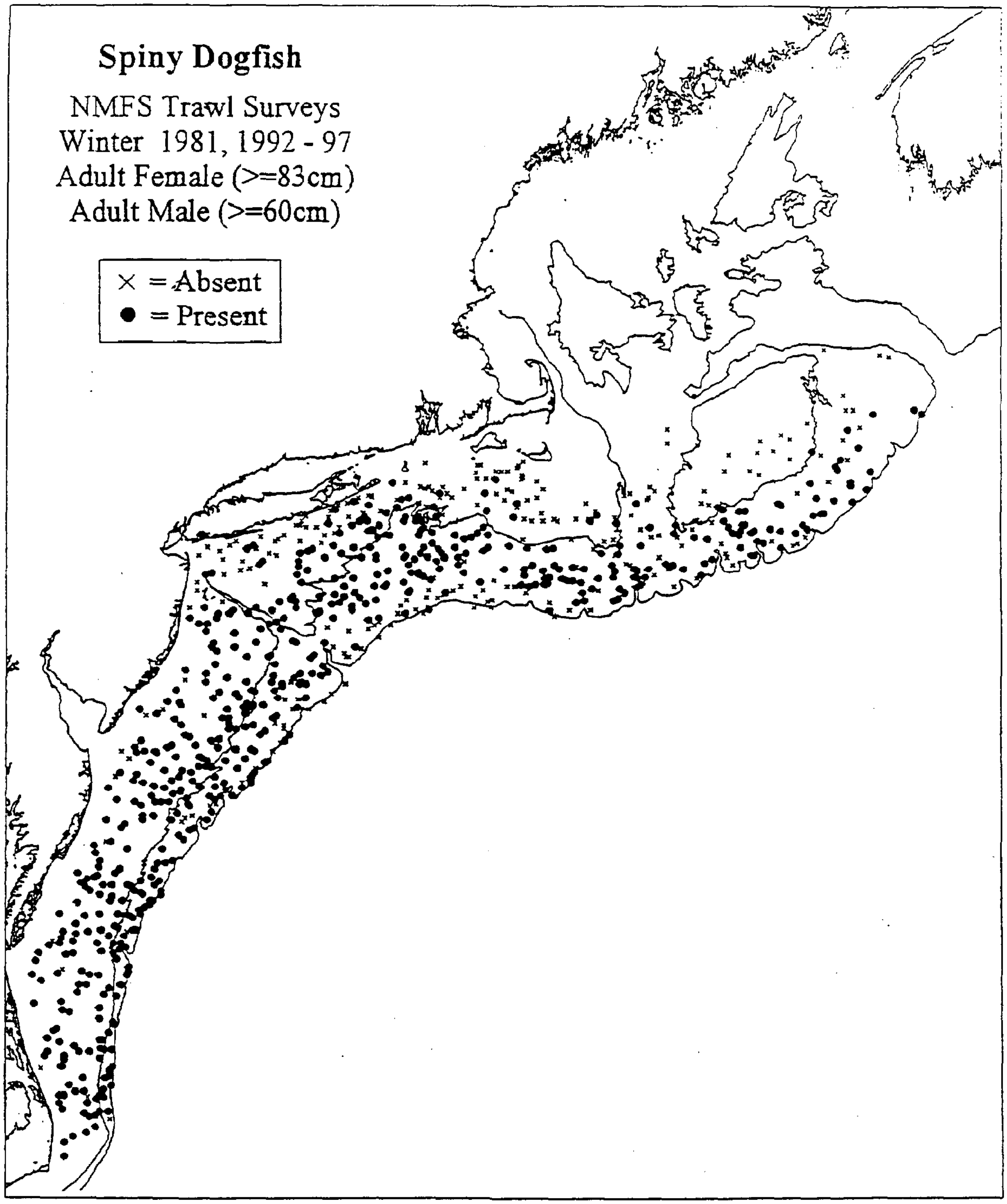


Figure 8. Distribution of stations sampled and stations where spiny dogfish were captured from NMFS, NEFSC bottom trawl surveys.
Source: McMillan and Morse 1998.

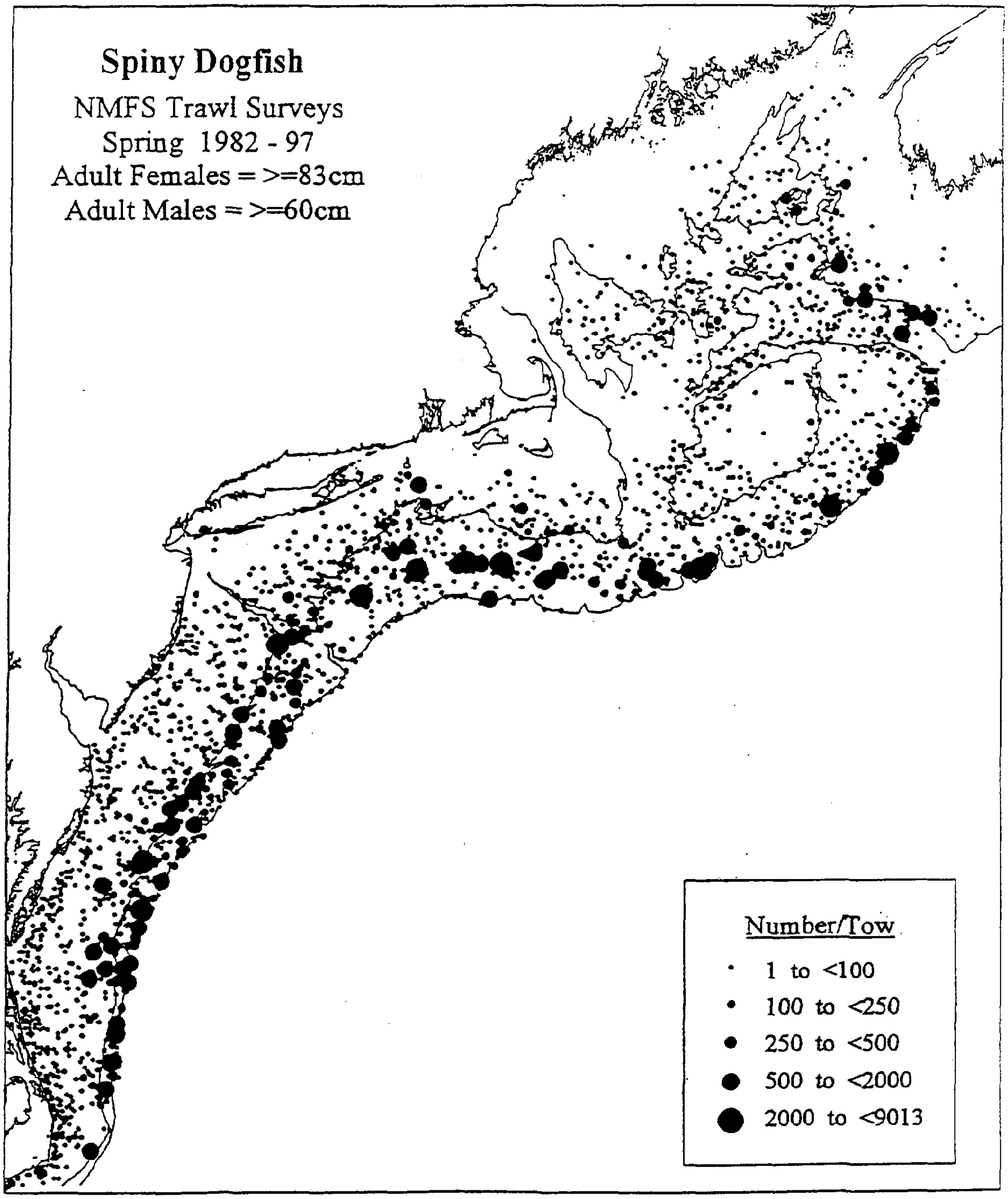


Figure 9. Distribution and relative abundance of spiny dogfish from NMFS, NEFSC bottom trawl surveys.
Source: McMillan and Morse 1998.

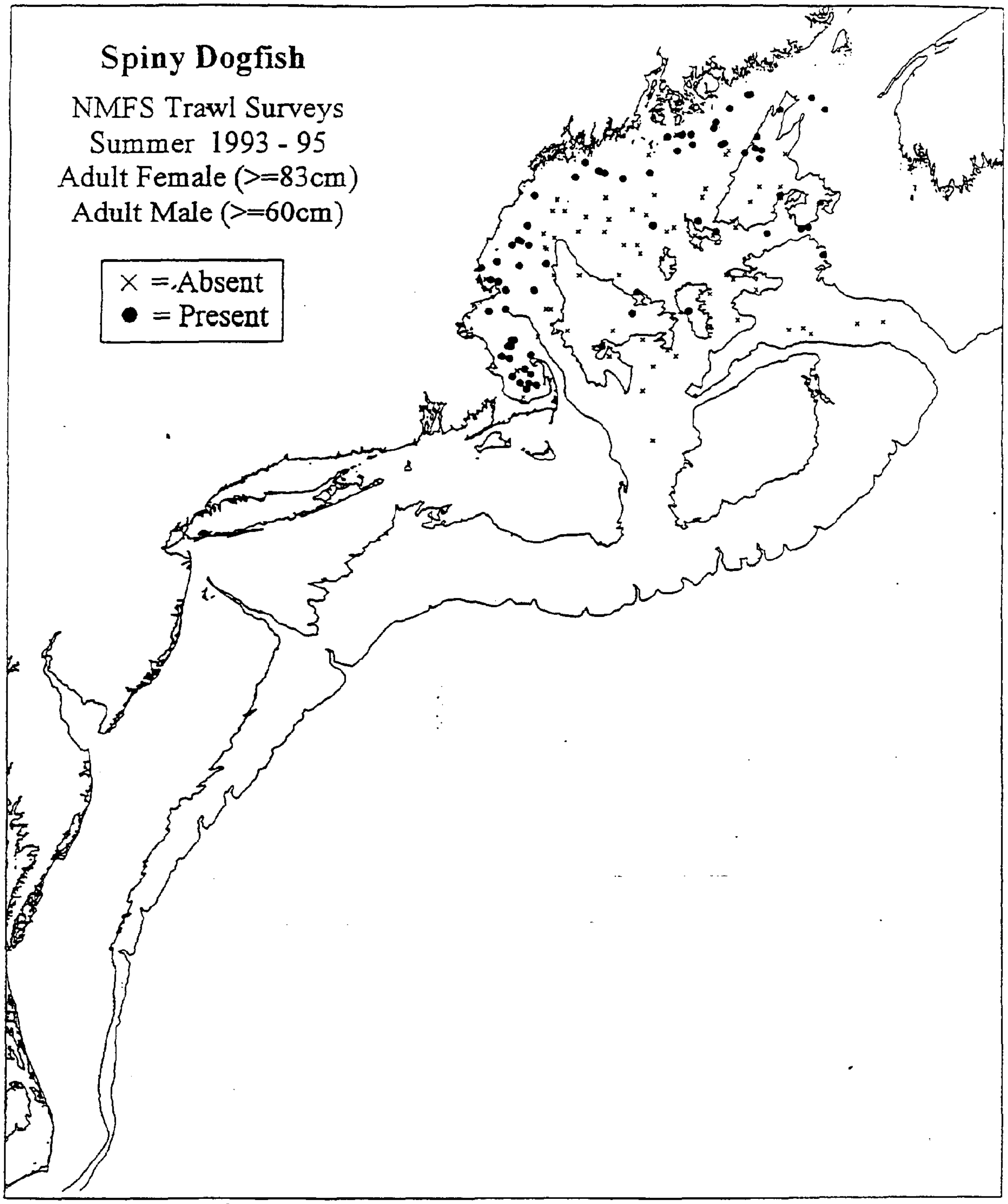


Figure 10. Distribution of stations sampled and stations where spiny dogfish were captured from NMFS, NEFSC bottom trawl surveys.
Source: McMillan and Morse 1998.

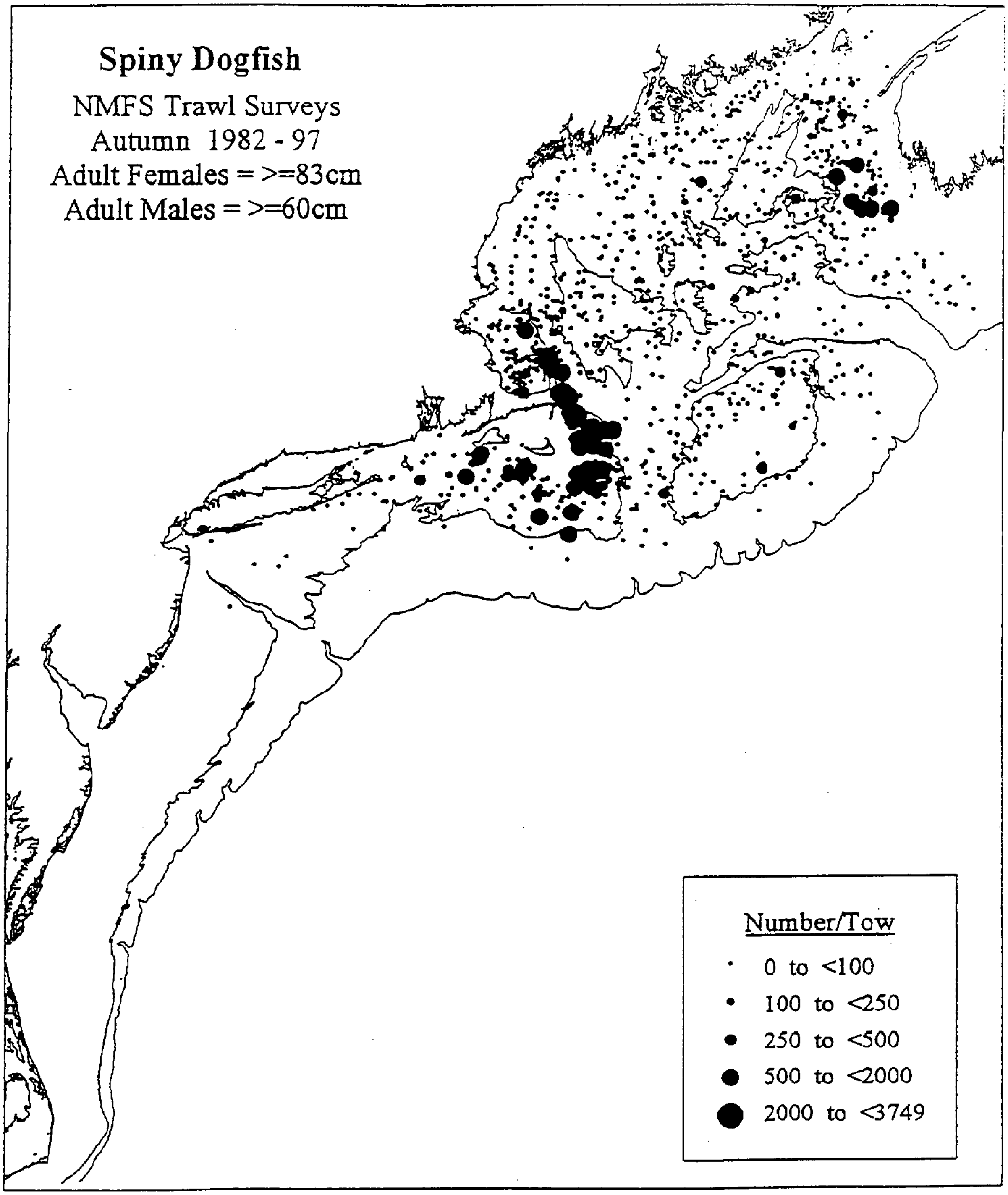


Figure 11. Distribution and relative abundance of spiny dogfish from NMFS, NEFSC bottom trawl surveys.
Source: McMillan and Morse 1998.

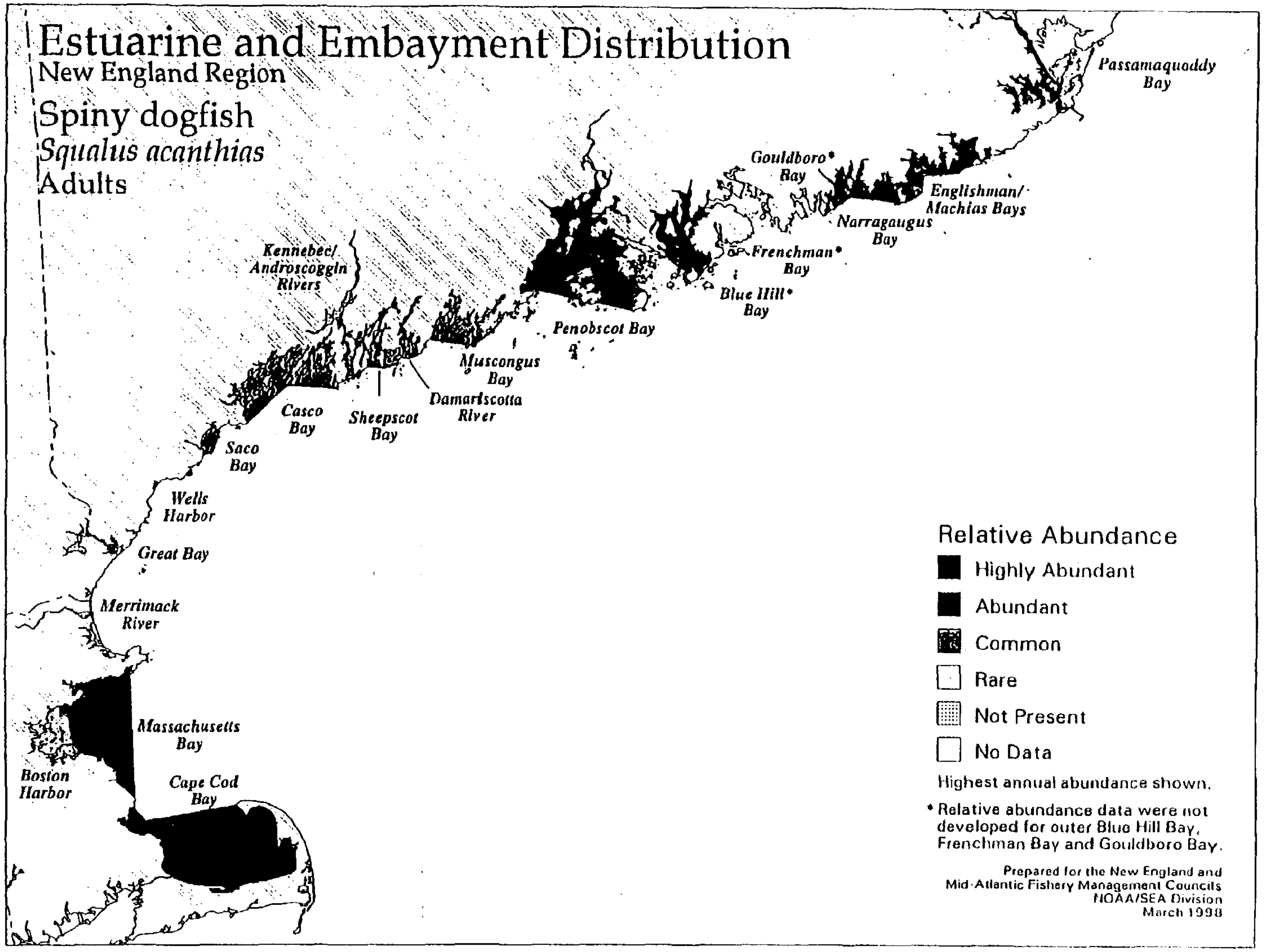


Figure 12. Relative abundance and distribution of juvenile dogfish in Atlantic coast estuaries. Those estuaries in which juvenile dogfish are classified as abundant or common are designated as EFH.
Source: ELMR data.

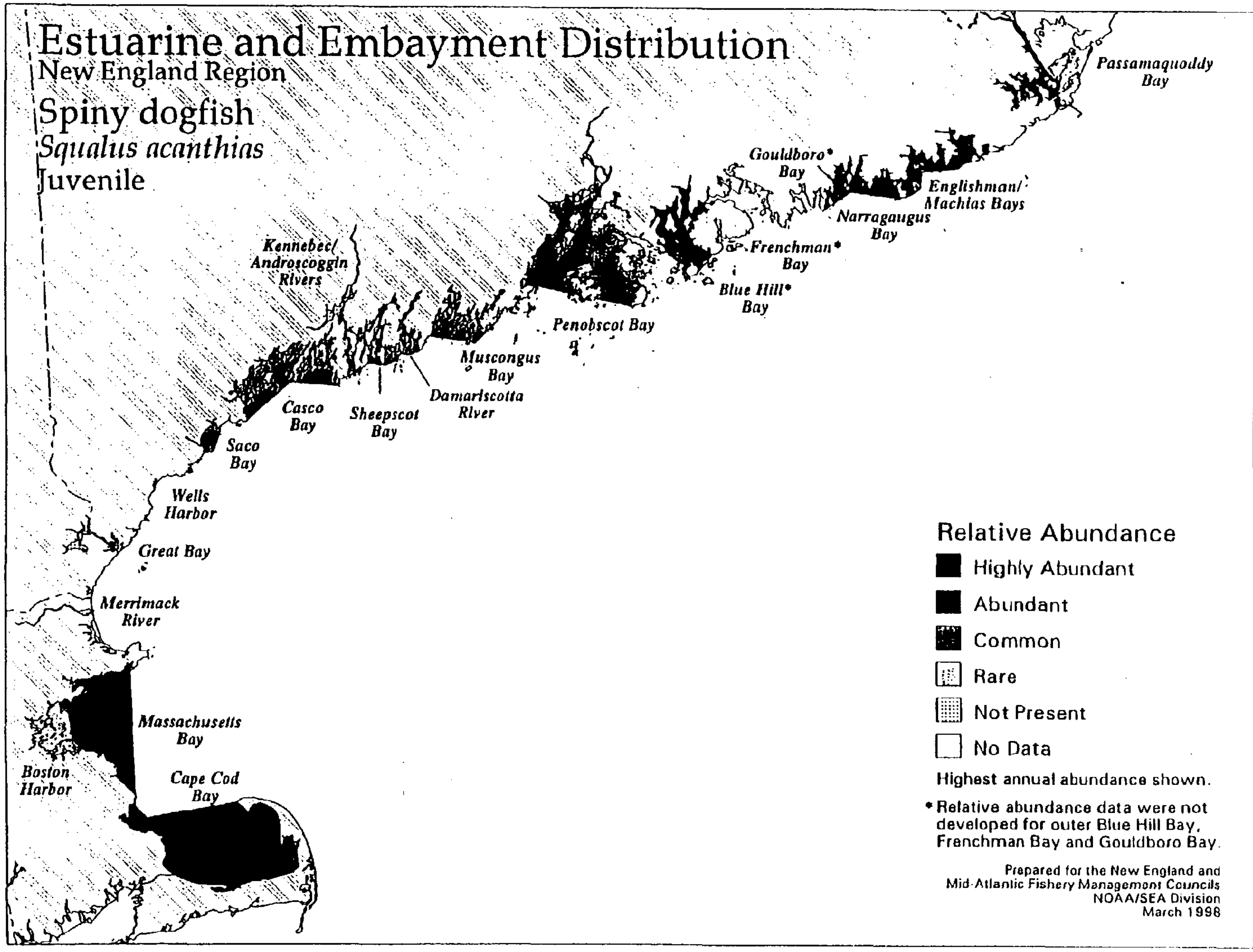


Figure 13. Relative abundance and distribution of adult dogfish in Atlantic coast estuaries. Those estuaries in which adult dogfish are classified as abundant or common are designated as EFH.
Source: ELMR data.

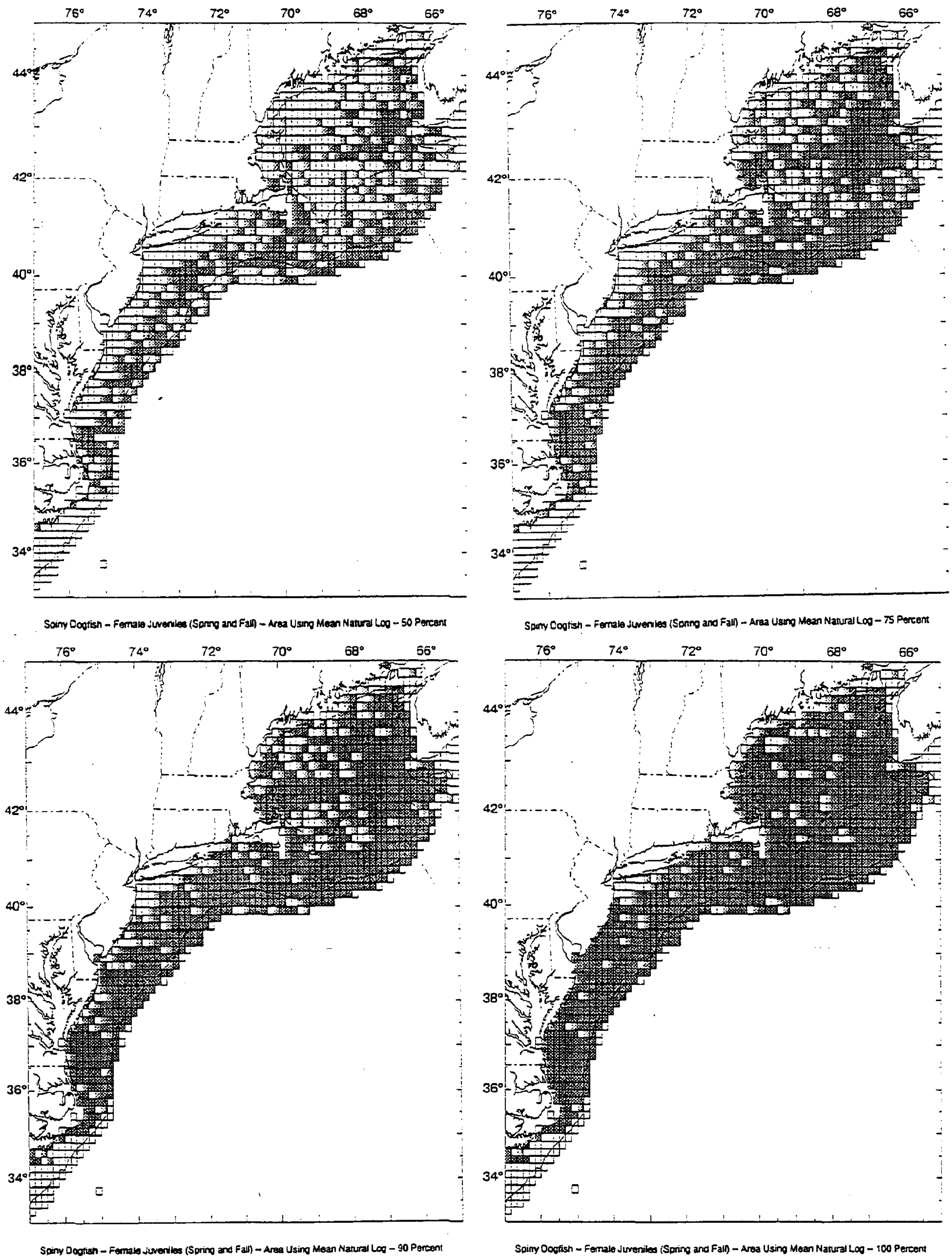


Figure 14a. Four options for designating EFH for female juvenile dogfish under Alternative 5, the preferred alternative: 1) the top 50% of the area, 2) the top 75% of the area, 3) the top 90%, and 4) the top 100% of the area where juvenile dogfish were found in the NEFSC trawl survey.
Source: Cross pers. comm.

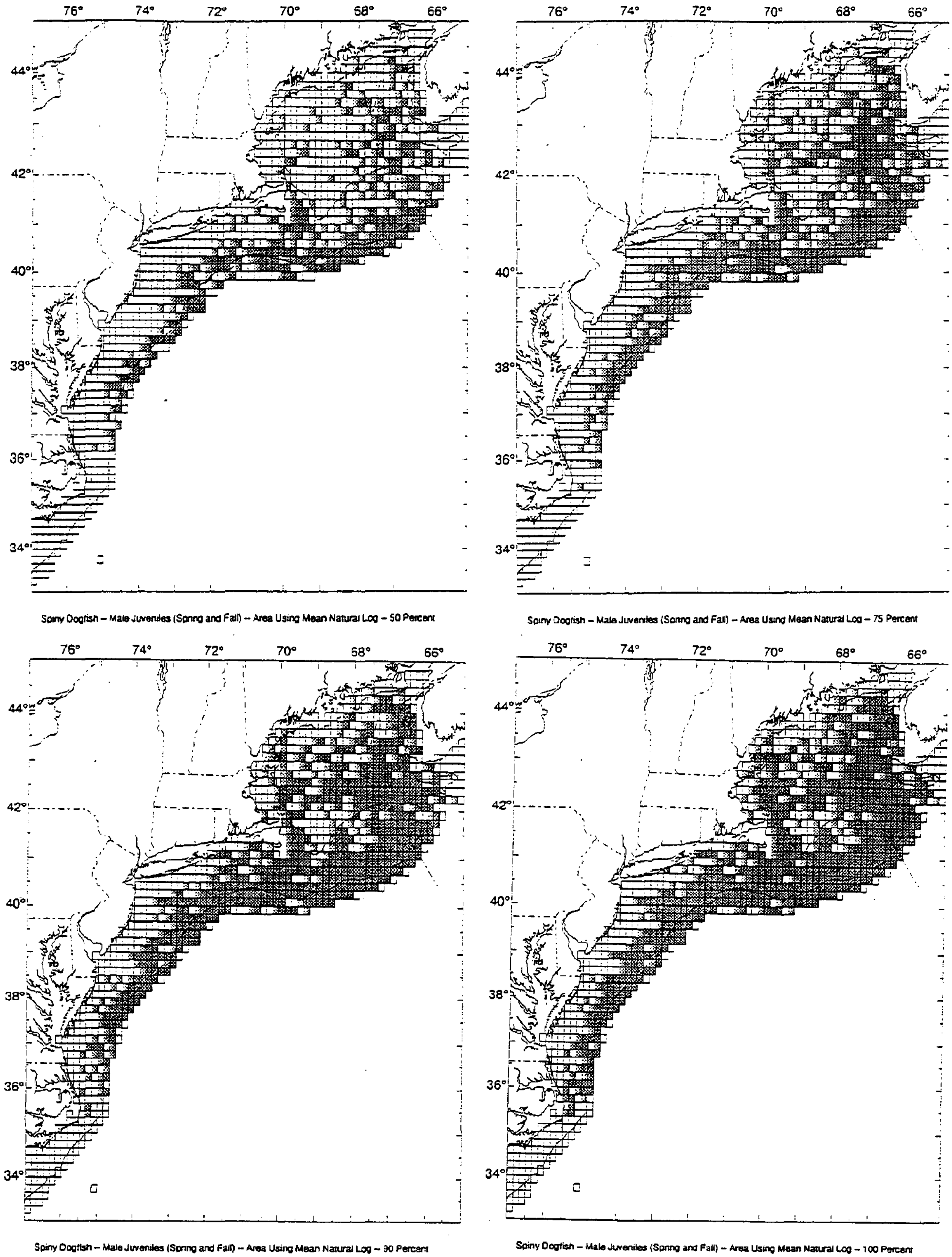


Figure 14b. Four options for designating EFH for male juvenile dogfish under Alternative 5, the preferred alternative: 1) the top 50% of the are, 2) the top 75% of the area, 3) the top 90%, and 4) the top 100% of the area where juvenile dogfish were found in the NEFSC trawl survey.
Source: Cross pers. comm.

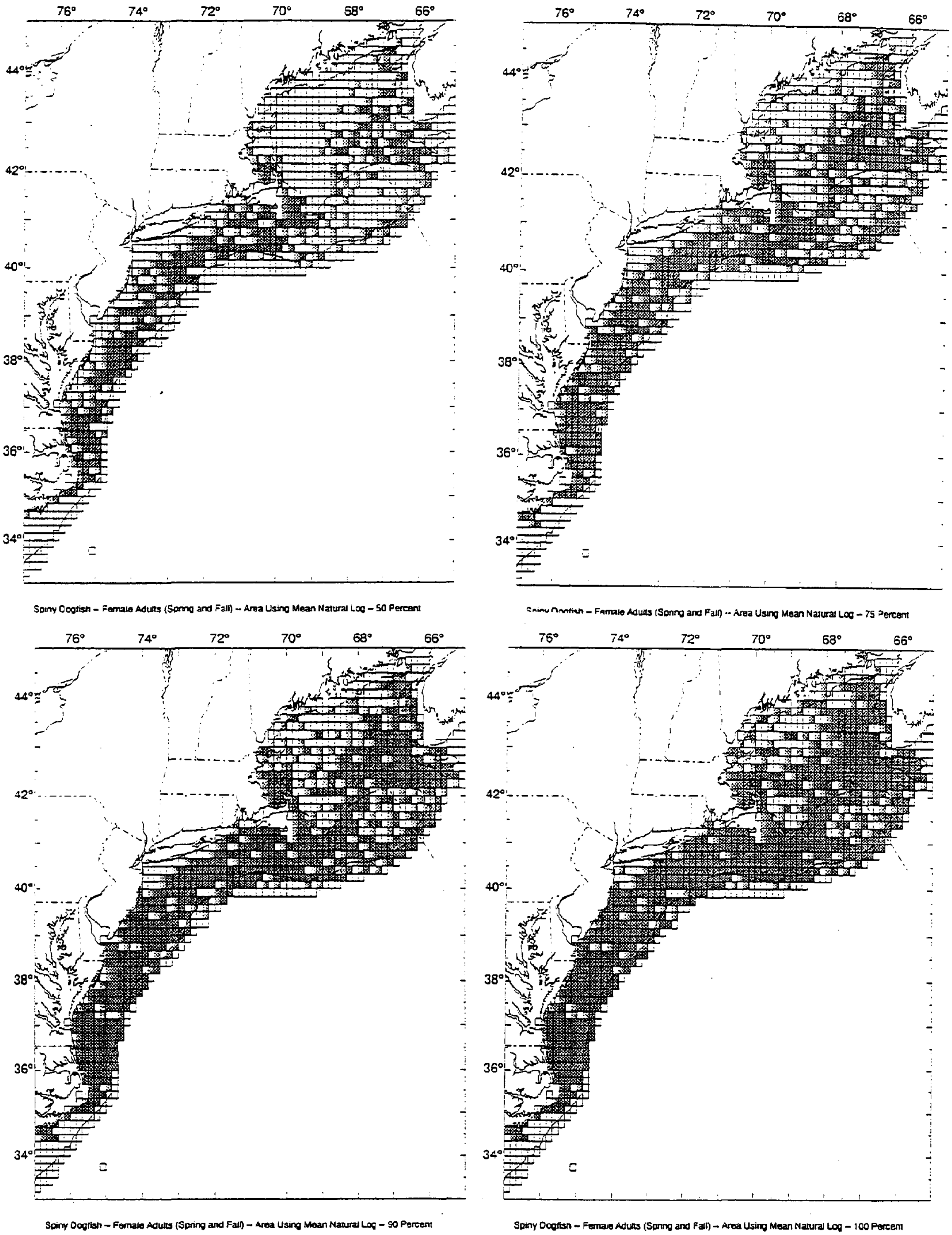


Figure 15a. Four options for designating EFH for female adult dogfish under Alternative 5, the preferred alternative: 1) the top 50% of the are, 2) the top 75% of the area, 3) the top 90%, and 4) the top 100% of the area where adult dogfish were found in the NEFSC trawl survey.
Source: Cross pers. comm.

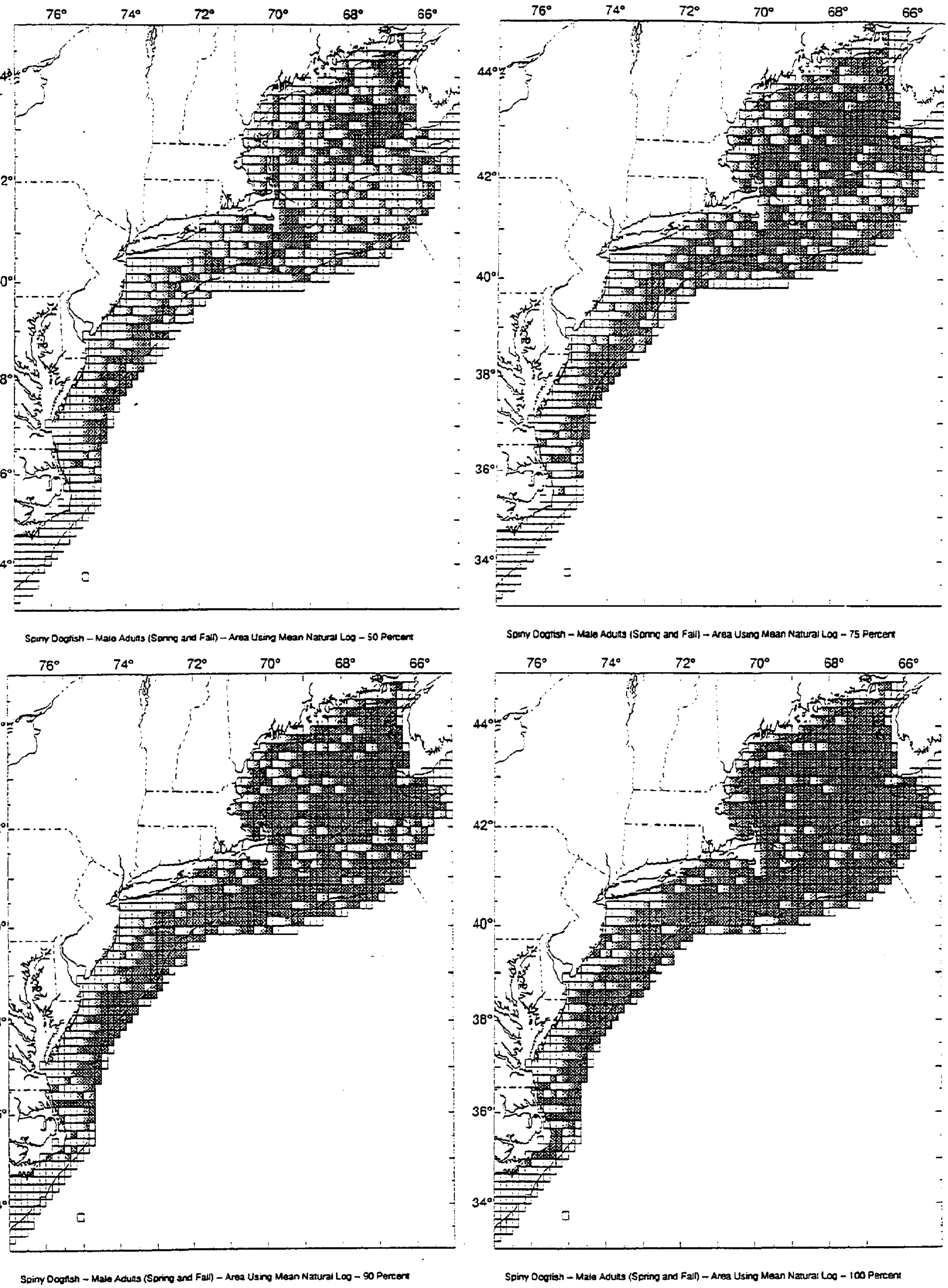


Figure 15b. Four options for designating EFH for male adult dogfish under Alternative 5, the preferred alternative: 1) the top 50% of the are, 2) the top 75% of the area, 3) the top 90%, and 4) the top 100% of the area where adult dogfish were found in the NEFSC trawl survey.
Source: Cross pers. comm.

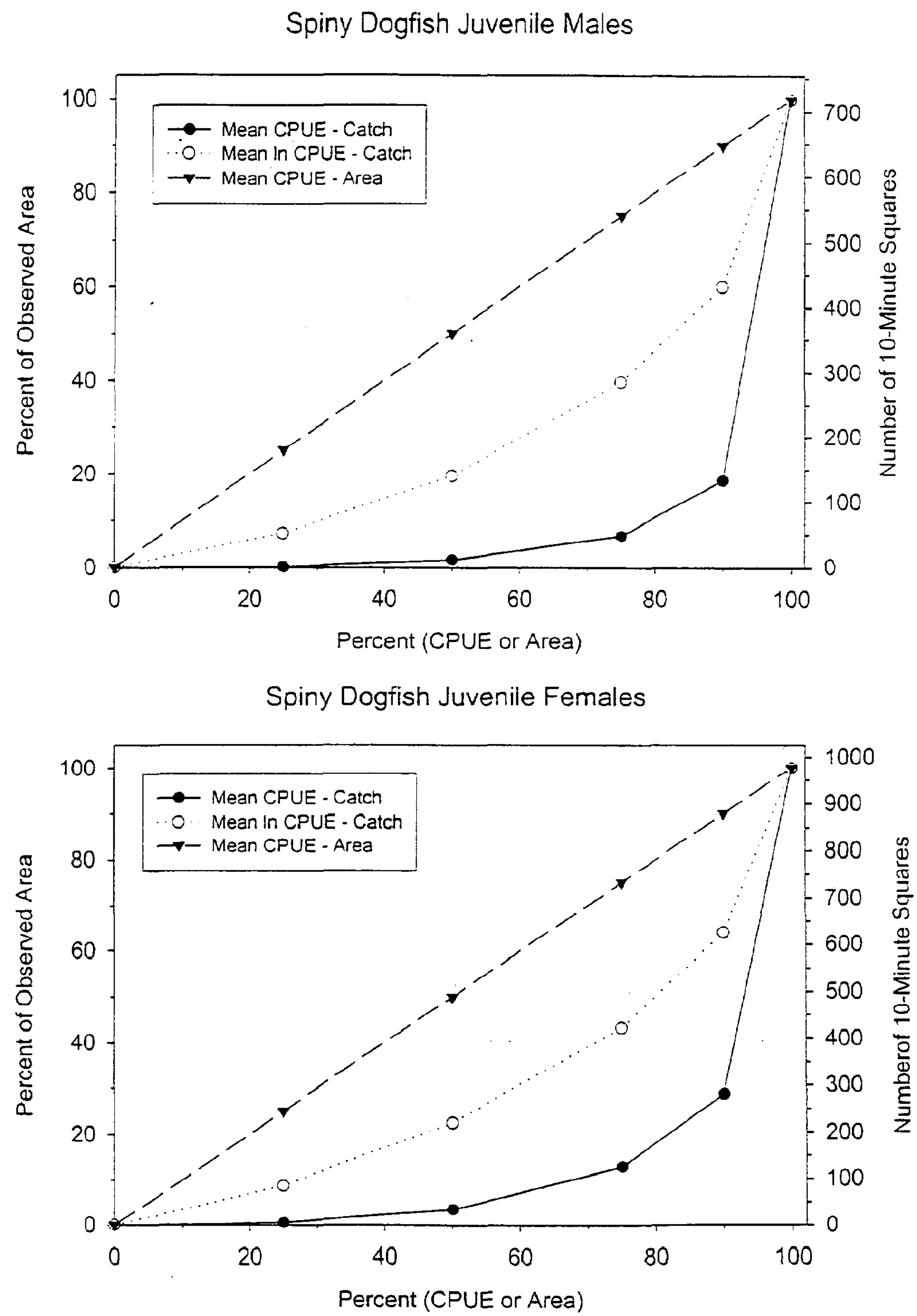
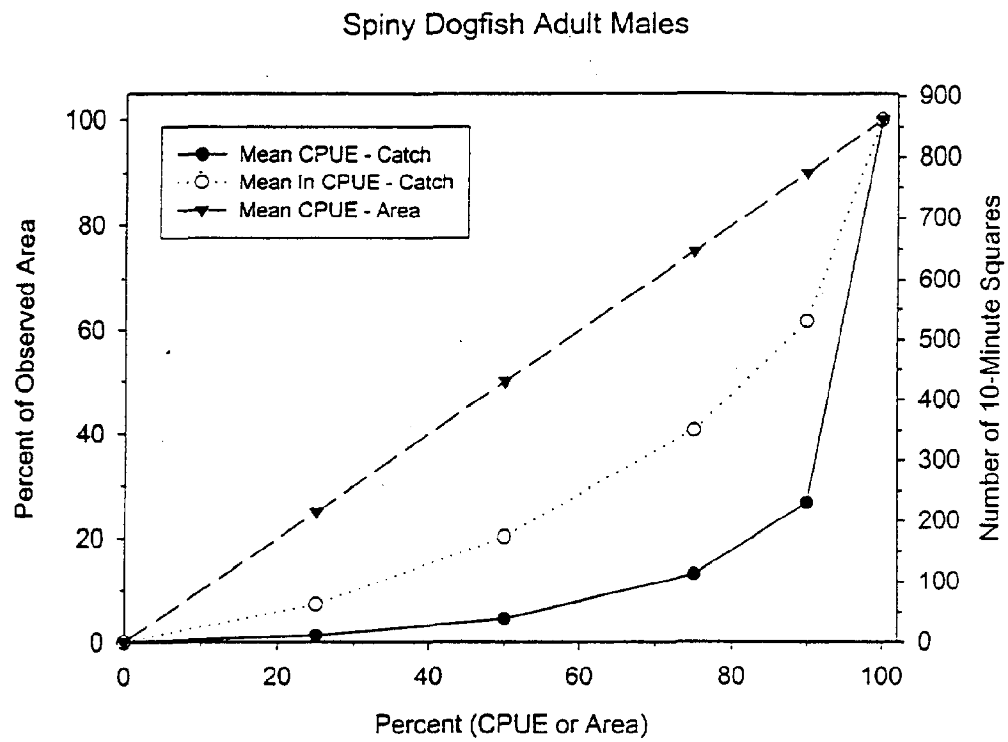


Figure 16a. Graphical representation of percent area and numbers of 10 minute squares encompassed in the a) area analysis, b) logged CPUE analysis, and c) CPUE of female and male juvenile dogfish.
Source: Cross pers. comm.



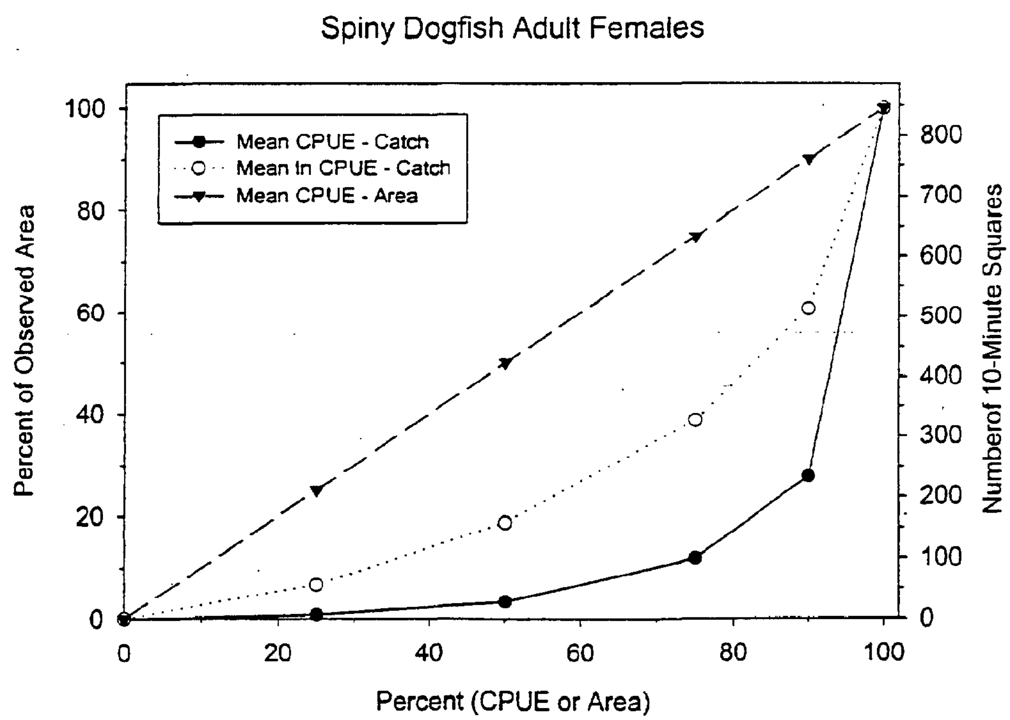


Figure 16b. Graphical representation of percent area and numbers of 10 minute squares encompassed in the a) area analysis, b) logged CPUE analysis, and c) CPUE of female and male adult dogfish.
Source: Cross pers. comm.

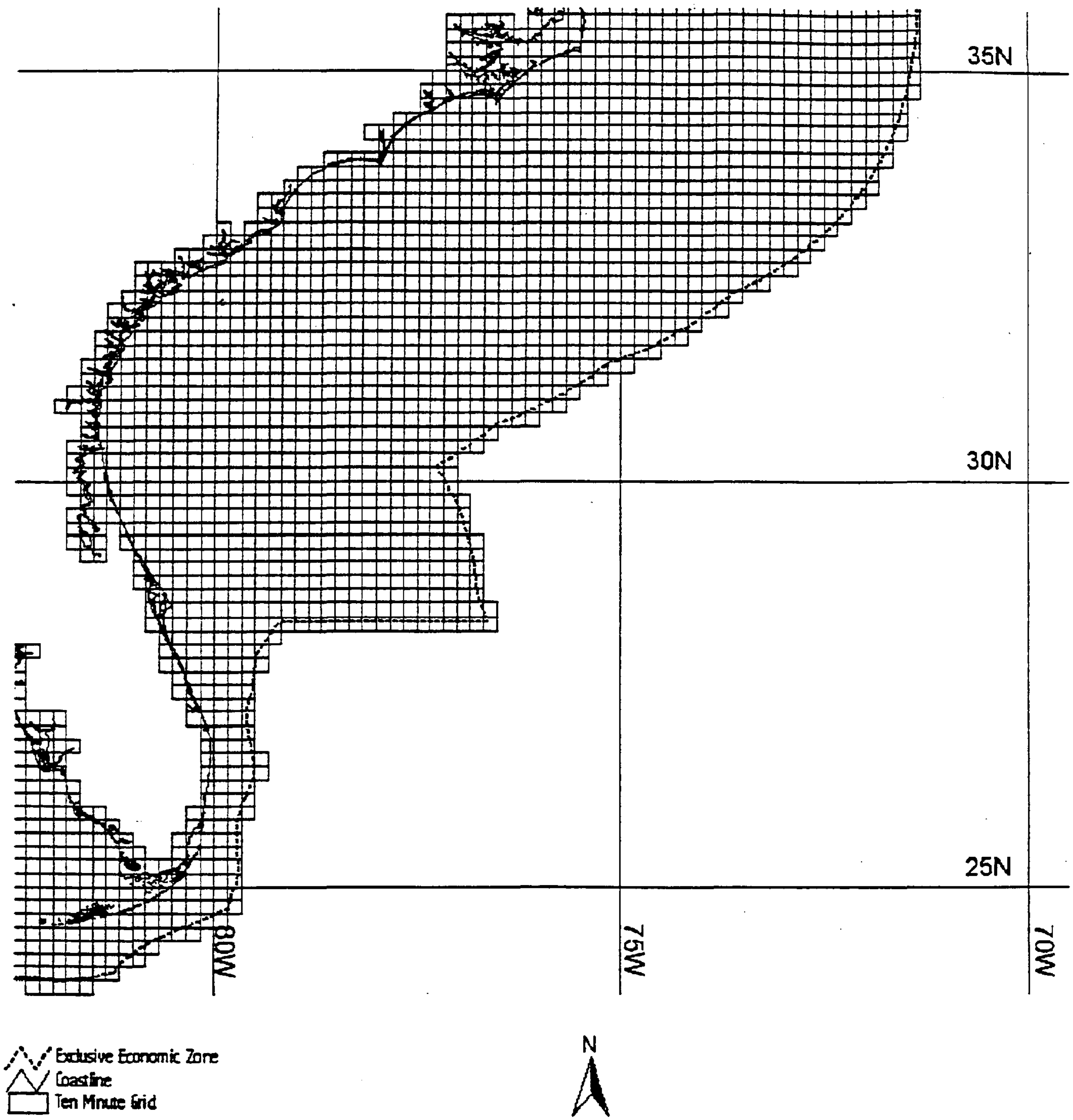


Figure 17. EFH for juvenile and adult dogfish south of Cape Hatteras, 100% of the epibenthic waters over the Continental Shelf (from the offshore boundary of the EEZ) through Florida.
Source: Cross pers. comm.

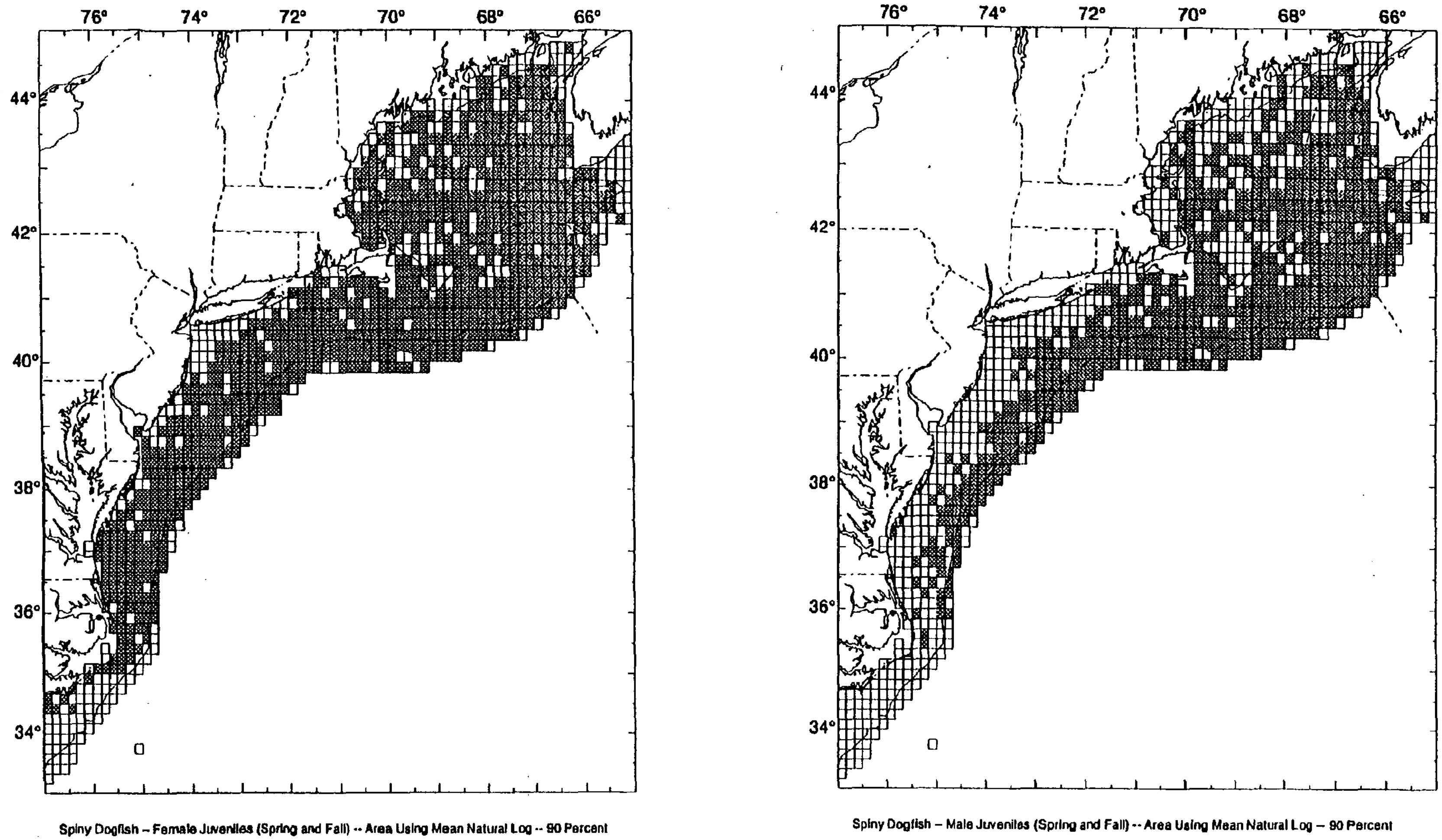


Figure 18. EFH for juvenile dogfish, areas which encompasses the top 90% of the areas where female and male juvenile dogfish were collected by the NEFSC trawl survey between 1963 and 1966.
Source: Cross pers. comm.

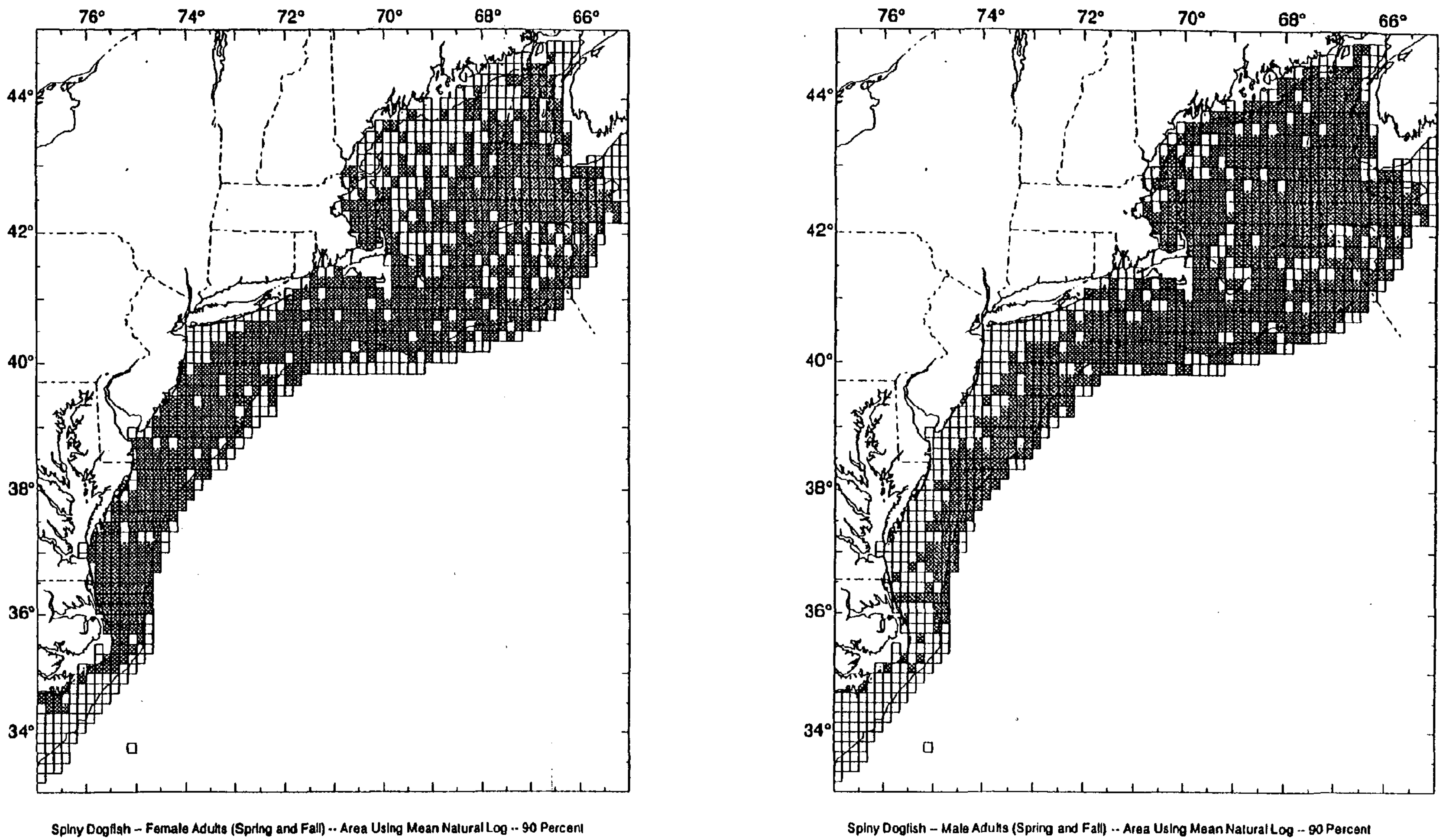


Figure 19. EFH for adult dogfish, areas that encompass the top 90% of the areas where female and male adult dogfish were collected by the NEFSC trawl survey between 1963 and 1996.
Source: Cross pers. comm.

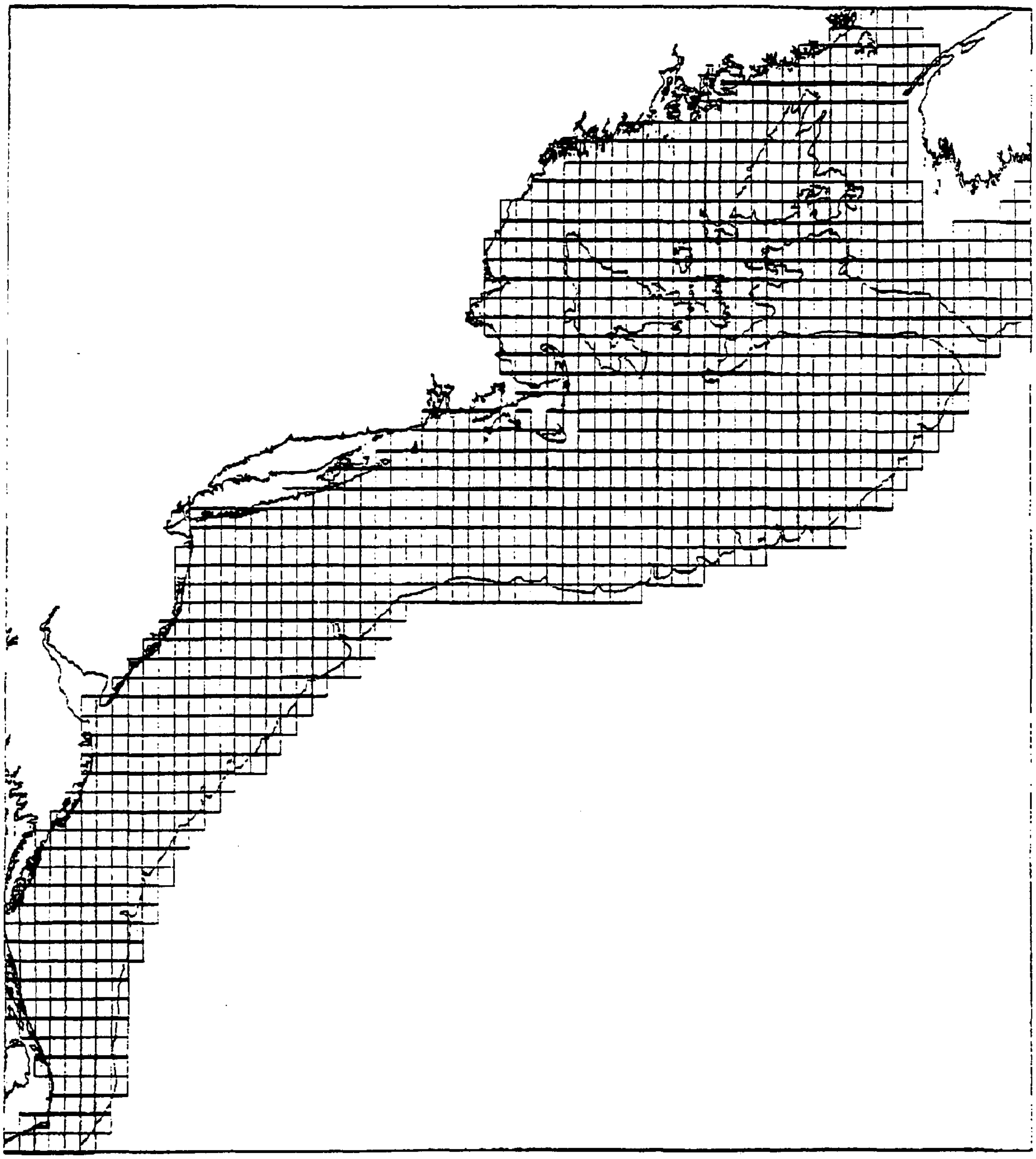


Figure 20. Blank 10 minute grid, north of Cape Hatteras, NC for input by the public on dogfish EFH.

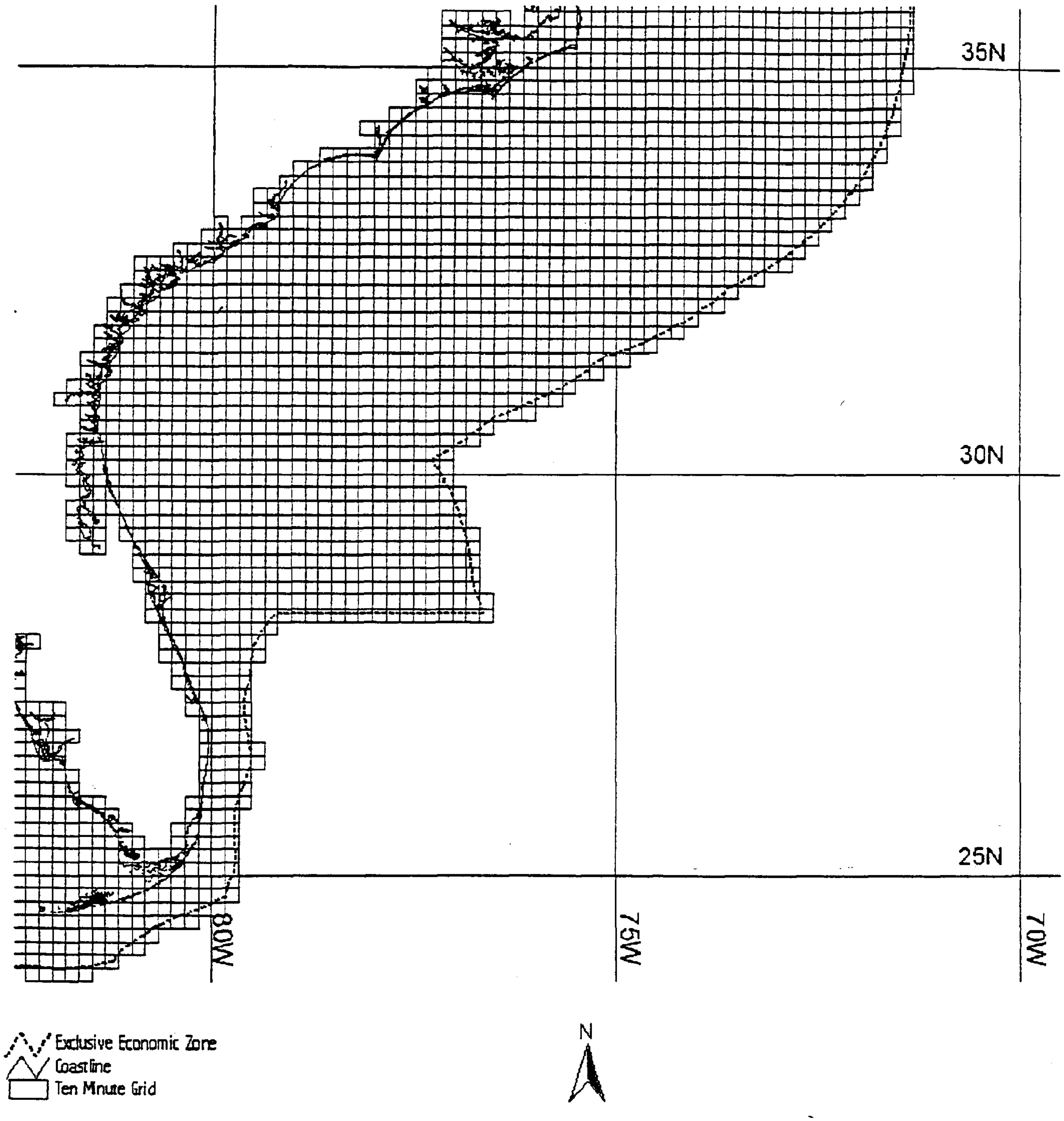


Figure 21. Blank 10 minute grid, south of Cape Hatteras, NC for input by the public on dogfish EFH.

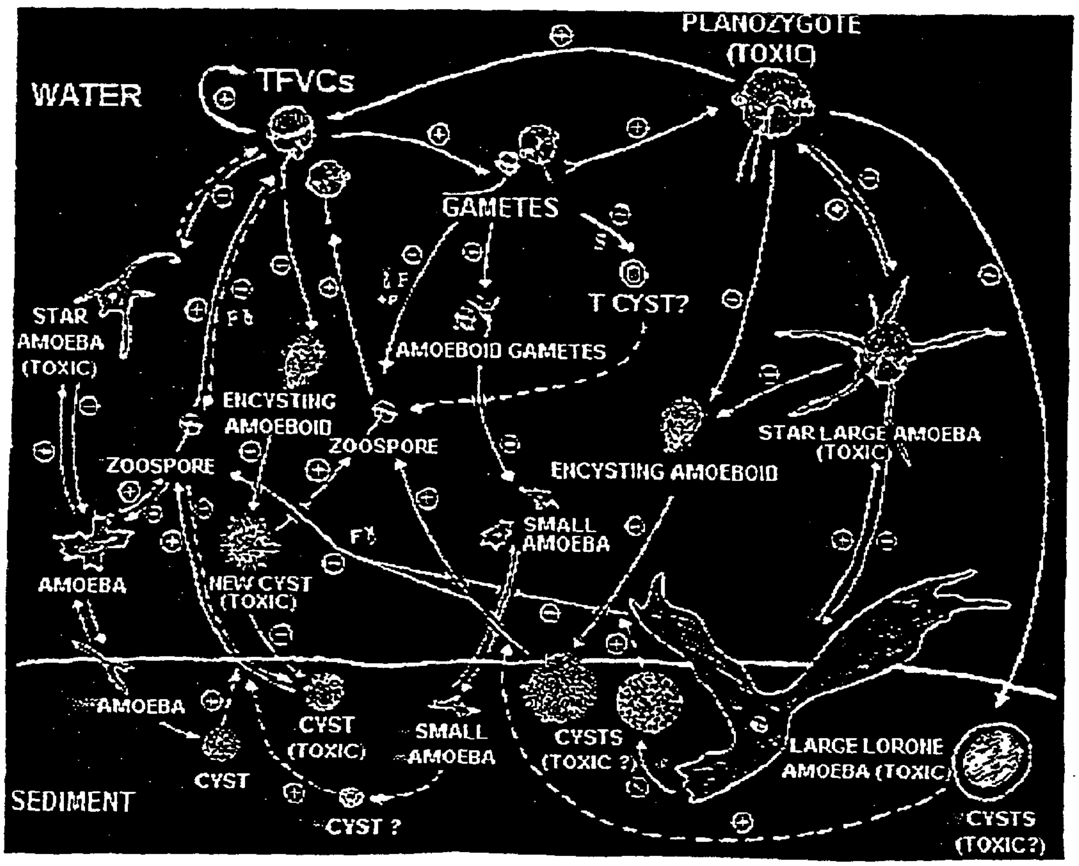


Figure 22. Diagrammatic life history of *Pfiesteria piscicida*.
Source: NCSU 1998.

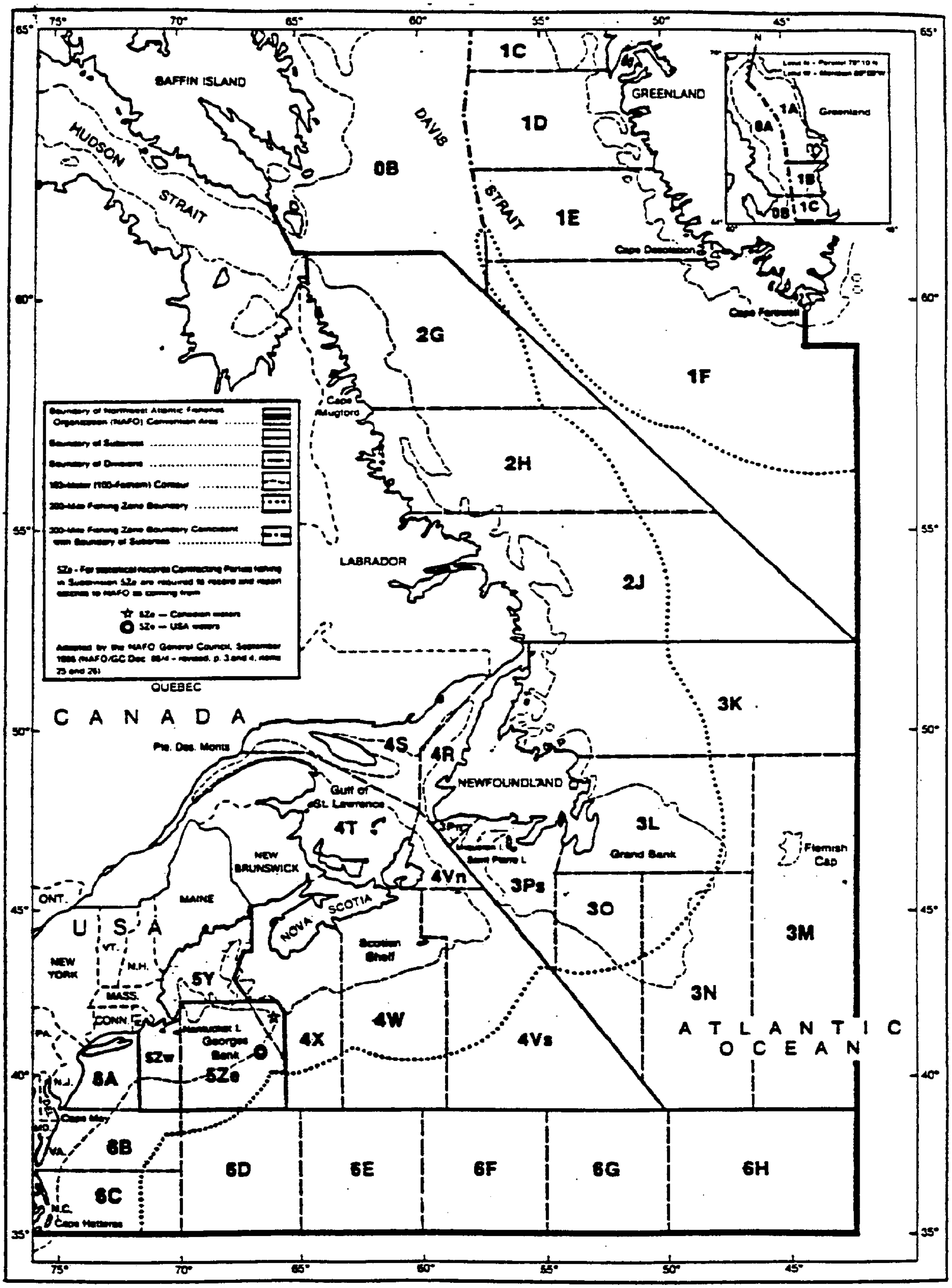


Figure 23. NAFO statistical areas used to report commercial landings in the Northwest Atlantic.

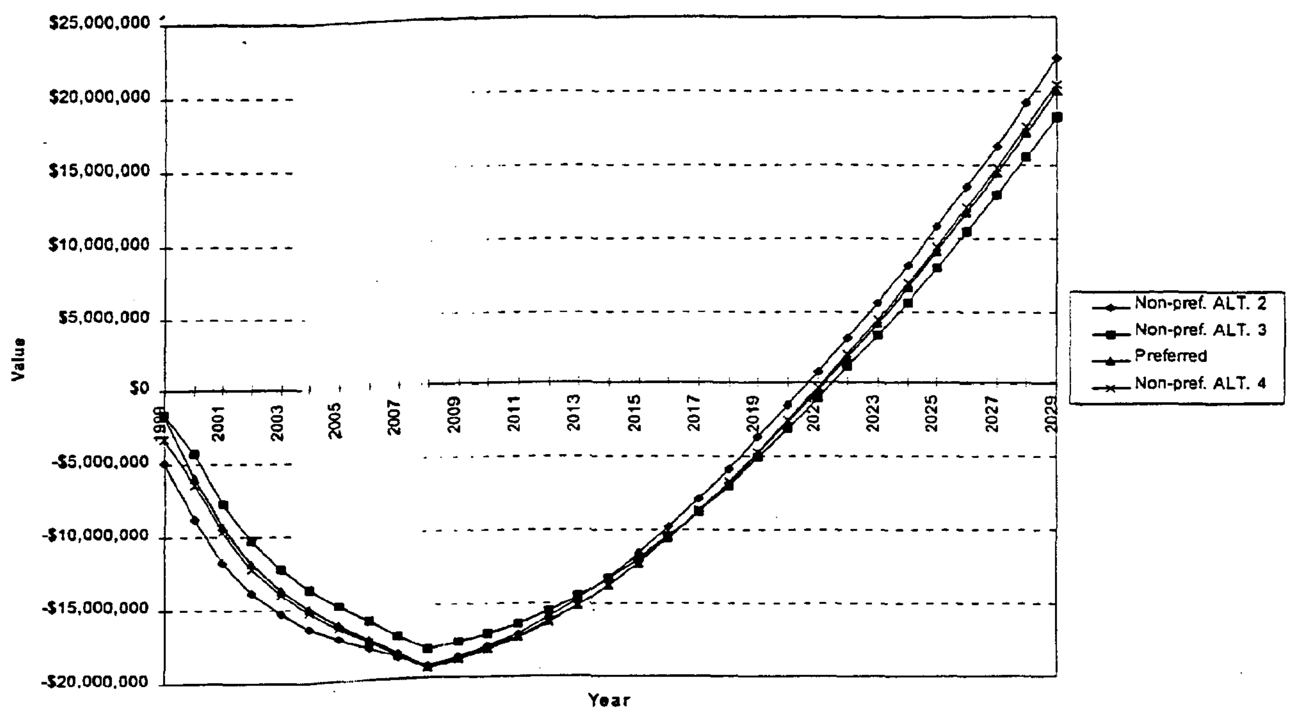


Figure 24. Management options minus status quo, (cumulative, no discounting).

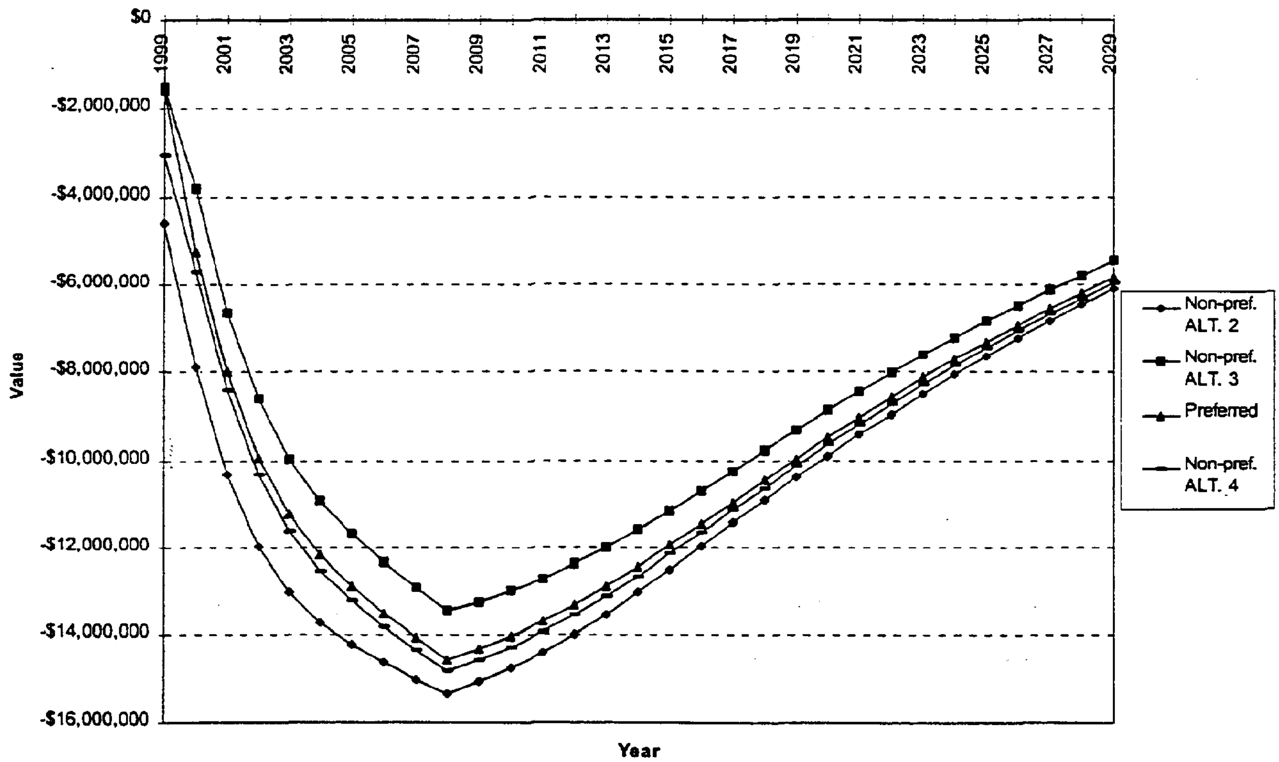


Figure 25. Management options minus status quo, (cumulative, disc.=7%).

APPENDIX 3. PROPOSED REGULATIONS

50 CFR PART 648

Fisheries of the Northeastern United States; Spiny Dogfish Fishery Management Plan

1. The authority citation for part 648 continues to read as follows:

Authority: 16 U.S.C. 1801 et seq.

2. The following would be added to Section 648.2 (Definitions):

Spiny dogfish means *Squalus acanthias*.

Spiny Dogfish Monitoring Committee means a committee made up of staff representatives of the MAFMC, NEFMC, the NMFS Northeast Regional Office, the Northeast Fisheries Science Center, and the states. The MAFMC Executive Director or a designee chairs the committee.

3. Add to Section 648.4 (commercial vessel permits):

(8) spiny dogfish vessels - Any commercial vessel of the United States must have been issued and carry on board a valid vessel permit to fish for, possess, or land spiny dogfish for sale in or from the EEZ.

4. Section 648.4 (Vessel and commercial permits), paragraph b, is revised to read as follows:

(b) *Permit conditions*. Any person who applies for a fishing permit under this section must agree as a condition of the permit that the vessel and the vessel's fishing activity, catch, and pertinent gear (without regard to whether such fishing occurs in the EEZ or landward of the EEZ, and without regard to where such fish or gear are possessed, taken or landed), are subject to all requirements of this part, unless exempted from such requirements under this part. All such fishing activities, catch, and gear will remain subject to all applicable state requirements. Except as otherwise provided in this part, if a requirement of this part and a management measure required by a state or local law differ, any vessel owner permitted to fish in the EEZ for any species managed under this part must comply with the more restrictive requirement. Owners and operators of vessels fishing under the terms of a summer flounder moratorium, scup moratorium, black sea bass moratorium permit or bluefish vessel permit or spiny dogfish vessel permit must also agree not to land summer flounder, scup, black sea bass, bluefish, or spiny dogfish respectively, in any state after NMFS has published a notification in the Federal Register stating that the commercial quota for that state or period has been harvested and that no commercial quota is available for the respective species. A state not receiving an allocation of summer flounder, scup, black sea bass, or bluefish either directly or through a coastwide allocation, is deemed to have no commercial quota available. Owners or operators fishing for surf clams and ocean quahogs within waters under the jurisdiction of any state that requires cage tags are not subject to any conflicting Federal minimum size or tagging requirements. If a surf clam and ocean quahog requirement of this part differs from a surf clam and ocean quahog management measure required by a state that does not require cage tagging, any vessel owners or operators permitted to fish in the EEZ for surf clams and ocean quahogs must comply with the more restrictive requirement while fishing in state waters. However, surrender of a surf clam and ocean quahog vessel permit by the owner by certified mail addressed to the Regional Administrator allows an individual to comply with the less restrictive state minimum size requirement, as long as fishing is conducted exclusively within state waters. If the commercial black sea bass quota for a period is harvested and the coast is closed to the possession of black sea bass north of 35 deg.15.3' N. lat., any vessel owners that hold valid commercial permits for both the black sea bass and the NMFS Southeast Region Snapper-Grouper fisheries may surrender their moratorium Black Sea Bass permit by certified mail addressed to the Regional Administrator and fish pursuant to their Snapper-Grouper permit, as long as fishing is conducted exclusively in waters, and landings are made, south of 35 deg.15.3' N. lat. A moratorium permit for the black sea bass fishery that is voluntarily relinquished or surrendered will be reissued upon the receipt of the vessel owner's written request after a minimum period of 6 months from the date of cancellation.

5. Spiny dogfish would be added to the species identified in section 648.5 (Operator permits), paragraph (a).

6. Spiny dogfish would be added to the species identified in section 648.6 (Dealer/processor permits), paragraph (a).

7. Spiny dogfish dealers would be added to section 648.7 (Record keeping and reporting requirements), paragraph (a)(1)(i) and (a)(2)(i).

8. Vessel owners with a commercial vessel permit for spiny dogfish would be added to section 648.7 (Record keeping and reporting requirements), paragraph (b)(1)(i).

9. Spiny dogfish would be added to the species identified in section 648.7 (Record keeping and reporting requirements), paragraph (c) (3).

10. Spiny dogfish would be added to the species identified in section 648.11 (At-sea sea sampler /observer coverage) (a) and (e).

11. Section 648.12 (Experimental Fishing) is revised to read as follows:

The Regional Administrator may exempt any person or vessel from the requirements of subparts B (Atlantic mackerel, squid, and butterfish), D (sea scallop), E (surf clam and ocean quahog), F (NE multispecies), G (summer flounder), H (scup), I (black sea bass), J (bluefish) or K (spiny dogfish) of this part for the conduct of experimental fishing beneficial to the management of the resources or fishery managed under that subpart. The Regional Administrator shall consult with the Executive Director of the Council regarding such exemptions for the Atlantic mackerel, squid, and butterfish, the summer flounder, the scup, the black sea bass, the bluefish and spiny dogfish fisheries.

12. The following would be added to section 648.14 (prohibition of finning):

Finning, the act of removing the fins of spiny dogfish and discarding the carcass, will be prohibited. Vessels which land spiny dogfish must land fins in proportion to carcasses, with a maximum of three fins per carcass. Fins may not be stored aboard a vessel after the first point of landing.

13. Subpart k (Management measures for the Spiny Dogfish Fishery) would be added as follows:

§ 648.200 Catch quotas and other restrictions.

(a) *Annual review*. The Spiny Dogfish Monitoring Committee will review the following data, subject to availability, on or before February 15 of each year to determine the total allowable level of landings (TAL) and other restrictions necessary to achieve a target fishing mortality rate (F) of 0.2 in 1999-2000; a target F of 0.03 in 2000-2009; and a target F of 0.11 thereafter: Commercial and recreational catch data; current estimates of fishing mortality; stock status; recent estimates of recruitment; virtual population analysis results; levels of noncompliance by fishermen or individual states; impact of size/mesh regulations; sea sampling data; impact of gear other than otter trawls and gill nets on the mortality of spiny dogfish; and any other relevant information.

(b) *Recommended measures.* Based on this review, the Spiny Dogfish Monitoring Committee shall recommend to the Joint Spiny Dogfish Committee of the MAFMC and NEFMC the following measures to assure that the F specified in paragraph (a) of this section will not be exceeded:

(1) A TAL set from a range of 0 to the maximum allowed to achieve the specified F.
(2) Restrictions on quantity of gill nets.

(c) *Seasonal allocation of quota*. The fishing year shall be defined as May 1 - April 30. The annual quota specified in paragraph (a) of this section shall be allocated into two semi-annual quota periods as follows: May 1-October 30 (57.9%) and November 1-April 30 (42.1%).

(d) *Annual fishing measures.* The Joint Spiny Dogfish Committee shall review the recommendations of the Spiny Dogfish Monitoring Committee. Based on these recommendations and any public comment, the Joint Spiny Dogfish Committee shall recommend to the MAFMC and NEFMC (Councils) measures necessary to assure that the applicable specified F will not be exceeded. The Councils shall review these recommendations and, based on the recommendations and any public comment, recommend to the Regional Administrator measures necessary to assure that the applicable specified F will not be exceeded. The Councils recommendations must include supporting documentation, as appropriate, concerning the environmental and economic impacts of the recommendations. The Regional Administrator shall review these recommendations. After such review, the Regional Administrator will publish a proposed rule in the Federal Register by February 15 to implement a coastwide commercial quota for the commercial fishery. After considering public comment, the Regional Administrator will publish a final rule in the Federal Register to implement the measures necessary to assure that the applicable specified F will not be exceeded.

§ 648.201 Closures.

(a) *EEZ closure*. The Regional Administrator shall close the EEZ to fishing for spiny dogfish by commercial vessels for the remainder of the semi-annual fishing year by publishing notification in the Federal Register if he/she determines that the specified quota is expected to be exceeded.

§ 648.202 Gear restrictions.

Commercial gill net vessels fishing for spiny dogfish will be prohibited from fishing more than a total of 80 nets (50 fathoms each).

§ 648.203 Framework specifications.

(a) *Within season management action.* The Councils may, at any time, initiate action to add or adjust management measures if it finds that action is necessary to meet or be consistent with the goals and objectives of the Spiny Dogfish FMP.

(1) *Adjustment process.* After a management action has been initiated, the Councils shall develop and analyze appropriate management actions over the span of at least two Council meetings. The Councils shall provide the public with advance notice of the availability of both the proposals and the analysis and opportunity to comment on them prior to and at the second Council meeting. The Council's recommendation on adjustments or additions to management measures must come from one or more of the following categories: Minimum fish size, maximum fish size, gear requirements, restrictions or prohibitions (including, but not limited to, mesh size restrictions and net limits), regional gear restrictions, permitting restrictions and reporting requirements, recreational fishery measures including possession and size limits and season and area restrictions, commercial season and area restrictions, commercial trip or possession limits, fin weight to spiny dogfish landing weight restrictions, onboard observer requirements, commercial quota system including commercial quota allocation procedure and possible quota set asides to mitigate bycatch, recreational harvest limit, annual quota specification process, FMP Monitoring Committee composition and process, designation of essential fish habitat, overfishing definition and related thresholds and targets, regional season restrictions (including option to split seasons), restrictions on vessel size (LOA and GRT) or shaft horsepower, target quotas, measures to mitigate marine mammal entanglements and interactions, any other management measures currently included in the FMP, and any other commercial or recreational management measures.

(2) *MAFMC and NEFMC recommendation.* After developing management actions and receiving public testimony, the Councils shall make a recommendation to the Regional Administrator. The Council's recommendation must include supporting rationale and, if management measures are recommended, an analysis of impacts and a recommendation to the Regional Administrator on whether to issue the management measures as a final rule. If the Councils recommend that the management measures should be issued as a final rule, they must consider at least the following factors and provide support and analysis for each factor considered:

(i) Whether the availability of data on which the recommended management measures are based allows for adequate time to publish a proposed rule, and whether regulations have to be in place for an entire harvest/fishing season.

(ii) Whether there has been adequate notice and opportunity for participation by the public and members of the affected industry in the development of the Councils recommended management measures.

(iii) Whether there is an immediate need to protect the resource.

(iv) Whether there will be a continuing evaluation of management measures adopted following their implementation as a final rule.

(3) *Regional Administrator action.* If the Councils recommendation includes adjustments or additions to management measures and, after reviewing the Councils recommendation and supporting information:

(i) If the Regional Administrator concurs with the Councils recommended management measures and determines that the recommended management measures should be issued as a final rule based on the factors specified in paragraph (b)(2) of this section, the measures will be issued as a final rule in the Federal Register.

(ii) If the Regional Administrator concurs with the Councils recommendation and determines that the recommended management measures should be published first as a proposed rule, the measures will be published as a proposed rule in the Federal Register. After additional public comment, if the Regional Administrator concurs with the Councils recommendation, the measures will be issued as a final rule in the Federal Register.

(iii) If the Regional Administrator does not concur, the Councils will be notified in writing of the reasons for the non-concurrence.

(b) *Emergency action.* Nothing in this section is meant to derogate from the authority of the Secretary to take emergency action under section 305(e) of the Magnuson-Stevens Act.