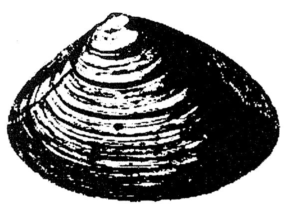
AMENDMENT 13

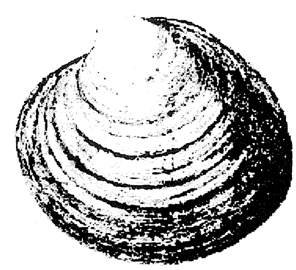
TO THE

ATLANTIC SURFCLAM AND OCEAN QUAHOG FISHERY MANAGEMENT PLAN

(Includes: Final Supplemental Environmental Impact Statement, Regulatory Impact Review, Regulatory Flexibility Analysis, Social Impact Assessment, and Essential Fish Habitat Assessment)

VOLUME 1





JUNE 2003

Mid-Atlantic Fishery Management Council
in cooperation with the
National Marine Fisheries Service

Draft adopted by Council: May 1, 2002
Final adopted by Council: January 22, 2003
Final approved by NOAA: December 16, 2003

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

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
PROGRAM PLANNING AND INTEGRATION
Silver Spring, Maryland 20910

SEP 26 2003

Dear Reviewer:

In accordance with provisions of the National Environmental Policy Act of 1969 (NEPA), we enclose for your review the Final Supplemental Environmental Impact Statement (FSEIS) for Amendment 13 to the Atlantic Surf Clam and Ocean Quahog Fishery Management Plan. This document is also available at http://www.mafmc.org/mid-atlantic/publications.

The Council has prepared this FSEIS under NEPA to assess the potential effects of the proposed actions on the human environment. There are five issues addressed in this Amendment: 1) a new surf clam overfishing definition, 2) analyses of fishing gear impacts on essential fish habitat, 3) the ability to suspend or adjust the surf clam minimum size limit through a framework adjustment, 4) multi-year fishing quotas, and 5) inclusion of a vessel monitoring system, when such a system is economically viable.

Any written comments or questions you have should be submitted to Daniel T. Furlong, Executive Director, Mid-Atlantic Fishery Management Council, Federal Building, Room 2115, 300 South New Street, Dover, Delaware, 19904-6790 by November 10, 2003, or faxed to 302-674-5399. Also, one copy of your comments should be sent to NOAA Office of Strategic Planning in Room 15603, 1315 East-West Highway, Silver Spring, Maryland 20910.

Sincerely,

Joyce Wood

Joyce Wood
NEPA Coordinator

Enclosure

Supplement to the Initial Regulatory Flexibility Analysis for Amendment 13 to the Fishery Management Plan for Atlantic Surf Clams and Ocean Quahogs

Prepared by the Mid-Atlantic Fishery Management Council in Cooperation with the Northeast Regional Office of the National Marine Fisheries Service

August 2003

As required by section 603 of the Regulatory Flexibility Act, a description of the reasons why this action is being considered, and the objectives and legal basis of this proposed rule can be found in Sections 1.0 and 1.1 of the Final Environmental Impact Statement (FEIS) for the action and are not repeated here. There are no recordkeeping, reporting, or other compliance costs resulting from this action. The proposed rule would not duplicate, overlap, or conflict with any other Federal rules.

Meanwhile, in consideration of the remaining measures in this action, all of the affected businesses (fishing vessels) are considered small entities under the standards described by the Small Business Administration because they have annual returns (revenues) that do not exceed $3.5 million annually.

The economic impacts of actions were analyzed by employing quantitative approaches to the extent possible. Effects on profitability associated with the proposed management measures should be evaluated by looking at the impact the proposed measures would have on individual vessel costs and revenues. However, in the absence of cost data for individual vessels engaged in these fisheries, changes in gross revenues are used as a proxy for profitability.

The proposed action could affect any vessel holding an active Federal permit for these species. In 2001, there were 51 vessels that landed either surf clams (21 vessels), ocean quahogs (16 vessels), or both (14 vessels). There were 31 vessels in 2001 that fished under the Federal limited access Maine mahogany quahog permit for Maine ocean quahogs.

Management measures contained in this rule would establish multi-year quotas and add the suspension of the surf clam minimum size limit and adjustment of the minimum size to the list of frameworkable measures under the FMP.

None of the proposed management measures in this rule would result in a substantial change in revenues or profitability of vessels comprising these fisheries. Although additional alternatives were considered for these management measures, the preferred alternative would minimize economic impacts to the greatest extent possible.

The proposal to revise the overfishing definition for surf clams does not alter the optimum yield of the fishery, a basis for determining annual quotas, and does not directly impact gross revenues. Therefore, no change to vessel profitability is expected from this revision. However, an initial regulatory flexibility analysis must be prepared at the times when quotas or other management measures that control landings are proposed. The Council considered three alternative overfishing definitions, none of which would meet the requirements of National Standard 1 of the Magnuson-Stevens Act. As in the case of the preferred alternative, none of these alternatives would directly affect the gross revenues of individual vessels.

The proposal to establish multi-year quotas and frameworkable minimum size limits and adjustments for surf clams are purely administrative and will not directly impact gross revenues of individual vessels. However, the Council will be required to prepare an initial regulatory flexibility analysis for each quota set by the Council and for each surf clam minimum size limit adjustment, if applicable.

The Council considered two alternatives to the multi-year quota measure including the status quo and an alternative that would set multi-year quotas without annual review. The Council also considered two alternatives to the minimum size limits and adjustments including the status quo and an alternative to adjust minimum sizes when the multi-year decisions occur. All alternatives are purely administrative in nature. However, as explained above, any changes to annual quotas or adjustments to surf clam minimum size that could result from any alternatives considered would require, subject to the preparation of a proposed rule, preparation of regulatory flexibility analyses at that time.

The Council is proposing to establish a vessel monitoring program at a later point in time since the implementation of a system is dependent upon the determination by the Regional Administrator of an economically viable monitoring system. If and when the Regional Administrator determines that an economically viable monitoring system is achievable, the Council must prepare an initial regulatory flexibility analysis that fully examines the compliance costs associated with that system. A mandatory VMS requirement would be implemented through proposed and final rulemaking by a regulatory amendment.

The Council proposes no change to existing management measures to address fishing gear impacts on EFH at this time. Therefore, there are no impacts on vessel profitability resulting from this aspect of Amendment 13. However, the Council analyzed potential closures of three areas as alternatives to the no action measure including a closing of the Georges Bank Area, the Southern New England East Area, and the Habitat Area of Particular Concern (HAPC) for Tilefish. For Georges Bank, there would be no economic impact to vessels since this area has been closed to fishing for surf clams and ocean quahogs for over ten years and no landings have been recorded from that area during the closure time. For Southern New England East, the Council concluded that there would be minimally negative economic impacts to vessels from a loss of potential revenue. Although 12 percent of the ocean quahog biomass is located in the area, the Council believes that effort would be redirected on other areas resulting in only a minimal economic cost from the closure. A closure in this area would most likely affect vessels fishing out of Massachusetts and Rhode Island since increased fuel costs needed to steam to another fishable area could reduce their profitability. The Council estimated that this closure would reduce gross revenues for quahog vessels by $1,065 per trip and for surf clam vessels by $2 per trip. The Council determined that the closure of the Tilefish HAPC could result in the largest negative impact to quahog vessels, with a loss in profitability of $2,637 per trip and a loss in profitability to surf clam vessels of $71 per trip. However, economic impacts from the closure of Tilefish HAPC are likely to be grossly overestimated relative to the actual area that would be specified in any regulations. The impacts are more a function of creating complete 10-minute squares for closures and attempting to minimize the jagged nature of the 250-foot (76.2 meter) bathymetric contour. Based purely on sediment preference, it is unlikely ocean quahogs and tilefish would coexist in concentrated areas.

Results of the IRFA indicate that there are no significant alternatives considered that would minimize adverse economic impacts or increase economic benefits relative to the proposed management measures contained in this proposed rule. The economic impacts of actions were analyzed by employing quantitative approaches to the extent possible. Effects on profitability associated with the proposed management measures should be evaluated by looking at the impact the proposed measures would have on individual vessel costs and revenues. However, in the absence of cost data for individual vessels engaged in these fisheries, changes in gross revenues are used as a proxy for profitability.

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EXECUTIVE SUMMARY

Amendment 13 to the Atlantic Surfclam and Ocean Quahog Fishery Management Plan (FMP), prepared by the Mid-Atlantic Fishery Management Council (MAFMC or Council), is intended to manage the Atlantic surfclam and ocean quahog fisheries pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSFMCA) of 1976, as amended by the Sustainable Fisheries Act (SFA) in October 1996. The purpose of this Amendment is to rectify the two disapproved issues (surfclam overfishing definition and fishing gear impacts to EFH) from Amendment 12 (MAFMC 1998), consider the establishment of multi-year quotas, implement a vessel monitoring system that is satisfactory to both the NMFS and the industry, and add to the list of framework measures the suspension of the surfclam minimum size limit and adjustment of the minimum size.

Fishery Management Plans and amendments must meet the requirements of a number of Federal laws and regulations. In addition to MSFCMA, these laws and regulations include the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), Executive Order 12866, and the Regulatory Flexibility Act (RFA). This document has been developed to meet all these Federal requirements and contains all the elements of an FMP including the Final Supplemental Environmental Impact Statement (FSEIS), Regulatory Impact Review (RIR), Regulatory Flexibility Analysis (RFA), Social Impact Assessment (SIA) and the Essential Fish Habitat Assessment (EFH Assessment).

The FMP modified by this Amendment was implemented in 1977 (MAFMC 1977). The management unit is all Atlantic surfclams (*Spisula solidissima*) and ocean quahogs (*Arctica islandica*) in the Atlantic EEZ. In 1988 the American Malacological Union officially changed the common name of "surf clam" to the one word name "surfclam". This was published in the American Fisheries Society special publication 16 entitled *Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Mollusks* (American Fisheries Society 1988). The ocean quahogs managed in this FMP include a small-scale fishery in eastern Maine that harvests small ocean quahogs which are generally sold for the half-shell market. Locally these small ocean quahogs off the coast of Maine are known as "mahogany quahogs" and have been under Council management since implementation of Amendment 10 (MAFMC 1997). The Maine ocean quahog fishery occurs in both state and Federal waters, but anyone fishing in the EEZ must comply with all Federal regulations.

The overall goal of this management plan is to continue the effective management of these two resources while preventing any future overfishing. To meet the overall goal, the following objectives were adopted in Amendment 8(MAFMC 1988):

1. Conserve and rebuild Atlantic surfclam and ocean quahog resources by stabilizing annual harvest rates throughout the management unit in a way that minimizes short term economic dislocations.

2. Simplify to the maximum extent the regulatory requirement of surfclam and ocean quahog management to minimize the government and private cost of administering and complying with regulatory, reporting, enforcement, and research requirements of surfclam and ocean quahog management.

3. Provide the opportunity for industry to operate efficiently, consistent with the conservation of surfclam and ocean quahog resources, which will bring harvesting capacity in balance with processing and biological capacity and allow industry participants to achieve economic efficiency including efficient utilization of capital resources by the industry.

4. Provide a management regime and regulatory framework which is flexible and adaptive to unanticipated short term events or circumstances and consistent with overall plan objectives and long term industry planning and investment needs.

The fishing year for surfclams and ocean quahogs is the twelve (12) month period beginning 1 January each year.

Management Strategy

The 1996 SFA, which reauthorized and amended the MSFCMA, 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. The Council intends to continue to prevent overfishing of these two resources, as they have done during the previous two plus decades of management, and meet the purposes specified in the SFA.

When Amendment 12 (MAFMC 1998) was partially approved in April of 1999 the surfclam overfishing definition was disapproved by the Secretary because it was based on the sustainability of the Northern New Jersey area, where 80+% of the fishery occurred in the past decade. However, it was determined that this proxy was too conservative and did not represent global values over the entire range of the resource. In the summer of 1999 a research survey was conducted that lead to the December 1999 SARC (Appendix 1) where a new surfclam overfishing definition was proposed for the Council. The Council unanimously adopted this new overfishing definition at its meeting in March 2000.

The Council's action in this amendment is intended to replace the disapproved overfishing definition that was submitted as part of Amendment 12. The Council's action was based on the advice of the 30th SAW and, as such, this new overfishing definition should meet the concerns of NMFS expressed in the Regional Administrator's April 28, 1999 partial approval letter.

This proposed surfclam definition is global rather than focused only on the Northern New Jersey area, and as such, should be approvable by the Center. Table 1 details the specific reference points and should replace the surfclam portion of the overfishing table on page 121 of Amendment 12. The approved ocean quahog reference points are included for comparison.

With regards to the other disapproved measure in Amendment 12, fishing gear impacts to EFH, the NMFS, NEFMC, and the MAFMC sponsored a workshop on the effects of fishing gear on marine habitats in October 2001. Based on the results of that workshop the Council concluded that there is sufficient information that clam dredges could have an effect on EFH if the gear is fished improperly or in the wrong sediment type. For example, hydraulic clam dredges would have a significant impact to a coral reef or an SAV bed if such gear was used in a stable, fragile, structured, environment like one of those environments. However, the clam resources are concentrated in high energy sandy sediment and the fishing gear has evolved over the past five decades to fish most efficiently in this type of sandy sediment. This evolution of the fishing gear has minimized the effect on fishery habitat (Wallace and Hoff in press). Natural events have more effect on the benthic community than this type of fishing gear since all of the fishing activity takes place in sandy shallow water. Chiarella *et al.* (2002) describing the October 2001 workshop concluded that hydraulic clam dredges were not a major concern relative to otter trawls and scallop dredges. All of the hydraulic clam dredging for an entire year, would impact about 100 square nautical miles of bottom (Table 2). Putting this in context, this 100 square nautical miles is roughly the area of one ten minute square, and there are over 1200 ten minute squares in the EEZ between Cape Hatteras and Georges Bank. Thus, it does not appear that either surfclam or ocean quahog EFH is effected by fishing gear.

A qualitative EFH vulnerability analysis conducted by Stevenson *et al.* (in press) suggests that the EFH of several species may be vulnerable to impacts associated with the use of hydraulic clam dredges. This includes black sea bass (juveniles and adults), scup (juveniles), ocean pout (all life stages), red hake (juveniles), silver hake (juveniles), winter flounder (juveniles and adults), and Atlantic sea scallops (juveniles). (See section 2.2.5.5.2 for more detail)

Based upon existing information the Council concluded that there may be potential adverse effects on EFH from the hydraulic clam dredge, but concurred with the workshop panel (Appendix 4). The panel concluded that as the clam fishery is currently prosecuted, in sand habitats, there are potentially large, localized impacts to biological and physical structure, however the recovery time is relatively short. Since the recovery time is relatively short (hours to months) the adverse impacts to this high energy environment can be considered temporary. The preamble to the EFH Final Rule (50 CFR Part 600) defines temporary impacts as those that are limited in duration and that allow the particular environment to recover without measurable impact. Since these impacts are potentially effecting a relatively small portion (approximately 100 square nautical miles) of the overall large uniform area of high energy sand along the continental shelf (approximately 54,900 square nautical miles) these adverse impacts can be considered minimal. Additionally, the 100 square nautical miles impact each year (approximately 1.5 ten minute squares of latitude and longitude) represents a small fraction of the total EFH of the above listed vulnerable EFH and species. The preamble of the EFH Final Rule defines minimal impacts as those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions.

Although the Council has concluded that the clam fishery has an adverse effect on EFH that is no more than minimal and temporary in nature, a NEPA analysis was conducted in order to verify that any adverse effects from clam dredging were indeed minimized to the extent practicable. Based upon guidance from the Assistant Administrator (January 22, 2001), if information is inconclusive, a NEPA analysis should examine alternatives that could be taken in the face of uncertainty. For NEPA purposes, the guidance from the Assistant Administrator stated that the analysis of alternatives needs to consider explicitly a range of management measures for minimizing potential adverse effects, and the practicability and consequences of adopting those measures. The advise from Dr. Hogarth continues: "In other words, if there is evidence that a fishing practice may be having an identifiable adverse effect on EFH, even if there is no conclusive proof of adverse effects, it is not sufficient to conclude *prima facie* that no new management measures are necessary without first conducting a reasonably detailed alternatives analysis."

Alternative Management Measures

The Council adopted two preferred management measures to meet the objectives of the FMP and rectify the two disapproved sections of Amendment 12. The Council considered a number of alternatives that address the three additional issues included here (a complete description of these management measures is given in section 1.2). These alternatives are as follows:

1. Overfishing definition is the preferred alternative as identified in Table 1, there are three other non-preferred alternatives.
2. Fishing gear impacts to EFH retains the no action alternative with additional clarification as the preferred alternative, there are eight other non-preferred alternatives.
3. Three alternatives for multi-year quotas, with the Council recommending multi-year (up to three years) quotas with an annual review.
4. Three alternatives for the suspension of the surfclam minimum size limit, with the Council adding to the list of framework management measures the suspension of the surfclam minimum size limit and future adjustment to the minimum size.
5. Four alternatives for vessel monitoring - type system (VMS), with the Council recommending mandatory implementation of an electronic tracking system that is satisfactory to NMFS and the industry when such a system is economically viable.

After the public hearings, at the January 2003 Council meeting, the Council unanimously approved (with RA always abstaining so as to preserve the Secretary's options) both the preferred overfishing definition and the no action alternative for fishing gear impacts to EFH. The Council also unanimously approved a multi-year quota up to three years with an annual review. The Council voted overwhelmingly (15 to 1 with RA abstaining) for implementation of a mandatory electronic tracking system that is satisfactory to the NMFS and the industry. The Council could not come to closure on the reversal of regulatory language for the suspension of the surfclam minimum size limit, but instead decided to add to the list of framework management measures both the suspension of the surfclam minimum size limit and an adjustment of the minimum size for surfclams.

Summary of Impacts from the Management Measures

Surfclams are not overfished, nor do they appear likely to be in the near future. Section 648.71 of 50 CFR specifies that annual quotas for surfclams be set between 1,850,000 and 3,400,000 bushels (31.5 to 57.8 million pounds of meats) . This is the OY range (always less than the MSY) and the OY range will remain at "status quo" based upon the new overfishing definition at this time. The Council will await the results of the upcoming assessment to ascertain whether a change in the OY range is warranted. Therefore there is no reason that this new overfishing definition for surfclams will have any biological impacts, economic impacts, social impacts, effects on essential fish habitat or effects on marine mammals, sea turtles, or seabirds.

The Council concluded from the fishing gear impacts workshop (Appendix 4) that there is sufficient information that clam dredges could have an effect on EFH if the gear is fished improperly or in the wrong sediment type. For example, hydraulic clam dredges would have a significant impact to a coral reef or an SAV bed if such gear were used in a stable, fragile, structured, environment like one of those environments. However, the clam resources are concentrated in high energy sandy sediment and the fishing gear has evolved over the past five decades to fish most efficiently in this type of sandy sediment. It does not appear that either surfclam or ocean quahog EFH is effected by fishing gear. The Council concluded that there may be potential adverse effects on EFH from the hydraulic clam dredge, but concurred with the panel that as the fishery is currently prosecuted any impacts are temporary and minimal. Since the preferred alternative is the no action, there would be no biological impacts, economic impacts, social impacts, effects on essential fish habitat, or effects on marine mammals, sea turtles, or seabirds from the current situation. Closed area non preferred alternatives vary widely in their social and economic impacts, while the biological benefits are largely unquantifiable at this time.

Implementation of multi-year quotas would allow for more efficient use of the regulatory process in that time and effort could be saved in the monitoring cycle, alternatives development, notice, comment, and final regulation cycles. There should be minimal biological, economic or social impact of allowing multi-year (up to three years) quota setting. This is mostly an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and possibly the industry by considering this issue in this amendment.

NMFS needs to annually conduct a finding and publish a regulatory action to suspend the minimum surfclam size limit if the Council recommends this course of action. There has not been a minimum size limit imposed since implementation of the ITQ program in 1990. The minimum size limit was necessary after the 1976 anoxic event off of New Jersey which killed much of the benthic fauna over a large area, and resulted in only small surfclams being available for numerous years. Additionally, at that time, the resource as a whole had been overfished, industry was not getting sufficient amounts of large clams for the strip market, and ITQs had not been implemented which were all factors in the implementation of the minimum size limit. At the January 2003 Council meeting where these issues were fully discussed and the amendment voted on for approval, the Council could not come to closure on this one issue. Some in industry argued effectively that should a size limit be needed, that it is easier to implement with the status quo rather than reversing the procedure. The final Council compromise was to add to the list of framework items (established in Amendment 12) the suspension of the surfclam minimum size limit and adjustment of the minimum size. By simply adding to the list these two measures, no impacts are expected. When a framework management measure is proposed the Council would need to fully evaluate all the impacts at that time. Thus, there should be no biological impact, economic impact, social impact, effect on essential fish habitat, or effect on marine mammals, sea turtles, or seabirds of adding these two measures to the framework list at this time.

A vessel monitoring system (VMS) has been in place in New England for the past several years for Atlantic sea scallops, multispecies, and Atlantic herring using a costly product of a company called Boatracs. A VMS for these two fisheries could replace the burdensome call-in system and provide accurate location data that could be useful in stock assessments and other analyzes. There should be no biological impact, no effect on essential fish habitat, and no effect on protected species from implementing a vessel monitoring-type system. There will be some economic impacts of a VMS and some minor social impacts. This is mostly an administrative issue where the Council is attempting to reduce the workload for the industry and provide more accurate, timely, and less expensive data for NMFS and the Council. The Council is also encouraging an electronic data reporting system that could be used to replace either or both the vessel and processor logbooks which are currently filled out in paper. It is possible that an electronic data reporting system could be combined with a VMS-type system for the vessels which would allow for additional efficiencies, i.e. replacement of both the call-in system and the vessel logbooks with one new system. Significant work is ongoing among the NEFSC, NERO, industry, and Council staff to develop an affordable, workable, efficient electronic reporting system. The Council approved mandatory implementation of an electronic tracking system when one is designed that is satisfactory to the NMFS and industry. The Council recommends that the RA implement this system when an economically viable system is available for the industry based on the advise of the Council.

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APPENDICES

*Note that (FSEIS) identifies sections of the FMP required for the Final Supplemental Environmental Impact Statement

1.0 INTRODUCTION

Amendment 13 to the Atlantic Surfclam and Ocean Quahog Fishery Management Plan (FMP), prepared by the Mid-Atlantic Fishery Management Council (MAFMC or Council), is intended to manage the Atlantic surfclam and ocean quahog fisheries pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSFMCA) of 1976, as amended by the Sustainable Fisheries Act (SFA) in October 1996. The purpose of this amendment is to rectify the two disapproved issues (surfclam overfishing definition and fishing gear impacts to EFH) from Amendment 12 (MAFMC 1998), consider the establishment of multi-year quotas, implement a vessel monitoring system that is satisfactory to both the NMFS and the industry, and add to the list of framework measures the suspension of the surfclam minimum size limit and adjustment of the minimum size.

Fishery Management Plans and amendments must meet the requirements of a number of Federal laws and regulations. In addition to MSFCMA, these laws and regulations include the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), Executive Order 12866, and the Regulatory Flexibility Act (RFA). This document has been developed to meet all these Federal requirements and contains all the elements of an FMP including the Final Supplemental Environmental Impact Statement (FSEIS), Regulatory Impact Review (RIR), Regulatory Flexibility Analysis (RFA), Fishery Impact Statement (FIS), Social Impact Assessment (SIA), and the Essential Fish Habitat Assessment.

The Council prepared this FSEIS under NEPA to assess the potential effects of the proposed actions on the human environment. There are five issues addressed in this amendment: 1) a new surfclam overfishing definition, 2) analyses of fishing gear impacts on EFH, 3) addition to the list of framework management measures the suspension of the surfclam minimum size limit and adjustment of the minimum size, 4) multi-year (up to three years) quotas, and 5) inclusion of a vessel monitoring system (VMS) that is satisfactory to both the NMFS and the industry. The NEPA requires the Council conduct scoping meetings to inform interested parties of the proposed action and alternatives, and to solicit comments on the scope of issues included in the FSEIS. The Council held a scoping hearing on 21 March 2001 and accepted comments from 7 March through 6 April 2001. The Council evaluated a reasonable range of alternatives under each of the proposed actions. Once the Council approved the alternatives in a hearing draft (May 2002) the public had a chance to comment through a public hearing process. Specifically, upon the release of the Notice of Availability for the draft amendment/DSEIS, the public had a minimum of 45 days to review and comment on the document. There was a series of three public hearings held on this Amendment 13. Hearings were held in Maine on September 24, in New Jersey on September 30, and in Delaware on October 2 of 2002 (Appendix 7). Six comment letters were received by the Council, with three from government agencies (NMFS, EPA, and the State of Maine) and three from industry representatives (Appendix 8). After the public hearing process was complete, and after consideration of all public comments, the Council choose the alternatives and recommended the appropriate action be implemented by NMFS at their January 2003 Council meeting.

1.1 PURPOSE AND NEED FOR ACTION

1.1.1 Problems for Resolution

This Amendment 13 for the surfclam and ocean quahog fisheries will rectify the two disapproved issues (new surfclam overfishing definition and fishing gear impacts to EFH) from Amendment 12, allow for the implementation of multi-year quotas, recommends that the RA implement a mandatory electronic tracking system that is satisfactory to the NMFS and industry, and add to the list of framework management measures the suspension of the surfclam minimum size limit and adjustments of the minimum size limit. The Council has selected preferred alternatives for each of the five issues for its recommendations to the Secretary.

1.1.2 History of FMP Development

The Mid-Atlantic Fishery Management Council (MAFMC or Council) has been involved in surfclam and ocean quahog management since its first meeting (September 1976), when it was discussed that the surfclam fishery should be the first to have a plan developed. At the February 1977 meeting the Council voted to accept responsibility for the surfclam plan and began discussion of possible management measures. From April through August 1977 every meeting included a debate over possible management measures. Public hearings were conducted during June 1977, with major revisions proposed to the management system based on public comments. The MAFMC developed the original FMP which was approved in November 1977 for the period through September 1979 (MAFMC 1977). Amendment 1 extended it through 31 December 1979. It contained specific quarterly quotas for surfclams (350,000 bushels each for October - December and January - March and 550,000 bushels each for April - June and July - September) and an annual quota (3,000,000 bushels) for ocean quahogs. The effort limitation, permit, and logbook provisions were included. The FMP also instituted a moratorium in the surfclam fishery (all surfclams, since there was no New England Area) for one year to allow time for the development of an alternative limited entry system "such as a stock certificate program" (MAFMC 1977). A Final Supplemental Environmental Impact Statement (FSEIS) was prepared for the FMP.

Amendment 1 (MAFMC 1979a) extended the FMP for ninety days, until the end of 1979 (primarily to allow for completion of the latest stock assessment). It added processor reporting requirements and removed the requirement that each quarter begin with four days of fishing (even though the stock was depressed, the excess harvesting capacity led to closures very quickly). The moratorium was continued. A Supplemental EIS was prepared for this amendment.

Amendment 2 (MAFMC 1979b) extended the FMP through the end of 1981, divided the surfclam portion of the management unit into the New England and Mid-Atlantic Areas. Annual quotas were 25,000 bushels of surfclams for the New England Area, 1,800,000 bushels of surfclams for the Mid-Atlantic Area, 3,500,000 bushels of quahogs for 1980, and 4,000,000 bushels of quahogs for 1981. The quarterly quotas in the Mid-Atlantic Area were moving closer to equal (400,000 bushels for the fall and winter quarters and 500,000 bushels for the spring and summer quarters). The bad weather make up day was introduced. The moratorium was continued in the Mid-Atlantic Area. Again, a Supplemental EIS was prepared for this amendment.

Amendment 3 (MAFMC 1981), approved 13 November 1981, extended the FMP indefinitely. A 5.5" surfclam minimum size limit was imposed in the Mid-Atlantic Area. The surfclam fishing week in the Mid-Atlantic Area was expanded to Sunday - Thursday from Monday - Thursday. Quota setting was put on a framework basis with ranges of 1.8 - 2.9 million bushels for Mid-Atlantic Area surfclams, 25,000 - 100,000 bushels for New England Area surfclams, and 4 - 6 million bushels for ocean quahogs. The Council proposed a permit limitation system to replace the moratorium which was disapproved by NMFS; NMFS extended the moratorium. Again, a Supplemental EIS was prepared for this amendment.

Amendment 4 was initiated in response to a closure of the New England Area to surfclam fishing during the second half of 1983. On 21 July 1983 the New England Council sent a letter to the Secretary of Commerce requesting Secretarial action to reopen the New England Area surfclam fishery. The Mid-Atlantic Council passed a motion in August 1983 recommending that the Secretary not accept the proposal of the New England Council. After receiving a letter from the Secretary on 6 September 1983 denying implementation of emergency action to reopen the surfclam fishery in the New England Area, work was begun to investigate methods for avoiding an extended closure in 1984. In November 1983 the Mid-Atlantic Council passed a motion authorizing the Regional Administrator and the New England Council to prepare an amendment for the New England Area involving trip limits, quarterly quotas, or similar strategies to insure fishing throughout the year. A proposed Amendment 4 was drafted by the New England Council staff in cooperation with NMFS staff and hearings were held on 21 and 22 March 1984. At a joint meeting of the New England and Mid-Atlantic Councils in May 1984 representatives of the surfclam industry from both New England and the Mid-Atlantic presented revisions to the proposed regime. The Mid-Atlantic Council passed a motion to adopt the proposed Amendment 4 to the Surfclam and Ocean Quahog FMP as amended to provide that any unharvested portion of a bimonthly allocation be added to the immediately following bimonthly allocation rather than being prorated over all remaining bimonthly periods and that trip and weekly limits be by vessel classes based on relative fishing power using the following ratios: Class 1 = 1.0, Class 2 = 1.8, and Class 3 = 3.4, and that NMFS use a rulemaking procedure to implement the amendment on an emergency basis. The New England Council voted at the same meeting to adopt the amendment.

The provisions of Amendment 4 were implemented on an emergency basis for 180 days beginning 1 July 1984, during which time the amendment was finalized by the New England Council and submitted for Secretarial approval. However, it was determined that the document was not structurally complete.

Amendment 5 (MAFMC 1984), approved 28 February 1985, allowed for revision of the surfclam minimum size limit provision, extended the size limit throughout the entire fishery, and instituted a requirement that cages be tagged. An Environmental Assessment (EA) was prepared for this amendment.

Amendment 6 (MAFMC 1986) was begun in October 1984 following an exploratory fishery conducted on Georges Bank as a result of emergency regulations published 2 August 1984 (49 *FR* 30946 - 30948), primarily to address problems associated with the development of a surfclam fishery on Georges Bank. At its October 1984 meeting the Council voted to divide the New England Area into the Nantucket Shoals and Georges Bank Areas, the dividing line being 69° longitude. At the same meeting the Council voted to approve revising proposed Amendment 4 so its provisions applied to that portion of the New England Area west of 69° longitude.

In response to the Council's recommendation that Amendment 4 be revised to apply only to that portion of the New England Area west of 69° longitude, the New England Council held a hearing on 11 December 1984.

At its December 1984 meeting the Council adopted the provisions of Amendment 6. The amendment was adopted by the Council for hearings in January 1985, with hearings held 18 and 19 February 1985. The Council adopted Amendment 6 for Secretarial approval at its March 1985 meeting. At that time Amendment 4 still had not been found structurally complete. Given the relationship between the provisions of Amendments 4 and 6, the decision was made to abandon Amendment 4 and that the Mid-Atlantic Council would combine the provisions of Amendment 4 with the Mid-Atlantic Council's Amendment 6 in one document. The combination of Amendments 4 and 6 did not change any substantive provisions of either amendment.

The Council was notified via a letter of 25 July 1985 that NMFS had partially approved Amendment 6. The letter from Acting Regional Administrator Richard Schaefer to Council Chairman Robert Martin stated in part that:

"The measures in Amendment 6 that I disapproved are the Nantucket Shoals Area bimonthly quota guidelines and effort control measures, the one landing per day restriction applying to the Mid-Atlantic Area, the provision prohibiting the Regional Director from subdividing allowable fishing hours when the hours are set at 12 or less, and the portion of the notification provision prohibiting vessels that have fished in a notification zone from returning to fish in the same notification zone within that calendar month. The disapproval of the bimonthly guidelines for Nantucket Shoals removed the basis for adjusting the quotas between bimonthly periods when harvest either exceeds or falls short of quota. Therefore, this provision, while not specifically disapproved, can not be implemented on Nantucket Shoals at this time." (This measure was one developed jointly by the New England Council and the NMFS Northeast Regional Office.)

The Council revised Amendment 6 to replace the bimonthly quotas with quarterly quotas, eliminate the weekly landing limits for the Nantucket Shoals Area, clarify the quota adjustment provisions for the Nantucket Shoals and Georges Bank Areas, and presented additional justification for the one landing per trip provision. The other disapproved provisions (prohibition on subdividing allowed fishing times under certain conditions and portions of the notification system) were deleted from the amendment. The amendment was approved by the Secretary of Commerce on 9 April 1986 when the 60-day review period expired without action by NMFS. An Environmental Assessment (EA) was prepared for this amendment.

Amendment 7 (MAFMC 1987) was developed to change the quota distribution on Georges Bank (from 10:40:40:10 to equal quarterly quotas) and revise the roll over provisions from one period to the next. This amendment was taken to public hearings in February 1987, approved by NMFS, and final regulations published on 24 July 1987. An Environmental Assessment (EA) was prepared for this amendment.

Amendment 8 (MAFMC 1988) established an individual transferable quota (ITQ) system primarily to replace the regulated fishing time system in place in the mid-Atlantic surfclam fishery. This fishery was operating under a moratorium on vessel permits. Allowable fishing time in this fishery went from 96 hours a week in 1978 to six 6 hour trips per quarter in 1988. The ITQ system essentially converted allowable fishing time into allowable individual levels of harvest. The Council had several alternatives under consideration during the development of Amendment 8 with respect to management of the New England surfclam fishery and the ocean quahog fishery. These fisheries were controlled through quotas prior to Amendment 8. The ocean quahog quota has never been fully harvested. Many felt that the Council should simply impose a moratorium on this fishery until such time as restraints on harvest were necessary. When such restraints were necessary, an ITQ system could be imposed based on reported landings. The Council decided to bring the ocean quahog fishery under the ITQ system because it believed that the problems experienced in the surfclam fishery under the moratorium would simply be relived under a quahog moratorium.

The vessel owners that received allocation under the ITQ system were those whose vessels had reported landings under the mandatory logbook requirement that had been in place since 1978. All of the vessels that had reported landings were those that were involved in the commercial surfclam and ocean quahog fisheries prosecuted mainly off the Mid-Atlantic. These fisheries involve large vessels towing hydraulic dredges the catch from which is emptied into metal cages holding roughly 32 bushels. These cages are the industry standard that enables processors to handle large volumes of product given the limitations of processing plant size, vessel capacity, and stability as well as that of moving and hauling equipment.

Amendment 8 employed three formulae that gave participants in the Mid-Atlantic surfclam fishery, the New England surfclam fishery and the ocean quahog fishery, respectively, an allocation percentage. Initial allocation percentages were based largely on a vessel's average historical catch. The average catch was weighted with respect to mid-Atlantic surfclam allocations and a vessel size factor was added in to calculate the initial allocation percentage. This percentage was applied to the annual quota to give the participant his/her allocation. This number was again divided by 32, the number of bushels in a standard cage to determine the number of cage tags the participant was to be issued by NMFS.

A participant's bushel allocation will change in any year if the annual quota is revised. Since these allocations may be bought and sold, a participant's allocation may change as he/she purchases or sells allocation. Each transfer of allocation must be approved by the Regional Administrator. Allocation permits are modified by NMFS to reflect modifications to the participant's allocation percentage following a transfer. Monitoring the harvest of individual allocations and, in turn, the annual quota is facilitated by a cage tagging requirement and mandatory reporting by vessel owners and dealers with respect to the amount of surfclams and ocean quahogs landed and purchased. Amendment 8 also: (1) allows for the minimum surfclam size to be suspended from year to year; (2) merges the New England and Mid-Atlantic surfclam areas into one management area; (3) authorizes the Regional Administrator to issue shucking-at-sea permits to owners of surfclam vessels based upon certain conditions; and (4) empowers the Regional Administrator to authorize an experimental fishery to gather information necessary for management. An Environmental Assessment (EA) was prepared for this amendment.

Amendment 9 (MAFMC 1996) was developed to revise the overfishing definitions in response to a scientific review by NMFS. The overfishing definitions were changed from an MSY based definition to a percentage maximum spawning potential (MSP) definition. The Amendment 9 overfishing definition for surfclams was a fishing mortality rate of $F_{20\%}$ (20% of the maximum spawning potential, or MSP), which equated to an annual exploitation rate of 15.3%. The Amendment 9 overfishing definition for ocean quahogs was a fishing mortality rate of $F_{25\%}$ (25% of the MSP), which equated to an annual exploitation rate of 4.3%. An Environmental Assessment (EA) was prepared for this amendment.

Amendment 10 (MAFMC 1998) which was approved in May of 1998 provided management measures for the small artisanal fishery for ocean quahogs off the northeast coast of Maine which had been operating as an experimental fishery since 1990. As Individual Transferrable Quota (ITQ) management, through Amendment 8 in 1990, was implemented for surfclams and ocean quahogs, it was discovered that the Maine inshore ocean quahog, or "mahogany quahog," fishery that occurred on the same species (*Arctica islandica*) was moving out of state waters into the Exclusive Economic Zone. This created a problem, in that the Magnuson-Stevens Fishery Management and Conservation Act mandates that "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" (National Standard 3). The small-scale eastern Maine ocean quahog fishery differed profoundly from the large-scale industrial EEZ ocean quahog fishery that occurs south of Georges Bank in numerous respects. The management tools developed during the first twenty years of Federal management for surfclams and ocean quahogs did not fit the Maine fishery well. In 1990, the Regional Administrator granted experimental status to the eastern Maine ocean quahog fishery in order to avoid the potential adverse impacts which would have resulted from the imposition of regulations which were not designed for a small artisanal fishery. The experimental fishery status was granted to the Maine ocean quahog fishery until a better and more permanent solution could be found.

Amendment 10 provided that solution and fully integrated the historical Maine fishery into the Surfclam and Ocean Quahog FMP since the expiration of the experimental fishery on 30 September 1997. There was little known about the extent and abundance of the portion of the ocean quahog resource off of the coast of Maine, and because of this lack of knowledge Amendment 10 established an initial maximum quota for ocean quahogs caught in a zone of both state and Federal waters off the eastern coast of Maine north of 43° 50' north latitude. This initial maximum quota for this zone is not to exceed 100,000 Maine bushels, where 1 Maine bushel = 1.2445 cubic feet. Adjustments to the quota can be made in subsequent years within the range of 100,000 and 17,000 Maine bushels as part of the annual quota setting process. Once a survey and assessment has determined a long-term, biologically-sustainable quota for this zone, the FMP will be modified to reflect this new quota. Amendment 10 established a moratorium on entry to the Maine EEZ fishery zone. The moratorium is to be maintained until it is eliminated or replaced with an alternative management program in a subsequent amendment. It is the Council's intention that such a change would preferably be made in concert with a new assessment-based quota. The amendment established criteria for continued participation in this zone (north of 43° 50' north latitude) which requires that a vessel must have reported harvesting at least one bushel of ocean quahogs from this zone while participating at least once in the experimental fishery (October 1990 through September 1997). Vessels which had not participated in the experimental fishery or which had not landed at least one bushel of ocean quahogs from this zone during the past seven years, are eligible to fish in the State of Maine waters only or may use their ITQ allocation. Existing ITQ holders are permitted to fish within the EEZ portion of this zone as long as they use their ITQ allocation. All landings from moratorium permitted vessels and State of Maine only permitted vessels count against the initial maximum quota. Landings of ITQ allocation will not count against the initial maximum quota. All State of Maine only permitted vessels and all moratorium permitted vessels must land in Maine and comply with all the State of Maine landing laws. The vast majority of this Maine ocean quahog fishery occurs with Federally licensed vessels, but there are a few boats that can participate by landing in Maine territorial waters. Amendment 10 provided for the protection of public health by restricting harvesting of ocean quahogs in this zone to only those areas surveyed and certified to be free of the organisms which cause PSP. An ITQ vessel may land in Maine (and thus must comply with Maine laws) or may land outside of Maine, but must have the catch certified safe for human consumption through testing at facilities with a NMFS/FDA/state approved dockside Paralytic Shellfish Poisoning (PSP) testing protocol. The principal intent of the amendment was to allow the artisanal nature of this fishery to continue while promoting appropriate conservation and management of the resource. An Environmental Assessment (EA) was prepared for this amendment.

Amendment 11 (NMFS 1998) was drafted to achieve consistency among Mid-Atlantic and New England FMPs on vessel replacement and upgrade provisions, permit history transfer and splitting and renewal regulations for fishing vessels issued Northeast Limited Access Federal Fishery permits. It is the intent of the Council, that any management measures implemented by earlier amendments and not specifically referenced herein are intended to continue in force. An Environmental Assessment (EA) was prepared for this amendment.

Amendment 12 (MAFMC 1998) was drafted to bring this FMP into compliance with the new and revised National Standards and other requirements of the 1996 Sustainable Fisheries Act. In addition that amendment added a framework adjustment procedure that allowed the Council to modify management measures through a streamlined public review process, and implemented an Operator Permit requirement for fishermen that did not already have them for other fisheries. In April of 1999 the Regional Administrator partially approved Amendment 12 with the exceptions of the proposed surfclam overfishing definition and the fishing gear impacts to EFH section. These two disapproved items are the genesis for Amendment 13. An Environmental Assessment (EA) was prepared for Amendment 12.

1.1.3 Management Objectives

The four management objectives listed below were generated for Amendment 8 (MAFMC 1988) with the ITQ initiation and the Council sees no reason to change these farsighted ideas which have produced one of the best FMPs ever.

1. Conserve and rebuild Atlantic surfclam and ocean quahog resources by stabilizing annual harvest rates throughout the management unit in a way that minimizes short term economic dislocations.

2. Simplify to the maximum extent the regulatory requirement of surfclam and ocean quahog management to minimize the government and private cost of administering and complying with regulatory, reporting, enforcement, and research requirements of surfclam and ocean quahog management.

3. Provide the opportunity for industry to operate efficiently, consistent with the conservation of surfclam and ocean quahog resources, which will bring harvesting capacity in balance with processing and biological capacity and allow industry participants to achieve economic efficiency including efficient utilization of capital resources by the industry.

4. Provide a management regime and regulatory framework which is flexible and adaptive to unanticipated short term events or circumstances and consistent with overall plan objectives and long term industry planning and investment needs.

1.1.4 Management Unit

The management unit is all Atlantic surfclams (*Spisula solidissima*) and ocean quahogs (*Arctica islandica*) in the Atlantic EEZ. In 1988 the American Malacological Union officially changed the common name of "surf clam" to the one word name "surfclam". This was published in the American Fisheries Society special publication 16 entitled *Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Mollusks* (American Fisheries Society 1988). The ocean quahogs managed in this FMP include a small-scale fishery in eastern Maine that harvests small ocean quahogs which are generally sold for the half-shell market. Locally these small ocean quahogs off the coast of Maine are known as "mahogany quahogs" and have been under Council management since implementation of Amendment 10 (MAFMC 1998).

A southern subspecies of surfclam, *Spisula solidissima similis*, occurs south of Cape Hatteras (Walker and Heffernan 1994). Another species, *Spisula raveneli*, occurs in the southern part of the range of *S. solidissima*. This species distinction, based on distribution and morphology (Porter and Schwartz 1981), is controversial (Vecchione and Griffis 1996).

1.1.5 Management Strategy

The management strategy for this amendment is to provide the information and evaluations necessary to meet the Congressional mandates associated with the SFA of 1996 and rectify the two disapproved sections from Amendment 12 (MAFMC 1998). Effective Federal fishery management of surfclams and ocean quahogs has occurred for the past two decades. The Council intends to continue to prevent overfishing of these two resources, as they have done in the previous two plus decades of management, meet the purposes specified in the SFA, and continue to attain the management objectives identified in Amendment 8 (MAFMC 1988) which have allowed efficient operation of the fishery on a well managed resource.

1.2 ALTERNATIVE MANAGEMENT MEASURES

There are five problems for resolution that this Amendment 13 addresses (section 1.1.1). Each of these five issues are thoroughly described below and various management alternative measures are identified for each issue. Of course, the evaluation of any government action must also consider the "No Action Alternative".

The " No Action Alternative" would maintain the current ITQ based management regime from Amendment 8. Not doing anything would thus mean that there would be no resolution of the two disapproved portions of Amendment 12 (overfishing definition and fishing gear impact to EFH). The no action alternative would also not allow for multi-year quotas, add the suspension of the surfclam minimum size limit and adjustment of the minimum size to the list of framework management measures or recommend to the RA that she implement an electronic tracking system when an economically viable system is viable. The last three management measures are mostly administrative and designed to generate efficiencies for the industry, Council and NMFS. It must be emphasized that this amendment does not alter the basics of the management system or change the range of the optimum yield and thus does not have any resource urgency. The Council has managed these two species efficiently and effectively for the past twenty five years and would continue to do so whether this amendment is approved or not.

With regards to the on-going successful management of these resources, 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. The MSY is based on the overfishing definition proposed below (section 1.2.1). OY is to be based 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. The Council has determined that the OY specification will remain at "statue quo" based on any new overfishing definition. The OY range as specified in Amendment 3 (MAFMC 1981) is 1.8 to 3.4 million bushels of surfclams and 4.0 to 6.0 million bushels of ocean quahogs. Amendment 10 (MAFMC 1987) established a range of 17,000 to 100,000 bushels for the Maine ocean quahog fishery. OY must never exceed MSY.

After the public hearings, at the January 2003 Council meeting, the Council unanimously approved (with RA always abstaining so as to preserve the Secretary's options) both the preferred overfishing definition and the no action alternative for fishing gear impacts to EFH. The Council also unanimously approved a multi-year quota up to three years with an annual review. The Council voted overwhelmingly (15 to 1 with RA abstaining) for implementation of a mandatory electronic tracking system that is satisfactory to the NMFS and the industry. The Council could not come to closure on the reversal of regulatory language for the suspension of the surfclam minimum size limit, but instead decided to add to the list of framework management measures both the suspension of the surfclam minimum size limit and an adjustment of the minimum size for surfclams.

1.2.1 Surfclam Overfishing Definition (Revised)

SURFCLAM OVERFISHING DEFINITIONS – Alternative 1 = Council preferred			
ALTERNATIVE	DESCRIPTION	SECTION DESCRIBED	SECTION EVALUATED
1	New Proposed	1.2.1.1	3.3.1.1
2	Amendment 12 No action	1.2.1.2	3.3.1.2
3	Amendment 9	1.2.1.3	3.3.1.3
4	Amendment 8	1.2.1.4	3.3.1.4

The 1996 Magnuson-Stevens Act or SFA imposed new requirements concerning definitions of overfishing in US fishery management plans. To comply with National Standard 1 section 3 (29) of the SFA requires that each Council FMP define both overfishing and overfished as a rate or level of fishing mortality that jeopardizes a fisheries' capacity to produce maximum sustainable yield (MSY) on a continuing basis. The proposed guidelines for implementation of the new National Standards suggest that sustainability or the phrase "on a continuing basis" are generally accepted to mean an average stock level and/or average potential yield from a stock over a long period of time. Each FMP must specify an MSY, and a harvest strategy that, if implemented, is expected to result in long-term average yield close to MSY. Section 2.1.4 discusses the long-term sustainability of these resources. The Council has managed to prevent overfishing during the past twenty plus years of Federal management and as identified above, has not changed the OY range for surfclams or ocean quahogs since implementation of Amendment 3 (MAFMC 1981).

There are four surfclam overfishing alternatives, however only the preferred alternative is likely to meet the requirements associated with the new National Standard 1guidelines. It has to be emphasized that it is not an issue that alternatives 2, 3, or 4 would allow for overfishing to occur. These three alternatives have allowed rebuilding of the surfclam resource during the late 1970s and 1980s (Alternative 4), allowed the maintenance of a healthy resource during the 1990s (Alternative 3) and has at least one of the rejected alternatives that is more conservative for the resource (Alternative 2) than is the preferred (Alternative 1). The issue is that only Alternative 1 is likely to meet the new National Standard guidelines (passed after the 1996 SFA) because those guidelines are very specific. Section 600.310 is very specific that the OY is based on MSY, or on MSY as it may be reduced for social, economic and ecological factors. The guidelines call for an "MSY control rule" (which none of the previous overfishing definitions had) that means a harvest strategy which, if implemented, would be expected to result in a long-term average catch approximating MSY. The guidelines identify specification of status determination criteria which include both a maximum fishing mortality threshold and minimum stock size threshold levels (which also were not required during the time of development of the previous definitions). The new National Standard 1 guidelines (after the SFA) comprise over 40% of the text associated with all ten of the national standards. Congress wanted overfishing addressed with the 1996 passage of SFA and NMFS did an extensive job in clarifying what exactly needed to be identified in order to prevent overfishing. It is because of this specificity that Alternative 1 is likely the only one of the four alternatives that can meet the current guidelines but it needs to be emphasized that the previous Council definitions successfully rebuild and then prevented overfishing of the surfclam resource for the past two and a half decades.

1.2.1.1 Alternative 1. The Council unanimously passed the following motion at its March 16, 2000 meeting. The motion establishes an overfishing definition for surfclams as follows:

> *Biomass target = ½ of current biomass as a proxy for Bmsy,*
> *Biomass threshold = ½ of proxy for Bmsy,*
> *Fishing mortality threshold should be F_{MSY}, where the current best proxy for Fmsy is M,*
> *Fishing mortality target will always be set less than the F threshold and will be the F associated with the Council selected quota.*
> *Finally, the overfishing definition should have an MSY control rule as identified in Figure E6 of the 30th SAW advisory report on stock status.* (Figure E6 of the SAW report is Figure 1 of this document.)

The Council's action was based on the advice of the 30th SAW (Appendix 1) and, as such, this new overfishing definition should meet the concerns of NMFS expressed in the Regional Administrator's April 28, 1999 partial approval letter. This new proposed definition is global rather than just focused on the Northern New Jersey area, and as such, should be certifiable by the Center. Table 1 details the specific reference points and should replace the surfclam portion of the overfishing table on page 121 of Amendment 12. The approved ocean quahog reference points are included in Table 1 for comparison. The most recent ocean quahog stock assessment is included in this document as Appendix 2.

Under the definition recommended by the SARC and unanimously approved by the Council, overfishing occurs whenever F exceeds the threshold fishing mortality rate. The threshold fishing mortality rate is F_{MSY}, but reduced in a linear fashion towards zero when stock biomass falls below the biomass threshold value ($1/2B_{MSY}$). The surfclam stock would be overfished whenever stock biomass falls below the biomass threshold level. Estimates of fishing mortality and biomass thresholds and the biomass target based on MSY can be expected to change in each assessment as data accumulate and models improve.

1.2.1.2 Alternative 2 -- The disapproved definition from Amendment 12 is included here in this amendment for comparison. This definition was disapproved by the Secretary because it was based on the sustainability of the Northern New Jersey area, where 80+% of the fishery occurred in the past decade. It was determined that this proxy did not represent global values over the entire range of the resource and thus could not be certified under SFA by the NEFSC. The disapproved Amendment 12 definition was:

Biomass target = 1997 NNJ biomass as a proxy for Bmsy (900 million pounds),
Biomass threshold = ½ of proxy for Bmsy (450 million pounds),
Fishing mortality threshold = F_{po} *which is the equilibrium replacement rate for NNJ,*
Fishing mortality target =$F_{20\% MSP}$ *(0.18) .*

1.2.1.3 Alternative 3 -- The pre-SFA Amendment 9 (MAFMC 1996) definition also is included for comparison, but the Council was told that that definition needed revision because it was based on a fishing mortality rate that minimized the potential for recruitment overfishing $F_{20\% MSP}$ (0.18) rather than a specific MSY strategy as is required in the SFA guidelines on National Standard 1. It is likely that this also would not meet the current National Standard 1 guidelines, since there is no biomass target or threshold.

1.2.1.4 Alternative 4 -- The Amendment 8 (MAFMC 1988) and earlier amendments all the way back to the original FMP (MAFMC 1977) had an MSY estimate of 2.9 million bushels for surfclams, which is approximately 50 million pounds of shucked meats, for the mid-Atlantic portion of the resource. This estimate was based upon commercial landings from 1960 through 1976. It too is included as an alternative for comparison purposes and would not likely meet the current National Standard 1 guidelines as it is not now applicable over the range of the resource and does not have an associated fishing mortality rate threshold or target.

The Council voted unanimously (with RA abstaining) at its January 2003 meeting in support of Alternative 1.

1.2.2 Alternatives to Minimize Fishing Gear Impacts to EFH (Revised)

FISHING GEAR IMPACTS TO EFH – Alternative 1 = Council preferred			
ALTERNATIVE	DESCRIPTION	SECTION DESCRIBED	SECTION EVALUATED
1	No Action	1.2.2.1	3.3.2.1
2	Closed – Georges Bank	1.2.2.2	3.3.2.2
3	Closed – Southern New England east	1.2.2.3	3.3.2.3
4*	Closed – Nearshore Around Estuaries	1.2.2.4	3.3.2.4
5*	Closed – Hudson Canyon	1.2.2.5	3.3.2.5
6	Closed – Tilefish HAPC	1.2.2.6	3.3.2.6
7*	Closed – Maine EEZ	1.2.2.7	3.3.2.7
8*	Closed – Maine Zone 1	1.2.2.8	3.3.2.8
9*	Surfclam Increase, Ocean Quahog Decrease	1.2.2.9	3.3.2.9

*Council considered but rejected for thorough economic, social, etc. analysis.

The Council evaluated nine alternatives that focused mostly on closed areas. The fishing gear impacts workshop (Appendix 4) concluded that effort reductions (i.e. harvest limits) and gear modifications (i.e. restrictions) were not workable for this fishery and that if the clam dredges were found to have significant adverse effects on EFH, then spatial closures were the only viable alternative to mitigate the adverse effects of this fishing gear. Since surfclams are underfished and the annual quotas are actually being increased, it seems to make little sense to restrict harvest limits for EFH reasons, however there is an alternative for analysis where the ocean quahog optimum yield range would be reduced to trade off against an increase in surfclam quota. Finally, seven potential closed area alternatives were identified. These closed areas are being considered to be closed to clam dredging for 5 years. The distribution of the surfclam and ocean quahog resources based on the 1999 survey are depicted in Figures 5 through 8. Landings of the two species in 2000 are shown in Figures 9 and 10.

Of the nine alternatives that the Council considered initially relative to fishing gear impacts to EFH, four were thoroughly evaluated for their biological, economic, and social impacts. The Council did not thoroughly evaluate alternatives 5, 7, 8, and 9 for social and economic impacts because they determined that these closures were not reasonable with all of the data uncertainties associated with each alternative. The Council eliminated alternative 4 for thorough evaluation because it is in shallow water and storm events are much more significant at causing sediment disturbances in those depths than is hydraulic clamming activity.

1.2.2.1 **Alternative 1 --** This no action alternative, with additional clarification is again the preferred alternative after the fishing gear impacts workshop. The Council has implemented many regulations that have directly and indirectly acted to reduce fishing gear impacts on EFH. The foremost management regulation is that of implementing ITQs which has significantly reduced gear impacts on bottom habitat since effort was so significantly reduced and there is no longer a "race to fish" as is common of so many effort restricted fisheries. With the lack of the race to fish, industry delivers a better product to the plants, bycatch is minimized, minimal short-term damage to habitat occurs, and fishermen become better conservationists because the ITQs are based on a percentage of the total allowable harvest. Thus, ITQs encourage fishermen to use their collective and very innovative minds to enhance future stocks and their environments.

Currently, there are 32 stocks managed by NEFMC, MAFMC, and SAFMC in the Atlantic ocean that are designated as overfished. These designations have resulted in a reduction of fishing effort from Maine through Florida. This reduction of effort translates into less gear impact on habitat throughout the western Atlantic ocean. Additionally, the majority of habitat in the Mid-Atlantic region is dynamic sandy bottom. Current research shows that bottom tending mobile gear has a short-term impact on this type of habitat (Appendix 4). As such, further EFH regulations are not necessary at this time.

1.2.2.2 Alternative 2 -- Prohibit clam dredging on Georges Bank east of 69 degrees. Currently harvesting of surfclams and ocean quahogs are prohibited east of 69 degrees (Figure 11) because of PSP. The possibility of PSP toxin in the clams has basically closed Georges Bank since 1990. This alternative, as are all the closed area alternatives would continue this closure for five years after implementation of the amendment. After five years, the EFH closure of the area would be removed. Whether industry pushed for a reopening of the area because of the lack of PSP would be up to industry and they would have to sponsor research and monitoring to document that PSP was no longer a problem.

1.2.2.3 Alternative 3 -- Prohibit hydraulic clam dredging east of 70 degrees, 20 minutes. This closed area alternative (Figure 11) is an alternative for the NEFMC Amendment 13 for groundfish. The hypothesis is that hydraulic clam dredging in southern New England may interfere with successful yellowtail flounder reproduction. Note that only hydraulic clam dredging is being prohibited and that this alternative does not affect the Maine ocean quahog fishery. This alternative, as are all the closed area alternatives would continue this closure for five years after implementation of the amendment. After five years, the EFH closure of the area would be removed.

1.2.2.4 Alternative 4 -- Prohibit clam dredging in the nearshore areas of Albemarle Sound, Chesapeake Bay, Delaware Bay, and New York Harbor, from 3 miles offshore extending to the 60-foot depth contour. This alternative and alternative 5 were developed for the summer flounder/scup/black sea bass Amendment 13 that was just implemented. The proposed nearshore closed areas (areas 1 through 4 of Figure 12) are partly based on the results of a workshop designed to identify the priority ocean areas for protection in the mid-Atlantic (Figure 13) and partly on the concentration of non-biogenic reef habitat (Figure 14). This alternative, as are all the closed area alternatives would continue this closure for five years after implementation of the amendment. After five years, the EFH closure of the area would be removed.

This alternative is similar to Alternative 2 of Amendment 13 of the Summer Flounder, Scup and Black Sea Bass FMP (MAFMC 2002) which would prohibit fishermen from using bottom tending mobile gear in the nearshore areas of Albemarle Sound, Chesapeake Bay, Delaware Bay, and New York Harbor (Table 30 and Figure 12). Bottom tending mobile gear in the summer flounder amendment in these areas include: bottom otter trawls, clam dredges, and scallop dredges.

This alternative was included because these estuaries are important nursery areas and EFH for summer flounder, scup, black sea bass and other species. Additionally, the closed areas include important summer flounder spawning habitat, and are areas where all three species congregate in warmer months. Many states currently restrict trawling in estuaries. This alternative would extend the restriction from the 3-mile line to offshore areas.

These areas also include reef areas and structured habitat in Federal waters, which are considered EFH for scup and black sea bass (Steimle and Zetlin 2000, Figure 14). Structured habitat, such as reef habitat is more complex and thus more vulnerable to fishing gear. Thus, the prohibition could complement the special management zone (SMZ) program that exists for the Summer Flounder, Scup and Black Sea Bass FMP. This program established a process that allows the Council to develop management measures to control fishing on artificial reefs on a case by case basis. The intent of this program is to protect artificial reefs from: "a) entanglement of other boating and fishing gear: b) entanglement in reef structure ('ghost gear'); and c) damage to or movement of reef structure."

The Council chose to not thoroughly evaluate this alternative for impacts because they decided that this alternative was not reasonable since the bottom sediments in these areas were so vulnerable to storm and wave action that any clam dredging would be overwhelmed by the natural perturbation from the environment.

1.2.2.5 Alternative 5 -- Prohibit clam dredging from the areas adjacent to the Hudson Canyon, between the 200-foot and 500-foot depth contour. The workshop that identified priority ocean areas in the mid-Atlantic (Figure 13) identified Hudson Canyon as the most important area north of Cape Hatteras. The Hudson Canyon area is important for its biodiversity and usage by a variety of species from marine mammals, sea turtles, highly migratory species, and tilefish.

This alternative is also similar to Alternative 3 of the Summer Flounder, Scup, and Black Sea Bass FMP which would prohibit fishermen from using bottom tending mobile gear in area surrounding the head of the Hudson Canyon, between the 200-foot and 500-foot isobaths (Table 31 and Figure 12). Bottom tending mobile gear for the Summer Flounder Amendment 13 in these areas include: bottom otter trawls, clam dredges, and scallop dredges.

This alternative was included for public consideration because this is an area that has been identified as an important overwintering area for summer flounder, scup, black sea bass and other species in NRDC (2001). The Hudson Canyon area is important for its biodiversity and usage by a variety of species from marine mammals, sea turtles, highly migratory species, and tilefish. The Council chose to not thoroughly evaluate this alternative for impacts because they decided that this alternative was not reasonable since the sediment types and steepness of the bottom topography is not conducive for ocean quahog habitation.

1.2.2.6 Alternative 6 -- Prohibit clam dredging in Tilefish HAPC which is depths between 250 and 1200 feet between Cape Cod and Cape May. Limited fishing for ocean quahogs occurs beyond 250 feet and the1999 survey indicated limited resource abundance beyond this depth especially south of southern New England. Tilefish habitat areas of particular concern (HAPC) are defined as between 250 and 1200 feet between Cape May and Cape Cod (Figure 15). For enforcement and management purposes, this area was conservatively represented by the six sided figure described in Table 32.

1.2.2.7 Alternative 7 -- Prohibit all clam dredging in the EEZ off the State of Maine. Maine ocean quahogs are managed as a unit north of 43 degrees 50 minutes (Figure 16). Significant amounts of ocean quahogs are landed from both State of Maine waters and the EEZ annually. The Council chose to not thoroughly evaluate this alternative for impacts because they decided that this alternative was not reasonable with all the data uncertainties.

1.2.2.8 Alternative 8 -- Prohibit all clam dredging in the EEZ off the State of Maine west of zone 1 (Figure 16). This alternative is similar to alternative 2 in that this area is currently closed to fishing because of PSP. This alternative would codify the closure for the next 5 years and ideally provide the incentive to compare fished and unfished areas during that time.

1.2.2.9 Alternative 9 -- Trading a reduction in the optimum yield range for ocean quahogs as justification for increasing the surfclam annual quota increases. The optimum yield range for ocean quahogs is 4 to 6 million bushels with an annual quota of 4.5 million bushels recently. Ocean quahogs are found in deeper waters which are less susceptible to storm disturbances and they are longer-lived than surfclams. It is highly likely that fishing for surfclams in their high energy environment may have less fishing gear impacts than fishing in the deeper, relatively more stable environment of ocean quahogs. The Council staff, Plan Development Team, and industry members were unable to strategize exactly how this alternative could be developed and implemented at this time. The Council chose to not thoroughly evaluate this alternative for impacts because they decided that this alternative was not reasonable with all the data uncertainties.

The Council voted unanimously (with RA abstaining) at its January 2003 meeting in support of Alternative 1.

1.2.3 Multi-year Quotas

MULTI-YEAR QUOTAS – Alternative1 modified = Council preferred			
ALTERNATIVE	DESCRIPTION	SECTION DESCRIBED	SECTION EVALUATED
1	Multi-year, Annual evaluation	1.2.3.1	3.3.3.1
2	No action, Annual evaluation	1.2.3.2	3.3.3.2
3	Multi-year, No annual evaluation	1.2.3.3	3.3.3.3

In order to allow multi-year quotas, the FMP needs to be amended as the regulations currently require an annual quota setting process. Given the status of the two resources (surfclams are under-exploited and ocean quahogs are not overfished and overfishing is not occurring) and the likelihood of research surveys only every three years or so, this amendment has two alternatives that propose thorough quota setting only after each survey and stock assessment.

Instead of working through the entire specification process annually (Quota recommendation paper, Industry Advisors meeting with Committee, Council recommendation then significant document preparation -- EAs, RIRs, EFH Assessments, etc.), the Council would establish specifications to be in effect for up to three fishing years. The specifications would be the same each year of the term or could be stepped to track well-identified trends in biomass.

The longer term specifications should provide industry with greater regulatory consistency and predictability. The uncertainty in projections is a function of time and management measures may need to be more conservative to provide an additional buffer.

Implementation of multi-year quotas would allow for more efficient use of the regulatory process in that time and effort could be saved in the monitoring cycle, alternatives development, notice, comment and final regulation cycles.

The Surfclam and Ocean Quahog Committee met with the Industry advisors at the March 2002 Council meeting and the *Industry Advisors were unanimous in their desire to remain at the status quo.* The industry did not feel comfortable that there would not be a thorough review and quota setting process each year. For this reason, the Council decided that there was not a preferred alternative for the public hearing draft document.

The RA in her comment letter to the Council Chairman (October 15, 2002) identified NMFS support for streamlining the quota specification process, as appropriate and thus supported Alternative 1.

1.2.3.1 Alternative 1 -- Multi-year quotas set after each survey and stock assessment with minor annual review. Clam surveys are currently scheduled every three years and multi-year quotas would be set for the years between surveys. Staff would continue to produce the annual quota recommendation paper for the Council to review and if no changes from the previous multi-year schedule were recommended by the Council, no further work would be required by staff or NMFS. The staff would generate the quota paper for the June Council meeting. The Surfclam and Ocean Quahog Committee would meet with the Industry Advisors at the beginning of the Council meeting, review the quota recommendation paper and then recommend to the Council whether changes were necessary or whether the previously recommended quotas should stay in existence. The Council would need to decide at the June meeting whether changes were necessary so that any changes would need to be in place for the start of the next fishing year beginning January 1. At this time there is no reason to set up some boundaries of what exactly the Council will look at in the "off" years and what would trigger the need to take action (i.e., to change the quota), because the Council will consider recommendations from industry and/or staff at the time of each of the June Council meeting. Should any group have valid reasons to change the previously agreed quota, the Council will consider those reasons in their entirety. The Council has stated that these multi-year quotas can not exceed three years.

1.2.3.2 Alternative 2 -- No action. This alternative would continue the complete development of staff's annual quota recommendation paper for the Council, along with all the associated Regulatory Impact Review, Environmental Assessment, Proposed Regulations, etc. It would also continue to require significant work on NMFS part annually. This is the alternative that was initially favored by the Industry Advisors.

1.2.3.3 Alternative 3 -- Multi-year quotas set after each survey and stock assessment with no annual review. Similar to Alternative 1, but there would be no annual quota recommendation paper or Council review. Quotas would be set only after surveys and would remain on an agreed upon schedule until the next survey.

The Council voted unanimously (with RA abstaining) at its January 2003 meeting in support of Alternative 1 for multi-year quotas not to exceed three years with an annual review.

1.2.4 Reversal of Suspension of Size Limit

REVERSAL OF SUSPENSION OF SIZE LIMIT – Alternative 2 modified with framework measures = Council preferred			
ALTERNATIVE	DESCRIPTION	SECTION DESCRIBED	SECTION EVALUATED
1	Reverse regulatory language	1.2.4.1	3.3.4.1
2	No action	1.2.4.2	3.3.4.2
3	No action with multi-year decision after each stock assessment	1.2.4.3	3.3.4.3

NMFS needs to annually conduct a finding and publish a regulatory action to suspend the minimum surfclam size limit if the Council recommends this course of action. There has not been a minimum size limit imposed since implementation of the ITQ program. The minimum size limit is specified in the regulations as 4.75 inches, which was originally based on the size of surfclams that maximizes yield per recruit (YPR). The minimum size limit was necessary after the 1976 anoxic event off of New Jersey which killed much of the benthic fauna over a large area, and resulted in only small surfclams being available for numerous years. Additionally, at that time, the resource as a whole had been overfished, industry was not getting sufficient amounts of large clams for the strip market, and ITQs had not been implemented which were all factors in the implementation of the minimum size limit.

Section 648.72 of 50 CFR specifies the minimum size limit and what is the determination of compliance with the size limit. The section identifies the suspension as: "Upon the recommendation of the MAFMC, the Regional Administrator may suspend annually, by publication in the Federal Register, the minimum shell-height standard, unless discard, catch, and survey data indicate that 30 percent of the surfclams are smaller than 4.75 inches (12.065 cm) and the overall reduced shell height is not attributable to beds where the growth of individual surfclams has been reduced because of density dependent factors."

The above section was proposed to read: "The Regional Administrator may implement the surfclam minimum shell-height standard if discards or survey data indicate that 30 percent of the surfclams are smaller than 4.75 inches."

The Surfclam and Ocean Quahog Committee met with the Industry advisors at the March 2002 Council meeting and the *Industry Advisors desired to remain at the status quo.* The industry did not feel comfortable with this proposed change and did not feel that significant amounts of time were spent by NMFS in suspending the size limit annually. For this reason, the Council decided that there was not a preferred alternative for the public hearing draft document.

The RA in her comment letter to the Council Chairman (October 15, 2002) again identified her strong support for Alternative 1. She also recommended modifying the current regulatory language regarding surfclam size suspension found at section 648.72©). Specifically, the reference to using *discards or survey data* to determine if 30 percent of the surfclams are smaller than 4.75 inches should be replaced with *annually reviewed landings and biological sampling data.* She stated that this change would better reflect what is actually used to make this determination and, thus, would be more accurate.

1.2.4.1 Alternative 1 -- NMFS would like to reverse the process from an active regulatory action that must annually be suspended to one where the size limit could remain in the regulations, but would need a regulatory action to implement. This action would continue as part of the quota setting process.

1.2.4.2 Alternative 2 -- No action. The Council has recommended suspension of the minimum size limit since 1990. The NERO performs significant work to justify the annual suspension.

1.2.4.3 Alternative 3 – No action with multi-year decision after each stock assessment. After each surfclam stock assessment the Council would recommend whether the minimum size limit should be suspended for the years until the next stock assessment. The NERO would continue to perform the analyses to justify the suspension, however it would not be on an annual basis. Recently the surfclam survey and assessment have been conducted about every third year (1994, 1997, 1999, and 2002).

The Council wrestled with this issue extensively at the January 2003 meeting because some in industry still opposed the proposed changes. Many Council members believed the system currently works well with limited effort and that should the size limit be needed in order to prevent fishermen from fishing on beds of small clams, it may be harder to implement than simply suspend. Finally, the Council voted unanimously (with RA abstaining) to add to the list of framework management measures this suspension of the surfclam minimum size limit and adjustment of the surfclam minimum size.

The framework adjustment process was established in Amendment 12. The Council can currently use a framework adjustment process to change the overfishing definition, change the description and identification of EFH, address any habitat area of particular concern, and implement a vessel tracking system. This procedure allows the Council to add or modify management measures through a streamlined public review process. Section 3.1.1.4 of Amendment 12 identifies the entire process the Council would need to follow if it determined that an addition or adjustment to management measures was necessary to meet the goals and objectives of the FMP. It would have to recommend, develop, and analyze appropriate management actions over the span of at least two Council meetings. Recent Council activities associated with the Summer Flounder, Scup, and Black Sea Bass FMP, as well as the Atlantic Mackerel, Squid, and Butterfish FMP indicate that framework management measures do not necessarily lessen the amount of work involved in a framework versus an actual FMP amendment.

The Council would like to take the RA's (October 15 letter) suggestion about modifying the current regulatory language regarding surfclam size suspension found at section 648.72©). Specifically, the reference to using *discards or survey data* should be replaced with *annually reviewed landings and biological sampling data.*

1.2.5 Vessel Monitoring System (VMS)

VESSEL MONITORING SYSTEM (VMS) – Alternative 1 modified = Council preferred			
ALTERNATIVE	DESCRIPTION	SECTION DESCRIBED	SECTION EVALUATED
1	Mandatory VMS	1.2.5.1	3.3.5.1
2	No action – call-in	1.2.5.2	3.3.5.2
3	Voluntary VMS	1.2.5.3	3.3.5.3
4	IVR	1.2.5.4	3.3.5.4

The Regional Administrator has had extensive experience during the past few years with a VMS system for the Atlantic Sea Scallop FMP and more recently with the Multispecies and Sea Herring FMPs. The regulations implementing the scallop VMS are located at section 648.9 of 50 CFR and deal with everything from the system being fully automatic and operational at all times, to being capable of tracking vessels in all US waters in the Atlantic Ocean, to being capable of providing network message communications between the vessel and shore. The major purpose of the mandatory scallop VMS has been to make sure that boats are tracked near the off-limits fishing areas that are so common in New England. Scallop vessels have to have a recording every half hour with 24/7 reporting. It is envisioned that a VMS for these two fisheries would require less constant monitoring and would be more like the sea herring requirements where the position of the vessel is only monitored on an hourly basis. Vessels would need to identify whether they were fishing for surfclams or ocean quahogs on the trip and then the transponder would provide the location of fishing. Fishing location is important for the enforcement of closed areas and in the provision of data that can be used to perform adequate analyses of considered closed areas. Accurate location data are also used in the stock assessment and this automatic data collection will provide more accurate location data than are currently being collected through the vessel logbook system. Enforcement personnel currently believe that the provision of the targeted species (surfclam versus ocean quahog) and then the automatic replies from the transponders are sufficient to allow the discontinuation of the vessel call-in system that has been in place for nearly two decades (Doyle pers. comm.).

The industry has been asking for this type of system for nearly a decade so that they could get away from the call-in system. The specific requirements of the surfclam and ocean quahog call-in system are located at section 648.15 of 50 CFR and include the name of the vessel, NMFS permit number assigned to the vessel, expected date and time of departure from port, whether the trip will be directed on surfclams or ocean quahogs, expected time, and location of landing, and the name of the individual.

All the above information was critical prior to implementation of the ITQ program in 1990. Enforcement resources are always limited and when fishermen were racing to catch the fish (because of the extreme effort limitations) and underreporting their catches, it was imperative the enforcement resources be used as efficiently as possible. However, with implementation of the ITQs most of the dockside enforcement necessity disappeared and enforcement could focus on the cage tags. Violations of the call-in during the past 12 years have been less than a half dozen (McDonald pers. comm.).

It is probable that various enforcement agencies at this time will favor the implementation of VMS because of the facilitated knowledge of legitimate activities for readily identifiable vessels, thus increasing national security. It is because of this national security issue since September 11, 2001 that the industry and Council did not have a preferred alternative for public hearing. The Council had a presentation at the May 2002 meeting and it is likely that homeland defense will have one overall uniform system for vessel identification at sea. Industry and the Council do not favor implementing a system that could be changed in some manner once a unified homeland security system is adopted. This unified national system issue is currently in flux. As recently as April 9, 2002, WorldCatch News Network reported that NMFS will reimburse Alaska fishermen for their cost of a VMS.

The Surfclam and Ocean Quahog Committee met with the Industry advisors at the March 2002 Council meeting and the *Industry Advisors recommended waiting at this time until the various enforcement agencies develop a plan.* The industry did not feel comfortable with any proposed change and did not feel that significant amounts of money should be spent to implement something that may be changed in the near future. For this reason, the Council decided that there was not a preferred alternative for the public hearing draft document.

There are several major issues that need to be resolved before implementation of a VMS-type system. First, only Boatracs is currently certified for the Northeast and this vendor is perceived as too costly both in terms of initial cost ($6,000 per unit) and monthly connection charges ($250). Second, it is desirable that a new reporting/tracking system replace the current call-in system and, at the same time, provide the potential for an electronic logbook system. However, according to the RA's October 15, 2002 letter, a prototype electronic logbook system will not be available until the end of 2003. Third, there is an equity issue if, in some regions of the country, the government purchases units for the industry and, in other areas, industry bears the cost. Last, there is some concern that homeland security issues may lead to a mandated tracking system that might prove incompatible with current VMS units.

Individuals in the NEFSC (Terry Smith), Region (Reggie Howe and Karen Mareiro in statistics and Todd Dubois and Jim St. Cyr of enforcement), industry (Dave Wallace and Dan Cohen), and Council staff (Clay Heaton and Tom Hoff) have been working as an ad hoc group (CLEAN) which has been developing approaches for electronic reporting from both clam processors and fishermen. Briefings from enforcement personnel indicate that perhaps as early as June of 2003 an additional VMS technology would be certified (other than BoatTracs) that could be about a quarter of both the initial and monthly costs associated with BoatTracs. This team believes that ultimately an electronic tracking, reporting and noticing system would be ideal, but that perhaps it is best to think about implementation of electronic two-way communication capability in three phases. Phase 1 would be to get the units onto vessels and collect information sufficient to replace the current call-in system. Phase 1 would benefit both enforcement and the industry. Phase 2 would involve the design and implementation for electronically reporting trip data to replace the current requirement to submit paper vessel logbook reports. This would benefit industry and the data collection people. Phase 3 would consider implementation of detailed "real time" information on catch information, size frequencies and other scientific information. Phase 3 would be responsive to science needs and not part of the enforcement or reporting system. A likely timeframe for implementation could be six months for Phase 1 and by the end of 2003 (as per RA letter) for Phase 2. Phase 3 could be implemented when and if it becomes appropriate to collect tow specific information under the assumption that the unit is capable of two-way communication via some e-mail type system.

The RA in her comment letter to the Council Chairman (October 15, 2002) again identified her support for Alternative 1, a mandatory vessel monitoring system.

The Council voted overwhelmingly (15 to 1 with RA abstaining) at its January 2003 meeting to adopt alternative 1, mandatory implementation of an electronic tracking system that is satisfactory to the NMFS and industry. The Council recommends that the RA implement this system when an economically viable system is available for the industry based on the advice of the Council. It is expected that the CLEAN team will continue its efforts to coordinate among the various interest groups in the government, industry, and Council staff and when additional certified systems are available, they will provide their recommendations to the Council. Specifically, the Council envisions the future process to move along the following lines.

MANDATORY VMS		
PHASE 1	PHASE 2	PHASE 3
VMS Notification System (Replacement of call-in system)	Electronic Vessel Reporting (Replacement of Vessel Logbooks or VTR)	Collection of Scientific Information
Monitoring of Closed Areas		

Once an economically viable VMS system is available, and which meets the needs of the mandatory VMS requirements of Amendment 13, this system would be implemented on the advice of the Mid-Atlantic Council through several phases, starting with the beginning of the next fishing year following the agreement to implement the VMS system, as discussed below. Once the VMS system is recommended to be implemented, the owner of a vessel intending to harvest surfclams or ocean quahogs must provide documentation to the Regional Administrator that the vessel has an operational VMS unit installed on board that meets specific criteria (identified below) when renewing its surfclam and/or ocean quahog permit for the following year. If a vessel has already been issued a permit without the owner providing such documentation, the Regional Administrator shall allow at least 30 days for the vessel to install an operational VMS unit that meets the criteria and for the owner to provide documentation of such installation to the Regional Administrator. Vessel permits would automatically be revoked if the vessel did not comply with the VMS installation requirements in the allotted time frame.

The Regional Administrator could exempt vessels that hold a limited access Maine mahogany ocean quahog permit from the VMS requirement. However, under this exemption, vessels that hold both a limited access Maine mahogany ocean quahog permit and an open access ocean quahog and/or surfclam permit would be required to use the call-in notification system when fishing under an ITQ quota.

PHASE 1 - VMS NOTIFICATION SYSTEM

Phase 1 would implement a VMS notification system to replace the current surfclam/ocean quahog call-in system. Vessels would be required to report through the VMS e-mail messaging system prior to leaving the dock to fish in the EEZ on a surfclam or ocean quahog trip, and again prior to returning to the dock to offload a surfclam or ocean quahog trip, in accordance with instructions provided by NMFS. The VMS notification system would not necessarily require that the VMS system be operational at all times but only during the time that the vessel reports beginning and ending a trip as described above.

Prior to departure from the dock to fish for surfclams and/or ocean quahogs, the vessel must report the following information via the VMS e-mail messaging system (some of this information is captured automatically by the VMS): Name of the vessel; NMFS permit number assigned to the vessel; expected date and time of departure from port; whether the trip will be directed on surfclams or ocean quahogs; expected date, time, and location of landing; and name of the individual providing notice. Prior to returning from a surfclam or ocean quahog trip, the vessel must report where the vessel will be offloading its catch, and the date and time of offloading, through the VMS e-mail messaging system.

PHASE 2 - ELECTRONIC VESSEL REPORTING

Phase 2 would implement an electronic vessel reporting system that would replace the current Vessel logbook. Unless otherwise specified under an FMP-wide vessel electronic reporting system implemented by NMFS, the electronic vessel reporting system would require that the owner or operator of any vessel conducting a surfclam or ocean quahog fishing trip, except those conducted exclusively in waters of a state that requires cage tags or when the vessel has surrendered the surfclam and ocean quahog fishing vessel permit, must report the following information through the VMS e-mail messaging system, in accordance with instructions provided by NMFS (some of this information is captured automatically by the VMS system): Name and permit number of the vessel, total amount in bushels of each species taken, date(s) caught, time at sea, duration of fishing time, locality fished, crew size, crew share by percentage, landing port, date sold, price per bushel, buyer, tag numbers from cages used, quantity of surf clams and ocean quahogs discarded, and allocation permit number. This information would need to be provided daily or upon returning to port. Electronic vessel reporting would not necessarily require that the VMS system be operational at all times but only during the time that the vessel reports its electronic trip information.

PHASE 3 - COLLECTION OF SCIENTIFIC INFORMATION

This would be a similar system to Phase 2 but information would be collected on a tow by tow basis. The specific information requested could include all of the information required under Phase 2, as well as any additional biological information deemed appropriate by the Council and NMFS.

For Phase 1-3, the VMS Notification System, Electronic Vessel Reporting and Collection of Scientific Information, the performance criteria for the VMS system is as follows, or as modified further by NMFS, as deemed necessary:

(1) The VMS shall be tamper proof.
(2) The VMS shall be capable of transmitting and storing information including vessel identification, date, time, and latitude/longitude.
(3) The VMS shall be capable of providing network message communications between the vessel and shore.
(4) The VMS vendor shall be capable of archiving vessel position histories for a minimum of 1 year and providing transmission to NMFS of specified portions of archived data in response to NMFS requests and in a variety of media (tape, floppy, etc.).

MONITORING OF CLOSED AREAS (INDEPENDENT OF PHASES 1-3)

Once an economically viable VMS system becomes operational, the Council could decide whether or not closed areas should be monitored to better aid enforcement, independent of implementation of Phases 1-3, if the system selected is capable of providing this information. Monitoring of closed areas would require that the VMS unit be fully automatic and operational at all times and meet all other performance criteria. To monitor closed areas, the VMS system must meet the minimum performance criteria outlined as follows, or as modified further by NMFS, as deemed necessary:

(1) The VMS shall be tamper proof, i.e., shall not permit the input of false positions; furthermore, if a system uses satellites to determine position, satellite selection should be automatic to provide an optimal fix and should not be capable of being manually overridden by any person aboard a fishing vessel or by the vessel owner.
(2) The VMS shall be fully automatic and operational at all times, regardless of weather and environmental conditions, unless the vessel is "powered-down," i.e., the vessel will be continuously out of the water for more than 72 consecutive hours; and a valid letter of exemption was obtained pursuant to 648.9(c)(2)(ii) of and issued to the vessel and is on board the vessel and the vessel is in compliance with all conditions and requirements of said letter.
(3) The VMS shall be capable of tracking vessels in all U.S. waters in the Atlantic Ocean from

the shoreline of each coastal state to a line 215 nautical miles offshore and shall provide position accuracy to within 400 m (1,300 ft).
(4) The VMS shall be capable of transmitting and storing information including vessel identification, date, time, and latitude/longitude.
(5) The VMS shall provide accurate hourly position transmissions every day of the year unless the vessel is powered-down, as described above in item 2. In addition, the VMS shall allow polling of individual vessels or any set of vessels at any time and receive position reports in real time. For the purposes of this specification, "real time" shall constitute data that reflect a delay of 15 minutes or less between the displayed information and the vessel's actual position.
(6) The VMS shall be capable of providing network message communications between the vessel and shore. The VMS shall allow NMFS to initiate communications or data transfer at any time.
(7) The VMS vendor shall be capable of transmitting position data to a NMFS-designated computer system via a modem at a minimum speed of 9600 baud. Transmission shall be in a file format acceptable to NMFS.
(8) The VMS shall be capable of providing vessel locations relative to international boundaries and fishery management areas.
(9) The VMS vendor shall be capable of archiving vessel position histories for a minimum of 1 year and providing transmission to NMFS of specified portions of archived data in response to NMFS requests and in a variety of media (tape, floppy, etc.).

1.2.5.1 Alternative 1 -- Mandatory. A mandatory VMS would replace the call-in system and work similar to the scallop VMS, but could be less intensive reporting (hourly rather than every half-hour). It is estimated that 50 (non Maine) vessels who fish for surfclam and ocean quahogs in Federal waters would have to purchase and maintain the equipment from approved vendors. It is anticipated that the small-scale artisanal Maine vessels will be exempted from this requirement currently as the Regional Administrator has the authority to exempt them from the call-in system. Implementation of this mandatory system would operate as identified above.

1.2.5.2 Alternative 2 -- No action. Currently all fishing vessels must call into enforcement to notify them of their activities and where and when they will be landing.

1.2.5.3 Alternative 3 -- Voluntary. This alternative would combine the current call-in system with an optional VMS so that the vessels would have the choice between the two.

1.2.5.4 Alternative 4 – Interactive Voice Response (IVR). The existing IVR system allows dealers holding Federal permits to quickly and easily report their weekly fish purchases using a touch-tone telephone. This system is used for all quota-managed species in the northeast except for surfclams and ocean quahogs. Permit types that already report include: Atlantic bluefish, black sea bass, northeast multispecies, scup, spiny dogfish, squid/mackerel/butterfish, and summer flounder.

1.3 PUBLIC HEARINGS COMMENTS AND COUNCIL RESPONSE

The Council held three public hearings on the draft FMP and draft Supplemental EIS. These hearing were held in Machias, Maine on September 24, in Atlantic City, New Jersey on September 30, and at the Council meeting in Claymont, Delaware on October 2, 2002. The public hearing summaries of each hearing can be found in Appendix 7.

The Council also received written comments through October 15, 2002 (Appendix 8). Six comment letters were received with three from government agencies (NMFS, EPA and State of Maine) and three from industry representatives (National Fisheries Institute – Clam Committee, Wallace and Associates for the North Atlantic Clam Association, and the Maine Quahog Association). The Council reviewed the entire public record at their January 22, 2003 Council meeting.

At the January 2003 Council meeting, each of the five issues in the FMP were addressed separately by reviewing the public input, having further discussion among the Council members, accepting additional public testimony, and finally passing a motion.

The public record shows that the surfclam overfishing definition had wide support. At the January Council meeting, the Council voted unanimously (with the RA abstaining) in support of alternative 1. The overfishing definition alternatives are described in section 1.2.1 and evaluated in section 3.3.1.

The public record also shows that the evaluation of the fishing gear impacts to EFH had wide support. At the January Council meeting, the Council voted unanimously (with the RA abstaining) in support of alternative 1. The fishing gear impacts to EFH alternatives are described in section 1.2.2 and evaluated in section 3.3.2.

The public record indicates that the industry had some significant reservations with implementing multi-year quotas. All comments supported the continued annual Council review, even with multi-year quotas. After extensive debate, the Council voted unanimously (with RA abstaining) in support of alternative 1 for multi-year quotas not to exceed three years with an annual review. The multi-year quota alternatives are described in section 1.2.3 and evaluated in section 3.3.3.

The public record also indicates that the industry had some significant reservations with reversing the suspension of the surfclam minimum size limit. Many in industry and on the Council believe the system currently works well with limited effort and that should the size limit be needed in order to prevent fishermen from fishing on beds of small clams, it may be harder to implement than simply suspend. After extensive debate, the Council voted unanimously (with RA abstaining) in support of alternative 1 for maintaining the no action alternative, but adding to the list of framework items the suspension of the surfclam minimum size limit and adjustment of the surfclam minimum size. The suspension of the surfclam minimum size limit alternatives are described in section 1.2.4 and evaluated in section 3.3.4.

The public record indicates that the VMS issue also generated a divergent set of comments. Most of industry's concerns stem from the fact that there is currently only one certified vendor in the Northeast and that system does not seem to accomplish what was being attempted with the implementation of VMS in these fisheries. After extensive debate again, the Council voted overwhelmingly (15 to 1 with RA abstaining) to adopt alternative 1, mandatory implementation of an electronic tracking system that is satisfactory to the NMFS and industry. The Council recommends that the RA implement this system when an economically viable system is available for the industry based on the advice of the Council. It is expected that the CLEAN team will continue its efforts to coordinate among the various interest groups in the government, industry, and Council staff and when additional certified systems are available, they will provide their recommendations to the Council. The VMS alternatives are described in section 1.2.5 and evaluated in section 3.3.5.

2.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

2.1 DESCRIPTION OF THE STOCK

2.1.1 Species Description and Distribution

The Atlantic surfclam occurs both in state waters and the US EEZ along the Atlantic seaboard from Maine through North Carolina (Figures 5 and 6). Surfclams have planktonic larvae which may disperse sufficiently to cause gene flow throughout this geographical range.

Surfclams are found primarily in sandy sediment and are predominantly oceanic, where they are most common in turbulent waters just beyond the breaker zone (Ropes 1980). Encroachment into estuarine zones is probably limited by salinity requirements (Fay *et al.* 1983). Surfclams are generally found from the beach zone to a depth of about 200 feet; beyond 130 feet however, abundance is low (MAFMC 1988).

Ocean quahogs are distributed on both sides of the Atlantic from the Bay of Cadiz of Southwest Spain intermittently across the North Atlantic and down the North American coast to Cape Hatteras. Commercial concentrations occur throughout the continental shelf area between Georges Bank and Cape Hatteras, at least to depths of about 250 feet (Figures 7 and 8). Dahlgren *et al*. (2000) examined some population genetics of *Arctica,* and for the one gene they sequenced, they found little geographical divergence from Maine to Virginia. There are differences between the US population of *Arctica* and populations from Iceland, Sweden, and Norway (Weinberg pers. comm.). However, given the extended larval life span of ocean quahogs, animals on the southern shelf are likely components of a single population. Life history differences between Gulf of Maine and the ocean quahogs south of Georges Bank exist; environmental factors may play a large role in producing these differences (USDC 1998b).

Some information is available on environmental conditions influencing the distribution of ocean quahogs. Turner (1949 and 1953) believed that temperature may be the factor influencing the depth zonation of the species. Intolerance to high temperatures probably explains its absence from shallow water in the southern part of the range (Merrill *et al.* 1969). Ocean quahogs are rarely found when bottom water temperatures exceed 60°F and thus occur progressively further offshore between Cape Cod and Cape Hatteras. Highest densities in the mid-Atlantic region are between 130 feet and 200 feet; few ocean quahogs have been found in the mid-Atlantic in excess of 300 feet. Medcof (1958) has reported large stocks in the Southern Gulf of St. Lawrence; other major areas of concentrations have been reported along the coasts of Scandinavia, Greenland, and Newfoundland (Parker and McRae 1970). Ocean quahogs are probably present on much, if not most, of the continental shelf of North America. Mann at VIMS has provided most of the recent literature on environmental conditions and distribution where he has examined the seasonal cycle of gonadal development (Mann 1982), seasonal changes in the depth distribution of larvae (Mann 1985), and larvae swimming behavior in response to pressure and temperature (Mann and Wolf 1983).

Greatest concentrations of ocean quahogs are in offshore waters south of Nantucket to the Delmarva Peninsula (Serchuk *et al.* 1982). The inshore limit of their distribution appears to be limited by the 60° F bottom isotherm in the summer months (Mann 1989). Most are found at depths of 80-200 feet (Merrill and Ropes 1969, Serchuk *et al.* 1982) and some have been found as deep as 840 feet (Ropes 1978). They are found in relatively shallow water in eastern Maine (but never intertidally) and in deeper, more offshore waters south of Cape Cod (MAFMC 1998).

The southern distribution of surfclams is limited by water temperatures of 73°F (Saila and Pratt 1973). This fact becomes apparent when the depth distribution of adult clams is examined. Adults are found intertidally in New England, but no significant numbers are found inshore off the Delmarva Peninsula. The fishery started in New England; clams were harvested with hand equipment (Yancey and Welch 1968). No commercial beds are found inshore off Delmarva (Loesch and Ropes 1977) but commercial quantities are found 15 or more miles off the coast. This phenomenon is not from lack of recruitment inshore, because densities of spat as high as 1 - 2 million per mile were estimated in the intertidal zone of Wallops Island, Virginia (Yancey and Welch 1968). Mortality of these recruits were attributed to high water and air temperatures (Ropes and Merrill 1970).

The management unit is all Atlantic surfclams (*Spisula solidissima*) and ocean quahogs (*Arctica islandica*) in the Atlantic EEZ. In 1988 the American Malacological Union officially changed the common name of "surf clam" to the one word name "surfclam". This was published in the American Fisheries Society special publication 16 entitled *Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Mollusks* (American Fisheries Society 1988). The ocean quahogs managed in this FMP include a small-scale fishery in eastern Maine that harvests small ocean quahogs which are generally sold for the half-shell market. Locally these small ocean quahogs off the coast of Maine are known as "mahogany quahogs" and have been under Council management since implementation of Amendment 10 (MAFMC 1998).

A southern subspecies of surfclam, *Spisula solidissima similis*, occurs south of Cape Hatteras (Walker and Heffernan 1994). Another species, *Spisula raveneli*, occurs in the southern part of the range of *S. solidissima*. This species distinction, based on distribution and morphology (Porter and Schwartz 1981), is controversial (Vecchione and Griffis 1996).

2.1.2 Abundance and Present Condition

The 1999 region-wide survey for Atlantic surfclams and ocean quahogs was conducted in continental shelf waters, from Cape Hatteras to Georges Bank aboard the R/V DELAWARE II in June and July. Three hundred and eighty four survey stations were randomly selected to give abundance measurements. Therefore, the survey data were not always on or near known locations of high clam abundance. The distribution and abundance of surfclams from the 1999 survey are documented in Figures 5 and 6, while ocean quahog distribution and abundance are shown in Figures 7 and 8. Ocean quahogs were sampled during the 1999 survey from waters deeper than had been previously feasible (greater than about 240 feet). Stock assessments were conducted at the December 1999 and June 2000 Stock Assessment Review Committee (SARC) meetings for surfclams and ocean quahogs, respectively. Key findings from these SARC reports are summarized below and reproduced in their entirety in Appendices 1 and 2. Survey strata used in the assessments are shown in Figure 17. A clam survey was conducted in the summer of 2002 and a stock assessment for surfclams will be June 2003.

The EEZ surfclam resource is at a high level of biomass and is under-exploited. Fishing mortality is low. The majority of the catch is derived from the Northern New Jersey (NNJ) area which contains about 38% of the coast-wide resource (Figure 18). Large fractions of the resource are exploited at low levels (Delmarva containing 25% of the resource) or not at all (Georges Bank containing 21% of the resource). Estimated mean annual fishing mortality rates from 1997-1999 were 0.02 for the entire EEZ resource, 0.03 - 0.04 for the NNJ region, and 0.04 - 0.07 for the SNJ region. Age composition data from the 1997 survey for NNJ and Delmarva indicate that the populations contain at least 18 cohorts, none of which are dominant. The length frequencies for these two regions between the 1997 and 1999 surveys did not significantly vary. Fishing mortality can be increased for the surfclam resource taken as a whole. However, it may be advantageous to avoid localized depletion.

The ocean quahog resource in surveyed EEZ waters from Southern New England (SNE) to southern Virginia (SVA) is not overfished and overfishing is not occurring. The current biomass is high with current catches near MSY. Fully 36% of the current biomass is in the unfishable region of Georges Bank (Figure 19). Annual recruitment is approximately 1 - 2% of stock biomass and lower than, or roughly equal to, the rate of natural mortality. Since the fishery began in the mid 1970s, biomass has declined slowly from virgin levels. At current catch levels biomass is projected to decline gradually over the next decade. The percentage of virgin biomass in the assessed areas (not including Georges Bank because of PSP unavailability) is 82%. The stock off the coast of Maine continues to be harvested, but the condition of the resource there is unknown. Current fishing mortality is near F_{target} for the resource taken as a whole. However, it may be advantageous to avoid localized depletion.

2.1.3 Ecological Relationships and Stock Characteristics

2.1.3.1 Spawning and early life history

Both surfclams and ocean quahogs are dioecious, although hermaphrodism has been reported in surfclams (Ropes 1968). Male and female clams and quahogs are identical in external appearance, and histological sectioning and examination of gonads is the only sure way to determine gender.

Male and female surfclams reach sexual maturity during their second year, even though ripe gonads and some spawning activity may occur during their first year (Ropes 1979; Chintala and Grassle 1995). Sexual maturity in ocean quahogs is reached by age eight for half the males and age 11 for half the females. No observations on fecundity of surfclams (Fay *et al.* 1983) or ocean quahogs are available.

Spawning in surfclams has been reported to occur both during a single time and over multiple periods from mid July through early November (Fay *et al.* 1983). Within a bed of clams, spawning is probably a synchronous annual event (Ropes 1968). Water temperature is an important factor influencing initiation and time of spawning (Ropes 1980), and may influence the rate of gonadal ripening and number of major spawning periods per year. After eggs and sperm are broadcast, fertilization occurs in the water column above the spawning bed of clams (Murawski and Serchuk 1981).

Spawning in ocean quahogs occurs over a prolonged period from May through November with spawning activity being most intense from August through November (Mann 1982). Multiple annual spawnings at both the individual and population level occur. After an assessment of the hydrographic conditions in the area, Mann (1982) hypothesized that larval survival is probably greatest during the months of October and November, which is the breakdown of the intense seasonal thermocline and before the onset of low winter seawater temperatures.

Eggs and larvae of both surfclams and ocean quahogs are planktonic, and water currents are important in determining eventual patterns of distribution and settlement for developing juveniles. Dispersal and redistribution of surfclams to other areas, through swimming and crawling activities and water currents, occur primarily during the larval stages. The generalized surface water layer circulation between the Gulf Stream and the East Coast (that is, the area inhabited by surf lams and ocean quahogs) is a southerly flow (Figure 20), so that planktonic eggs and larvae generally would be drifting from north to south. Specific information on the interaction of water currents and larval settlement patterns is unavailable (Ropes 1980), but recent studies have examined habitat selection by settling larvae (Snelgrove *et al.* 1998 and 1999).

2.1.3.2 Age and growth

Growth is not uniform over the year; temperature significantly affects surfclam growth, physiology, and behavior. Henderson (1929) determined the upper lethal temperature of surfclams to be 98.6°F, however, this was based on only 5 individuals. Mid-Atlantic surfclams reared in Georgia did not survive water temperatures above 82°F (Spruck *et al.* 1995). Surfclams rarely encounter such temperatures in the field, and are usually found in areas where the bottom temperature rarely exceeds 77°F. The minimum temperatures experienced by surfclams are probably not less than 33°F. Ambrose *et al.* (1980) noted that growth of surfclams in the Middle Atlantic Bight was positively correlated with temperature and negatively correlated with variation in temperature. Davis *et al.* (1997) found that growth in the coastal Gulf of Maine was higher at warmer temperatures and higher chlorophyll *a* concentrations. Stable oxygen isotopes revealed that shell growth reflects seawater temperature; growth is most rapid in spring/early summer, slow in late-summer and fall, and extremely slow or non-existent in winter in New Jersey waters (Jones 1983). In the laboratory, surfclam heart rate increased with increasing temperature from 41-59°F (deFur and Mangum 1979).

Age-length keys from 1997 were applied to regional size frequency distributions to obtain the age composition of the NNJ and DMV surfclam populations for 1997 (Figure 21). In each region, the population consisted of at least 15 cohorts in 1997 (Weinberg 1999). NNJ appears to be composed of a greater proportion of older individuals than DMV (USDC 1998a). Surfclam growth rates vary among regions and over time (Weinberg and Helser 1996). Surfclam growth rates have been shown to decline as a function of intraspecific density in the Delmarva region (Weinberg 1998).

Great longevity is an interesting recent discovery about the ocean quahog. One probably lived for 225 years, making it the longest lived, slowest growing, bivalve yet known (Brownlow and Ropes1984). Recent age and growth studies based on external and internal growth markings (Jones 1980; Murawski *et al.* 1980; Thompson *et al.* 1980) and mark-recapture techniques (Murawski *et al.* 1980) have assessed the ages of ocean quahogs. Quahogs larger than 3.5 inches shell length, common in NMFS survey catches in the mid-Atlantic, are estimated to be 70 years or older.

The size composition of landings is similar to that from resource surveys of the exploited areas (Murawski and Serchuk 1983). Average 1980 - 1982 size compositions of ocean quahog landings were compared to size data from corresponding resource surveys in the areas actually being fished (Murawski and Serchuk 1983). Survey size distributions were nearly identical to those in the fishery, indicating little commercial culling.

Based upon size composition data and the age-size relationship it is apparent that a significant proportion of the ocean quahog population is in excess of 100 years old (Murawski and Serchuk 1983). Assuming an average shell size of 3.8 inches at age 100, then at least 17% of the New Jersey resource and 16% of the Delmarva resource are in excess of 100 years (Murawski and Serchuk 1983). Since ocean quahogs from 2.5 to 4 inches comprise the bulk of the resource, these are individuals were spawned 20 to 100 years ago.

2.1.3.3 Mortality

Fishing mortality for surfclams is low (Appendix 1). Estimated mean annual fishing mortality rates (F) from 1997 - 1999 were 0.02 for the entire EEZ resource, 0.03 - 0.04 for the northern New Jersey (NNJ) region, and 0.04 - 0.07 for the southern New Jersey (SNJ) region.

The most recent SARC (Appendix 1) wrestled with the previously assumed estimate for natural mortality (M) in surfclams. Using age length keys, survey length composition, survey catch rates, catch curves, literature for species with similar life histories, the best estimate of M was increased from 0.05 to 0.15. The oldest surfclam ever aged by NEFSC was 36 years old, but maximum ages of 40 years are plausible.

Annual fishing mortality on ocean quahogs is also low and estimated to be around 0.02 (Appendix 2). This resource is not overfished and overfishing is not occurring.

The assumed natural mortality for ocean quahogs, M = 0.02, is imprecisely known.

2.1.3.4 Food and feeding

Surfclams and ocean quahogs feed on plankton and detritus. Feeding occurs when sea water is drawn in through and expelled from the siphons. This process is also related to respiration and excretion. Leidy (1878) made observations on the contents of the digestive tract of surfclams from a New Jersey beach. He was surprised "at the number of different genera and species of diatoms found" but mentioned only *Amphiprora constricta* and a suspected ciliated infusorian *Tintinnus*. Feeding both these species in culture facilities involves a wide variety of mixed plankton cultures.

2.1.3.5 Predators and competitors

Surfclams have many predators (Weissberger *et al.* 1998a), including the naticid snails *Euspira heros* and *Neverita duplicata* (Franz 1976), the sea star *Asterias forbesi* (Meyer *et al.* 1981), the lady crab *Ovalipes ocellatus* and the Jonah crab *Cancer borealis*, the haddock *Melanogrammus aeglefinus* and the cod *Gadus morhua*, and the horseshoe crab *Limulus polyphemus*. The sevenspine bay shrimp *Crangon septemspinosa* preys on recently settled clams. In the New York Bight, crabs accounted for 48.3-100% of mortality while moon snails accounted for only 2.1% of mortality.

Many animals prey on ocean quahogs (Weissberger *et al.* 1998b). Invertebrate predators include rock crabs, sea stars, and other crustaceans. Teleost predators of ocean quahogs include longhorn sculpin, ocean pout, haddock, cod, and sculpin. Medcof and Caddy (1971) noted many predators feeding on ocean quahogs damaged by a dredge. These included cod, winter flounder, sculpin, skates, moon snails, and hermit crabs. Other potential predators, including eelpout, sea stars, and whelks, were seen in the dredge tracks, but not observed feeding.

A variety of benthic organisms occur in the beds of surfclams and ocean quahogs. It is not known whether they may compete with the clams. Some of the effects of these species are to occupy space at the sediment surface, build tubes, crawl through the sediment, and cause bioturbation.

2.1.3.6 Parasites and diseases

Surfclams are susceptible to several parasites, including the thigmotrich *Sphenophyra dosinae*, the cyclopoid copepod *Myocheres major*, a cestode of the genus *Echeneribothrium*, a nematode tentatively identified as *Paranisakiopsis pectinis*, and the hyperparasite haplosporidian *Urosporidium spisuli*. Protistan organisms, larval trematodes, larval cestodes, and tumors are among known parasites and diseases of marine commercial clams (Sindermann and Rosenfield 1967).

2.1.4 Maximum Sustainable Yield

The 1996 Magnuson-Stevens Act or SFA imposed new requirements concerning definitions of overfishing in US fishery management plans. To comply with National Standard 1 section 3 (29) of the SFA requires that each Council FMP define both overfishing and overfished as a rate or level of fishing mortality that jeopardizes a fisheries' capacity to produce maximum sustainable yield (MSY) on a continuing basis. The proposed guidelines for implementation of the new National Standards suggest that sustainability or the phrase "on a continuing basis" are generally accepted to mean an average stock level and/or average potential yield from a stock over a long period of time. Each FMP must specify an MSY, and a harvest strategy that, if implemented, is expected to result in long-term average yield close to MSY.

The Secretary of Commerce did not approve the Council proposed surfclam overfishing definition that was in Amendment 12 (MAFMC 1998). There are four surfclam overfishing alternatives for this amendment public hearing draft, however only the preferred alternative is likely to meet the requirements associated with the new National Standard 1 guidelines.

The Council's preferred surfclam overfishing definition was based on the advice of the 30th SAW (Appendix 1). This proposed definition is global rather than just focused on the Northern New Jersey area as in the definition proposed by Amendment 12. Table 1 details the specific reference points and should replace the surfclam portion of the overfishing table on page 121 of Amendment 12. The approved ocean quahog reference points are included in Table 1 for comparison. The SARC recommended an MSY control rule (Figure 1) . The default MSY control rule calculates a maximum fishing mortality rate threshold. Overfishing (as a rate) occurs by definition whenever fishing mortality is as large or larger than the fishing mortality rate threshold. The threshold fishing mortality rate used to define overfishing is reduced in the default MSY control rule whenever stock biomass falls below a biomass threshold value (Appendix 1).

The overfishing definition in Amendment 12 for ocean quahogs was approved by the Secretary of Commerce. For MSY of ocean quahogs, it is generally assumed that MSY for harvested populations occurs at one-half the virgin biomass. The 1997 surveyed biomass estimate (roughly 3 billion pounds of meats) is at about 80% of the virgin biomass (roughly 4 billion pounds of meats) (Figure 22) and exploitation rates are below $F_{0.1}$, $F_{25\%}$, and F_{max}. The combination of current biomass and F is highly unlikely to represent overfishing, as defined by the current SFA guidelines (USDC 1998b). There is however, significant time to determine the exact nature of the sustainability of the resource, since total removals (which have averaged about 40 million pounds/year) over the past two decades have only reduced the virgin biomass by about 20%.

The current biomass is less than the likely carrying capacity (K) of the resource, but well above K/2 which is generally considered to be where MSY occurs.

In conclusion, the overfishing definition "target" for ocean quahogs is one-half the virgin biomass and the $F_{0.1}$ level of fishing mortality for the exploited region. The overfishing definition "threshold" would be one-half B_{MSY} or one-quarter of the virgin biomass (as recommended by Applegate *et al.* 1998) with an $F_{25\%}$ level of fishing mortality that should never be exceeded. The $F_{25\%}$ MSP level is the threshold level recommended by the NEFSC for Amendment 9 (MAFMC 1996) and reviewed and approved by the MAFMC Scientific and Statistical Committee.

2.1.5 Probable Future Condition

Surfclam management advice from SARC 30 (USDC 2000a and Appendix 1):

Note: the following "Management Advice" and "Projections" sections are taken directly from the most recent SARC advisory reports, and therefore are expressed in metric units (1 kg = 2.205 lbs, there are 17 lbs/bushel for surfclams and 10 lbs/bushel for ocean quahogs). The SARC text, tables, and figures can be found in Attachment 1 (surfclams) and Attachment 2 (ocean quahogs).

Management Advice: Fishing mortality can be increased for the surfclam resource taken as a whole. However, it may be advantageous to avoid localized depletion.

Forecasts: Short term deterministic projections for 1999-2002 were performed using recent catch (average 1997-1999) with 20% non-catch mortality from fishing, recent recruitment levels (average 1997-1999) and assuming $M=0.15\ y^{-1}$. Projections suggest little change (4%) in total clam biomass during 1999-2002, although larger changes in some regions are possible (Table 4). Biomass and recruitment are in metric tons.

Ocean Quahog Management Advice from SARC 31(USDC 2000b and Appendix 2)

Management Advice: Current fishing mortality is near F_{target} for the resource taken as a whole. However, it may be advantageous to avoid localized depletion.

Forecasts for ocean quahogs can be found in Table 5, with full discussion in Appendix 2.

2.2 DESCRIPTION OF HABITAT

2.2.1 Habitat Characterization of Northeast Shelf Ecosystem

The NMFS (USDC 2001) developed a report entitled *The Effects of Fishing on Marine Habitats of the Northeastern United States* (Appendix 3). This report was used as the background document for the fishing gear impacts workshop in October of 2001 (Appendix 4). Much of the descriptive background information included in this section was generated for the NMFS report.

The purpose of this section is to describe the habitats of the Northeast Shelf Ecosystem which is important for two reasons. First, the ecosystem's structure must be reviewed in order to provide a basis for understanding the types of disturbance and their implications. Second, the application of research results from other regions can only be determined with some general understanding of how the two systems compare.

The Northeast Shelf Ecosystem is influenced broadly by winds, climate changes, river runoff, estuarine exchange, tides, and Gulf Stream meanders and rings. Each regional subsystem has its own distinct characteristics. This discussion will focus on oceanographic processes and habitat characteristics of each regional system. The information provided will contribute to a more complete understanding of the effects of fishing gear on habitat of the Northeast Shelf ecosystem.

2.2.1.1 Habitat functions and characteristics

In order to adequately evaluate fishing gear impacts on habitat, one must first comprehend the functional value of habitats to the ecosystem. From a biological perspective, habitats provide living things with the basic life requirements of nourishment and shelter. Habitats may also provide a broader range of benefits to the ecosystem. For example, seagrasses physically stabilize the substrate, and help recirculate oxygen and nutrients. In this general discussion, there will be a focus on the first-level, direct value of habitats, such as food and shelter from predation, for Federally managed species.

The spatial and temporal variation of prey abundance influences the survivorship, recruitment, development, and spatial distribution of organisms at every trophic level. For example, phytoplankton abundance and distribution are a great influence on ichthyoplankton community structure and distribution. In addition, the migratory behavior of juvenile and adult fish is directly related to seasonal patterns of prey abundance and changes in environmental conditions, especially water temperature. Prey supply is particularly critical for the starvation-prone early life history stages of fish.

The availability of food for planktivores is highly influenced by oceanographic properties. The seasonal warming of surface waters in temperate latitudes produces vertical stratification of the water column, which isolates sunlit surface waters from deeper, nutrient-rich water, leading to reduced primary productivity. In certain areas, upwelling, induced by wind storms, and tidal mixing, injects nutrients back into the photic zone, stimulating primary production. Changes in primary production from upwelling and other oceanographic processes affect the amount of organic matter available for other organisms, and thus influence their distribution.

Oceanographic properties can also influence the food availability for sessile benthic organisms. For example, certain areas in the Gulf of Maine have a much more limited epifaunal community than similar sediments on Georges Bank. This difference is due at least in part to a difference in the availability of food.

Benthic organisms provide an important food source for many managed species. For example, populations of sand lance are important sources of nutrition for many piscivorous species, and benthic invertebrates are the main source of nutrition for many adult demersal fishes. Additionally, recent research on benthic primary productivity indicates that benthic micro-algae may contribute more to primary production than has been originally estimated (Cahoon 1999).

Another important functional value of benthic habitat is considered to be the shelter provided by structure and the availability of hard surface for attachment of epibenthic organisms. The importance of benthic habitat complexity was discussed by Auster (1998) and Auster and Langton (1999) in the context of providing a conceptual model to visualize patterns in gear impacts across a gradient of habitat types. Based on this model, habitat value increased with structural complexity.

This NMFS report cites evidence from many studies that bottom otter trawls and other fishing gear can reduce habitat complexity, with greater potential for change in more complex habitats. Less is known about the subsequent effects of reduced complexity on Federally managed species. A prime example of this issue in the Northeast Region is the question of whether removal of emergent epifauna from gravel and rocky habitat affects survival of juvenile cod and other species. There are field studies (in northeast US and eastern Canadian waters), laboratory experiments and modeling studies addressing this question. Because of the controversy associated with this issue in the Northeast Region, the research is addressed in depth.

The first field study linking survival of juvenile cod (and haddock) to habitat type on Georges Bank was by Lough *et al.* (1989). Using submersibles, they observed that recently-settled 0-group juvenile cod (and haddock), < 4 inches long, were primarily found in pebble-gravel habitat at 200 to 300 feet depths on eastern Georges. The authors hypothesized that the gravel enhanced survival through predator avoidance; coloration of the fish mimicked that of the substrate, and from the submersible the fish were very difficult to detect against the gravel background. The authors considered increased prey abundance to be another, but less likely, explanation for the concentration of these juvenile fish on gravel. Presence of emergent epifauna, and any effects of epifauna on survival of the juveniles, were not noted.

Gregory and Anderson (1997), using submersibles in 50 to 500 foot depths in Placentia Bay, Newfoundland, similarly found that the youngest cod observed (age 1, 4 to 5 inches long) were primarily associated with gravel substrate with low relief; their mottled color appeared to provide camouflage in the gravel. Older juveniles (ages 2-4) were most abundant in areas with coarser substrate and more relief, e. g., submarine cliffs. No selection by juvenile cod for substrates with macroalgae cover was seen, and emergent epifauna was not mentioned.

In the first study suggesting an added value of emergent epifauna on Georges Bank gravel, Valentine and Lough (1991) observed from submersibles that attached epifauna was much more abundant in areas of eastern Georges which had not been fished (due to the presence of large boulders). They felt the increased bottom complexity provided by the epifauna might be an important component of fisheries habitat, but both trawled and untrawled gravel were considered important for survival of juvenile cod.

Other field studies on the relationship of juvenile cod abundance to habitat complexity have been in shallower inshore waters, and results may not be directly applicable to conditions on Georges Bank. In 5 to 40 foot depths off the Newfoundland coast, Keats *et al.* (1987) found (in contrast to Gregory and Anderson 1997 [above]) juvenile cod to be much more abundant in macroalgae beds than in adjacent areas which had been grazed bare by sea urchins. This was true of 1-year-old fish (3 to 5 inches) as well as older larger (5 to 10 inches) juveniles. The larger fish fed on fauna associated with the macroalgae, so enhanced food supply was a probable benefit of the increased complexity. The smallest 1-year-olds fed on plankton, and it was unlikely their growth was affected by presence of macroalgae.

Tupper and Boutilier (1995b), examining four habitat types (sand, seagrass, cobble, rock reef) in St. Margaret's Bay, Nova Scotia, reported that cod settlement was equal in all habitats, but survival and juvenile densities were higher in the more complex habitats. Growth rate was highest in seagrass beds, but predator (larger cod) efficiency was lowest, and juvenile survival highest, on rock reef and cobble. The authors considered the different habitats to provide a tradeoff between enhanced foraging and increased predation risk. In another study in St. Margaret's Bay, Tupper and Boutilier (1995a) found that cod settling on a rocky reef inhabitated crevices in the reef, and defended territories around the crevices. Fish that settled earlier and at larger sizes grew more quickly and had larger territories. Size at settlement and timing of settlement were thus considered important in determining competitive success of individuals.

Habitat associations of juvenile cod were also examined by Gotceitas *et al.* (1997) using SCUBA in Trinity Bay, and beach seines in Trinity, Notre Dame and Bonavista Bays, Newfoundland. In both types of surveys, almost all age-0 cod were found in eelgrass beds as opposed to less structurally complex areas, and eelgrass was suggested to be an important habitat for these fish. Older juveniles were more abundant on mud, sand and rocky bottoms than in eelgrass.

A seining study by Linehan *et al.* (2001) in Bonavista Bay, Newfoundland, found age 0 cod (< 4 inches long) to be more abundant in vegetated (eelgrass) than in unvegetated habitats, both day and night. However, potential predators of juvenile cod were also most abundant in eelgrass. Tethering experiments with age 0 cod at 6 sites in 2 to 60 f00 depths indicated that predation increased with depth, being about three times higher at deeper sites. At shallow sites, predation was generally higher in unvegetated sites than in eelgrass.

Information on effects of habitat complexity on juvenile cod survival is also available from several laboratory studies. Gotceitas and Brown (1993) observed juvenile cod (2 to 5 inches) in a tank with two substrate types from among sand, gravel-pebble and cobble, before and after introduction of a larger cod. Before the predator was introduced, small cod preferred sand or gravel-pebble over cobble. In the presence of the predator, they chose cobble if available, and the cobble reduced predation. The experiment did not test effects of emergent epifauna on substrate choices or survival. Gotceitas *et al.* (1995) conducted a similar study, but with 1.5 to 3 inch cod in a tank with three substrates, either 1) sand, gravel, and 12 inch long strips of plastic to simulate kelp (*Laminaria* sp.), or 2) sand, cobble, and "kelp". Based on the authors' earlier study, cobble was considered to provide a "safe" habitat that reduced predation. Responses to introduction of two kinds of larger cod were tested: fish which actively attempted to eat the smaller cod, vs. "passive" predators showing no interest in the smaller fish. In the presence of passive predators, small cod preferred sand substrates and avoided kelp. When exposed to an active predator, they hid in cobble if available, or kelp if there was no cobble. Both cobble and kelp significantly reduced predation, and small cod appeared able to modify their behavior based on the varying risk presented by different predators.

Fraser *et al.* (1996) tested responses of age 0 (2 to 3 inch) and age 1 (4 to 6 inch) cod to predators (3-year-old cod), using the same tanks as Gotceitas *et al.* (1995) but with only two substrate choices: sand vs. gravel, and sand vs. cobble. With no predator present, age 0 and 1 cod preferred sand to gravel or cobble, but if both age 0 and 1 fish were in the tank, the smaller fish tended to avoid the larger ones and to increase use of gravel/cobble. When a predator was introduced, both age 0 and 1 cod hid in cobble if available; in the sand/gravel trials, they attempted to flee from the predator. In the predator's presence, the avoidance of age 1 cod by age 0 cod disappeared; overall, however, there was some indication of habitat segregation between age 0 and age 1 cod.

Gotceitas *et al.* (1997) again used the same experimental system to compare use of sand, gravel and cobble substrates, and three densities of eelgrass, by age 0 cod (1.5 to 4 inch) in the presence and absence of a predator (age 3 cod). With no predator, the small cod preferred sand and gravel to cobble. When a predator was introduced and cobble was present, age 0 fish hid in the cobble or in dense eelgrass ($\geq$ 720 stems/m^2) if present. With no cobble, they hid in all three densities of eelgrass. Age 0 cod survival (time to capture and number of fish avoiding capture) was highest in cobble or $\geq$ 1000 eelgrass stems/m^2. In other combinations, time to capture increased with both presence and density of vegetation.

Lindholm *et al.* (1999) tested effects of five habitat types, representing a gradient of complexity, on survival of age 0 cod (3 to 4 inch) in the presence of age 3 conspecifics. Substrates were sand, cobble, sparse short sponge, dense short sponge, and tall sponge. Sponge presence significantly reduced predation compared to that on sand, with density of sponges being more important than sponge height. Increasing habitat complexity reduced the distance from which a predator could react to the prey. The authors concluded that alteration of seafloor habitat by fishing could lower survival of juvenile cod. [There was no significant increase in survival in epifauna compared to bare cobble, however.]

Finally, effects of habitat complexity on post-settlement survival of juvenile cod have been examined via modeling (Lindholm *et al.* 1998, 2001). Data from the Lindholm *et al.* (1999) laboratory study described above were used to assign maximum values of 0.98 for juvenile mortality in the least complex habitats, and 0.32 in habitats of greatest complexity. Twelve monthly runs of a dynamic model were made, with the first month representing settlement of the cod. Results indicated that reduction of habitat complexity by fishing had significant negative effects on survival of juvenile cod, and that preservation of complexity through use of marine protected areas could reduce these negative effects.

In some situations, complexity may not be an important habitat characteristic. As discussed above, Lough *et al.* (1989) hypothesized that gravel substrate enhanced survival of juvenile cod because the coloration of these juveniles mimicked the substrate. In a similar example, American plaice adults are thought to associate with gravel-sand sediments for appropriate coloration for predation refuge (Scott 1982). It is apparent that in the consideration habitat value, a broad range of characteristics associated with habitat structure and function must be included, which may vary by species and life stage. Considerations cannot be limited to individual aspects such as substrate type. Unfortunately, the amount of information available for individual aspects is limited, much less that which is available for multivariate analyses. Further development of multivariate relationships between biological, chemical, and physical habitat features will increase our understanding of the marine environment and advance the evidence of direct links between habitat conditions and fishery productivity.

2.2.1.2 Description of regional systems

The Northeast Shelf Ecosystem (Figure 23) has been described as including the area from the Gulf of Maine south to Cape Hatteras, extending from the coast seaward to the edge of the continental shelf, including the slope sea offshore to the Gulf Stream (Sherman *et al.* 1996). A number of distinct subsystems comprise the region, including the Gulf of Maine, Georges Bank, and Mid-Atlantic Bight.

The Gulf of Maine is an enclosed coastal sea, characterized by relatively cold waters and deep basins, with a patchwork of various sediment types. Georges Bank is a relatively shallow coastal plateau that slopes gently from north to south and has steep submarine canyons on its eastern and southeastern edge. It is characterized by highly productive, well-mixed waters and fast-moving currents. The Mid-Atlantic Bight is comprised of the sandy, relatively flat, gently sloping continental shelf from southern New England to Cape Hatteras, NC.

Pertinent aspects of the physical characteristics of each of these subsystems are described below. This review is based on several summary reviews (Cook 1988, Pacheco 1988, Stumpf and Biggs 1988, Abernathy 1989, Townsend 1992, Mountain *et al.*1994, Beardsley *et al.* 1996, Brooks 1996, Sherman *et al.* 1996, NEFMC 1998, Steimle *et al*. 1999). Literature citations are not included for generally accepted principles; however, new research and specific results of research findings are cited.

2.2.1.3 Gulf of Maine

Although not obvious in appearance, the Gulf of Maine is actually an enclosed coastal sea, bounded on the east by Browns Bank, on the north by the Nova Scotian (Scotian) Shelf, on the west by the New England states and on the south by Cape Cod and Georges Bank (Figure 24). The Gulf of Maine (GOM) was glacially derived, and is characterized by a system of deep basins, moraines and rocky protrusions with limited access to the open ocean. This geomorphology influences complex oceanographic processes which result in a rich biological community.

Topographic highlights of the area include three basins that exceed 800 feet in depth – Jordan to the north, Wilkinson to the west, and Georges just north of Georges Bank. The average depth in the Gulf of Maine is 450 feet. The Northeast Channel between Georges Bank and Browns Bank, leads into Georges Basin, and is one of the primary avenues for exchange of water between the GOM and the North Atlantic Ocean. Other prominent ledges or banks include Cashes Ledge, Stellwagen Bank, Jeffreys Ledge and Platts Bank.

An intense seasonal cycle of winter cooling and turnover, springtime freshwater runoff, and summer warming influences oceanographic and biologic processes in the Gulf of Maine. The Gulf has a general counterclockwise nontidal surface current which flows around the coastal margin of the Gulf (Figure 24). It is primarily driven by fresh, cold Scotian Shelf water that enters over the Scotian Shelf and through the Northeast Channel, and freshwater river runoff, which is particularly important in the spring. Dense relatively warm and saline slope water entering through the bottom of the Northeast Channel from the continental slope also influences gyre formation. Counterclockwise gyres generally form in Jordan, Wilkinson, and Georges Basins and the Northeast Channel as well. These surface gyres are more pronounced in spring and summer; with winter, they weaken and become more influenced by the wind.

Stratification of surface waters during spring and summer seals off a mid-depth layer of water that preserves winter salinity and temperatures. This cold layer of water is called "Maine intermediate water" (MIW) and is located between more saline Maine bottom water and the warmer, stratified Maine surface water. The stratified surface layer is most pronounced in the deep portions of the western GOM. Tidal mixing of shallow areas prevents thermal stratification and results in thermal fronts between the stratified areas and cooler mixed areas. Typically, mixed areas include Georges Bank, the southwest Scotian Shelf, eastern Maine coastal waters, and the narrow coastal band surrounding the remainder of the Gulf.

The Northeast Channel provides an exit for cold MIW and outgoing surface water while it allows warmer more saline slope water to move in along the bottom and spill into the deeper basins. The influx of water occurs in pulses, and appears to be seasonal, with lower flow in late winter and a maximum in early summer.

Gulf of Maine circulation and water properties can vary significantly from year to year. Notable episodic events include shelf-slope interactions such as the entrainment of shelf water by Gulf stream rings, and strong winds which can create currents as high as 4 feet/second over Georges Bank. Warm core Gulf Stream rings can also influence upwelling and nutrient exchange on the Scotian shelf, and affect the water masses entering the GOM. Annual and seasonal inflow variations also affect water circulation.

Internal waves are episodic and can greatly affect the biological properties of certain habitats. Internal waves can shift water layers vertically, so that habitats normally surrounded by cold MIW are temporarily bathed in warm, organic-rich surface water. On Cashes Ledge, it is thought that deeper nutrient rich water is driven into the photic zone, providing for increased productivity. Localized areas of upwelling interaction occur in numerous places throughout the Gulf.

The glacial origin of the GOM's bottom structure resulted in a complex variety of sediments and topography. Sand and gravel (gravel is typically defined to include gravel, pebbles, cobbles, and boulders) banks developed from large moraines deposited by the glaciers. Rocky outcrops form significant features such as Cashes Ledge (Figure 25). Patches of sand, silt and clay are found dispersed throughout the Gulf of Maine, with finer sediments accumulating in the deeper basins. Gravel pavement is found primarily in the northeast channel, with other smaller, more variable gravel areas interspersed in the Gulf. Topographic highs are subject to relatively more currents, and characterized by coarser sediments. In areas along the northeast coast of Maine, sediments are generally silt and clay, while the bottom type south of Casco Bay is largely sand.

The Gulf of Maine's geologic features, when coupled with the vertical variation in water properties, result in a great diversity of habitat types. Watling *et al.* (1988) used numerical classification techniques to separate benthic invertebrate samples into six types of bottom communities. These communities are identified in Table 6 and their distribution is indicated in Figure 26. This classification system illustrates the combined effects of substrate type and water properties.

An in-depth review of GOM habitat types has been prepared by Brown (1993). Although still preliminary, this classification system is a promising approach. It builds on a number of other schemes, including Cowardin *et al.* (1979), and tailors them to Maine's marine and estuarine environments. A significant factor that is included in this system but has been neglected in others is the amount of "energy" in a habitat. Energy could be a reflection of wind, waves, or currents present. This is a particularly important consideration in a review of fishing gear impacts since it indicates the natural disturbance regime of a habitat. The amount and type of natural disturbance is in turn an indication of the habitat's recoverability. Although this work appears to be complete in its description of habitat types, unfortunately, the distribution of many of the habitats are unknown.

2.2.1.4 Georges Bank

Georges Bank is a shallow (10 to 500 foot depth), elongate (100 miles wide by 200 miles long) extension of the continental shelf formed by the Wisconsinian glacial episode (Figure 24). It is characterized by a steep slope on its northern edge and a broad, flat, gently sloping southern flank. It is separated from the rest of the continental shelf to the west by the Great South Channel. The central region of the bank is shallow, and the bottom is characterized by shoals and troughs, with sand dunes superimposed upon them. The two most prominent elevations on the ridge and trough area are Cultivator and Georges Shoals. This shoal and trough area is a region of strong currents, with average flood and ebb tidal currents greater than 4 km per hour, and as high as 7 km per hour. Glacial retreat during the late Pleistocene deposited the bottom sediments currently observed on eastern Georges Bank, and the sediments have been continuously reworked and redistributed by the action of rising sea level, and by tidal, storm and other currents.

Bottom topography on eastern Georges Bank is characterized by linear ridges in the western shoal areas; a relatively smooth, gently dipping sea floor on the deeper, easternmost part; and steeper and smoother topography incised by submarine canyons on the southeastern margin. The nature of the sea bed sediments varies widely, ranging from clay to gravel (Figure 25). Surficial sediments composed of a gravel-sand mix have been noted as important postlarval habitat for Atlantic cod, haddock, winter flounder, yellowtail flounder and other species. American plaice adults have been demonstrated to associate with gravel-sand sediments for a variety of potential reasons. Gravel-sand sediments have been noted as habitat for sea scallops, where movement of sand is relatively minor (Langton and Uzmann 1990; Valentine and Lough 1991). The gravel-sand mixture is usually a transition zone between coarse gravel and finer sediments. Natural processes continue to erode and rework the sediments on Georges Bank. It is anticipated that erosion and reworking of sediments will reduce the amount of sand available to the sand sheets, and cause an overall coarsening of the bottom sediments (Valentine *et al.* 1993). The strong, erosive currents affect the character of the biological community.

Oceanographic frontal systems separate water masses from the Gulf of Maine and the remainder of the Atlantic on Georges Bank and differ in temperature, salinity, nutrient concentration, and planktonic communities, which influence productivity and may influence fish abundance and distribution. Currents on Georges Bank include a weak, persistent clockwise gyre around the bank, a strong semidiurnal tidal flow predominantly northwest and southeast, and very strong, intermittent storm-induced currents, which can all occur simultaneously (Figure 24). Tidal currents over the shallow top of Georges Bank can be very strong, and keep the waters over the bank well mixed vertically. This results in a tidal front that separates the cool waters of the well-mixed shallows from the warmer, seasonally stratified shelf waters on the seaward and shoreward sides of the bank. The clockwise gyre is instrumental in distribution of the planktonic community, including larval fish. For example, there is passive drift of Atlantic cod and haddock eggs and larvae in a southwest residual pattern around Georges Bank. Larval concentrations are found at varying depths along the southern edge between 200 and 300 feet.

Shelf waters from the Gulf of Maine south are intermittently but intensely affected by the Gulf Stream. The Gulf Stream begins in the Gulf of Mexico and flows northeastward at an approximate rate of 3 feet/second, transporting warm waters north along the eastern coast of the US, and then east towards the British Isles. Conditions and flow of the Gulf Stream are highly variable on time scales ranging from days to seasons. The principal source of variability in slope waters are intrusions from the Gulf Stream.

The location of the Gulf Stream's western boundary is variable because of meanders and eddies. Gulf Stream eddies are formed when extended meanders enclose a parcel of sea water and pinch off. These eddies can be cyclonic, meaning they rotate counterclockwise and have a cold-core formed by enclosing slope water (cold core ring), or anticyclonic, meaning they rotate clockwise and have a warm core of Sargasso Sea water (warm core ring). The rings are shaped like a funnel, wider at the top and narrower at the bottom, and can have depths of over 2000 m. They range in size from 150-230 m in diameter. There are 35% more rings and meanders in the vicinity of Georges Bank than in the Mid-Atlantic region. A net transfer of water on and off the shelf may result from the interaction of rings and shelf waters. These warm or cold core rings maintain their identity for several months until they are reabsorbed by the Gulf Stream. The rings and the Gulf Stream itself have a great influence over oceanographic conditions all along the continental shelf.

The interaction of environmental factors (e.g. availability and type of sediment, current speed and direction, and bottom topography) have been investigated; and found to combine to form seven sedimentary provinces on eastern Georges Bank, which are outlined in Table 7.

Georges Bank is characterized by high levels of primary productivity, and historically, high levels of fish production. It has a diverse biological community that is influenced by many environmental conditions. Several studies have attempted to identify demersal fish assemblages over large spatial scales on Georges Bank. Overholtz and Tyler (1985) found five depth-related groundfish assemblages for Georges Bank and Gulf of Maine that were persistent temporally and spatially (Table 8). Depth and salinity were identified as major physical influences explaining assemblage structure.

2.2.1.5 Mid-Atlantic Bight

The Mid-Atlantic Bight includes the shelf and slope waters from Georges Bank south to Cape Hatteras, and east to the Gulf Stream. Like the rest of the continental shelf, the Mid-Atlantic Bight was shaped largely by sea level fluctuations caused by past ice ages. The shelf's basic morphology and sediments derive from the retreat of the last ice sheet, and the subsequent rise in sea level. Since that time, currents and waves have modified this basic structure.

The shelf slopes gently from shore out to between 75 and 150 miles offshore where it transforms to the slope (300 – 600 feet water depth) at the shelf break. In both the Mid-Atlantic and on Georges Bank, numerous canyons incise the slope, and some cut up onto the shelf itself. The primary morphological features of the shelf include shelf valleys and channels, shoal massifs, scarps, and sand ridges and swales (Figure 27).

Most of these structures are relic except for some sand ridges and smaller sand related features. Shelf valleys and slope canyons were formed by rivers of melted glacier which deposited sediments on the outer shelf edge as they entered the ocean. Most valleys cut about 30 feet into the shelf, with the exception of Hudson valley which is about 100 feet deep. The valleys were partially filled as the glacier melted and egressed across the shelf. The glacier also left behind a lengthy scarp near the shelf break from Chesapeake Bay north to the eastern end of Long Island (Figures 27 and 28). Shoal retreat massifs are produced by extensive deposition at a cape or estuary mouth. Massifs were also formed as estuaries retreated across the shelf.

Some sand ridges (Figure 27) are more modern in origin than the shelf's glaciated morphology. Their formation is not well understood; however, they appear to develop from the sediments that erode from the shore face. They maintain their shape, so it is assumed that they are in equilibrium with modern current and storm regimes. They are usually grouped, with heights of about 30 feet, lengths of 5 to 30 miles and spacing of 1 mile. Ridges are usually oriented at a slight angle towards shore, running in length from northeast to southwest. The seaward face usually has the steepest slope. Sand ridges are often covered with smaller similar forms such as sand waves, megaripples, and ripples. Swales occur between sand ridges. Since ridges are higher than the adjacent swales, they are exposed to more energy from water currents, and experience more sediment mobility than swales. Ridges tend to contain less fine sand, silt and clay while relatively sheltered swales contain more of the finer particles. Swales have greater benthic macrofaunal density, species richness and biomass, due in part to the increased abundance of detrital food and the physically less rigorous conditions.

Sand waves are usually found in patches of 5-10 with a heights of about 6 feet, lengths of 150 to 300 feet and about a mile between patches. Sand waves are primarily found on the inner shelf, and often observed on sides of sand ridges. They may remain intact over several seasons. Megaripples occur on sand waves or separately on the inner or central shelf. During the winter storm season, they may cover as much as 15% of the inner shelf. They tend to form in large patches and usually have lengths of 10 to 15 feet with heights of 1 to 3 feet. Megaripples tend to survive for less than a season. They can form during a storm and reshape the upper 20 to 40 inches of the sediments within a few hours. Ripples are also found everywhere on the shelf, and appear or disappear within hours or days, depending upon storms and currents. Ripples usually have lengths of about 1 to 60 inches and heights of a few centimeters.

Sediments are fairly uniformly distributed over the shelf in this region (Figure 25). A sheet of sand and gravel varying in thickness from 0 to 30 feet covers most of the shelf. The mean bottom flow from the constant southwesterly current is not fast enough to move sand, so sediment transport must be episodic. Net sediment movement is in the same southwesterly direction as the current. The sands are mostly medium to coarse grains, with finer sand in the Hudson shelf valley and on the outer shelf. Mud is rare over most of the shelf, but is common in the Hudson valley. Occasionally relic estuarine mud deposits are re-exposed in the swales between sand ridges. Fine sediment content increases rapidly at the shelf break, which is sometimes called the "mud line," and sediments are 70-100% fines on the slope.

Sand provides suitable habitat properties for a variety of fishes, invertebrates, and microorganisms. Invertebrates, such as surfclams, razor clams, and ocean quahogs, burrow between the grains to support their characteristic sessile behavior. Dunes and ridges provide refuge from currents and predators and habitat for ambush predators. Several species inhabit sand habitats (e.g. amphipods, polychaetes) that are important prey for flounder. Yellowtail and winter flounder distribution has been correlated to sand (Langton and Uzmann 1990). In general, flatfish are more closely associated with sand and finer sediments than are other demersal fishes.

Canyons occur near the shelf break along Georges Bank and the Mid-Atlantic, cutting into the slope and occasionally up into the shelf as well. Canyons were shaped by alternating erosional and depositional geologic episodes. The canyons look similar to land canyons of fluvial origin, including features such as steep walls, exposed rocks, and tributaries. Some are extensions of shelf valleys. They exhibit a more diverse fauna, topography, and hydrography than the surrounding shelf and slope environments.

The relative biological richness of canyons is in part due to the diversity of substrate types found in the canyons, and the greater abundance of organic matter. Canyons on Georges Bank appear to serve as nursery grounds for species such as lobster, Jonah crab, red crab, tilefish, and several species of hake, which hide in excavated shelters in the fine clay sediments or boulder fields.

Shelf and slope waters of the Mid-Atlantic Bight have a slow southwestward flow which is occasionally interrupted by warm core rings or meanders from the Gulf Stream. On average, shelf water moves parallel to bathymetry isobars at speeds of 2 to 4 inches/second at the surface and 1 inch/second or less at the bottom. Storm events can cause much more energetic variations in flow. Tidal currents on the inner shelf have a higher flow rate of 8 inches/second that increases to 40 inches/second near inlets.

Slope water tends to be warmer than shelf water because of its proximity to the Gulf Stream, and also tends to be more saline. The abrupt gradient where these two water masses meet is called the shelf-slope front. This front is usually located at the edge of the shelf and touches bottom at about 200 to 300 feet depth of water, and then slopes up to the east toward the surface. It reaches surface waters approximately 10 to 30 miles further offshore. The position of the front is highly variable, and can be influenced by many physical factors. Vertical structure of temperature and salinity within the front can develop complex patterns because of the interleaving of shelf and slope waters – for example cold shelf waters can protrude offshore, or warmer slope water can intrude up onto the shelf.

The seasonal effects of warming and cooling increase in shallower, nearshore waters. Stratification of the water column occurs over the shelf and the top layer of slope water during the spring-summer and is usually established by early June. Fall mixing results in homogenous shelf and upper slope waters by October in most years. A permanent thermocline exists in slope waters from 600 to 1200 feet deep.

The "cold pool" is an annual phenomenon particularly important to the Mid-Atlantic Bight. It stretches from the Gulf of Maine along the outer edge of Georges Bank and then southwest to Cape Hatteras. It becomes identifiable with the onset of thermal stratification in the spring and lasts into early fall until normal seasonal mixing occurs. It usually exists along the bottom between the 125 and 300 foot isobaths and extends up into the water column for about 100 feet, to the bottom of the seasonal thermocline. The cold pool usually represents about 30% of the volume of shelf water. Minimum temperatures for the cold pool occur in early spring and summer, and range from 33°F to 40°F.

Three broad faunal zones related to water depth and sediment type were identified for the Mid-Atlantic by Pratt (1973). The "sand fauna" zone was defined for sandy sediments (1% or less silt) which are at least occasionally disturbed by waves, from shore out to 150 feet (Figure 29). The "silty sand fauna" zone occurred immediately offshore from the sand fauna zone, in stable sands containing at least a few percent silt and slightly more (2%) organic material. Silts and clays become predominant at the shelf break and line the Hudson valley, and support the "silt-clay fauna."

Building on Pratt's work, the Mid-Atlantic shelf was further divided by Boesch (1979) into seven bathymetric/morphologic subdivisions based on faunal assemblages. Sediments in the region studied (Hudson Shelf Valley south to Chesapeake Bay) were dominated by sand with little finer materials. Ridges and swales are important morphological features in this area. Sediments are coarser on the ridges, and the swales have greater benthic macrofaunal density, species richness and biomass. Faunal species composition differed between these features, and Boesch incorporated this variation in his subdivisions (Table 9). Much overlap of species distributions was found between depth zones, so the faunal assemblages represented more of a continuum than distinct zones.

Faunal assemblages were described at a broad geographic scale for Mid-Atlantic Bight continental shelf demersal fishes, based on NMFS bottom trawl survey data between 1967-1976 (Colvocoresses and Musick 1983). There were clear variations in species abundances, yet they demonstrated consistent patterns of community composition and distribution among demersal fishes of the Mid-Atlantic shelf. This is especially true for five strongly recurring species associations that varied slightly by season (Table 10). The boundaries between fish assemblages generally followed isotherms and isobaths. The assemblages were largely similar between the spring and fall collections, with the most notable change being a northward and shoreward shift in the temperate group in the spring.

2.2.1.6 Coastal features

Coastal and estuarine features such as salt marshes, mud flats, rocky intertidal zones, sand beaches, and submerged aquatic vegetation are critical to inshore and offshore habitats and fishery resources of the Northeast. Coastal areas and estuaries are important for nutrient recycling and primary production, and certain features serve as nursery areas for juvenile stages of economically important species.

Salt marshes are found extensively throughout the region. Tidal and subtidal mud and sand flats are general salt marsh features and are also occur in other estuarine areas . Salt marshes provide nursery and spawning habitat for many finfish and shellfish species. Salt marsh vegetation can also be a large source of organic material that is important to the biological and chemical processes of the estuarine and marine environment.

Rocky intertidal zones are periodically submerged, high energy environments found in the northern portion of the Northeast system. Sessile invertebrates and some fish inhabit rocky intertidal zones. A variety of algae, kelp, and rockweed are also important habitat features of rocky shores. Fishery resources may depend upon particular habitat features of the rocky intertidal which provide important levels of refuge and food.

Sandy beaches are most extensive along the Northeast coast. Different zones of the beach present suitable habitat conditions for a variety of marine and terrestrial organisms. For example, the intertidal zone presents suitable habitat conditions for many invertebrates, and transient fish find suitable conditions for foraging during high tide. Several invertebrate and fish species are adapted for living in the high energy subtidal zone adjacent to sandy beaches.

2.2.2 Habitat Requirements by Life History Stage

According to section 600.815 (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) 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. The habitat requirements by life history stage for surfclams and ocean quahogs are thoroughly described in section 2.2.1 of Amendment 12.

Most of the information in Amendment 12 on historical stock size and geographic range (Figures 5and 6) of the managed species, as well as habitat requirements and the distribution and abundance of eggs/larvae and juveniles/adults in sections 2.2.1.1.1 through 2.2.1.1.3 for Amendment 12 is taken directly from the EFH Source Documents "Surfclam, *Spisula solidissima*, Life History and Habitat Requirements" (Cargnelli *et al.* 1999a which is included here as Appendix 5) and "Ocean Quahog, *Arctica islandica,* Life History and Habitat Requirements" (Cargnelli *et al.* 1999b which is included here as Appendix 6). These documents are referred to hereafter as the surfclam EFH background document and the ocean quahog EFH background document. Most of the Tables and Figures from Cargnelli *et al.* (1999a and b) are included in Amendment 12.

An extensive review and synthesis of peer-reviewed literature provides information on the habitat requirements and preferences of Atlantic surfclams (Table 11) and ocean quahogs (Table 12). The review and synthesis concentrates primarily on beds in U.S. water; most information is from beds in the Middle Atlantic Bight.

2.2.3 Description and Identification of Essential Fish Habitat

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 surfclam and ocean quahog EFH background documents (Appendices 5 and 6) are considered the best scientific information available for EFH in order to meet National Standard 2 of the MSFCMA.

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.

Matrices of habitat parameters (i.e. temperature, salinity, light, etc.) for eggs/larvae and juveniles/adults were developed in the surfclam and ocean quahog EFH background documents and included in this FMP as Tables 11and 12.

Amendment 12 (MAFMC 1998) identified and described essential fish habitat for surfclams and ocean quahogs in section 2.2.2. No new information exists that would provide the basis for changing the EFH identification and description that was developed in Amendment 12.

Surfclams

> **Juveniles and adults:** Throughout the substrate, to a depth of three feet below the water/sediment interface, within Federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ, in areas that encompass the top 90% of all the ranked ten-minute squares for the area where surfclams were caught in the NEFSC surfclam and ocean quahog dredge surveys (Figures 30 and 31). Surfclams generally occur from the beach zone to a depth of about 200 feet, but beyond about 125 feet abundance is low.

Ocean quahogs

> **Juveniles and adults:** Throughout the substrate, to a depth of three feet below the water/sediment interface, within Federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ, in areas that encompass the top 90% of all the ranked ten-minute squares for the area where ocean quahogs were caught in the NEFSC surfclam and ocean quahog dredge surveys (Figures 32 and 33). Distribution in the western Atlantic ranges in depths from 30 feet to about 800 feet. Ocean quahogs are rarely found where bottom water temperatures exceed 60 °F, and occur progressively further offshore between Cape Cod and Cape Hatteras.

Since the NEFSC clam survey only briefly (no stratified random design) surveyed the Gulf of Maine twice in the early 1990s, no attempt is currently made to designate EFH for the small artisanal fishery that occurs north of 43° 50' north latitude at this time. The State of Maine is desirous of sampling this resource to quantify its extent, however no definitive plans are yet in place. It was identified in Amendment 12 that although no data exist to map even the presence or absence of the resource reliably (i.e., there is “Level 0" data), the habitat supports a resource that sustains a small fishery and thus it would seem worthwhile to attempt to identify valuable habitat areas through discussions with the fishing industry to designate EFH in the Gulf of

Maine. No comments were received from Maine fishermen or State representatives that would provide useful anecdotal information. The Council has determined that when Maine performs a survey and has useful quantitative data to designate EFH, the information will be supplied to the Habitat Monitoring Committee for their review.

2.2.4 Identification of Habitat Areas of Particular Concern

According to section 600.815 (a)(8), 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 did not recommend any portions of EFH as HAPC for surfclams or ocean quahogs in Amendment 12 and has no new information to warrant a change at this time. This is because no strong associations between habitat type or location and recruitment for these species have been identified in the EFH background documents (Appendices 5 and 6). The information in the EFH background documents appear inadequate at this time to put a high priority on any specific habitat.

2.2.5 Fishing Activities that May Adversely Affect EFH

2.2.5.1 Statutory requirements

The 2002 final rule for EFH requires that fishery management plans minimize to the extent practicable adverse effects on essential fish habitat caused by fishing (section 600.815 (a) (2)). Pursuant to the final EFH regulations (50 CFR 600.815(a)(2)), FMPs must contain an evaluation of the potential adverse effects of fishing on EFH designated under the FMP, including effects of each fishing activity regulated under the FMP or other Federal FMPs. The evaluation should consider the effects of each fishing activity on each type of habitat found within EFH. FMPs must describe each fishing activity, review and discuss all available relevant information (such as information regarding the intensity, extent, and frequency of any adverse effect on EFH: the type of habitat within EFH that may be affected adversely; and the habitat functions that may be disturbed), and provide conclusions regarding whether and how each fishing activity adversely affects EFH. The evaluation should also consider the cumulative effects of multiple fishing activities on EFH. The evaluation should list any past management actions that minimize potential adverse effects on EFH and describe the benefits of those actions to EFH. The evaluation should give special attention to adverse effects on habitat areas of particular concern and should identify for possible designation as habitat areas of particular concern any EFH that is particularly vulnerable to fishing activities. Additionally, the evaluation should consider the establishment of research closure areas or other measures to evaluate the impacts of fishing activities on EFH. In completing this evaluation, Councils should use the best scientific information available, as well as other appropriate information sources. Councils should consider different types of information according to its scientific vigor.

In order to meet the above mandates, NMFS (Appendix 3) developed a report which summarizes available information concerning impacts of fishing on marine habitats in the Northeast region of the United States (North Carolina – Maine). Some of the studies that are cited were conducted in the Northeast region, while others were conducted in other locations in the United States or in other countries. Information sources include peer reviewed scientific journals, as well as non peer-reviewed reports. Major bibliographic sources include Rester (2000), NMFS Alaska Fisheries Science Center bibliography (Wion and McConnaughey 2000), and numerous ICES reports. In addition, a thorough literature search was completed to ensure inclusion of recent articles.

Research results are presented in Appendix 3 by gear type for three major gear categories: bottom-tending mobile gear, bottom-tending static gear, and mobile and static pelagic gear. Sixty different gear types were considered in this report. In addition to summarizing research results, the report also includes a description of each gear type, information on the spatial distribution of fishing activity for 17 individual gears used in the Northeast region during 1995 – 2000, and, where appropriate, summaries of the management implications of research. An attempt was made to identify the sediment type (e.g., mud, sand, hard bottom) and location of each study. No attempt was made in the report to draw any conclusions concerning the habitat impacts of any type of fishing gear. Any conclusions that appear in the report are those reached by the authors of the research that are summarized in the report.

2.2.5.2 Information needs and research approaches

The NMFS (USDC 2001) report entitled *The Effects of Fishing on Marine Habitats of the Northeastern United States* (Appendix 3) addresses the information that is needed to assess habitat impacts as well as the research approaches used. The Council concurs with those sections identified by NMFS in the report.

2.2.5.3 Generalized fishing gear effects

A number of scientific reviews summarize existing information on the effects of fishing gear to habitat (McAllister 1991, ICES 1992, Jennings and Kaiser 1998, Auster and Langton 1999, Blaber *et al.* 2000, Collie *et al.* 2000a). Within these reviews, types of effects fall into specific categories, including alteration of physical structure, sediment suspension, chemical modifications, benthic community changes, and ecosystem changes. These effects are discussed below.

2.2.5.3.1 Alteration of physical structure

Physical effects of fishing gear can include scraping, ploughing, burial of mounds, smoothing of sand ripples, removal of stones or dragging and turning of boulders, removal of taxa that produce structure, and removal or shredding of submerged aquatic vegetation (Fonseca *et al.* 1984, Messieh *et al.* 1991, Black and Parry 1994, Gordon *et al.* 1998, Kaiser *et al.* 1998, Lindeboom and deGroot 1998, Schwinghamer *et al.* 1998, Auster and Langton 1999, Kaiser *et al.* 1999, Ardizzone *et al.* 2000). These physical alterations reduce the heterogeneity of the sediment surface, alter the texture of the sediments, and reduce the structure available to biota as habitat. As mobile gear is dragged across the seafloor, parts of the gear can penetrate up to 2 to 12 inches into the substrate under usual fishing conditions, and likely to greater depths under unusual conditions (Drew and Larsen 1994).

Direct effects on the seafloor are evident in tracks left by mobile gear that can endure for up to 16 hours in hard sand sediments or for as long as 5 years in soft sediments (Thompson 1993). Effects on hard substrates, such as coral reefs, can persist much longer. Within these tracks, large percentages of emergent epifauna, such as sponges, corals or gorgonians, are often removed, crushed, or broken (Van Dolah *et al.* 1987, Behnken 1994).

A number of review papers have focused specifically on the physical effects of bottom trawls. According to an ICES working report (1973), otter trawls, beam trawls and dredges are all similar in their types of impacts on the seabed, but the magnitude of impact increases from shrimp to sole beam trawls with tickler and stone guards, to Rapido trawl, to mollusc dredge. Moran and Stephenson (2000) conclude that semi-pelagic trawls towed above the seafloor inflict less damage/mortality on benthos, but result in lower catches of target fishes and that the light trawl gear currently in use in northwest Australia results in less mortality (15.5% vs. 89% documented by Sainsbury *et al.* 1997) than heavy gear used in the past. This statement should be evaluated for trawl gear used in U.S. fisheries (Appendix 3).

2.2.5.3.2 Sediment suspension

Resuspension of sediments occurs as fishing gear is dragged along the seafloor. Effects of sediment suspension can include reduction of light available for photosynthetic organisms, burying benthic biota, smothering of spawning areas, and negative effects on feeding and metabolic rates of organisms. If resuspension occurs over a large enough area it can actually cause large scale redistribution of sediments (Messieh *et al.* 1991, Black and Parry 1994). Resuspension can also have important implications for regional nutrient budgets due to burial of fresh organic matter and exposure of deep anaerobic sediment, upward flux of dissolved nutrients in pore water, and change in metabolism of benthic infauna.

Effects of sediment resuspension are site-specific and depend on sediment grain size and type, hydrological conditions, faunal influences, and water mass size and configuration (Hayes *et al.* 1984, LaSalle 1990, Barnes *et al.* 1991, Coen 1995). Effects are likely more significant in waters that are normally clear compared with areas that are already highly perturbed by physical forces (Kaiser 2000). Schoellhamer (1996) concluded that resuspension by natural mechanisms in a shallow estuary in west-central Florida was less frequent and of smaller magnitude than anthropogenic mechanisms (i.e., fishing) and that sediments disturbed by fishing were more susceptible to resuspension by tidal currents. Modeling by Churchill (1989) concluded that resuspension by trawling is the primary source of suspended sediment over the outer continental shelf, where storm-related stresses are weak. In the Kategat Sea, Sweden, sandy sediments above the halocline were more affected by wind induced impacts than by fishing effort, but mud sediments below the halocline experienced an increase in the frequency of disturbance by 90% in the spring and summer and by 75-85% in the autumn and winter due to fishing (Floderus and Pihil 1990). Thus, even when recovery times are fast, persistent disturbance by fishing could lead to cumulative impacts. In contrast, Dyekjaer *et al.* (1995) found that in Denmark, although local effects of short duration might occur, annual release of suspended particles by mobile fishing gear is relatively unimportant compared with that resulting from wind and land runoff.

Chronic suspension of sediments and resulting turbidity can also affect aquatic organisms through behavioral, sublethal and lethal effects, depending on exposure. Species reaction to turbidity depends on life history characteristics of the species. Mobile organisms can move out of the affected area and quickly return once the disturbance dissipates (Simenstad 1990, Coen 1995). Even if species experience high mortality within the affected area, species with short life history stages and high levels of recruitment or high mobility can repopulate the affected area quickly. However, if effects are protracted and occur over a large area relative to undisturbed area, recovery through recruitment or immigration will be hampered. Furthermore, chronic resuspension of sediments may lead to shifts in species composition by favoring those species that are better suited to recover or those that can take advantage of the pulsed nutrient supply as nutrients are released from the seafloor to the euphotic zone (Churchill 1998).

2.2.5.3.3 Changes in chemistry

Fishing gear can result in changes to the chemical makeup of both the sediments and overlying water mass through mixing of subsurface sediments and porewater. In shallow water this mixing might be insignificant in relation to that from tidal and storm surge and wave action, but in deeper, more stable, waters, this mixing can have significant effects (Rumohr 1989). In a shallow, eutrophic sound in the North Sea, fishing caused an increase in average ammonia content (although horizontal variations prevented interpretations of these increases) and a decrease in oxygen due to the mixing of reduced particles from within the sediments (Reimann and Hoffman 1991). Also in the North Sea, fishing enhances phosphate released from sediment by 70-380 tonnes per year for otter trawls and by 10,000-70,000 tones per year for beam trawlers (ICES 1992).

It is unclear how changes in chemistry might affect fish populations. During seasons when nutrients are low, the effective mixing of the sediments could cause increased phytoplankton primary production and/or eutrophication. Rijnsdorp and Van Leeuwen (1996) found increased growth (based on back calculated growth from otolith growth zones) in the smallest size classes of plaice in the North Sea correlated to eutrophication in nearshore areas and both eutrophication and increased beam trawling farther offshore. The authors hypothesized that increased nutrient release (availability) due to anthropogenic activities, including fishing, increased prey availability, and thus resulted in higher growth. Alternatively, ICES (1992) concluded that these pulses are compensated by lower fluxes after the trawl has passed, and that the releases from fishing gear that recycle existing nutrients are probably less influential than new inputs from rivers and land runoff (ICES 1992).

2.2.5.3.4 Changes to benthic community

Benthic communities are affected by fishing gear through damage to the benthos in the path of the gear and disturbance of the seafloor to a depth of up to 12 inches. Many kinds of epibenthic animals are crushed or buried, while infauna is excavated and exposed on the seabed.

Specific impacts from fishing depend on the life history, ecology and physical characteristics of the biota present (Bergman and Van Santbrink 2000). Mobile species that exhibit high fecundities and rapid generation times will recover more quickly than non-mobile, slow-growing organisms. In Mission Bay, California, polychaetes with reduced larval phases and postlarval movements had small-scale dispersal abilities which permitted rapid recolonization of disturbed patches and resulted in maintenance of high infaunal densities (Levin 1984). Those with long-lived larvae were only available for successful recolonization if the timing of disturbance coincided with periods of peak larval abundance, however, these species were able to colonize over much larger distances. In the Wadden Sea, 60 years of observations revealed long-term changes in abundance and species composition of benthic communities as a result of continued trawling (Rinjsdorp 1988). Slow growing and reproducing epibenthic species had been replaced by fast growing species, the total number of individuals had grown, and the diversity of species of molluscs and crustaceans had decreased while that of polychaetes had increased.

The physical structure of biota also affects their ability to sustain and recover from physical impacts with fishing gear. Thin shelled bivalves and starfish show higher damage than solid-shelled bivalves in fished areas (Rumohr and Krost 1991). Animals that are able to retract below the surface of the seafloor or live below the penetration depth of the fishing gear will sustain much less damage than epibenthic organisms. Animals that are more elastic and can bend upon contact with fishing gear will suffer much less damage than those that are hard and inflexible (Eno *et al.* 2001). Kaiser *et al.* (2000a) found that chronic fishing around the Isle of Mann, UK had removed large-bodied fauna such that benthic communities are now dominated by smaller-bodied organisms that are less susceptible to physical disturbance.

Increased fishing pressure can also lead to changes in distribution of species, either through movement of animals away from or towards the fished area (Kaiser and Spencer 1993 and1996, Ramsay *et al.* 1996, Kaiser and Ramsay 1997, Ramsay *et al.* 1998, Bradshaw *et al.* 2000, Demestre *et al.* 2000). For example, Morgan *et al.* (1997) documented large scale changes in the structure of spawning cod shoals after otter trawling, and concluded that high trawling effort could lead to persistent disturbances over large distances. On the other hand, opportunistic feeders are attracted to areas disturbed by mobile fishing gear. Frid and Hall (1999) found higher prevalence of fish remains and scavengers and a lower abundance of sedentary polychaetes in stomach contents of dabs in the North Sea in areas of higher fishing effort. Kaiser and Spencer (1994) document that gurnards and whiting aggregate over beam trawl tracks and have higher numbers of prey items in their stomachs shortly after trawling. Based on these studies, researchers have speculated that mobile fishing may lead to increased populations of species that exhibit opportunistic feeding behavior. Fonds and Groenewold (2000) modeled results for the southern North Sea indicated that the annual amount of food supplied by beam trawling is approximately 7% of the food demand of common benthic predators. This level could help maintain populations but is insufficient to support further population growth (Appendix 3).

2.2.5.3.5 Changes to ecosystem

The role these physical and community effects have on harvested populations is unknown in most cases. However, a growing body of empirical observations and modeling suggests that effects can be seen in population responses. For example, population models for Atlantic cod indicate that when the adult stock is at low levels (i.e., spawning and larval survivorship does not produce sufficient recruits to saturate available habitats), a reduction in habitat complexity has measurable effects on population dynamics. Off the northwest shelf of Australia, removal of epibenthic fauna by trawling resulted in a switch of dominant species from Lethrinids and Lutjanids (which are almost exclusively associated with habitats supporting large epibenthos) to Saurids and Nemipterids (which were found on open sand; Sainsbury 1998). The ICES Impact II Report edited by Lindeboom and deGroot (2001) concludes that bottom trawling affected the food web structure of the North Sea and Irish Sea, although the magnitudes and seriousness of the consequences of these effects on ecosystem properties are uncertain (Appendix 3).

2.2.5.3.6 Summary of literature reviews on gear effects

A number of authors have reviewed existing scientific literature on the effects of fishing on habitat (Kenchington 1995, Auster *et al.* 1996, Collie 1998, Jennings and Kaiser 1998, Rogers *et al.* 1998, Auster and Langton 1999, Hall 1999, Collie *et al.* 2000, Lindeboom and de Groot 2000, Barnett 2001).

Collie *et al.* (2000) analyzed 39 published studies to compile and evaluate current findings regarding fishing gear effects on habitat. Regarding the type and use of research, the authors found: (1) 89% of the studies were undertaken at depths less than 200 feet; (2) otter trawl gear is the most frequently studied; (3) most studies have been done in Northern Europe and East North America. The authors also had several conclusions pertaining to effects of fishing gear: (1) intertidal dredging and scallop dredging have the greatest initial effects on benthic biota, followed by otter trawling and then beam trawling (although beam trawling studies were conducted in dynamic sandy areas, where effects might be less apparent); (2) fauna in stable gravel, mud and biogenic habitats are more adversely affected than those in less consolidated coarse sediments; (3) recovery appears most rapid in less physically stable habitats (inhabited generally by more opportunistic species); (4) we may accurately predict recovery rates for small-bodied taxa, but communities often contain one or two long-lived, vulnerable species; (5) large-bodied organisms are more prevalent before trawling (Greenstreet and Hall 1996, Frid and Clark 1999, Veale *et al.* 2000); and (6) the mean initial response to fishing impacts is negative (55% reduction of individual taxa). Based on these findings, the authors suggest that the scientific community abandon short-term small-scale experiments and argue for support to undertake larger scale press and relaxation experiments that mirror the timing and frequency of disturbance by commercial fishing (Appendix 3).

Auster *et al.* (1996) reviewed 3 studies of mobile fishing gear in the Gulf of Maine and concluded that mobile fishing gear alters the seafloor, and reduces complexity, sedimentary structures, and emergent epifauna. Collie (1998) reviewed studies from New England and concluded that results indicate significant impacts of bottom fishing gear on benthic habitats. Auster and Langton (1999) discuss both long-term and short-term effects on structural components of habitat, community structure, and ecosystem processes, as well as the implications of these effects for management. Kenchington (1995) reviewed studies on effects of mobile gear in the North Sea, Atlantic Canada, and Scotland. While many of these reviews focus on a given gear type or a specific geographic area, most agree that fishing has at least some negative impact on the seabed and benthos. Furthermore, literature presented in these reviews suggest that chronic fishing has led to changes in community structure in many areas of the world (Dayton *et al.* 1995, Jennings and Kaiser 1998, Collie *et al.* 2000a and b).

2.2.5.4 Evaluation of impacts on habitat

2.2.5.4.1 Fishing gears used in the Northeast

The NMFS (USDC 2001) report entitled *The Effects of Fishing on Marine Habitats of the Northeastern United States* (Appendix 3) addresses the various fishing gear that are in use in the Northeast and provides an evaluation of the impacts of the various gear to different habitats. The Council concurs with those sections identified by NMFS in the report.

The Northeast Region falls within the jurisdiction of the New England and Mid Atlantic Fishery Management Councils as well as the individual States from Maine through North Carolina which are represented by the Atlantic States Marine Fisheries Commission (ASMFC). These jurisdictions are responsible for the management of many different fisheries extending from the upper reaches of the estuaries out to 200 miles offshore at the EEZ.

The EFH regulations promulgated pursuant to the Magnuson-Stevens Fishery Conservation and Management Act require that Fishery Management Plans contain an assessment of all potential adverse effects of all fishing equipment types used in EFH. This review includes gear managed by the Councils as well as those gear used exclusively in state waters. Fifty-nine categories of fishing gear were identified as having been associated with landings of Federal or state managed species based on a review of the National Marine Fisheries Service commercial fisheries landings data for 1999 and an ASMFC report on gear impacts to submerged aquatic vegetation (Stephan *et al.* 2000).

For this review of the impacts of fishing activities on EFH, gears of concern are those that have been identified as having landed any amount of species managed by either the NEFMC or MAFMC (Table 13) as well as gears that contributed 1% or more of any states total landings for all species (Table 14). Although certain gear types are not managed under the auspices of the MSA, this methodology recognizes that certain gear utilized in state waters may have adverse impacts to EFH that is designated in nearshore or estuarine areas. Table 15 provides the list of all 59 gears considered for this review and indicates whether the gear is utilized in estuaries, coastal waters (0-3 miles), or offshore waters (3-200 miles). Since the seabed is the location of the habitat types most susceptible to gear disturbances, Table 15 also indicates whether the gear contacts the bottom.

Figure 34 provides a general indication of the areas that are being fished based upon landings, in the New England States compared to the Mid-Atlantic States based on landings for 1999. On a relative scale, using landings as a very rough proxy for fishing effort, most of the fishing effort in New England is in the offshore waters (> 3 miles) compared to inshore waters (< 3 miles) for Mid-Atlantic States. Figure 35 shows how this compares for each State from Maine through North Carolina based on landings for 1999.

For the purposes of this review, the various gear types have been placed into 3 categories: 1) bottom-tending mobile gear; 2) bottom-tending static gear, and; 3) mobile and static pelagic gear. The gear types have been further placed into functional categories to allow for a more generalized discussion of potential impacts due to a lack of specific information for all gear types.

Gear descriptions included in the report (Appendix 3) were originally prepared for the New England Fishery Management Council Essential Fish Habitat amendment in 1998. Primary sources for these descriptions were Sainsbury (1996), Carr and Milliken (1998), and DeAlteris (1998).

2.2.5.4.2 Distribution of fishing trips by gear type

Numbers of fishing trips made by Federal vessel permit holders in the northeast United States (North Carolina - Maine) during the period 1995 - 2000 were aggregated for 18 individual gear types and 3 major gear categories (Table 16), assigned to 10 minute "squares" of latitude and longitude, and plotted to show spatial distribution patterns. Logbook data included in the analysis are currently provided by vessels operating in Federal waters and participating in the following fisheries: northeast multispecies; sea scallops; surfclams and ocean quahogs; monkfish; summer flounder, scup, and black sea bass; squid, mackerel, and butterfish; spiny dogfish; bluefish; Atlantic herring; and tilefish. Logbook data provided by ocean quahog and surfclam dredge vessels are archived in a separate database and were analyzed separately. Data for lobster pots were provided by vessels with multispecies permits. Vessels that operate strictly within state waters (0-3 miles from shore) are not required to have a Federal permit and therefore do not submit logbooks. For this reason, fishing trips in nearshore 10 minute squares that include a significant proportion of state water were under-represented.

Permit holders are required to submit a vessel trip report each time they make a fishing trip. A trip is defined as a single departure and return to port. Actual fishing time could not be computed because the only temporal datum that was common to all gear types was total trip duration. Although some additional information is available (the number of hauls and average duration of each haul) which could possibly be used to obtain more precise estimates of fishing time for mobile gear types such as bottom trawls and dredges, it is not reported for all trips and is meaningless when applied to stationary gear types such as pots and gill nets. No attempt was made to estimate fishing time for this analysis. Therefore, the results presented here are not intended to represent the spatial distribution of fishing effort.

Permit holders are given the option of reporting the location of a trip as a point (latitude and longitude or Loran bearings) or inside a statistical area. Only trips which were reported as a point location and therefore could be assigned to a 10 minute square were included in this analysis. Trips made south of 35° N latitude (Cape Hatteras) or north of 45° N latitude (U.S.-Canada border in the Bay of Fundy) were excluded from this analysis. Each ten minute square covers an area of 100 square miles or 259 square kilometers (Appendix 3).

Plots of the cumulative number of fishing trips by ten minute square were made for each gear type using ArcView. Data were classified using a statistical formula (Jenk's optimization) that identifies natural breakpoints between classes. This is the default classification method used in ArcView. It provided more demonstrable groupings of the data than the other classification methods that were available. For gear types or groups with >150,000 trips, all 10 minute squares with <10 trips were eliminated in order to "clean up" the distribution plots. For gear types with 20,000-70,000 trips, all 10 minute squares with <5 trips were eliminated from the plots; for gears with 4,000-15,000 trips, squares with only a single trip were eliminated; and for gears with <4,000 trips, all trips were used. The number of trips noted at the top of each plot (N) is the number of trips represented in the plot, not (in most cases) the total number of trips (Appendix 3).

Overall, 752,681 trips were included in the analysis, representing 79.5% of all trip reports submitted during the six-year period for these 18 gear types (Table 16). Most (98.4%) of these trip reports were included in the GIS plots. For individual gears, the "coverage" varied from 30.8 to 100%, with Danish seines ranking the lowest and hydraulic and non-hydraulic clam dredges ranking the highest. For the major gear types (gears with >4,000 analyzed trips), the percentages of reported trips that were analyzed ranged from 72.8 to 100%.

2.2.5.4.3 Hydraulic clam dredges

2.2.5.4.3.1 Hydraulic clam dredges – description

Hydraulic dredges are used to extract clams from the sediment. In hydraulic dredging, high pressure water jets ahead of the rake teeth or blade are used to scour out the shells which are then dug up by the blades and passed back into the bag. High pressure water is supplied to the jets through a hose from the operating vessel by a diesel pump and the bag is generally carried on a heavy sled. This gear is generally fished in relatively shallow inshore and estuarine areas (Sainsbury 1996).

In the Atlantic surfclam (*Spisula solidissima*) fishery, large vessels (>95 feet), tow dredges up to 15 feet in width slowly across the seabed. The vessels are equipped with large pumps, connected to the dredges via flexible hoses, that use water and inject it into the sediment through a manifold with multiple nozzles, ahead of the blade of the dredge. The dredge must be towed slowly so as to not exceed the liquefaction rate. These dredges, operated correctly, are highly efficient, taking as much as 90% of clams in their path. A secondary species that is also harvested in this fishery is the ocean quahog, *Arctica islandica*.

A fishing gear impacts workshop was held in Boston in October 2001 that reviewed and discussed exactly how the hydraulic and nonhydraulic (Maine ocean quahog fishery) clam dredges operate and what their potential impacts could be. The panelists heard presentations and had discussions on: 1) the actual fishery descriptions, 2) the effects of the fishery on the environment, 3) the strength of the evidence of those effects, and 4) what potential management implications were possible. The full discussion of the clam dredge analyses from the workshop is presented here and the full workshop report evaluating all gear is included in this amendment as Appendix 4.

Mr. Dave Wallace (Wallace and Associates) presented a thorough description of the evolution and current use of the hydraulic clam dredge for the surfclam and ocean quahog fisheries. A brief discussion of "dry dredges" used in the Maine "mahogany" ocean quahog fishery was led by Wallace with contributions from the workshop panelists. Subsequent to the workshop, Wallace (pers. comm.) has additionally estimated that the average hydraulic clam dredge takes about 600 man-hours to build and constitutes an investment of almost $30,000 (without hoses and pumps). Thus, industry is quite leery of hanging the dredge up and potentially losing it. This section of the report summarizes his presentation and the panel discussion.

Hydraulic clam dredges have been used in the surfclam fishery for over five decades and in the ocean quahog fishery since its inception in the early 1970s. These dredges are highly sophisticated and are designed to: 1) be extremely efficient (80 to 95% capture rate); 2) produce a very low bycatch of other species; and 3) retain very few undersized clams.

The typical dredge is 12 feet wide and about 22 feet long and uses pressurized water jets to wash clams out of the seafloor. Towing speed at the start of the tow is 2.5 knots and declines as the dredge accumulates clams. The dredge is retrieved once the vessel speed drops below 1.5 knots, which can be only a few minutes in very dense beds. However, a typical tow lasts about 15 minutes. The water jets penetrate the sediment in front of the dredge to a depth of about 8 - 10 inches, depending on the type of sediment and the water pressure. The water pressure that is required to fluidize the sediment varies from 50 pounds per square inch (psi) in coarse sand to 110 psi in finer sediments. The objective is to use as little water as possible since too much pressure will blow sediment into the clams and reduce product quality. The "knife" (or "cutting bar") on the leading bottom edge of the dredge opening is 5.5 inches deep for surfclams and 3.5 inches for ocean quahogs. The knife "picks up" clams that have been separated from the sediment and guides them into the body of the dredge ("the cage"). If the knife size is not appropriate, clams can be cut and broken, resulting in significant mortality of clams left on the bottom. The downward pressure created by the runners on the dredge is about 1 psi.

It was pointed out by a panel member that the high water pressure associated with the hydraulic dredge can cause damage to the flora and fauna associated with bottom habitats. However, water pressure greater than that required for harvesting will reduce the quality of the clams by loading them with sand and increase the rate of clam breakage. Therefore, water pressure is usually self regulated.

There are currently two types of hydraulic dredges used in the fishery, stern rig dredges and side rig dredges. The chain bag on a side rig dredge drags behind the dredge and helps smooth out the trench created by the dredge. The chain bag results in significantly more damage to small clams and other bycatch than occurs with the stern rig dredge. With the stern rig dredge, which is basically a giant sieve, small clams and bycatch fall through the bottom of the cage into the trench and damage or injury is minimal. Improvements in gear efficiency have reduced bottom time and helped to limit the harvest of surfclams to a relatively small area in the mid-Atlantic Bight.

Prior to 1990, the resource was managed by controlling the number of hours a vessel could fish. Consequently, towing speeds were maximized to catch as many clams as possible regardless of the damage done to the clams or the habitat. Cutting and breakage of discarded clams were estimated to be as high as 90% in some locations and under some conditions decomposition of dead clams caused reduced oxygen concentrations in sediments to the point that clams were killed. Incidental mortality is currently estimated to be well under 10% because quota management has removed the need for vessels to catch as many clams as possible as quickly as possible.

Concurrent with the change in harvesting practices that occurred after 1990, there has also been a significant reduction in fishing effort and a shift to stern rig dredges. About 60 side-rig vessels pulling 80 dredges were taken out of the fishery after 1990. The number of surfclam vessels decreased from 128 in 1990 to 35 in 2001, while the number of vessels that landed ocean quahogs (excluding the Maine fishery) dropped from 56 in 1990 to 30 in 2001. Currently there are only 4 side rig vessels pulling five dredges left in the fleet.

Surfclams live mostly in sand which is disturbed and re-suspended by storms and, in some locations, by strong bottom currents. Ocean quahogs live at greater depths, mostly in finer sand and silt/clay substrates which are less affected by natural physical disturbances. Surfclams and ocean quahogs are not found in commercial quantities in gravel or mud habitats or in depths greater than about 250 feet.

Hydraulic clam dredges can be operated in areas of large grain sand, fine sand, sand and small grain gravel, sand and small amounts of mud, and sand and very small amounts of clay. Most tows are made in large grain sand. Dredges are not fished in clay, mud, pebbles, rocks, coral, large gravel greater than one half inch, or seagrass beds. Boat captains will not dredge in areas with very soft or hard substrate where they run the risk of losing or damaging the gear. The fishery is also limited to sandy sediment because the processors do not want mud blown into the clam bodies by the dredge.

The spatial scale of fishing effort varies depending on which species is the target: surfclams are harvested primarily in a small area off the New Jersey coast whereas ocean quahogs are harvested over a larger area that includes offshore waters. Areas with denser concentrations of clams would presumably be dredged more intensively, i.e., a higher percentage of the bottom would be affected. Because surfclams are concentrated in a very defined area off the New Jersey coast where the bottom is so homogeneous, a high proportion of the bottom over this large contiguous area is affected by dredging. Surfclams grow much more rapidly than ocean quahogs and surfclam beds are dredged every few years. Areas dredged for ocean quahogs are left untouched for many years. Ocean quahogs are much more likely to be dredged from a number of more or less discrete patches that are surrounded by undisturbed areas. It was noted, as a general rule, that once 50% of the harvestable clams are removed from an area, the catch rates drop to a point where it is no longer economically feasible for fishing to continue there.

In Federal waters, the amount of bottom area directly impacted by the hydraulic clam dredge fleet in 2000 was about 110 square nautical miles (Table 2). An additional 15 square nautical miles were dredged in State waters of New Jersey, New York, and Massachusetts. The predominant substrate on the southern New England/Mid-Atlantic Bight shelf is sand. Thus, during any given year, this fishery is conducted in a very small proportion of a habitat type that characterizes most of the 40,000 square nautical miles of continental shelf between the Virginia/North Carolina border and Nantucket Island (69° W longitude). The Georges Bank region has been closed to clam harvesting since 1990 because of the potential of paralytic shellfish poisoning.

The dry dredge used in the Maine fishery is a cage with wide skis and a series of teeth about 6 inches long in the front. These dredges are used on smaller boats (about 30 to 40 feet long) and are pulled through the seabed using the boat's engine. The cutter bar is limited to a width of 36 inches by State law. This fishery takes place in small areas of sand and sandy mud found among bedrock outcroppings in depths of 30 to > 250 ft in state and Federal coastal waters north of 43 degrees 20 minutes N latitude. The dredges scoop up clams and sediment, and the vessel's propeller wash is used to clean out the sand and mud.

Trips reported by vessels using hydraulic clam dredges during 1991-2000 were made over a broad area of the continental shelf from Cape Cod to the Delmarva peninsula (Figures 37 and 38). Areas where fishing with this gear type was concentrated (235 trips per 100 square nautical miles) were located off the New Jersey coast and south of Long Island. Dredging in southern New England was less intense. The concentration of the "dry" dredge in the Maine ocean quahog fishery is depicted in Figure 39.

2.2.5.4.3.2 Hydraulic clam dredges - impacts and recovery

The following information is from a draft report by Stevenson *et al.* entitled *"The Effects of Fishing on Marine Habitats of the Northeastern United States"* that is to be published in the late spring/summer of 2003. This report is an updated/expanded version of the report in Appendix 3.

Hydraulic Clam Dredges – Mud

Hall and Harding (1997) evaluated the effects of suction dredging on intertidal infaunal communities in Auchencairn Bay, on the north side of the Solway Firth, on the west coast of Scotland. Sediments were 60-90% silt/clay in the interior of the bay and 25-60% silt/clay in the center and outer parts of the bay. Commercial dredging for cockles (*Cerastoderma edule*) in the bay was prohibited four and a half months before experimental dredging began. Core samples were collected in control plots prior to dredging, and in experimental plots immediately after, and one, four, and eight weeks after dredging. Dredge tracks could not be seen after the first day. The total number of infaunal individuals and species increased in both plots over time, but were significantly lower in the experimental plots than in the control plots immediately after dredging and after four weeks. Species diversity also increased significantly over time, but was not significantly different in the two plots at any point during the experiment. Three of the five dominant species were significantly reduced by dredging over the course of the study. By the end of the study (eight weeks), much of the difference between dredged and control sites had been lost, but the disturbed plots still had a higher partial-dominance index.

Summary

Results of a single experimental study are summarized here. It examined the physical and biological effects of individual suction dredge passes in an intertidal mud habitat and monitored recovery for eight weeks. Dredging produced dredge tracks that disappeared after one day. There were significant reductions in the total number of infaunal individuals and species that lasted four weeks, and three out of five dominant species were reduced in abundance during the entire eight-week duration of the experiment. However, infaunal community structure recovered nearly completely by the end of the experiment.

Hydraulic Clam Dredges – Sand

(1). Hall *et al.* (1990) studied the physical and biological effects of a commercial escalator dredge used to harvest razor clams (*Ensis* spp.) in a shallow sea loch (Loch Gairloch) on the west coast of Scotland in November 1989. The depth at the study site was 22 feet and the sediment was fine sand. It was located near a recently-dredged area, but was not exploited itself. Experimental and control plots were visually inspected and sampled by divers immediately after dredging and 40 days later. Each experimental plot was dredged intensively for approximately five hours in order to simulate commercial fishing activity. After dredging, the experimental plots were crisscrossed by shallow trenches (0.5 m wide and 10 inches deep) interspersed with larger holes (up to 10 feet wide and 2 feet deep) that were presumably produced when the dredge remained stationary for a brief period. Sediment in the holes and trenches was "almost fluidized" and sand in the bottom of the trenches had a significantly higher median particle size. After 40 days, however, none of these features remained.

The number of infaunal species and individuals were reduced in the experimental plots immediately after dredging (significantly, for individuals), but there were no detectable differences between experimental and control plots 40 days later. There were no significant differences in the abundance of individual species in the control and experimental plots on either sampling occasion. The authors concluded that dredging caused a short-term, non-selective reduction in the numbers of all infaunal species and that recovery from physical effects was accelerated by a series of winter storms and considerable sediment disturbance in the study area. No attempt was made to assess the mortality of large polychaetes and crustacea that were observed to be retained on the wire mesh conveyor belt or fell off the end of the belt, or ocean quahogs (*Arctica islandica*) that were often cracked by the dredge.

(2). Kaiser *et al.* (1996b) investigated the effects of suction dredging for cultivated manila clams (*Tapes philippinarum*) on a muddy sand intertidal flat in southeast England in December 1994. Samples of benthic infauna and sediment were collected prior to, three hours after, and seven months after harvest in one cultivated plot and in nearby control locations. There were significantly higher densities of infaunal organisms in the cultivated plot prior to dredging, but no differences in the number of species or in four indices of taxonomic diversity. Large amounts of fine sand were re-suspended by the dredge, exposing the underlying clay. There were also significant reductions in the mean numbers of infaunal species and individuals in the dredged plot immediately after harvest, to values that were statistically the same as in the control locations. Crustaceans and bivalve mollusks were particularly affected. Seven months later there were no significant differences between the benthic community in the harvested plot and in the control locations and the proportion of fine sand in the harvested plot had increased significantly, indicating that recovery from the effects of clam cultivation and harvesting was complete.

(3). MacKenzie (1982) sampled benthic invertebrate assemblages in three ocean quahog beds with contrasting fishing histories located about 40 miles east of Cape May, New Jersey (USA), in the mid-Atlantic Bight, in October 1978. One bed had never been fished, one had been actively fished for two years, and one had been fished for about a year but then abandoned 4-5 months prior to this study. All three beds were in very fine to medium sand sediments in 110 feet of water. Commercial dredging was conducted with cage dredges in this area. Sampling was limited to a total of 30 grab samples from all three sites. No significant differences were found in numbers of invertebrate individuals or species, or in species composition, between previously dredged and un-dredged areas or between dredged and un-dredged sample locations at the two fished sites. Hydraulic dredging thus did not appear to have any lasting effect on the invertebrate populations in these beds. Comparison of samples from previously dredged and un-dredged sample locations also indicated that hydraulic jetting of the bottom re-sorts bottom sediments, leaving shell fragments on the surface and coarser sediments at the bottom of dredge tracks.

(4). Maier *et al.* (1995) assessed the effects of escalator dredges in four muddy sand tidal creeks in South Carolina (USA) by comparing pre- and post-dredging turbidity levels and benthic infaunal assemblages. Turbidity was monitored two weeks before, during, and two weeks after dredging at one location and during and immediately after dredging at another. Infaunal samples were collected three weeks before and two weeks after dredging in a creek that had been commercially dredged five years prior to the study and in a creek that had never been dredged before. Turbidity was elevated in the vicinity of the dredge and immediately downstream while it was operating, but the sediment plumes only persisted for a few hours. Sampling failed to detect any significant changes in the abundance of dominant infaunal taxa, or in the total numbers of individuals, after dredging.

(5). Medcof and Caddy (1971) utilized divers and a submersible to compare the physical effects of a hydraulic cage dredge and a non-hydraulic toothed scallop dredge in shallow water (20 to 35 feet) sand inlets in southern Nova Scotia (Canada). On sand and sand-mud habitats, hydraulic dredges left smooth tracks with steeply cut walls that averaged 8 inches deep and slowly filled in by slumping. The hydraulic dredge raised a sediment cloud which seldom exceeded 2 feet in height and usually settled within 1 minute. Dredge tracks were still easily recognizable after 2-3 days.

(6). Meyer *et al.* (1981) observed the effects of a small (4 feet wide) hydraulic clam cage dredge in an un-harvested surfclam bed located near Rockaway Beach on the south shore of Long Island, New York (USA). The study was conducted in 1977, three years after the area was closed to commercial clamming. The sediment in the study area was fine to medium sand covered with a 3 inch-thick layer of silt and the maximum depth was 100 feet. The study area was exposed to strong bottom currents that caused considerable movement of sand. As part of a larger study to evaluate gear performance, the effects of dredging on bottom substrate and fauna were assessed by divers during a single 2-minute tow immediately after and 2 and 24 hrs after dredging. The dredge formed trenches which were initially rectangular, as wide as the dredge, and over 8 inches deep. Mounds of sand 6 to 15 inches wide and 2 to 6 inches high were formed on either side of the trench. The dredge raised a cloud of silt 1 to 5 feet in height, which settled within four minutes. Slumping of the trench walls began immediately after the tow and became more apparent with time. Two hours after dredging, slumping of the trench walls had rounded the depression. After 24 hours the dredge track was less distinct, appearing as a series of shallow depressions, and was difficult to recognize. The dredging attracted predators, with lady and rock crab preying on damaged clams, and starfish, horseshoe crabs and moon snails attacking exposed but undamaged clams. By 24 hours after dredging, the abundance of predators appeared to have returned to normal, and the most obvious evidence of dredging was whole and broken clam shells without meat.

(7). Pranovi and Giovanardi (1994) studied the effects of an 8 foot wide hydraulic cage dredge in 5 to 7 foot depths in the Venice Lagoon (Italy, Adriatic Sea). Divers collected samples of sediment and benthic organisms from experimentally-dredged and control areas at two sites inside and outside a commercial fishing ground immediately after experimental dredging and every three weeks for two months. A single tow with a commercial dredge was made at each site. The dredge created 3 to 4 inch-deep furrows, one of which was clearly visible two months later. In this study, sediment grain size was not significantly affected by dredging, although portions of the fishing grounds which had been predominantly silt and clay 15 years earlier had a considerably higher sand content at the time of the study. Hydraulic dredging in this area often cracks the shells of bivalves. Within the fishing grounds, total numbers and biomass of benthic infauna and epifauna were significantly reduced in the experimental plot immediately following dredging. Densities, especially of small species and epibenthic species, recovered two months later, but biomass did not. Inside the fishing ground, there were also fewer species in the dredged area than in the control area immediately after, and three and six weeks after, dredging, but no differences two months afterwards. Outside the fishing ground, immediately after passage of the dredge, there were no significant faunal differences between dredged and undredged areas.

(8). Tuck *et al.* (2000) examined the effects of hydraulic dredging on the seabed and benthic community in a shallow (6 to 15 feet), sandy site in the Outer Hebrides (Sound of Ronay), on the west coast of Scotland in March 1998 that was closed to commercial dredging. Sediments in the study area consisted of moderately well-sorted medium or fine sand and tidal currents reached speeds as high as three knots. Divers collected core samples and made observations and video recordings, before, during, and after dredging inside and outside six dredge tracks and returned to re-examine the site 5 days and 11 weeks after dredging. The dredge was a commercial dredge used to harvest razor clams that employs a hollow blade that protrudes 1 foot into the sediment with holes that direct pressurized water forward into the sediment.

Immediately after dredging the track had distinct vertical walls and a depth similar to the dredge blade. However, once the dredge was hauled, the side walls collapsed and the tracks had a flat-bottomed "V" shape. The sediment within the base of the tracks was fluidized to a depth of approximately 1 foot and within both side walls to approximately 6 inches. The tracks were still clearly visible after five days, but less pronounced, and the depth of fluidized sediment remained the same. After 11 weeks the tracks were no longer visible, but 8 inches of sand was still fluidized. Immediately after fishing, there was significantly less silt in the sediments inside the tracks than outside, but there was no difference after five days. Numerically, the infauna at the study site was dominated by polychaetes. There was a significant decrease in the proportion of polychaetes, and an increase in amphipods, in the dredge tracks within five days of dredging, but not after 11 weeks. Bivalves were not affected by dredging. Within a day of dredging the total number of species and individuals was significantly lower in the dredge tracks, but there was no difference after five days. Dredging had an immediate effect on the abundance of a number of individual species, but no effects were detected 11 weeks after dredging. Owing to the strong currents, there was a very sparse epifauna in the area: the only observed effect of dredging was the attraction of crabs into the area to scavenge on material disturbed by the dredge.

Summary

Results of eight hydraulic dredge studies in sandy substrates are summarized in this report. Five of them examined the effects of "cage" dredges of the type used in the Northeast region of the U.S. (3, 5-8) and three examined the effects of escalator and suction dredges. Three of them were published prior to 1990, and five since then. Four were performed in North America, one in the Adriatic Sea and three in the United Kingdom. One study was conducted on the U.S. continental shelf at a depth of 110 feet, five in shallower, nearshore waters (5 to 40 feet), and two in intertidal environments. Three studies were observational in nature and five were controlled experiments. Three studies compared effects in commercially-dredged and un-dredged areas and four were conducted in previously un-dredged areas. Six studies examined the effects of individual dredge passes, one evaluated the effects of repeated passes in the same area during a short period of time, and one compared infaunal communities in an actively dredged, a recently dredged, and an un-dredged location. Seven studies examined physical and biological effects and one was limited to physical effects. All of the biological studies examined effects to infauna. Recovery was evaluated in four cases for periods ranging from 40 days to seven months.

Physical effects

Hydraulic clam dredges created steep-sided trenches 3 to 12 inches deep that started deteriorating immediately after they were formed (1, 5-8). Trenches in a shallow, inshore location with strong bottom currents filled in within 24 hours (6). Trenches in a shallow, protected, coastal lagoon were still visible two months after they were formed (7). Hydraulic dredges also fluidized sediments in the bottom and sides of trenches (1, 8), created mounds of sediment along the edges of the trench (6), re-suspended and dispersed fine sediment (2, 4-6), and caused a re-sorting of sediments that settled back into trenches (3). In one study (8), sediment in the bottom of trenches was initially fluidized to a depth of 12 inches and in the sides of the trench to 6 inches. After 11 weeks, sand in the bottom of the trench was still fluidized to a depth of 8 inches. Silt clouds only last for a few minutes or hours (4-6). Complete recovery of seafloor topography, sediment grain size, and sediment water content was noted after 40 days in a shallow, sandy environment that was exposed to winter storms (1).

Biological effects

Some of the larger infaunal organisms (*e.g.*, polychaetes, crustaceans) retained on the wire mesh of the conveyor belt used in an escalator dredge, or that drop off the end of the belt, presumably die (1). Benthic organisms that are dislodged from the sediment, or damaged by the dredge, temporarily provided food for foraging fish and invertebrates (1, 6). Predator densities returned to normal within 24 hours in one study (6). Hydraulic dredging caused an immediate and significant reduction in the total number of infaunal organisms in three separate studies (1, 2, 8) (but not in another (4)) and in the number of macrofaunal organisms in a fourth study (7). There were also significant reductions in the number of infaunal species in two cases (2, 8) and in the number of macrofaunal species and biomass in a third case (7). In one study, polychaetes were most affected (7). Two studies failed to detect any reduction in the abundance of individual taxa (1, 4). Evidence from the study conducted off the New Jersey coast indicated that the number of infaunal organisms and species, and species composition, were the same in actively dredged and un-dredged locations (3).

Recovery times for infaunal communities were estimated in four studies. Three of these studies (1,7, 8) were conducted in very shallow (5 to 22 feet) water and one (2) in an intertidal environment. Total infaunal abundance and species diversity had fully recovered only five days after dredging in one location where tidal currents reach maximum speeds of three knots (8). Some species had recovered after 11 weeks. Total abundance recovered 40 days after dredging in another location exposed to winter storms, when the site was re-visited for the first time (1). Total infaunal abundance (but not biomass) recovered within two months at a protected, commercially-exploited site (7), where recovery was monitored at three-week intervals for two months, but not at a nearby unexploited site. Full recovery at the intertidal site was noted seven months after it was suction dredged when it was re-visited for the first time (2). Actual recovery times at this site and at one of the exposed sub-tidal sites (1) may have been much quicker than seven months and 40 days.

Hydraulic Clam Dredges - Mixed Substrates

Murawski and Serchuk (1989) used manned submersibles to observe effects of hydraulic dredging on sand, mud, and gravel bottom habitats in a number of offshore locations in the mid-Atlantic Bight (U.S. Atlantic coast) between Delaware Bay and Long Island (water depths not reported). They reported that hydraulic cage dredges penetrate deeper into the sediments and, on a per-tow basis, result in greater short-term disruption of the benthic community and underlying sediments than do scallop dredges (no data were provided). In coarse gravel, the sides of hydraulic dredge trenches soon collapsed, leaving little evidence of dredge passage. There was also a transient increase in bottom water turbidity. In finer-grained, hard-packed sediments, tracks persisted for several days after dredging. Non-harvested benthic organisms (*e.g.*, sand dollars, crustaceans, polychaetes) were substantially disrupted by the dredge. Sand dollar assemblages appeared to recover quickly, but short-term reductions in infaunal biomass were considered likely. Numerous predatory fish (*e.g.*, red hake, spotted hake, and skates) and invertebrates (rock crabs and starfish) were observed in and near dredge tracks consuming broken quahogs. Densities of crabs and starfish were estimated to be 2.5 times higher in dredge tracks than in nearby undredged areas within one hour of experimental tows and >10 higher 8 hrs after dredging. Presumably, benthic infauna "tilled up" by the dredge were also being consumed, since not all predators observed foraging in the dredge paths were eating damaged shellfish.

Summary

An *in situ* evaluation of hydraulic dredge effects in sand, mud, and coarse gravel in the mid-Atlantic Bight indicated that trenches fill in quickly, within several days in fine sediment and more rapidly than that in coarse gravel. Dredging dislodged benthic organisms from the sediment, attracting predators.

Hydraulic Dredges - Biogenic Substrate

(1). Godcharles (1971) evaluated the physical effects of escalator dredging in seagrass (*Thallasia testudineum* and *Syringodinium filiforme*) beds, *Caulerpa* algae beds, and bare sand bottoms (depth not given) in Tampa Bay, Florida (USA) in 1968. Dredging was conducted with a commercial dredge at six sites. Water jets penetrated sediments to a maximum depth of 20 inches and left trenches that varied from 6 to 18 inches deep. Trenches were deeper in shallow areas where propellor wash scoured loose sediments from trenches and prevented redeposition of suspended sediments. The proportion of fine sediment in some trenches decreased immediately after passage of the dredge. Virtually all attached vegetation in the path of the dredge was uprooted, leaving open bottom areas. Trenches in grass beds remained visible longest (up to 86 days) while those in sandy areas filled in immediately. Most fluidized sediments hardened within a month, but some spots were still soft 500 days after dredging. Differences in silt/clay content between tracks and undisturbed areas became negligible after a year, but seagrasses had still not re-colonized disturbed areas. New algal growth was noted in some dredged areas after 86 days and after a year dredge tracks were completely covered.

(2). Orth *et al.* (1998) assessed damage to submerged aquatic vegetation (SAV) caused by escalator dredges in Chincoteague Bay, Virginia (USA) during 1996, 1997, and 1998. They reported a large number of circular "scars" in the vegetation, with 70-100% seagrass cover outside the scarred areas and an abrupt reduction to 15% or less at the scar edge. The percent cover of seagrass was low across the scar until a second abrupt increase in cover occurred at the center where seagrass had not been disturbed. There were no measurable differences in percent cover estimates in the scarred portions of areas that were dredged during the three years of observation, indicating that re-vegetation was proceeding very slowly. There were two factors that they believed were delaying re-vegetation: an increase in depth of 4 to 8 inches in the dredge tracks and large holes inside the un-vegetated portions of the scars made by organisms such as foraging cownose rays. The authors concluded that even the most lightly impacted areas would require a minimum of five years to fully recover.

Summary

Two studies were performed in the southeast U.S. in shallow, sub-tidal, vegetated habitats. One of them was a controlled experiment that compared the effects of escalator dredges in vegetated (seagrass and algae) and un-vegetated areas and the other evaluated damage to seagrass beds caused by commercial escalator dredging. In the experimental study (1), water jets penetrated sand substrate to a maximum depth of 18 inches, created trenches up to 12 inches deep, uprooted vegetation, and increased the silt/clay content of sediments in dredge tracks. Recovery times were extremely variable. In some cases, trenches were visible for only a day and in other cases for three months. In most cases, sediments hardened within a month, but in some tracks sediments were still fluidized 500 days after dredging. After a year sediment composition in dredge tracks had returned to normal, but seagrass had not re-colonized disturbed areas. There were no signs of recovery of seagrass in commercially-dredged areas three years after dredging (2).

2.2.5.4.4 Scallop dredges

Scallop dredges are discussed in detail in the NMFS report (USDC 2001) that is appended (Appendix 3). The panel determined that the effects of scallop dredging were of greatest concern in the following three habitat types: high and low energy sand and high energy gravel. Surfclams and ocean quahogs are found in sandy sediment. Low energy sand habitat occurs in deeper water where the bottom is unaffected by tidal currents and where the only natural disturbance is caused by occasional storm currents. In high energy sand habitat, effects on biological structure were considered to be low, since organisms in this environment would be adapted to a high degree of natural disturbance. It is unlikely that either surfclams or ocean quahogs would be significant since the gear rides on the surface and the surfclams and ocean quahogs are buried in the sediment.

2.2.5.4.5 Otter trawls

Otter trawls are discussed in detail in the NMFS report (USDC 2001) that is appended (Appendix 3). The panel concluded that the greatest impacts from otter trawls occur in low and high energy gravel habitats and in hard clay outcroppings. Both surfclams and ocean quahogs occur almost exclusively in sandy habitat.

2.2.5.4.6 Other gears

Gear other than hydraulic clam dredges, scallop dredges and otter trawls are discussed in some detail in the NMFS report (USDC 2001) that is Appendix 3. The panel concluded that the degree of impact caused by pots and traps to biological and physical structure and to benthic prey in mud, sand and gravel habitats was low. The panel concluded that sink gill nets and longlines cause some low degree impacts in mud, sand, and gravel habitats. Finally, the panel concluded that no management measures were necessary for beam trawls or pelagic gear because there were no impacts at this time.

2.2.5.5 Council determination of fishing impacts to surfclam and ocean quahog EFH

2.2.5.5.1 All fishing gear impacts to surfclam and ocean quahog EFH

Any mobile gear that comes into contact with the seafloor in surfclam and ocean quahog EFH may potentially have an impact to these immobile benthic organisms (MAFMC 1998). The gears expected to have the most adverse impact are hydraulic clam dredges and the scallop dredges (MAFMC 1998). EFH for surfclams and ocean quahogs is defined in section 2.2.3 and can be seen in Figures 30 and 31 for surfclams and 32 and 33 for ocean quahogs.

Section 2.2.5.4.3.2 discusses the impacts and recovery from hydraulic clam dredges. The Council considered the numerous studies identified above and the fact that the surfclam and ocean quahog fisheries are ITQ fisheries. As ITQ fisheries there is no reason that fishermen have a "rush to fish". One of the great benefits of ITQ fisheries from around the world is that it instills the sense of private property rights and ownership in the resource. Fishermen in these fisheries understand that they are not time driven to rape the resource and that by protecting the resource and its environment they are protecting their long term livelihoods. Unquestionably, ITQs and the way clams are now fished alleviate some environmental damage (Wallace pers. comm.)

The numbers of surfclam and ocean quahog fishermen have also decreased significantly with the implementation of ITQs. In 1979 there were 162 permitted surfclamming vessels. That number had fallen to 135 vessels the year before (1989) implementation of the ITQ program, and by 2001 the number was 35. For ocean quahogs the number of vessels were: 59 in 1979, 69 in 1989 and 30 in 2001. Most of these current vessels also use sorting machines which make it possible to harvest broken clams which are now not discarded.

A brief discussion on the concept of reserves, or areas where clam dredging would not be allowed, occurred at the June 1998 SARC. The idea of reserves was dismissed at this time by the SARC when it was quickly calculated that the greatest possible impact to the bottom, of all the clam dredging for an entire year, would be less than 100 square miles per year. Putting this in context, this 100 square miles is roughly the area of one ten minute by ten minute square. There are over 1200 ten minute squares in the EEZ between Cape Hatteras and Georges Bank.

Dr. James Weinberg (Northeast Fisheries Science Center - NEFSC) led the discussion at the fishing gear impacts workshop (Appendix 4) of the direct physical and biological effects of hydraulic clam dredging, and Dr. Roger Mann (Virginia Institute of Marine Science - VIMS) led the discussion on the available evidence. Most of the evidence for dredging impacts that was considered by the panel was from the Northeast U.S., but there are studies from other areas that show the same effects. It was noted that early studies done in the Northeast region were conducted during development of the fishery, when clam dredging was more damaging to the habitat than it is now.

According to these studies, the direct physical effects of hydraulic clam dredging are basically two-fold. First, a trench about 8 inches deep is left behind the dredge and windrows of sediment and organisms are formed on either side of the trench. The second direct physical effect is the resuspension of sediment. If a dredge goes through silt or loose sediment, it produces a sediment cloud. In the panel's judgement, fine sediment may take as long as 24 hours to resettle and would end up outside the trench, while heavier particles would settle much more rapidly, primarily back into the trench. The evidence for physical effects (trench, windrows, and sediment re-suspension) is strong because these effects are so obvious.

Physical impacts to bottom habitat last longer (months) in low energy environments than in high energy environments (hours). In sand, the sides of the trench start to erode as soon as it is cut; this happens more rapidly when bottom currents are strong. The rate at which it fills in depends on the grain size of the sediment, water depth, and the strength and frequency of storms and bottom currents. It was noted that there are permanent, longshelf, sand ridges with low elevation off the New Jersey coast, but there is no evidence to indicate that clam dredges remove them, even though they may be towed through them.

The direct biological effects of hydraulic dredges vary, depending on whether organisms are hard-bodied like clams or soft-bodied like amphipods or polychaetes. What happens when a clam dredge goes through an area is not fully known and more study is needed. It was noted that structure-forming epifauna such as anemones and sponges would clearly be removed. Emergent epifauna growing on shell beds in the mid-Atlantic Bight is known to provide cover for juvenile fish species like black sea bass. Removal of these organisms, or their burial by re-suspended sediments, could therefore cause the loss of habitat for some species of juvenile fish.

It is not clear what happens to soft-bodied organisms that are moved by the dredge or pass through the trench and are deposited back on the seafloor. Often, after an area is dredged, scavengers move in rapidly and eat broken clams and soft-bodied organisms that are removed from the substrate. However, the panel considered that evidence for effects on infaunal prey organisms was weak because there aren't many studies that link changes in benthic community structure in dredged areas to the food supply for fish, and those that do exist do not show definitive results. The panel concluded that infaunal communities would be likely to recover more quickly than emergent epifauna, and therefore removal of structure-forming organisms was judged to be more of a concern. However, one panelist noted that the potential loss of secondary production of benthic invertebrates which are prey for bottom-feeding fish is the effect that is least understood, and that any reduction in prey abundance – if it occurs – would not necessarily be limited to the dredge tracks themselves, but would affect the entire dredged area. Moreover, the effects of fluidizing the sediment on benthic infauna are unknown and may be important.

The panel noted that there may be cumulative physical and biological effects in areas that are dredged several times annually. As previously stated, surfclams grow much more rapidly than ocean quahogs and surfclam beds are dredged every few years, whereas areas dredged for ocean quahogs are left untouched for many years. It was also noted that benthic organisms that occupy muddy bottom in deep water are less adapted to physical disturbance and therefore would presumably take longer to recover from dredging than organisms in sandy bottom areas in shallower water.

The panel concluded that the habitat effects of hydraulic dredging were limited to sandy substrates, since the gear is not used in gravel and mud habitats (Table 3). Two effects -changes in physical and biological structure – were determined to occur at high levels. The evidence cited for these two effects was a combination of peer-reviewed scientific literature, gray literature, and professional judgement. There are no effects of hydraulic dredges on major physical features in sandy habitat because, in the panel's view, there are no such features on sandy bottom. Panel members evaluated changes to benthic prey as unknown.

The temporal scale of the effects varies depending on the background energy of the environment. Recovery of physical structure can range from days in high energy environments to months in low energy environments, whereas biological structure can take months to years to recover from dredging, depending on what species are affected.

The panel agreed that hydraulic dredges have important habitat effects, but even in a worse case scenario, where there were known to be severe biological impacts, only a small area is affected and therefore this gear type is less important than other gear types like bottom trawls and scallop dredges which affect much larger areas. It was also pointed out, however, that even though the effects of dredging (at least for surfclams) are limited to a relatively small area, localized effects of dredging on EFH could be very significant if the dredged area is a productive habitat for one or more managed fish resources. The same would be true if dredging in a particular area coincided with a strong settlement of larval fish. A major question for this gear is "what are its long-term biological impacts" *i.e.*, how, and to what extent, are benthic communities altered in heavily dredged areas, particularly the prey organisms, and how long does it take for them to recover once dredging ceases?

The Council concurs with the fishing gear workshop panel in that there may be some impacts but that they are short term and minimal.

2.2.5.5.2 Impacts of clam dredges to EFH of other Federally managed species and the vulnerability of that EFH to bottom-tending fishing gear

There is minimal bycatch in the surfclam and ocean quahog fisheries (section 3.1.9). From the 1997 NEFSC clam survey species listing (Table 34), surfclams and ocean quahogs comprise well over 80% of the total caught in the scientific survey. Commercial operations are certainly even cleaner than the scientific surveys (as the surveys use liners to collect all animals), as all animate and inanimate objects except for surfclams and ocean quahogs are discarded quickly before the resource is placed in the cages. The processors reduce their payments if "things" other than surfclams or ocean quahogs are in the cages.

Given that: (1) MacKenzie (1982) showed not pattern of any relationship of numbers of species or their abundance and the amount of dredging that had occurred, (2) that these fisheries are ITQ fisheries and as such there was not reason for fishermen to "rush to fish", (3) that the number of vessels has significantly decreased from 168 to less than 50 vessels during the ITQ decade and (4) that abiotic waves are formed frequently during high storm events as deep as 200 to 250 feet (Auster and Langton 1998), the Council proposes no specific management measures at this time. The Council will solicited public input on clam dredge gear impact during the public hearing process. The Council concurs with the 2001 Boston fishing gear impacts workshop that any impacts to EFH would be minimal and short-term, and thus they have concluded that there is not an adverse effect to other Federally managed species.

Two additional sources of evidence have just recently been received that also support the findings of the workshop and the concurrence of the Council. First, the National Research Council (2002) just completed a report entitled *Effects of Trawling and Dredging on Seafloor Habitat.* In addition, the Council's former Executive Director John Bryson also provided some personal thoughts from observations from the Johnson Sea Link submersible. Bryson (pers. comm.) reported that the substrate where clams are harvested tends to resettle quickly and in many areas this can be minutes not days. He also reports that he did not observe the large sediment cloud nor the deep track some authors report.

The NRC report upon review of what the Regional Council's did to address fishing gear impacts after SFA in 1996 stated: "The regional councils found it difficult to develop criteria for designating EFH due to gaps in existing knowledge on the distribution of benthic life stages of fishes and other species and the physical and biological characteristics of the seafloor. Similarly, the councils struggled with the requirement to assess the effects of bottom trawling and dredging because they had insufficient data on the spatial scale and extent of bottom fishing effort and lacked guidelines for generalizing the results of research on specific gears and habitats. These problems relate to the committee's task to recommend ways for using existing information in the management of the habitat effects of trawl and dredge fisheries."

The report continues: "A complete assessment of the ecosystem effects of trawling and dredging requires three types of information:

1) gear-specific effects on different habitat types (obtained experimentally);
2) the frequency and geographic distribution of bottom tows (trawl and dredge fishing effort data);
3) the physical and biological characteristics of seafloor habitats in the fishing grounds (seafloor mapping).

The NRC (2002) report summarizes the currently available data in the above three areas and describes how the low spatial resolution and availability of the fishing effort and habitat mapping data restrict a full evaluation of the ecosystem effects of trawling and dredging. The report concludes that in less consolidated coarse sediments in areas of high natural disturbance there are few initial effects. The report also states that since the 1990s there were significant reductions in the intensity and spatial extend of bottom fishing. Finally, the report also states that for most areas only coarse maps are available on habitat distribution. The conclusion is that: "existing data are not sufficient for optimizing the spatial and temporal distribution of trawling and dredging to protect habitat and sustain fishery yields. Resolution of the different, and at times conflicting, ecological and socioeconomic goals will require not only a better understanding of the relevant ecosystems and fisheries, but also more effective interaction among stakeholders."

Just about all the species managed by the Mid-Atlantic Council, New England Council, South Atlantic Council and NMFS – Highly Migratory Species, have EFH that overlap with the EFH of surfclams and ocean quahogs. Any actions implemented in this FMP that affect the other species that have overlapping EFH with surfclams and ocean quahogs will be considered in the EFH assessment of this FMP.

The purpose of this section is to evaluate potential adverse effects of bottom-tending fishing gears regulated by the Magnuson-Stevens Act (MSA) on benthic EFH in the Northeast region of the U.S. as required by the EFH final rule, 50 CFR 600.815(a)(2)(I). The EFH final rule recommends that the evaluation consider the effects of each fishing activity on each type of habitat found within the EFH for any affected species and life stage. The EFH rule further recommends that the following information be reviewed in making an evaluation: intensity, extent, and frequency of any adverse effects on EFH; the types of habitat within EFH that may be adversely affected; habitat functions that may be disturbed; and conclusions regarding whether and how each fishing activity adversely affects EFH.

The EFH final rule requires that EFH designations be based upon the best available information. This information may fall into four categories that range from the least specific (Level 1) to the most specific (Level 4). These categories are defined as follows:

Level 1: Presence/absence data are available to describe the distribution of a species (or life history stage) in relation to potential habitats for portions of its range.

Level 2: Quantitative data (*i.e.*, density or relative abundance) are available for the habitats occupied by a species or life history stage.

Level 3: Data are available on habitat-related growth, reproduction, and/or survival by life history stage.

Level 4: Data are available that directly relate the production rates of a species or life history stage to habitat type, quantity, and location.

Existing EFH designations in the Northeast region are based primarily on Level 2 information. This level of information is inadequate for making definitive determinations of the consequences of fishing-related habitat alterations on EFH for any species or life stage in the Northeast region because the habitat alterations caused by fishing can not be linked to any known effect on species productivity. This section of the report qualitatively evaluates the vulnerability of benthic EFH for each species and life history stage (eggs, larvae, juveniles, adults, and spawning adults) in the Northeast region that were determined by Stevenson *et al.* (in press) to be vulnerable to impacts from hydraulic clam dredges. Given the limited nature of the information available for this evaluation, emphasis was placed on the identification of potential adverse impacts of fishing on benthic EFH. Vulnerability is defined as the likelihood that the functional value of EFH would be adversely affected as a result of fishing.

The information that Stevenson *et al.* (in press) used to perform these evaluations included: 1) the EFH designations adopted by the Mid-Atlantic, New England, and South Atlantic Fishery Management Councils; 2) the results of a Fishing Gear Effects Workshop convened in October 2001; 3) the information provided in this report, including the results of existing scientific studies, and the geographic distribution of hydraulic clam dredge use in the Northeast region; and 4) the habitats utilized by each species and life stage as indicated in their EFH designations and supplemented by other references. First, the habitat's value to each species and life stage was characterized to the extent possible, based on its function in providing shelter, food and/or the right conditions for reproduction. For example, if the habitat provided shelter from predators for juvenile or other life stages, gear impacts that could reduce shelter were of greater concern. In cases where a food source was closely associated with the benthos (*e.g.* infauna), the ability of a species to use alternative food sources was evaluated. Additionally, since benthic prey populations may also be adversely affected by fishing, gear impacts that could affect the availability of prey for bottom-feeding species or life stages were of greater concern than if the species or life stages were piscivorous. In most cases habitat usage was determined from the information provided in the EFH Source Documents (NOAA Technical Memorandum NMFS-NE issues 123-153) with additional information from Collette and Klein-MacPhee (2002).

Based upon this qualitative draft assessment approach (Stevenson *et al.* in press) of the above information the following species and life stages have been determined (Stevenson *et al.* in press) to have EFH that may be vulnerable to impacts from hydraulic clam dredges:

Black sea bass (juveniles and adults), scup (juveniles), ocean pout (all life stages), red hake (juveniles), silver hake (juveniles), winter flounder (juveniles and adults), and Atlantic sea scallops (juveniles). The rationale for each determination is outlined below.

Black sea bass *(Centropristis striata)* are found in coastal waters of the northwest Atlantic, from Cape Cod south to Cape Canaveral (Collette and Klein-MacPhee 2002). Occasionally they stray as far north as the Bay of Fundy (Gulf of Maine). Juveniles are common in high salinity estuaries. Adults and juveniles are found in estuaries from Massachusetts south to the James River, VA (Stone *et al.* 1994).

Black sea bass larvae are pelagic, but then become demersal and occupy structured inshore habitat such as sponge beds, eelgrass beds, shellfish beds, shell patches, and other rough bottoms (Steimle *et al.* 1999) and offshore shell patches including clam beds (Able and Fahay 1998). The availability of structure limits successful postlarval and/or juvenile recruitment (Steimle *et al.* 1999). Juveniles are diurnal visual predators that feed on benthic invertebrates and small fish. Adults are also structure oriented, and thought to use structure as shelter during day- time, but may stray off it to hunt at night.

Each of these life stages is associated with structure that may be vulnerable to mobile fishing gear impacts. However, it is important to note that structured habitats comprised of wrecks or other artificial reefs prone to damage by mobile gear may be avoided by hydraulic clam dredges. This is true of high relief natural areas as well. Black sea bass eggs are pelagic, so vulnerability to EFH is not applicable. Although larvae are pelagic, they do become demersal as they transition into juveniles so larval EFH is also vulnerable to mobile gear.

Scup *(Stenotomus chrysops)* is a temperate species that occurs primarily from Massachusetts to South Carolina, although it has been reported as far north as the Bay of Fundy and Sable Island Bank, Canada (Steimle *et al.* 1999). Scup are primarily benthic feeders that use a variety of habitat types. Juveniles forage on epibenthic amphipods, other small crustaceans, polychaetes, mollusks, fish eggs, and larvae. They occur over a variety of substrates, and are most abundant in areas without structure. Limited observations of scup have shown periodic use of seafloor depressions for cover (Auster *et al.* 1991 and 1995).

Adults are found on soft bottoms or near structures. During the summer they are closer inshore and found on a wider range of habitats. In the winter they congregate offshore in areas that are expected to serve as a thermal refuge (Collette and Klein-McPhee 2002), particularly deeper waters of the outer continental shelf and around canyon heads. Smaller adults feed on echinoderms, annelids, and small crustaceans. Larger scup consume more squids and fishes. Since juvenile scup are primarily benthic feeders, their EFH is considered vulnerable to impacts from mobile bottom gear. EFH vulnerability for adults is minimal since there is less of a reliance on benthic prey items.

Ocean pout (*Zoarces americanus*) is a demersal species found in the western Atlantic from Labrador south to Cape Hatteras (Steimle *et al.* 1999e). It can occur in deeper waters south of Cape Hatteras, and has been found as deep as 1000 feet (Collette and Klein-MacPhee 2002). It is found in most estuaries and embayments in the Gulf of Maine, and is caught in greatest abundance by the NEFSC trawl survey off southern New England (Steimle *et al.* 1999).

Ocean pout eggs are laid in nests in crevices, on hard bottom or in holes and protected by the female parent for 2.5 to 3 months until they hatch (Collette and Klein-MacPhee 2002). Potential impacts to habitat from otter trawls, scallop dredges and clam dredges include knocking down boulder piles, removing biogenic structure and filling in bottom depressions, which may disturb nests and/or leave these areas less suitable for nests. In addition, fishing may frighten parents from nests leaving eggs susceptible to predation. Egg EFH is therefore considered to be vulnerable to all bottom-tending mobile gear.

Ocean pout have a relatively short larval stage, and in fact some authors (Collette and Klein-MacPhee 2002) suggest that there is no larval stage (Steimle *et al.* 1999). Since the NEFMC designated EFH for this life stage, it is considered here as a distinct life stage. Larvae (hatchlings) remain near the nest site; however, there is little information on their use of habitats. Larvae do not appear to be as closely associated with the bottom as eggs or juveniles; however, it is anticipated that loss of structure may impact larvae to some degree. Larval EFH is considered vulnerable to mobile bottom-tending gears.

Juvenile pout are found under rocks, shells and algae, in coastal waters and are closely associated with the bottom (Steimle *et al.* 1999). They feed on benthic invertebrates such as gammarid amphipods and polychaetes. It is expected that loss of structure may be a fairly significant impact to juvenile EFH. Juvenile EFH is considered vulnerable to all mobile gear.

Adult pout are found in sand and gravel in winter and spring, and in rocky/hard substrate areas for spawning and nesting (Collette and Klein-MacPhee 2002). They create burrows in soft sediments, and their diet consists mainly of benthic invertebrates including mollusks, crustaceans and echinoderms. Because of the strong benthic affinity of ocean pout, it is anticipated that adult EFH is vulnerable to all mobile gear.

Red hake (*Urophycis chuss*) is a demersal species that ranges from southern Newfoundland to North Carolina, and is most abundant between Georges Bank and New Jersey (Steimle *et al.* 1999). They occur at depths between 100 and 3000 feet, and are most common between 225 and 375 feet (Collette and Klein-MacPhee 2002). Larvae, juveniles, and adults have been found in estuaries from Maine south to Chesapeake Bay. Eggs and larvae are pelagic, and EFH vulnerability to bottom-tending fishing gear is not applicable.

Juvenile red hake are found in live Atlantic sea scallops or empty scallop shells, and are also associated with other objects such as other shells, sponges, and rocks (Collette and Klein-MacPhee 2002). Shelter appears to be a critical habitat requirement for this life stage (Able and Fahay 1998), and physical complexity, including biogenic structure other than scallop shells, may be important (Auster *et al.* 1991 and 1995). Their diet consists mainly of amphipods and other infauna and epifauna. Juvenile hake EFH is considered to be vulnerable to all three mobile gear groups.

Adult red hake feed mainly on euphausiids, and also consume other invertebrates and fish (Collette and Klein-MacPhee 2002). They are found mainly on soft bottoms (sand and mud) where they create depressions or use existing depressions. They are also found on shell beds, but not on open, sandy bottom. Offshore in Maryland and northern Virginia, adult red hake are found on temperate reefs and hard bottom areas. Clam dredges would not typically operate in these hard bottom areas, nor in the softer sediments with which red hake are usually associated in the northern extent of their range, but there is some overlap between adult EFH and clam dredge use in sandy habitats. Therefore, there is some EFH vulnerability to clam dredges.

Whiting or silver hake *(Merluccius bilinearis)* range from Newfoundland south to Cape Fear, NC, and are most common from Nova Scotia to New Jersey (Morse *et al.* 1999). They are distributed broadly, and are found from nearshore shallows out to a depth of 1200 feet (Collette and Klein-MacPhee 2002). All life stages have been found in estuaries from Maine to Cape Cod Bay (Morse *et al.* 1999). The vertical movement of offshore hake is governed chiefly by their pursuit of prey; both juveniles and adults show a vertical migration off the bottom at night when feeding activity is greatest.

In the mid-Atlantic Bight, juvenile whiting have been found in greater densities in areas with greater amphipod tube cover (Auster *et al.* 1997). Further, silver hake size distributions in sand wave habitats are positively correlated with sand wave period (*i.e.*, the spacing between sand waves), suggesting energetic or prey capture benefits in particular sand wave environments (Auster *et al* in press). Juveniles are primarily found on silt or sand substrate and feed mainly on crustaceans, including copepods, amphipods, euphausiids, and decapods (Morse *et al.* 1999). Juvenile EFH is considered vulnerable to mobile gear because of the potential connection between structure and habitat suitability for this life stage.

Adult whiting rest on the bottom in depressions by day, primarily over sand and pebble bottoms, and rarely in rockier areas. In the mid-Atlantic, adults were found on flat sand, sand wave crests, shell, and biogenic depressions, but were most often found on flat sand. At night, adults feed on anchovies, herring, lanternfish, and other fishes (Collette and Klein-MacPhee 2002). Piscivory increases with size for this species. Vulnerability of adult whiting EFH to the three mobile gear types is considered minimal because of whitings piscivorous food habits and preference for higher energy sand environments which recover quickly from fishing gear impacts. Eggs and larvae of this species are pelagic, so habitat vulnerability to fishing gear is not applicable.

Winter flounder *(Pseudopleuronectes americanus)* range from Labrador to Georgia, and are most abundant from the Gulf of St. Lawrence to Chesapeake Bay (Collette and Klein-MacPhee 2002). All life stages are common in estuaries from Maine through Chesapeake Bay. Juveniles and adults are found in waters less than 300 feet deep, and most are found from shore to 100 feet. They range far upstream in estuaries, and have been found in freshwater.

Winter flounder lay demersal adhesive eggs in shallow water less than 15 feet in depth, with the exception of spawning areas on Georges Bank and Nantucket shoals (Pereira *et al.* 1999). Substrates include sand, muddy sand, mud and gravel, with sand the most common. Although otter trawls, scallop dredges and clam dredges may affect the eggs directly, this was not considered a habitat impact. Since there is no indication that the eggs rely on any structure, egg EFH vulnerability to these three gears is considered minimal. Since early stage larvae are associated with the bottom and are at times demersal (Able and Fahay 1998) larval EFH may also have minimal vulnerability to all gears.

Juvenile and adult winter flounder are found on mud and sand substrates, and adults are also seen on cobble, rocks and boulders (Pereira *et al.* 1999). Both life stages can be opportunistic feeders, however their main prey items are infaunal invertebrates. Because of their reliance on infauna and their ability to use alternative food supplies, EFH is considered vulnerable to the three mobile gear types for these life stages.

Atlantic sea scallops (*Placopecten magellanicus*) are found on the continental shelf of the northwest Atlantic, from the Gulf of St. Lawrence south to Cape Hatteras (Packer *et al.* 1999). Benthic life stages occur at depths from shore out to approximately 325 feet. Larvae are pelagic, and EFH vulnerability to fishing gear impacts is not applicable.

Scallop eggs are heavier than seawater and are thought to remain on the bottom during development, but the functional value of this habitat for eggs is unknown. EFH vulnerability for eggs is considered minimal for all mobile gear types. Early juvenile scallops or spat (described as late stage larvae in the EFH descriptions) settle in areas of gravelly sand with shell fragments (Packer *et al.* 1999). Larsen and Lee (1978) indicated that spat may obtain a survival advantage in areas of increased structure, including sessile branching plants and animals. The availability of suitable hard surfaces on which to settle appears to be a primary requirement for successful reproduction (Packer *et al.* 1999). There is a close association between the bryozoan, *Eucratea loricata*, and spat. *Eucratea* attach to adult scallops, and have been found to contain large numbers of spat (Packer *et al.* 1999). Juvenile scallops (spat) are very delicate and do not survive on shifting sand bottoms (Packer *et al.* 1999). Since otter trawls, scallop dredges and hydraulic clam dredges can reduce the amount of benthic structure important to survival, juvenile scallop EFH is considered vulnerable to mobile benthic gears.

Adults are found in benthic habitats with some water movement, which is critical for feeding, oxygen and removal of waste; optimal growth for adults occurs at currents of 4 inches/sec (Packer *et al.* 1999). Adult scallops inhabit coarse substrates, usually gravel, shell, and rocks. They are less likely to be found in areas with fine clay particles. No scientific information exists that indicates mobile fishing gear has a negative impact on the functional value of adult scallop EFH. The vulnerability of adult scallop EFH to mobile benthic gears is therefore considered minimal.

2.2.5.6 Other species

Any species that could potentially be impacted by this FMP is considered part of the affected environment. General faunal assemblages specific to north and mid-Atlantic habitat types are described in Appendix 3. Species potentially impacted by this FMP can be described through predator/prey relationships, species with overlapping EFH, bycatch species of these fisheries, and marine mammals, sea turtles, and seabirds.

2.2.5.6.1 Predator/prey and other ecological relationships

Species that are in predator/prey and other ecological relationships with surfclams and ocean quahogs are fully described in section 2.1.3.

2.2.5.6.2 Bycatch

An analysis of bycatch is one way of determining other species that could be affected by this FMP. Section 3.1.9 includes a detailed description of the minimal bycatch of the surfclam and ocean quahog fisheries.

2.2.5.6.3 Marine mammals, sea turtles, and seabirds

Marine mammals, sea turtles, and seabirds that could have interactions with surfclam and ocean quahog fisheries are fully described in section 3.3. Any impacts that the management alternatives could have on these species are described in section 3.3, where applicable.

2.2.6 Alternatives for Managing Adverse Effects from Fishing

According to section 600.815 (a)(2), fishery management options may include, but are not limited to: (A) fishing equipment restrictions, (B) time/area closures, and ©) harvest limits.

According to section 600.815(a)(2)(ii) that deals with minimizing adverse effects: Each FMP must minimize to the extent practicable adverse effects from fishing on EFH, including EFH designated under other Federal FMPs. Councils must act to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely affects EFH in a manner that is more than minimal and not temporary in nature, based on the evaluation conducted pursuant to paragraph (a)(2)(I) of this section and/or the cumulative impacts analysis conducted pursuant to paragraph (a)(5) of this section. In such cases, FMPs should identify a range of potential new actions that could be taken to address adverse effects on EFH, include an analysis of the practicability of potential new actions, and adopt any new measures that are necessary and practicable. amendments to the FMP or to its implementing regulations must ensure that the FMP continues to minimize4 to the extent practicable adverse effects on EFH caused by fishing. FMPs must explain the reasons for the Council's conclusions regarding the past and/or new actions that minimize to the extent practicable the adverse effects of fishing on EFH.

Section 600.815(a)(2)(iii) defines the issue of practicability. In determining whether it is practicable to minimize an adverse effect from fishing, Councils should consider the nature and extent of the adverse effect on EFH and the long and short-term costs and benefits of potential management measures to EFH, associated fisheries, and the nation, consistent with National Standard 7. In determining whether management measures are practicable, Councils are not required to perform a formal cost/benefit analysis.

The Council assumed the panel of experts assembled at the fishing gear workshop in October 2001 provided the best synthesis of the existing scientific knowledge and the best management recommendations. The workshop panel concluded that the habitat effects of hydraulic dredging were limited to sandy substrates, since the gear is not used in gravel and mud habitats (Table 3). Two effects -changes in physical and biological structure – were determined to occur at high levels. The evidence cited for these two effects was a combination of peer-reviewed scientific literature, gray literature, and professional judgement. There are no effects of hydraulic dredges on major physical features in sandy habitat because, in the panel's view, there are no such features on sandy bottom. Panel members evaluated changes to benthic prey as unknown.

Dr. William DuPaul (VIMS) led the discussion at the fishing gear impacts workshop on the types of management actions that could be taken to minimize adverse impacts of hydraulic dredging to benthic habitat. The following two paragraphs are taken from that report (Appendix 4).

The effectiveness of the Individual Transferable Quota (ITQ) management program since 1990 and the opinion that the two resources are underfished, led the panel to conclude that reductions in effort are probably not practicable. Nor is it likely that gear substitutions or modifications are practical since the current gear is highly efficient at harvesting clams. Therefore spatial area management seems to be the only practicable approach to minimizing gear impacts, if necessary.

It was emphasized that hydraulic dredges are designed to operate in sandy substrate. This gear could be very destructive if fished in the wrong sediment type or in structured environments like gravel beds or tilefish pueblo villages. The panel emphasized the gear should not be used in sediment types where it would cause more damage. Areas of known structure-forming biota should be mapped and set aside as a priority. It was emphasized that since we really do not know what the effect of this gear is to soft-bodied benthic organisms, a possible precautionary measure would be to restrict the fishery to areas of high clam productivity. Seasonal closures were mentioned if times and areas of high recruitment could be detected.

The temporal scale of the effects varies depending on the background energy of the environment. Recovery of physical structure can range from days in high energy environments to months in low energy environments, whereas biological structure can take months to years to recover from dredging, depending on what species are affected.

The workshop panel agreed that hydraulic dredges have important habitat effects, but even in a worse case scenario, where there were known to be severe biological impacts, only a small area is affected and therefore this gear type is less important than other gear types like bottom trawls and scallop dredges which affect much larger areas. It was also pointed out, however, that even though the effects of dredging (at least for surfclams) are limited to a relatively small area, localized effects of dredging on EFH could be very significant if the dredged area is a productive habitat for one or more managed fish resource. The same would be true if dredging in a particular area coincided with a strong settlement of larval fish. A major question for this gear that the panel asked was "what are its long-term biological impacts" *i.e.*, how, and to what extent, are benthic communities altered in heavily dredged areas, particularly the prey organisms, and how long does it take for them to recover once dredging ceases?

The Council concluded from the above identified workshop (Appendix 4) that there is sufficient information that clam dredges could have an effect on EFH if the gear is fished improperly or in the wrong sediment type. For example, hydraulic clam dredges would have a significant impact to a coral reef or an SAV bed if such gear were used in a stable, fragile, structured, environment like one of those environments. However, the clam resources are concentrated in high energy sandy sediment and the fishing gear has evolved over the past five decades to fish most efficiently in this type of sandy sediment. This evolution of the fishing gear has minimized the effect on fishery habitat (Wallace and Hoff in press). Natural events have more effect on the benthic community than this type of fishing gear since all of the fishing activity takes place in sandy shallow water. Chiarella *et al.* (2002) describing the October 2001 workshop concluded that hydraulic clam dredges were not a major concern relative to otter trawls and scallop dredges. All of the hydraulic clam dredging for an entire year, would impact about 100 square miles of bottom (Table 2). Putting this in context, this 100 square miles is roughly the area of one ten minute square, and there are over 1200 ten minute squares in the EEZ between Cape Hatteras and Georges Bank. Thus, it does not appear that either surfclam or ocean quahog EFH is effected by fishing gear.

A qualitative EFH vulnerability analysis conducted by Stevenson *et al.* (in press) suggests that the EFH of several species may be vulnerable to impacts associated with the use of hydraulic clam dredges. This includes black sea bass (juveniles and adults), scup (juveniles), ocean pout (all life stages), red hake (juveniles), silver hake (juveniles), winter flounder (juveniles and adults), and Atlantic sea scallops (juveniles). (See section 2.2.5.5.2 for more detail)

Based upon existing information the Council concluded that there may be potential adverse effects on EFH from the hydraulic clam dredge, but concurred with the workshop panel (Appendix 4). The panel concluded that as the clam fishery is currently prosecuted, in sand habitats, there are potentially large, localized impacts to biological and physical structure, however the recovery time is relatively short. Since the recovery time is relatively short (hours to months) the adverse impacts to this high energy environment can be considered temporary. The preamble to the EFH Final Rule (50 CFR Part 600) defines temporary impacts as those that are limited in duration and that allow the particular environment to recover without measurable impact. Since these impacts are potentially effecting a relatively small portion (approximately 100 square nautical miles) of the overall large uniform area of high energy sand along the continental shelf (approximately 54,900 square nautical miles) these adverse impacts can be considered minimal. Additionally, the 100 square nautical miles impact each year (approximately 1.5 ten minute squares of latitude and longitude) represents a small fraction of the total EFH of the above listed vulnerable EFH and species. The preamble of the EFH Final Rule defines minimal impacts as those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions.

Although the Council has concluded that the clam fishery has an adverse effect on EFH that is no more than minimal and temporary in nature, there is enough uncertainty to warrant the evaluation of other measures that may be taken in light of this uncertainty. Based upon guidance from the Assistant Administrator (January 22, 2001), if information is inconclusive, a NEPA analysis should examine alternatives that could be taken in the face of uncertainty. For NEPA purposes, the guidance from the Assistant Administrator stated that the analysis of alternatives needs to consider explicitly a range of management measures for minimizing potential adverse effects, and the practicability and consequences of adopting those measures. The advise from Dr. Hogarth continues: "In other words, if there is evidence that a fishing practice may be having an identifiable adverse effect on EFH, even if there is no conclusive proof of adverse effects, it is not sufficient to conclude *prima facie* that no new management measures are necessary without first conducting a reasonably detailed alternatives analysis."

The Council evaluated nine alternatives that focused mostly on closed areas. The fishing gear impacts workshop (Appendix 4) concluded that effort reductions (i.e. harvest limits) and gear modifications (i.e. restrictions) were not workable for this fishery and that if the clam dredges were found to have significant adverse effects on EFH, then spatial closures were the only viable alternative to mitigate the adverse effects of this fishing gear. Since surfclams are underfished and the annual quotas are actually being increased (Table 27), it seems to make little sense to restrict harvest limits for EFH reasons, however there is an alternative for analysis where the ocean quahog optimum yield range would be reduced to trade off against an increase in surfclam quota. Finally, seven potential closed area alternatives were identified. These closed areas are being considered to be closed to clam dredging for 5 years. The distribution of the surfclam and ocean quahog resources based on the 1999 survey are depicted in Figures 5 through 8. Landings of the two species in 2000 are shown in Figures 9 and 10.

Of the nine alternatives that the Council considered initially relative to fishing gear impacts to EFH, four were thoroughly evaluated for their biological, economic, and social impacts. The Council did not thoroughly evaluate alternatives 5, 7, 8, and 9 for social and economic impacts because they determined that these closures were not reasonable with all of the data uncertainties associated with each alternative. The Council eliminated alternative 4 for thorough evaluation because it is in shallow water and storm events are much more significant at causing sediment disturbances in those depths than is hydraulic clamming activity.

2.2.7 Identification of Non-Fishing Activities and Associated Conservation and Enhancement Recommendations (Includes Cumulative Impacts)

According to section 600.815 (a)(4), 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.

Non-fishing activities and associated conservation and enhancement recommendations that affect surfclam and ocean quahog EFH are thoroughly described in section 2.2.5 of Amendment 12. No changes have been made to this section.

2.2.8 Prey Species

According to section 600.815 (a)(7), 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, surfclams and ocean quahogs are planktivorous siphon feeders therefore water quality is essential to the health of the stocks as well as their fitness for human consumption. There have been no changes to this section from Amendment 12.

2.2.9 Research and Information Needs

From section 600.815 (a)(9), 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 were five sets of recommendations included in this section (2.2.7) of Amendment 12. No changes have been made to this section for this amendment.

2.2.10 Review and Revision of EFH Components of FMP

In section 600.815 (a)(10), 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.

Review and revision of the EFH component of the surfclam and ocean quahog FMP is thoroughly described in section 2.2.8 of Amendment 12. No changes have been made to this section.

2.3 DESCRIPTION OF FISHING ACTIVITIES

2.3.1 Surfclam Fishing Activities

Note: Most of the following information was developed mainly for the 2002 quota recommendation specification package generated for the Regional Administrator. Most of the weights in the quota paper are expressed as bushels because that is what industry generally works in and thus most of the Tables and Figures are expressed in bushels rather than pounds or kilograms. The 30th SARC (Appendix 1) includes the most recent assessment of surfclams and a description of the fishery also, but the weights in that document are expressed in metric. The standard conversion is 1 bushel equals 17 pounds of surfclam meats and 1kilogram equals 2.2 pounds. It is important to also note that section 2.3.3 describes in detail the port and community activities associated with this fishery, while section 4 provides extensive economic evaluation of the alternatives as does section 5 for the social analyses of alternatives.

2.3.1.1 Overview

Traditionally, surfclams' dominant use has been in the "strip market" to produce fried clams. In recent years, however, they have increasingly been used in chopped or ground form for other products, such as high-quality soups and chowders.

Exvessel prices for surfclams can vary considerably depending on the quality and meat yield of surfclams from a particular area. Surfclam beds in New York State waters and off the Delmarva peninsula tend to have lower meat weights and command lower prices. Prices will also depend on the nature and terms of contracts which fishermen and allocation holders enter into with processors. The markets for surfclams and ocean quahogs have varied over time, and individual fishermen may have chosen to accept a lower price for an allocation of one species in return for assurances that the processor will purchase his allocation of the other species.

A trend evident over the past several years is one of increasing ties between the harvesting and processing sectors, which help assure each party that their needs will be met.

The reported prices in fishermen's logbooks for 2000 ranged from a low of $5.00 per bushel to a high of $15.00 per bushel for surfclams. Unfortunately, pricing data as it is currently collected is ambiguous for both surfclams and ocean quahogs. Under an individual allocation system, there are two components to the value of any particular harvest: 1) the actual cost of vessel and crew services in harvesting the catch, or "harvest services," and 2) the limited access or lease value which is created when only a limited number of individuals are granted legal access to a public resource. An ITQ system allows individuals the flexibility to harvest their annual share of the quota themselves, or to "lease" a portion or all of their harvest rights to others. Current lease prices for surfclams (as of mid-2001) are in the neighborhood of $6.00 per bushel.

Reported prices in fishermen's logbooks, however, do not specifically indicate whether a particular sale price includes the value of the lease, or not. If a vessel was fishing for a processor using allocation that was owned by the processor, then the vessel will receive a much lower price which reflects harvest services only (currently in the $5.00 - $6.00 range). If a vessel owns its own allocation, then the price for a good-quality bushel of Federal surfclams will be in the $8.00 - $13.00 range. Only the largest, premium surfclams fetch prices in the $14 - $15 range.

Prices for surfclams fell substantially from 1997 to 1998 under slack demand, causing the median price to drop from $12.00 to $10.00 per bushel. In 1999 the price continued to edge downward until stabilizing in the latter part of the year. The demand for surfclams increased in 2000 and continues strong into 2001, leading prices back up to the vicinity of $11.00 per bushel. A significant component of this trend is due to the widespread substitution of surfclams for ocean quahogs in the marketplace, which have become comparatively unattractive to harvesters because of their lesser value and increasing costs of harvest.

While many vessels will harvest both surfclams and ocean quahogs in a given year, surfclams have always been the preferred catch due to the higher price which they command. While meat yields can vary substantially with geographic location and from year-to-year, the standard government conversion factor is for 1 bushel of surfclams to yield 17 pounds of meats, and has been in use since the 1970's. For the smaller, less-desirable ocean quahog, the accepted standard is for 1 bushel to produce 10 pounds of meats.

2.3.1.2 Recent surfclam fishery performance

Coastwide landings of surfclams totaled 4.01 million bushels (bu) in 2000, an increase of 16% from the 3.46 million bushels landed in 1999 (Table 17). This continues a recovering trend which saw landings increase by 9.7% in 1999. The prior two years had experienced a decrease in landings of 5% and 11.2%. Reported exvessel value increased 22% in 2000 from $30.4 million to $37.1 million dollars. The improvement in the fortunes of surfclam fishermen is due largely to two factors: 1) the industry has been substituting surfclams for ocean quahogs as ocean quahog meats have become more expensive to produce, and 2) processors have had greater success in selling surfclam products relative to previous years. Industry has reported some success in marketing a thick, new "super-strip" product that is generated mainly from hand-shucked clams.

In recent years, surfclams have been harvested from four different jurisdictional areas: the Federal EEZ, and the State waters of New Jersey, New York, and Massachusetts. All but Massachusetts have established management regimes which include annual quotas and harvest limits for individual vessels. In 2000, quotas were fully harvested from New Jersey and Federal waters for the second time in years, while New York still retains a surplus.

2.3.1.3 The New Jersey inshore fishery for surfclams

New Jersey manages the largest state fishery for surfclams. According to their *Inventory of New Jersey surfclam (Spisula solidissima) resource* report (NJ Fish and Wildlife 2000) the total surfclam standing stock for New Jersey territorial waters from Shark River Inlet to Cape May in 1999 was 24 million bushels. The 1999 survey sampled 330 stations. The overall length-frequency distributions have not changed dramatically, but the mean shell lengths have been steadily increasing since 1993. The mean shell lengths of surfclams found in 1993 was 3.9 inches and has steadily increased to a mean shell length of 4.8 inches. The most notable difference was the lack of clams collected that measured less than 2.7 inches in the last several years. The majority of the resource is harvested from the territorial sea adjacent to the northern NJ assessment region, however in recent years the harvest from areas adjacent to the southern NJ region have increased dramatically for the first time since the early 1970s.

A constant annual quota of 600,000 bushels had been maintained for years until the 1999/2000 season, when the quota was increased to 700,000 (Table 18). New Jersey is unique in defining a season which begins in October of one calendar year and closes at the end of May in the next.

Many vessels in the New Jersey inshore fishery for surfclams also participate in the Federal fishery. For the recently completed fishing year (May 2001), none of the quota was left unharvested. The past three fishing years represent a significant improvement relative to the prior two seasons, which saw fully 22% of the quota unharvested each year. Fortunately, vessels experienced virtually no problems in selling their catches in the recently completed fishing year. There are 57 licenses for inshore New Jersey. Up to three licenses can be combined onto one vessel.

2.3.1.4 The New York inshore fishery for surfclams

New York inshore waters are divided into two segments: Long Island Sound and Atlantic Ocean waters out to three miles. While there are approximately 100 permits for the Long Island Sound area, the quantity of surfclams landed from that area is very small. With attractive shells of a golden-brown color, these surfclams are often harvested by hand, and sold fresh into sushi and premium bait markets.

The vast majority of New York State waters' harvest is from the Atlantic Ocean area, for which there are currently 23 moratorium vessel permits, held by 17 owners (Davidson pers. comm.). When a moratorium and quota management were instituted in 1994, there were a total of 25 moratorium vessel permits issued. Two of these permits were canceled for failing to meet the minimum harvest requirement of 5,000 bushels per year. (This requirement has since been repealed.)

The average catch from New York waters was approximately 173,000 bushels annually for the 20-year period spanning the 1970's and 1980's. Catches soared in 1990 with implementation of ITQ management in the Federal fishery, as surplus vessels sought alternative areas to fish.

Harvests peaked in 1993 at just over 850,000 bushels (Table 19), and have since trended significantly downward. As the market for surfclams began shrinking in the mid 1990s, the black, lower-yielding resource off New York's Atlantic coast most strongly felt the effects. As of

June 2001, more than half of the 23 vessel fleet had been idled since the beginning of the year (Davidson pers. comm.). Six vessels fishing for one owner and two for another owner were the only vessels that were consistently fishing. Many could be found either sunk, in a land fill, or tied to the dock for more than the past year.

The New York State Department of Environmental Conservation staffer who heads New York's surfclam program is Maureen Davidson. In a June 2001 contact she emphasized the fact that landings are below the annual quota for economic reasons related to the type of clams that are in greatest demand, not due to any problems associated with resource availability. The New York surfclam survey was completed in the summer of 1999, and there are "clams everywhere," an outcome which is similar to what their 1996 survey found. The 1996 estimate indicated there were 12.2 million bushels of surfclams in the 163 square mile area that is New York's Territorial Sea (Davidson pers. comm.). The 1999 survey data are still being analyzed, with the report yet to be finalized by State University of New York personnel, but preliminary estimates show a slight increase to 12.8 million bushels in the survey area.

A comparison of the landings for the first half of each year since 1994 indicates that landings are beginning to return to the levels experienced in the mid-1990's after the three year drop experienced between 1998 and 2000. Davidson (pers. comm.) indicates that fishermen are currently fishing hard and having little difficulty marketing the surfclams they catch.

In recognition of the difficulty which fishermen were having finding a market for their surfclams, in 1998 the State of New York waived the 5,000 bushel minimum harvest requirement (in order to maintain a moratorium permit).

2.3.1.5 Federal surfclam fishery

The Federal fishery for surfclams was conducted by a total of 31 vessels in 2000, a decrease of two vessels from the number participating in 1999 (Table 20). This number alone understates the decline in harvest capacity which occurred in 2000. The count of vessels in the larger size categories actually declined by 4 vessels (one Class 2 vessel and three Class 3 vessels). These departures were offset by the addition of two, small Class 1 boats, which only made modest harvests of surfclams off the State of Massachusetts.

For a broader perspective of how fleet capacity has changed over time, one may note that the 31 vessels operating in 2001 represent a 76% reduction from the 128 vessels reporting harvests of surfclams at the initiation of the ITQ program in 1990. The desired results of reducing overcapitalization and increasing efficiency in the fishery are readily observed by noting that the average annual catch per vessel in 1990 was 24,000 bushels, while in 2000 it surpassed 82,000 bushels per vessel. To the industry as a whole, this represents an enormous savings on the costs of maintaining vessels that were simply not needed to perform the function of harvesting the annual quota in the most efficient manner possible.

Virtually all of the 2.565 million bushel quota was harvested from Federal waters in 2000, repeating the performance of the prior year. The strengthened demand for surfclam products suggests the industry has largely overcome the marketing difficulties experienced in 1997 and 1998, when as much as 8% of the Federal quota was left unharvested on the ocean floor.

Exvessel prices inched higher in 2000, with a larger percentage of trips being reported at $10.00 per bushel than the year before. Verbal reports from industry members indicate that prices have increased further in 2001, climbing above the $11.00 per bushel mark.

A fleet-wide calculation of Landings Per Unit of Effort (LPUE) remained stable at 129 bushels per hour fished in 2000 (Table 20).

Harvests continue to be concentrated off the coast of New Jersey, with 51% of the catch coming from the "New Jersey Nearshore" (3973) degree square (Table 21). While average LPUE for this square did not change appreciably from 1999 for Class 3 vessels, harvests were down significantly when compared to the preceding years.

The second most intensively fished degree square is "Delaware - Maryland Nearshore (3874), supplying approximately 22% of the 2000 Federal harvest. LPUE from this area declined a surprising 29%.

A significant portion of the annual quota shifted from the largest, Class 3 vessels to the mid-sized, Class 2 vessels in 2000. Class 2 vessels have consistently reported higher catch rates than Class 3 vessels since 1992, however the opposite was true prior to that year.

Effort was spread across 2,041 individual trips, harvesting an average 1,255 bushels (39.2 cages) per trip.

2.3.1.6 Recreational or party and charter fisheries

There are no recreational or party and charter boat fisheries for surfclams and therefore there is no need to address these sectors or any animals released alive from them.

2.3.2 Ocean Quahog Fishing Activities

Note: Most of the following information was developed mainly for the 2002 quota recommendation specification package generated for the Regional Administrator. Most of the weights in the quota paper are expressed as bushels because that is what industry generally works in and thus most of the Tables and Figures are expressed in bushels rather than pounds or kilograms. The 31st SARC (Appendix 2) includes the most recent assessment of ocean quahogs and a description of the fishery also, but the weights in that document are expressed in metric. The standard conversion is 1 bushel equals 10 pounds of ocean quahog meats and 1kilogram equals 2.2 pounds. It is important to also note that section 2.3.3 describes in detail the port and community activities associated with this

fishery, while section 4 provides extensive economic evaluation of the alternatives as does section 5 for the social analyses of alternatives.

2.3.2.1 Overview

Traditionally, the dominant use of ocean quahogs has been in such products as soups, chowders, and white sauces. Their small meat has a sharper taste and darker color than surfclams, which has not permitted their use in strip products or the higher-quality chowders. With their lower exvessel price (typically less than $5.00 per bushel in 2000 for the full "lease plus harvest" value), ocean quahogs have historically been a bulk, low- priced food item. As in other fisheries such as Atlantic mackerel, the industrial ocean quahog fishery has only been viable when large quantities could be harvested quickly and efficiently. When catch rates fell below a certain point, vessels tended to shift their effort to higher-yielding areas.

As will be discussed in more detail in the following sections, there had been a shift toward greater utilization of the lower-priced ocean quahog meats in the years 1997 and 1998. Both years saw almost all of the ocean quahog quota harvested, while surfclam quota was left unharvested on the ocean floor. However this trend reverted back to the historical norm in 1999 as fuel prices spiked, and it became relatively more expensive to harvest ocean quahogs which are found farther offshore. Higher fuel prices combined with the increasing scarcity of dense ocean quahog beds have resulted in an overall decline in ocean quahog harvests. Industry focus returned to surfclams and they harvested nearly all of the Federal 1999 surfclam quota, while leaving 16% of the ocean quahog quota unharvested.

The trend became even stronger in the year 2000, which saw ocean quahog harvests (apart from Maine) plummet 16% to 3.161 million bushels, a level not seen in two decades. Again, the principal reason behind the fall is not a lack of demand, as demand is currently strong for both surfclams and ocean quahogs. The continued thinning of ocean quahog beds that have required decades to develop has combined with low dockside prices to the point where processors have great difficulty in convincing vessels to fish for them. Even a reported increase in price to between $6.00 - $7.00 per bushel in 2001 has been insufficient to spur vessels to direct substantial new effort toward ocean quahogs in the near term.

The larger vessels that make up the ocean quahog fleet currently average approximately 26 years of age. New or replacement vessels are likely to be required to maintain or expand future harvests.

2.3.2.2 Recent ocean quahog fishery performance

Landings of ocean quahogs from the high-volume fishery outside the State of Maine totaled 3.161 million bushels in 2000, a decrease of 16.2% from 1999 (Table 22). This fell on the heels of a 3.6% decline and 8.6% decline experienced in the preceding two years. Much of the earlier reduction was due to the Federal quota for ocean quahogs being reduced by 7% in 1998. Reported exvessel value declined 14.2% from $15.9 million dollars to $13.7 million in 2000.

2.3.2.3 Federal ocean quahog fishery

A total of 29 vessels participated in the 2000 fishery for ocean quahogs in Federal waters apart from Maine. Since 1996 there had been a dramatic exodus from the fishery, with the number of vessels falling from 36 to a low of 23 in 1999. Two of these vessels sank in weather-related accidents during January 1999, with the remainder leaving the fishery voluntarily. In 2000 the number of vessels willing to harvest ocean quahogs increased by an additional 6 vessels, however the average number of trips made by each vessel in the fleet declined markedly.

Of greatest significance is the fact that the 2000 harvest of ocean quahogs was the lowest in two decades, with fully 30% of the Federal quota left unharvested on the ocean floor. This compares with 16% of the quota unharvested in 1999. In 1996 and 1997 the quota had been binding on the industry, so the Mid-Atlantic Council recommended the quota be raised from 4.0 to 4.5 million bushels in 1999. None of this increase was tapped by the industry, and one can observe that landings have actually been on a declining trend from the 4.9 million bushel peak in 1992.

Industry members have reported that market demand for ocean quahog products remains strong. The decline in harvests is due to three principal factors:

1) The productivity of existing ocean quahog beds continues to decline steadily, as dense beds are fished down, and are not being replaced by new growth of this very long-lived species.

2) The harvest of ocean quahogs requires more fuel than surfclams, since they are located farther offshore. Fuel prices have increased substantially in the past two years.

3) The gradual consolidation of surfclam and ocean quahog quota onto fewer vessels in the fleet may have reached its' maximum point, such that increasing harvests may require new vessels. Even with the recent increase in the price of quahogs, investing over $1 million in a new ocean quahog vessel is seen as a risky venture. In the near term, if vessels are obliged to choose one species over the other to harvest, it appears that surfclams are proving to be the more profitable choice.

Processors are reporting difficulty in convincing vessels to increase their harvests of ocean quahogs.

Exvessel prices increased in 2000, with a larger percentage of trips reporting a price of $4.75 to $5.00 per bushel, compared to the $4.25 median price. Reports from industry members indicate that prices have continued sharply higher in 2001, reaching between $6.00 and $7.00 per bushel.

The total number of ocean quahog trips taken in 2000 declined by almost 13% from 1999. With the larger number of vessels making ocean quahog trips in 2000, it appears that the responsibility of satisfying ocean quahog demand is being borne by a larger percentage of the fleet. This increased sharing allowed the average number of ocean quahog trips made by each participating vessel to drop by over 30%.

A fleet-wide calculation of Landings Per Unit of Effort showed that the average yield continued its steady decline by 6.7% in 2000, from 119 to 111 bushels per hour of fishing (Table 23).

Harvests of ocean quahogs continue to be distributed over a larger geographic area than surfclams, although almost one-third of the 2000 catch came from the degree square off of eastern Long Island. LPUE for Class 3 vessels decreased 6% in this square, while the total harvest fell by 290,000 bushels compared to 1999 (Table 24).

Effort shifted somewhat from the area south of Block Island (4071) to below Martha's Vineyard (4070) in 2000, though LPUE values for these areas declined (Table 24).

Limits on the continued movement of the fleet eastward have been imposed by the closure of surfclam and ocean quahog beds east of the 69° line, due to the presence of PSP toxin. Vessels responded by pursuing ocean quahogs in the deeper waters further from shore.

2.3.2.4 Maine ocean quahog fishery

Amendment 10 (MAFMC 1998) fully integrated the historical Maine fishery into the Surfclam and Ocean Quahog FMP since the expiration of the experimental fishery on 30 September 1997. There was little known about the extent and abundance of the portion of the ocean quahog resource off of the coast of Maine, and because of this lack of knowledge Amendment 10 established an initial maximum quota for ocean quahogs caught in a zone of both state and Federal waters off the eastern coast of Maine north of 43° 50' north latitude. This initial maximum quota for this zone is not to exceed 100,000 Maine bushels, where 1 Maine bushel = 1.2445 cubic feet. Adjustments to the quota can be made in subsequent years within the range of 100,000 and 17,000 Maine bushels as part of the annual quota setting process. The moratorium is to be maintained until it is eliminated or replaced with an alternative management program in a subsequent amendment. It is the Council's intention that such a change would preferably be made in concert with a new assessment-based quota. The amendment established criteria for continued participation in this zone (north of 43° 50' north latitude) which requires that a vessel must have reported harvesting at least one bushel of ocean quahogs from this zone while participating at least once in the experimental fishery (October 1990 through September 1997). Vessels which had not participated in the experimental fishery or which had not landed at least one bushel of ocean quahogs from this zone during the past seven years, are eligible to fish in the State of Maine waters only or may use their ITQ allocation. Existing ITQ holders are permitted to fish within the EEZ portion of this zone as long as they use their ITQ allocation. All landings from moratorium permitted vessels and State of Maine only permitted vessels count against the initial maximum quota. Landings of ITQ allocation will not count against the initial maximum quota. All State of Maine only permitted vessels and all moratorium permitted vessels must land in Maine and comply with all the State of Maine landing laws. An ITQ vessel may land in Maine (and thus must comply with Maine laws) or may land outside of Maine, but must have the catch certified safe for human consumption through testing at facilities with a NMFS/FDA/state approved dockside Paralytic Shellfish Poisoning (PSP) testing protocol. The principal intent of the amendment was to allow the artisanal nature of this fishery to continue.

It must also be remembered that according to 50 CFR section 648.76 (2)(b)(iii): *All mahogany quahogs landed by vessels fishing in the Maine mahogany quahog zone for an individual allocation of quahogs under section 648,70 will be counted against the ocean quahog allocation for which the vessel is fishing.* In other words, even after the initial maximum quota of 100,000 Maine bushels is harvested from the Maine mahogany ocean quahog zone (north of 43°50'), vessels could obtain/use ITQ allocation and continue to fish in this zone. It is anticipated that some Maine fishermen will again rent ITQ allocation after the 100,000 bushel quota is reached in 2001 and 2002 as they did in 2000 when over 120,000 bushels were landed (Table 25).

Amendment 10 (MAFMC 1998) emphasized that there had been no comprehensive, systematic survey or assessment of the ocean quahog resource in eastern Maine. It also emphasized that a full stock assessment of the Maine resource should be a priority to ensure that this segment of the fishery would have a sustainable future. The initial maximum quota for the Maine zone was to remain in effect until a resource survey and assessment was completed. The agreement at the time of Amendment 10 was that the State of Maine was to initiate a survey once the initial maximum quota of 100,000 bushels became constraining. A representative of the Maine Dept. of Marine Resources (Mr. Chris Finlayson) initiated discussions with the NEFSC on the development of a scientific research survey in the spring of 2000. Unfortunately, discussions never developed beyond the initial contacts because Mr. Finlayson left the employ of the State of Maine. There is an effort within the State of Maine to initiate an ocean quahog survey in 2002.

Further description of the Maine fishery can be found in section 2.3.3.

2.3.2.5 Federal fleet profile of both surfclam and ocean quahog vessels

The total number of vessels participating in the surfclam and ocean quahog fishery outside the State of Maine increased by 2 vessels in 2000. This number somewhat overstates the case for increasing vessel capacity since it includes the addition of two, small Class 1 boats, which only made modest harvests of surfclams off the State of Massachusetts.

In addition to the overall trend of reducing vessel numbers through consolidating fishing operations on to fewer vessels, the current vessel count includes the loss of four vessels in weather-related accidents in January of 1999.

The major fleet shift which is apparent over time is the reduction in numbers of vessels participating in the fishery for ocean quahogs (Table 26). While the total number of vessels in the Federal surfclam and ocean quahog fleet declined 16% from 1996 to 1998 (from 56 to 47 vessels), that portion which participates in the harvest of ocean quahogs dropped by fully one-third over the same interval (from 36 to 24 vessels).

As discussed in earlier sections, this trend reversed slightly in 2000 as 6 additional vessels made trips for ocean quahogs outside the State of Maine. With the total number of ocean quahog trips taken in 2000 down by 13%, it appears that the additional vessels allowed the burden of supplying ocean quahog orders to be shared by a larger percentage of the fleet.

In the year 2001, the average age of a vessel participating in the Federal surfclam fishery was 23.9 years.

Newest vessel = Jersey Girl (14 years old - built in 1987)
Oldest vessel = Ocean Bird (34 years old - built in 1967)

Of those vessels participating in the Federal ocean quahog fishery, the average age was 25.7 years.

Newest vessel = John N (12 years old - built in 1989)
Oldest = Wando River (44 years old - built in 1957)

Federal surfclam and ocean quahog landings and quota for the past 22 years (1979 through 2000) can be found in Table 27.

2.3.2.6 Recreational or party and charter fisheries

There are no recreational or party and charter boat fisheries for ocean quahogs and therefore there is no need to address these sectors or any animals released alive from them.

2.3.3 Port and Community Description

Communities from Maine to Virginia are involved in the harvesting and processing of surfclams and ocean quahogs. Figure 40 shows the major localities and whether they are landing ports, sites of processing plants, or both. Ports in New Jersey and Massachusetts handle the most volume and value, particularly Atlantic City, Point Pleasant, New Bedford, and Cape May/Wildwood. There are also significant landings in Ocean City, Maryland, Warren, Rhode Island, and the Jonesport/Beals Island area of Maine. The Maine fishery is entirely for ocean quahogs, which are sold as shellstock for the half-shell market. The other fisheries are industrialized ones for surfclams and ocean quahogs, which are hand shucked or steam-shucked and processed into fried, canned, and frozen products. Processing plants are therefore major components of the fishery, and the communities in which they are found must be described as well as the port towns. Some of them meet the definition of "fishing community" found in the Sustainable Fisheries Act of 1996: "[t]he term "fishing community" means a community which is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such community." The following profiles of these communities and the counties in which they are found are arranged from northeast to southwest. They are based on government census and labor statistics and on observations and interviews carried out during the late 1990s (Hall-Arber *et al.* 2002, McCay and Cieri 2000) and in the fall of 2001.

2.3.3.1 Maine

The ocean quahog fishery of Maine accounted for over eight percent of the total value of Federal surfclams and ocean quahogs, although a much smaller percent of the weight, in 2000. It is a small-scale fishery of considerable importance within communities that have a very high economic, social, and cultural dependence on fisheries.

The ocean quahog fishery of Maine occurs north of 43° 50'. The fishery is located in the region of Downeast Maine, which includes both Hancock and Washington counties but is primarily concentrated in Washington County in the town of Jonesport and nearby Beals Island.

The Maine fishery differs markedly from the large-scale industrial EEZ ocean quahog fishery that occurs principally south of Georges Bank (Amendment 10 to the Fishery Management Plan for Atlantic Surfclam and Ocean Quahog Fisheries 1997). The typical vessel in the Maine ocean quahog fishery is a lobster-style hull ranging between 30 and 40 feet in length, far smaller than the 75-120 foot vessels used in other ocean quahog fisheries. The quahogs are harvested with a small dry dredge (limited to maximum 36" by state regulation). Unlike the industrial fishery, the Maine fishery targets small clams in the range of 1 ½ to 2 ½ inches. The quahogs are destined for the half-shell market rather than a processed product. Ocean quahogs are a golden-brown or "mahogany" color when found at these small sizes, therefore, in Maine they are often referred to as mahogany quahogs. This species, *Arctica islandica*, should not be confused with the hard clam, *Mercenaria mercenaria*, which is also referred to as quahog in New England.

The Maine ocean quahog fishery originally began in state waters in the 1970s as a summer supplemental fishery. However, starting in 1987, several areas in state waters have been closed due to paralytic shellfish poisoning (PSP). The fishery now occurs primarily in Federal waters. It was not until 1990 that the Maine "mahogany" quahog fishery was discovered to be harvesting the same species in Federal waters that is managed by the Mid-Atlantic Fishery Management Council through the Fishery Management Plan for Atlantic Surfclams and Ocean Quahogs. Between 1990 and 1997, the fishery was granted experimental status by the Regional Administrator until a suitable plan could be developed. In 1996, 82 vessels were licensed to participate in the EEZ experimental fishery.

Amendment 10 of the FMP (1997) established a moratorium on new entrants into the Maine EEZ fishery and established a Maine allocation of 100,000 bushels, to be managed separately from the rest of the ocean quahog stock. This quota is fished competitively by the limited number of Federally permitted vessels with a special Maine EEZ quahog permit. State landings also count against the quota. Once this collective quota has been reached, the fishery is shut down. Participants can lease additional quota from individuals or companies holding ITQ shares in the Mid-Atlantic region. Other vessels that do not hold the special Maine EEZ quahog permit but hold a State of Maine permit can fish in the Maine Territorial Sea, in areas not closed to fishing due to PSP or "red tide" concerns. In addition, vessels lacking the special Maine EEZ permit can participate in the Federal fishery if they lease or purchase allocation from the Mid-Atlantic ITQ holders.

2.3.3.1.1 Regional Description: Downeast Maine

The "mahogany" ocean quahog fishery takes place in the region of Downeast Maine. Downeast Maine is an important fishing area. Notable Downeast ports include Jonesport/Beals Island, Cutler, Eastport-Perry, and Lubec, in both Hancock and Washington counties. The ocean quahog fishery is primarily concentrated in Washington County.

Downeast Maine has a particularly high dependence on fishing (Hall-Arber *et al.* 2002). Over 500 individuals selected fishing as their primary occupation during the 1990 U.S. Census. At least that many more participated part-time in the industry. In truth, 500 is a very conservative number for those who fish as a primary occupation. Of the 17,858 people over 16 who worked in 1989 in Washington County, 1009 were employed in "agriculture, forestry, and fisheries" according to the U.S. Census 1990. Even the Federal 1997 permit files, which do not include most of the fishing vessels used in state waters, listed 218 vessels with addresses in Washington County. Furthermore, the State of Maine issued 556 commercial fishing licenses (held by 336 individuals) in Cobscook Bay alone in 1998. The largest number of these was for lobster/crab, but eel/elver, scallop, commercial shellfish, commercial fishing, sea urchins, marine worms, seaweed, mussels and ocean quahogs were also represented.

Unlike some other sub-regions in New England, no single port dominates the fishing scene in Downeast Maine. Communities in this region most closely fit the idealized model of a natural resource-dependent community, with a high degree of insularity and multi-generational dependence on fishing as a way of life. The isolation of Washington County has contributed to its dependence on the marine environment. In addition, this county is the poorest county in the New England region and the second poorest in the United States (Dyer *et al.* 1998). Nevertheless, generations of Downeasterners have lived close to the coast, using their skills, talent and regional knowledge to make a living from marine and other natural resources.

The geography and topography of the Downeast region have contributed to its uniqueness. For example, Cobscook and Passamaquoddy Bays are noted for their extreme tides and strong currents, which affect the gear needs and techniques used by local fishermen (Hall-Arber *et al.* 2002).

The region has seen many changes in the patterns of natural resource dependency. For example, during the 19th and early 20th century, the Cobscook Bay area boasted 40 sardine factories. With the demise of that lucrative industry, families turned to clam and sea urchin harvesting, lobster and other fishing, and salmon aquaculture. Blueberry harvesting and forest products (logs, pulpwood and wreaths) are the other natural resources the communities rely upon. However, increasingly, a variety of social, cultural, and economic factors result in less dependence on natural resources and some degree of coastal "gentrification." For example, the largest public employers in the Cobscook Bay area are the public service fields and light manufacturing. However, Downeast communities remain the most fishery-dependent communities of all the sub-regions in New England (Hall-Arber *et al.* 2002).

Like comparable communities in Newfoundland and Labrador in Canada, the small coastal communities of Downeast evolved as an economic response to fishing opportunities in the northern Gulf of Maine and the adjacent inlets, coves, and rivers of the region and the lack of alternatives. Consequently, the study of New England fishing communities (Hall-Arber *et al.* 2002) found that on the three "fishery-dependency" indices they used, it ranked first of all the New England's sub-regions, including other parts of Maine.

Reasons for such dependency on fishing and the vulnerability of the Downeast Maine communities to changes in fishing opportunities are several. The glacial till and wetlands that make up the region provide modest agricultural productivity. Maine's other great natural resource—pulp and wood products—that provides the economic base for some of the counties in the interior, traditionally required access to major waterways and railways. In Washington County, only Eastport had rail access, a factor distinguishing it from most of the coastal towns in Maine. Consequently, most of Downeast Maine depended heavily on marine and coastal natural resources, supplemented by some forestry-based work.
Fishing vessels from a variety of Downeast ports for many years traveled widely seeking groundfish and other species. It was a tremendous blow to the traditional "way of life" when prime fishing grounds just offshore were designated as Canadian under the 1984 decision by the International Court of Justice (known as the World Court) in The Hague, the Netherlands.

The region's proximity to Canada has been a mixed blessing. The loss of fishing grounds when the Hague Line was drawn was clearly a blow to the finfish-harvesting sector. In addition, Canadian processors provide stiff competition and draw some of the economic benefits of "value-added" processing away from Maine. On the other hand, access to a variety of marine suppliers and gear manufacturers relatively nearby makes the fishing industry of Downeast less isolated than it might otherwise be.

Today, the traditional dependence on the fishing industry is being transformed in some places by externalities of technology, economy, and culture (e.g. ecotourism), while in others, it remains essentially intact, with fishermen hoping that their sons and daughters can continue the fishing way of life. Understanding the dynamics of these processes of change is crucial for anticipating the impacts of changing fishing regimes on communities and households. Also, these processes do not confine themselves to the independent level of community, but also influence the regional networks of capital flows (Hall-Arber *et al.* 2002).

Two types of changes are occurring today. Some communities are beginning to display an economic mix characterized by a slow transformation towards modest tourism. Others, though retaining their dependency on fishing, are changing the nature of that dependency. Specifically, there is now a much greater specialization in lobstering rather than the more traditional mix of finfish fishing, fish processing, and shellfishing. Furthermore, in the border region with Canada, salmon aquaculture is developing as an alternative economy. Cobscook Bay is also the site of an effort to enhance shellfishing (especially clams).

Isolation is an historical factor, and is maintained in part by the lack of a major thoroughfare through the region. Only U.S. Route 1, along the coast, and Maine Routes 9 and 6 inland traverse Washington County. Some of the residents in sites like Cutler rarely leave their region, and reflect a cultural uniqueness born of their dependence on the natural resource opportunities presented by fishing the coves and coast of Downeast Maine.

The ocean quahog fishery

Thirty-three vessels with Maine ownership reported ocean quahog landings in 2000, a marked decline from the 82 vessels licensed in 1996. These vessels harvested approximately 120,000 bushels. This is more than the Maine ITQ allocation. The additional landings were possible through the leasing of allocation from other companies holding ITQ shares. Some informants indicate that leasing is essential to their business. This is especially true for those vessel owners who do not participate in other local fisheries and for vessel owners who are also dealers. Dealers must have a continuous supply to their markets or else their markets will look elsewhere for product. Others in the Maine fishery do not lease allocation from outside ITQ holders, because doing so represents a risk they feel they cannot afford to take. Leased allocation is relatively expensive and if not used by the end of the year is lost. A common alternative to leasing quota, many individuals rely on other fisheries (mainly urchins and scallops) when the Maine quota allocation has been reached.

Approximately 76 percent of the Federally permitted, Maine vessels that landed ocean quahogs in 2000 listed addresses in the towns of Addison, Beals Island, and Jonesport. The remaining vessels came from Machiasport, Roque Bluffs, Steuben, Winter Harbor, Columbia Falls, Harrington, and Cutler. In 2000, over two-thirds of the ocean quahogs were landed in Jonesport. Other towns with recorded landings in 2000 were Steuben, Addison, South Addison, Eastern Harbor, Beals Island, and Bucks Harbor (Figure 40).

Official statistics and published data on this fishery do not exist beyond permit lists and aggregate landings reports. Based on interviews done in November 2001, it appears that typical vessels are owner operated. However, some individuals own up to four ocean quahog boats. Some vessels are owned by dealers who hire captains to operate them. In general, each vessel has a crew of 3-4 men (including the captain). The crewmembers are generally hired locally. Some crewmembers come and go while others have fished for the same boat (or boat owner) for several years. In general, vessel owners do not have trouble finding good crew, but some report that when they find good, reliable crew, they do what they can to keep them. Many vessels also participate in other fisheries such as lobster, scallops, mussels, urchins, and periwinkles. Several vessels rely solely on quahogs, often because they do not hold permits in other fisheries.

In 2000, 9 dealers purchased quahogs. As expected, most of the dealers are located in or around Jonesport and nearby Beals Island. Other dealers purchasing ocean quahogs in Maine listed addresses in Machias, Cushing, Stonington, Brooklin, and Bucks Harbor. In general, dealers tend to rely on a few "core" vessels and purchase from other vessels on a sporadic basis. Owning vessels is another strategy utilized by several dealers. This ensures them a continuous supply to send to their markets. Most dealers also buy and sell a variety of other fishery products, such as lobsters, scallops, mussels, soft-shell clams, crabs, and periwinkles. Some companies handle only ocean quahogs. Generally, each dealer employs between 1-3 individuals (in addition to vessel crew).

Generally, the Maine ocean quahog is destined for the fresh, half shell market. The quahogs, therefore, are also trucked to markets, mostly outside of Maine. Some of the quahogs are sent to other dealers in Maine, but most are shipped out of state directly. Several dealers send trucks to different ports to pick up quahogs. There are several local trucking companies that ship the quahogs to market and some dealers also own their own trucks.

In Jonesport, the center of the fishery, there are four main wharves that handle ocean quahogs, including the public marina. However, several of these simply represent space leased out to vessel owners. The vessel owners hire their own crew and independently handle their own operations. Other vessel owners moor their vessels in other ports and land their vessels at the wharves utilized by the dealers to whom they sell.

2.3.3.1.2 Washington County

Washington County, the site of most ocean quahog activity, is Maine's easternmost county and thus squarely represents "Downeast Maine." Washington County consists of 2,528 square miles, with the county seat at Machias. The county's two cities are Calais and Eastport. The county had a population of 33,941 in 2000, a modest 3.9% increase from 1990 (Table 28). In 2000, 22.9% of the population was under 18 years of age and 17.3% of the population was 65 years of age or older.

In 1999, Washington County had a per capita personal income of $19,098, based on a 1997 model based estimate, 17.7% of the population was classified as living in poverty, compared with 10.7 percent for the entire state. In 1990, of the 27,264 persons 16 years of age or older, 3.7% were in the agriculture, forestry, and fisheries industries sector.

In 1997, 218 boats had Federal fishery permits with addresses in Downeast Maine. Most of the landings in that year were of lobster, ocean quahog, urchins, crabs, periwinkles and sea scallops. Other Washington county landings also included soft-shell clams, herring, sea cucumbers, worms, conch, bluefin tuna and small quantities of groundfish.

2.3.3.1.3 Beals Island and Jonesport, ME

In 1997, over half the Federally permitted vessels from Washington County listed addresses in Jonesport, Beals and Addison. In addition, the area boasts at least one source of each of the services needed by the local fishing industry. However, the local inhabitants are neither insulated from change nor trapped in an isolated outpost ((Hall-Arber *et al.* 2002).

According to the 2000 Census for Jonesport, the population was 1,408 (Table 29). In 2000, 97.8% of the population was white. In 2000, 21% of the population was under 18 years of age and 22.7% of the population was 65 years of age or older. Of the vacant housing units in Jonesport, 6.4% were used for seasonal, recreational, or occasional use.

The fishermen of Beals-Jonesport and Addison are now taking advantage of the wealth of lobsters, landing them year-round, though the highest landings are in the fall. Quahogs, crabs, clams, scallops and urchins are also actively fished.

Change is evident in the support sector. Boat building is a family tradition in the Jonesport/Beals Island area. When lobster boats were wooden, the traditional form evolved out of those boats built in this area. Generations of fishermen were also boat builders. Some names are famous and their boats recognizable. Now boat builders have switched to fiberglass, but they continue to build or finish boats in the winter.

Despite the small size of this area's population, it is by no means economically homogenous. Some of the fishing families, who are decedents of several generations of fishermen, are doing very well financially. Several have diversified their activities so that they can fish different species (some hiring captains to take out additional vessels) or have vertically integrated so that they obtain additional value for their catch by packaging and/or freezing, marketing, and trucking; it as part of the family's business. These fishing families also tend to have economic capital links that extend well beyond Beals-Jonesport-Addison.

Other fishing families maintain a more modest standard of living. Such fishermen tend to own and operate their own vessel, fish smaller numbers of traps, are less likely to have diversified into various forms of mobile gear fishing. Their economic capital links are more likely to be less diversified and closer to home than are those of the larger-scale fishing families.

While there is some rancor evident in discussions between the small-scale and larger-scale fishermen, there are unifying forces as well. The social capital and human capital links crosscut the economic differentiation. For example, high school sports, especially basketball, create one of the strong bonds among families in the area.

Also uniting the different fishing families is a concern about their children or grandchildren's ability to continue in fishing. While some say that it is too hard to make a living in fishing now and the regulations constrain choices too much, all key informants who fish love their occupation and would have liked to have been able to encourage their children to continue the tradition. In most cases, though, children are being encouraged to pursue an education and jobs out of the industry. This creates another worry—since there are few jobs in the area that are not dependent on the fishing industry, families must face separation.

Finally, another concern expressed by many of the families is the potential effect of an influx of people "from away." Real estate prices are beginning to reflect a higher demand and some fear the consequences.

Fishing community

According to the Sustainable Fisheries Act of 1996, "[t]he term "fishing community" means a community which is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such community." Because of their high dependency on fishing, both Beals Island and Jonesport meet the definition of fishing community (Hall-Arber *et al.* 2002). In addition, the minimum requirements of fishing community developed by the Atlantic States Marine Fisheries Commission's Committee for Economics and Social Sciences are also met (Hall-Arber *et al.* 2002). Specifically, fish are legally sold ex-vessel to a dealer, processor or the public; fishing support services are provided; there are public facilities providing dockage; fishing people satisfy their daily and weekly social and/or economic needs here, and some fishermen and their representatives participate in fisheries resource management. People of Beals Island and Jonesport recognize and act upon the critical importance of fishing to their communities.

Harvesting structure

Lobstering dominates fishing on Beals Island year round. Ocean quahogs were second in landings recorded by NMFS (1997) data. Mussels are also important. Both dragging for wild mussels and bottom culture, in which case wild seed is dragged, dumped and harvested later.

Most of the vessels tend to be in the 40-50 foot range, but beamy. "We don't have the docks, facilities or depth of water to take real large boats . . . the moorings couldn't hold them" (Hall-Arber *et al.* 2002).

Processing structure

According to Hall-Arber *et al.* (2002), one local processor-dealer handles lobsters, crabs, soft-shell clams, and scallops depending on the season and their availability. Whelks were not available in 1997 due to problems with red tide. Product for processing is purchased wherever it's available. Two buyers work out of Milbridge and Cutler.

Ten jobs are provided year round; August to November, up to 60 people are employed. Ninety-five percent of the workers are from Beals, Jonesport and Jonesboro. Few people in Washington County have one full-time job; most work in different fisheries or even different occupations at various times during the year.

When the company began, it was handling primarily live seafood; now it freezes product for sale anywhere in the U.S. Large food service companies purchase the frozen product. Live product is sold primarily in Maine and Massachusetts.

Support services

A Jonesboro trucking company transports frozen seafood for local processors. Fish is offloaded and sold in Jonesport or in Portland, lobsters in both Beals and Jonesport; fuel and air (for divers) is available in Jonesport, boat repair is locally available, fishing gear is available in both Beals and Jonesport. Bookkeeping is often done by spouses, but some consult accountants in Bangor for income tax filing.

Employment (year-around and seasonal)

While estimates varied about the numbers of fishermen, it was generally agreed that 50 to 75 percent of the people in the area are directly dependent on the industry, the rest indirectly. "If fishermen don't do well, no one does well." Informants estimated there are 1,000 fishermen in the Downeast region (1999) (Hall-Arber *et al.* 2002).

Off-season jobs may include carpentry, boat building, welding, mechanic, finfishing, digging for clams or "winkles," blueberry and/or cranberry-picking, tipping and wreath-making, and snow-blowing. Security guard work, teaching and nursing are alternative occupations. A few people go into Ellsworth to work (over 50 miles). The Columbia Falls radar station employs some people, and services such as grocers, automobile sales, bowling alley and movie theaters provide additional employment.

Species and seasons

Although there are lobster landings year round, landings tend to peak in October, with high volumes also in September and November. Ocean quahog fishing occurs year round. Quahog landings in Beals are highest in May and June, with significant volumes in January through March. Digging clams or marine worms is common in spring, summer and fall. In the fall and winter, picking periwinkles off the ledges, dragging for scallops, diving for urchins, keeping lobster pounds provides fishing and/or fishing-related income.

Federal data for Jonesport shows landings of rock crab, lobster, ocean quahog, periwinkles, sea scallops, urchins, and a small quantity of groundfish. "Winkles" (periwinkles) are sold in town to a buyer who transports them to Boston or New York. Ultimately, they are sold as "bar food."

Pollock was the principal groundfish landed before marine mammal protection measures forced gillnetters to change gear and before the market shifted in 1996 and supply contracts to the US government shifted to the West Coast (Sheehan and Moore 1998). However, cod, white hake, haddock and cusk were also regularly caught.

2.3.3.2 Massachusetts

The Federal surfclam and ocean quahog fishery in Massachusetts is located mainly in New Bedford (Bristol County), the site of shucking plants and offloading docks, but there is also some activity in the towns on the north side of Cape Cod. Massachusetts also has a state surfclam fishery, within 3 miles, that is regulated with a day limit of 200 bushels and a trip limit of 400 bushels, equivalent to about 12.5 cages. Bags are used instead of steel cages to offload clams. According to respondents, only a few boats are fishing the inshore clams even though they are of good quality.

2.3.3.2.1 Bristol County

According to the 2000 Census, Bristol County had a population of 534,678. This was a 5.6% increase from 1990. Ninety-one percent of the county population was white and of the total population 24.6% were under 18 years of age and 14.1% were 65 years of age or over. In 1999, Bristol had a per capita income of $27,461. Based on a 1997 model based estimate, 11.9% were living below the poverty level (Table 28)

In 2000, the unemployment rate was 3.9% and seasonally the rate ranged from a high of7.2% to a low of 3.9%. In 1990, of those 16 years of age or older, 1.5% of the total number employed were engaged in the agriculture, forestry, and fisheries industry.

2.3.3.2.2 New Bedford

New Bedford is a major deep-water port. Taunton, the county seat, lies about 27 miles from New Bedford. The area is highly developed, with a complex system of highways and public transportation, a waterfront with sections of industrial and leisure uses, hospitals, libraries, schools and all of the amenities and challenges of an old city. In addition to its port facilities, New Bedford has a municipal airport, major highways, rail, and bus service. A ferry service runs daily between Cuttyhunk and New Bedford. Increased service to Martha's Vineyard has recently been approved (Hall-Arber *et al.* 2002).

New Bedford's census profile is that of a struggling industrial port (Table 29). According to the 2000 Census, New Bedford had a population of 93,768, a 6.2% decrease from 1990. Eighty-three percent of the population was white and of the total population 34% was under 18 years of age and 16.7% was 65 years of age or over. In 1990, New Bedford had a per capita income of $10,923 and of the total population 16.8% were classified as living below the poverty level.

In 1990, the unemployment rate was 12.2%. Of those 16 years of age or older, only 1.3% of the total number employed were engaged in the agriculture, forestry, and fisheries industry, suggesting that the fisheries are marginal to the community. However, more extensive research shows that between 5 and 8 percent of the people in the New Bedford metropolitan statistical area receive their livelihoods primarily from fishing. Even a conservative estimate, assuming two other individuals are supported by each fisherman and fishing-related worker employed, places the proportion of the population dependent on fishing between 11 and 18% (Hall-Arber *et al.* 2002).

Fisheries

New Bedford's long history as an important commercial fishing port spans from 18th century whaling to the current economic boom associated with scallop harvesting. Fishing and allied industries still contribute one-fifth of the city's income. New Bedford remains one of the three premier fishing ports in New England and it is consistently numbered among the top U.S. ports for the value of its commercial fishery landings, number 1 in the year 2000. Its highly differentiated fishing infrastructure was developed early in its history and has continued to grow (Hall-Arber *et al.* 2002).

In recent years New Bedford has emerged as an important site for ocean quahog fishing, but its dependence on ocean quahogs is minor compared to the large quantities and value of scallops and groundfish landed and processed in the area. In 2000, the value of ocean clams landed in New Bedford (almost all ocean quahogs) was less than 4% of the total value of commercial fishery landings of 146.3 million dollars in New Bedford for that year. It ranks as the top port in New England for total landings and value of landings.

Of all major groundfishing ports in the eastern U.S., New Bedford and environs, including neighboring Fairhaven, has the most developed infrastructure for fishing, together with Portland, Maine and Chatham, MA (Hall-Arber *et al.* 2002). It has the most total capital invested in the fishing industry and the largest fleet of any port. According to one report (Hall-Arber *et al.* 2002), in the late 1990s there were a total of 1,131 crew manning 265 vessels. Of these, 82 are scallopers, typically with 7 member crews, and 183 were draggers with average crew size of four. There are also smaller lobstering and gill-net boats. In contrast, in 2000 there were only 9 New Bedford-based vessels engaged in ocean quahogging in Federal waters, with crews of four-to-five. (Some uncounted) smaller vessels were also engaged in surfclamming in state waters. In addition, digging for hard shell clams is a small niche fishery in the area.)

Estimates of the numbers of fishermen vary. Crew sizes on scallop and groundfish vessels have diminished in the past few years, partly due to regulations (e.g., scallop boats are restricted to 7 crewmembers). Consultants in a 1999 harbor planning process identified 2,600 jobs and $609 million in sales directly attributable to the core seafood industry. Another 500 jobs were indirectly related, as was about $44 million in sales (Hall-Arber *et al.* 2002.).

In addition to boat owners, captains, and crew, the full New Bedford/ Fairhaven fleet (neighboring Fairhaven is the home of many of the vessels) generates business for around 75 seafood processors and wholesale fish dealers and 200 other shoreside industries. Together, these businesses provide employment for around 6,000 to 8,000 additional workers (Hall-Arber *et al.* 2002).

Surfclam and ocean quahog fishery

The City of New Bedford attracted ocean clam businesses during the 1990s with generous tax packages as part of its attempts at economic redevelopment. A major goal was the creation of new local jobs as well as becoming a food processing "cluster." However, one planner interviewed for this project expressed disappointment in the commercial fishing industry in general and in one of the clam processing plants in particular. This disappointment stemmed from the plant's alleged failure to fulfill a promise to hire locals for the production line in exchange for favorable tax package guaranteed to the plant's former owners. Many of the workers, generally Hispanics, come from Providence, Rhode Island rather than New Bedford. The planner also expressed concern over clamshell disposal, which is a problem for all clam-processing plants.

There are three surfclam and ocean quahog processors located in New Bedford. The largest also has plants in Delaware and Maryland. A large Japanese seafood company owned it until 1999, when it was bought out by its management and merged with a New Jersey-based firm, which already owned many vessels. It is now a vertically integrated firm. Its web site claims 40 vessels and the status of the nation's largest supplier of clams in branded canned and frozen products. According to a plant manager, New Bedford has the largest volume and capacity for clam shucking on the East coast. The shucking plant, which began in 1995, does not own any boats per se, but it has a large ITQ allocation used with boats that fish for them in New Bedford. In November 2001 there were 8 boats fishing for this company in New Bedford, two of which also dock in Rhode Island. This plant is the only one in New Bedford with a pre-treatment wastewater facility. Ninety-five percent of their business is ocean quahogs. Surfclams are trucked in from the New York State fishery; this is about 5 percent of their business. All of the shucked product from this plant is shipped to other plants for further processing: mainly to its plant in Delaware or a plant in New Jersey. There is also a "co-packing" arrangement with another plant in Virginia.

The plant employs 75-80 people, not counting the captains and crews of boats. About 65 of the employees are contract laborers, mostly from Providence, RI, who travel in daily for work. Their employment is handled by a leasing agency, and plant managers know little or nothing about the pay or other conditions of employment. However, providing steady work is recognized as critical to maintaining reliable, talented workers. Among the competing employers are landscaping firms in the spring and cranberry farms in the fall.

Hand shucking of surfclams takes place at a plant purchased by a Rhode Island company in 1994. Their New Bedford plant is a hand shucking plant for the production of high quality chopped clam meat and specialty clam items such as clam strips. About 40 people are employed, approximately three-fourths of them women. Fifty to sixty percent were born in the U.S. They are said to be long-term employees with low turnover. Another plant was established in New Bedford in 1998, trying to create its own niche within the growing market for hand-shucked clams by offering a specialty cold hand-shucked product as well as value added products.

In 2000, nine vessels active in the Federal ocean quahog fishery listed New Bedford as their principal port, of which 7 listed New Bedford as their homeport as well. The other two listed Philadelphia as their homeport. In fact, several of the New Bedford boats, owners, and many of the captains and crew have roots in New Jersey. In 2000, New Bedford had the highest ocean quahog landings and value of any port.

Wholesalers and other support services

Vessel maintenance and repair facilities, equipment manufacturers and retailers and other suppliers (food, ice, fuel, oil, etc.) of the fishing fleet are also important employers. There are between 6 and 10 marine suppliers, three or four major ice suppliers, and at least four diesel fuel suppliers. In addition, an auction, dealers, 50 processing plants, and 12 trucking firms provide significant fishing-related employment (Hall-Arber *et al.* 2002). Although the surfclam and ocean quahog industry is relatively small, it does contribute to these services because all maintenance is done locally, utilities, electricity, water, and sewer and locally purchases; local employees spend in the area, and plants pay for the use of the land.

There is a maritime freezer company, an ice company, fuel and freight companies, boxes and other packaging manufacturers, truck rentals and temporary agencies in New Bedford—all of whom supply the fishing industry at times (Hall-Arber *et al.* 2002).

Ethnicity in the fisheries

Besides the Guatemalan and other Hispanic immigrants in the processing sector and Portuguese-American identity of some managers, the surfclam and ocean quahog industry in New Bedford does not support any particular ethnic group. This is in sharp contrast with the groundfish sector of the fishing industry, which is marked by a high degree of Portuguese identity and cultural and linguistic affiliation (Hall-Arber *et al.* 2002).

Kinship, family, and labor recruitment

Kinship and family ties do not seem to pervade the harvesting of surfclam and ocean quahogs the way they do in groundfishing. Harvesting ocean clams seems to have more in common with scalloping. According to Hall-Arber *et al.* (2002), it is more common to find family members fishing together on groundfish vessels than on scallop vessels. However, there are important ties of blood and marriage among the owners of surfclam and ocean quahog vessels and ITQ allocations, and there are families with generations of engagement in this fishery, even though it is unusual for family members to be actually working together on a boat. Owners are not often captains; the captains have responsibility for putting together their crews of first mate and two to four deckhands. In New Bedford, some of the captains and crew of the ocean quahog vessels commute from New Jersey or as far south as Virginia, a few including the owners of some of the vessels have moved to New Bedford, and the rest are local. Hiring reliable crew is a significant problem compounded by substance-abuse problems, some of which have been made public in National Transportation Safety Board and Coast Guard inquiries into the sinking of the New Bedford-based ocean quahogger Cape Fear and loss of 2 crew in January 1999.

Fishing-related programs and services

Many fishermen in New Bedford belong to ethnically defined and well-established social and cultural groups. Fishermen's wives associations and commercial fishing unions and other organizations provide social, economic and professional support to members of the industry by promoting social programs and marketing species (Hall-Arber *et al.* 2002). These have little to do with the surfclam and ocean quahog fishing industry.

Community support

The mayor of New Bedford is given credit by clam industry personnel for helping make New Bedford the top-producing port in the United States. Conflicts between tourism and industry are affecting some parts of New Bedford, but the surfclam/ocean quahog industry is in the North Terminal area, quite distant from the historic section and South Terminal where the odors and other by-products of commercial production become nuisances and can lead to costly restrictions.

Fishing community

While the city has consistently made an effort to diversify its economy, the Chamber of Commerce said in 1997 that 60% of the city's economy was based on fishing, an argument for considering New Bedford "substantially dependent"on the fisheries and thus a fishing community under National Standard 8. There is no question that it meets the criteria of the Atlantic States Marine Fisheries Commission: fish and shellfish are legally sold ex-vessel to a dealer, processor or the public; fishing support services are provided; there are public facilities providing dockage; fishing people satisfy some or all of their daily and weekly social and/or economic needs here, and some fishermen and their representatives participate in fisheries resource management.

2.3.3.2.3 Barnstable County

Some landings of Federal surfclams also take place in Barnstable or in Barnstable County, mostly from grounds on the northern side of Cape Cod. The boats involved in 2000 were said to have Wellfleet, MA and Tiverton, RI as their principal ports, and they sold to one of the New Bedford-based processors. Their surfclam landings amounted to less than three percent of the total value of all fish and shellfish landings reported from Barnstable Town or "Other Barnstable."

The Town of Barnstable includes seven villages within its boundaries. Each village has unique and significant cultural and historical qualities. Barnstable proper is located on the north side, which houses the County Complex and has a working harbor and several small beaches. The other villages are primarily residential, with beaches, inlets, and harbors for fishing and boating (http://www.state.ma.us/dhcd/iprofile/020.htm).

2.3.3.3 Rhode Island

Rhode Island is the home of two surfclam/ocean quahog processing plants—one at Bristol and the other at Warren, and two or three vessels are also docked at Tiverton and Warren. In "New England's Fishing Communities" (Hall-Arber *et al.* 2002), Rhode Island is described as a region characterized by diversity in both cultural and biophysical capital. Features include the coastal area of Eastern Long Sound, the complex shoreline and inlets of Narragansett Bay, and the tidal-riverine system of Sakonnet Point and Tiverton. The two main commercial fishing ports of Rhode Island are Point Judith and Newport. Warren and Bristol are among the upper Narragansett Bay ports, in an area known as "East Bay."

The upper Bay is the home of some 12 small (up to 40 feet) bay draggers and about 30 bay lobster boats that are not concentrated in any one location, but are scattered in small clusters in Kent, Providence, and Bristol Counties along the perimeter of the upper bay. These boats in aggregate rank third in importance in this sub-region (Hall-Arber *et al.* 2002). This has not always been the case. Upper bay ports such as Warren and Bristol were very important up to the 1940s when the oyster population of the bay was still healthy. In recent decades, with the decline of the bay finfish stocks, the number of bay draggers has declined to its current level and they are dispersed along the perimeter of the bay. There are no state commercial fishing dock facilities in the upper bay as there are in Point Judith and Newport, RI, so the boats must tie up in private marinas or other private facilities. The vast majority of fishermen in the upper bay are bullrakers who fish from skiffs for quahogs (*Mercenaria mercenaria*). This fishery is managed by the State of Rhode Island. The number of bullrakers is known to vary inversely with general economic conditions. As of 1997 there were approximately 300 licenses for this shellfish industry.

According to Hall-Arber *et al.* (2002) there are two ocean clam boats in the upper bay that tie up in Warren as their market dictates (the boats move to the market), although our interviews in 2001 indicate that there is usually only one. There are several herring boats and vessels that target under-utilized species (e.g., mackerel) that work from docks at Quonset Point (Davisville). There are perhaps as many as a dozen boats from other ports, both inside and outside of Rhode Island, that target species in the Bay from time to time.

Dockage is the problem in the upper bays as it is in Jamestown, Newport and Point Judith. This problem is related to gentrification and competition for waterfront land and space, including parking and gear areas.

Rhode Island fishing communities are among the most "gentrified" in New England, many with long histories of tourism focusing on water sports, sailing, and summer "cottages." Tourism is said to be pushing the fishing industry into the economic background as these ports become increasingly gentrified. For example, Bristol, the site of one of the ocean clam plants, is far better known as a yachting port, the home of the Herreshoff Marine Museum and America's Cup Hall of Fame, and the first town to celebrate the Fourth of July. Commercial fishing is thus relatively insignificant in context, with the exception of the port of Point Judith, which remains among the top ports of the U.S.

2.3.3.3.1 Bristol County

According to the 2000 Census, Bristol County had a population of 50,648. This was a 3.7% increase from 1990. 96.8% of the county population was white and of the total population 22.9% were under 18 years of age and 16.7% were 65 years of age or over (Table 28).

In 1999, Bristol County had a per capita income of $33,901. Based on a 1997 model based estimate, there were 6.9% classified as living below the poverty level.

In 2000, the unemployment rate in the county was 3.3% and seasonally the rate ranged from as high as 5.4% to as low as 2.8%. In 1990, of those 16 years of age or older, 1.9% of the total number employed were engaged in the agriculture, forestry, and fisheries industry.

2.3.3.3.2 Bristol

Bristol has a rich colonial and revolutionary war history. It was a major sailing and shipbuilding port, engaged in the slave trade and privateering. It is the home of Roger Williams University, the Marine Museum and America's Cup Hall of Fame, as well as historic homes and gardens, which make it a popular tourist destination. Yachting dominates the waterfront.

According to the 2000 Census, Bristol City had a population of 22,469, a 3.9% increase from 1990. 97.1% of the population was white and of the total population 19.6% was under 18 years of age and 17.7% was 65 years of age or over. In 1990, Bristol had a per capita income of $14,108 and of the total population 5.8% were classified as living below the poverty level (Table 29).

In 1990, the latest date for which information is available, the unemployment rate was 7.2% and of those 16 years of age or older, 1.6% of the total number employed were engaged in the agriculture, forestry, and fisheries industry.

There is a small surfclam processing plant in Bristol. It is a hand-shucking business that employs about 11 skilled people in the front office and management, and about 30 semi-skilled shuckers and pickers. The shuckers are almost always men and the pickers are women; they are mostly Hispanic. As is typical in the industry, the semi-skilled employees are paid on a piecework basis. It is one of the plants that has no ITQ allocation and no vessels of its own and thus appears very vulnerable to changes in the industry and the regulatory system. Like other small hand-shucking plants dependent on large surfclams, this one has difficulty obtaining raw product and hence running the plant at full capacity. It is currently dependent on one local boat and a contract with a New Jersey firm.

2.3.3.3.3 Warren

Warren, RI, is the site of seafood packing and processing company and the homeport of one surfclam/ocean quahog vessel. It is a small East Bay town, only 6.2 square miles, but has 11 churches, more than 30 restaurants, and numerous family-owned businesses. After the Revolution, it was a center of shipbuilding, maritime trades and whaling. Industrial mills and factories began in the mid-1800s, creating an ethnically diverse population, with large numbers of French Canadians, Italians, Portuguese, Poles, and Irish. Industries have declined, although a shipyard that specializes in cruise ships remains. Sailing and other water sports are important, and Warren has become a center for antiquing.

According to the 2000 Census, the Town of Warren had a population of 11,360, a 0.2% decrease from 1990. Of the total population 21% was under 18 years of age and 17.9% was 65 years of age or over (Table 29). In 1990, the latest date for which information is available, the unemployment rate was 8.1% and of those 16 years of age or older, 0.1% of the total number employed were engaged in the agriculture, forestry, and fisheries industry.

The clam fishery in Warren is tied to a family-owned processing and marketing business begun in 1946. The company has diversified beyond surfclams and ocean quahogs and related products (chowders, soups, and sauces) to include mussels, calamari, and New Zealand littleneck clams. It operates production facilities in Bristol, Rhode Island, and New Bedford, Massachusetts, a distribution center in East Providence, Rhode Island, and participates in two joint ventures involving production operations in Iceland and New Brunswick, Canada.

The company owns one surfclam vessel, the only large fishing vessel in town. The vessel employs 8 long-term employees on two shifts. Commercial fishing is very marginal in Warren, and the other fishing operations are mostly small-scale bay clammers. The facility is at the edge of an historic district on the Warren waterfront that goes back to the mid 1800s, and it therefore suffers from some "nuisance" complaints. The company also owns 4 other vessels that are leased out and work from other ports. They buy product from 6 boats on Long Island, 12 in New Jersey and 1 in Rhode Island. The processing plant in Warren employs about 140 people, 90% of whom are long-term employees rather than transients. About one half are women, and about 90% were born in the U.S. A major concern is the low inventory of product in the business, the short supply of surfclams, and the consequent use of ocean quahogs as a substitute, with effects on the markets.

Tiverton had a population of 15,260 in 2000, of whom 22.1% were under 18 years, and 16.5% 65 years and older; 98% stated that they were white. The population had grown by 6.6% since 1990. Only 3% of the living places were for seasonal use. 1989 per capita income was $14,839, and 1.1% of the civilian labor force was in agriculture, forestry, and fisheries in 1990. 5.2% lived below the poverty level in 1990.

2.3.3.3.4 Tiverton

Several ocean clam boats are reported as using Tiverton, Rhode Island, in Newport County, as their principal port. However, their landings are typically in other ports.

Tiverton is on the Sakonnet River, across the state line from Fall River, Massachusetts. It had cotton and woollen mills as early as 1827 and a menhaden oil factory until about 1900. Today the economy is based on trade and its growing importance as a summer resort and residential area.

2.3.3.4 New York

In 2000 no Federal surf clams or ocean quahogs were landed in New York ports. However, at earlier periods of the 1990s significant quantities were landed there, albeit from New

Jersey-based vessels, and a state-waters fishery continues. The one important clam processing plant, in the Freeport area, no longer handles Federal clams, and therefore asked not to be included in the study.

2.3.3.5 New Jersey

New Jersey has been the center of the surfclam and ocean quahog fisheries for many years. The surfclam industry began on Long Island in the 1940's but then shifted to New Jersey. In the late 1970s, again responding to changes in surfclam abundance, the industry shifted farther south, to waters off the Delmarva peninsula (Delaware, Maryland, Virginia). As surfclam stocks recovered, the harvesting sector has also moved north, back to waters off New Jersey and New York, although some processing plants remained in the south, particularly on the Delmarva peninsula. The ocean quahog industry began in New Jersey; it too has moved around, particularly to the north, with the establishment of operations in New Bedford.

New Jersey's inshore surfclam fisheries, within 3 nautical miles, remain an important adjunct to Federal water clams for many of the vessels in the surfclam fishery. The state fisheries are managed independently, as a winter fishery (providing more sheltered opportunities) with weekly and seasonal boat limits that are not full-fledged ITQs but have some elements of transferability, allowing vessel owners to combine the allocations of two or more boats on one permit. The vast majority of vessels in New Jersey's State fishery are also in the Federal fishery for surfclams.

Several New Jersey ports are central points of intersection between harvesting and processing for both Federal and state water fisheries. Point Pleasant Beach, Atlantic City, Wildwood, and Cape May have long and complicated histories in this regard, including changed fortunes of clam processing firms associated with these ports. Ocean quahogs and surfclams are landed at docks in Wildwood and Cape May (Cape May County), Atlantic City (Atlantic County), and Point Pleasant (Ocean County). Currently, important first-level processing plants (shucking, canning, and/or freezing) are located in Lower and Middle Townships (Cape May County), Port Norris and Millville (Cumberland County), and Point Pleasant Beach (Ocean County). Secondary processors, mainly large food processors that include lines of clam chowder, are also in New Jersey. Although important, they are not part of this report.

2.3.3.5.1 Ocean County

Point Pleasant Beach, northern Ocean County, is the site of surfclam and ocean quahog harvesting as well as a small processing plant. Ocean County is a long, large county the coast of which is dominated by seasonal tourism and commuter and retirement home developments. The commercial and recreational fisheries of Ocean County have very long histories of being ensconced in complex communities. A century ago, the barrier beach communities of Ocean and neighboring Monmouth County were referred to as the "Riviera of the Atlantic" because of the early development of elegant hotels and homes along the beaches, which the fishing communities supplied. Today Ocean County is more often called "The St. Petersburg of the Northeast" (Sokolic, 2001). It has the largest retirement communities in the state.

The total population in Ocean County was 510,916 in 2000 (Table 28). This was an 8.6 percent change from 1990. In 1990, only 20.4% of the population was rural, and less than 1% lived on a farm. Ocean County has grown rapidly from coastal tourism, retirement community development, and general suburban expansion within the NY-NJ Metropolitan Area. The population is ethnically diverse: in 2000, the white population was 65.9% of the total. Twenty-three percent of the population was under 18 years of age and 22.2% was 65 years of age or older. According to the 2000 census, the median age in Ocean County of 41 years is second in New Jersey only to that of Cape May County, 42.3 years.

In 1999, Ocean County had a per capita personal income of $27,694. Based on a 1997 model based estimate, 7.8% of the population were classified as living in poverty, compared with 9.3% for the state as a whole. In 2000, 3.9% of the population were unemployed. In 1990, of the employed persons 16 years of age and older, 1.5% were in the agriculture, forestry, and fishery industries sector.

2.3.3.5.2 Point Pleasant Beach

The town of Point Pleasant is located at the mouth of the Manasquan Inlet, where Ocean County borders on Monmouth County. The town's economy is geared toward the summer tourist and recreational business, as shown by the fact that according to the 2000 census, 72.8% of the vacant housing units in the area were used for seasonal, recreational, or occasional use (Table 29). However, it is more than a "beach town", and has a large resident population. The fisheries are concentrated in an area known as Channel Drive, in Point Pleasant Beach, a sandy strip on which are found restaurants, a fisherman's supply store, small marinas, charter and party boat docks, and two large commercial fishing docks as well as several smaller ones. As of 2001, there is one main dock utilized by surfclam and ocean quahog boats as well as a small hand-shucking operation.

According to the 2000 Census for Point Pleasant (and Point Pleasant Beach), the population was 24,620, a 5.7% increase from 1990 (Table 29). In 2000, 97.42% of the population were white, 22.7% were under 18 years of age, and 15.8% of the population was 65 years of age or older.

In 1990 in Point Pleasant Borough, the per capita income was $18,770. In 1990, 4.5% of the civilian labor force was unemployed. In 1990, only 0.9% and 0.3% persons 16 years of age or older were in the agriculture, forestry, and fisheries industries sector in Point Pleasant Borough and Point Pleasant Beach, respectively, reflecting the fact that the people who fish in these places do not, by and large, live in them. This is a typical feature of the fishing ports of the Mid-Atlantic, raising the question of how to define the fishing communities.

The fisheries

Point Pleasant is primarily an ocean fishing port, with a long history involving ocean pound-nets and otter trawl and gillnet fisheries, as well as sportfishing, focusing on the nearshore wrecks and the offshore "canyons" of the New York Bight. In terms of landings, the commercial fisheries of

Point Pleasant rank third in New Jersey to those of the Cape May-Wildwood area and Atlantic City.

Like so many ports of the Mid-Atlantic region, the port of Point Pleasant Beach is inlet-dependent. Ocean-going fishers must pass through the often dangerous Manasquan Inlet, a challenge shared with the recreational fishing community including the party and charter boat businesses of Point Pleasant and neighboring Brielle, in Monmouth County. This is a highly developed coastal region. Currently, there is a wholesale finfish packing dock and seafood retail store at Point Pleasant run by a fishermen's cooperative. Another dock is primarily used for offloading surfclams and ocean quahogs although finfish may be handled there as well. A dock once used for pelagic tunas and swordfish is now being used by a lobster boat.

The fisheries of Point Pleasant are very diverse, the classic situation in the Mid-Atlantic. Two stand out in terms of volume and value: otter trawls and gillnetting, the latter particularly important for spiny dogfish as well as bluefish, weakfish, and other species. But sea scallop dredging is very important, as are surfclamming/ocean quahogging and offshore lobstering. In terms of pounds landed, menhaden (purse-seined) and surfclams and ocean quahogs were the leading species in 1998, having come to replace the traditional otter trawl finfish fishery in importance over the past decade (McCay and Cieri 2000).

A fishermen's cooperative owns two waterfront properties, one for storing and working on gear and some dockage, the other including the coop's offices, gear storage, ice-making, packing house, and a retail store with a small café. The cooperative mostly depends on its fourteen or so members, who have older, wooden-hulled vessels, 45-67 feet in length. They are geared for bottom otter trawling in a mixed-species, diversified fishery. The vessels usually have a two or three man crew, including the captain, who are paid shares of the profits. They are all hired locally. Although there are families with several generations in the fisheries, in recent years crewmembers are not often related to the captain or owner. Members of the cooperative are typically first-, second-, or third-generation immigrants from Northern and Mediterranean Europe and other places. A few women have crewed on these boats. The boats are all owner-operated. They tend to fish in areas of Hudson Canyon called "the Mudhole" and "the Gully." The average trip to the Mudhole is one to three days, but for the Gully can last a week.

Point Pleasant also has a sizeable charter/party boat fleet, which, like the neighboring one of Brielle, is well known for diverse fishing opportunities, including overnight and two-day "canyon" trips, bottom-fishing, and wreck fishing. The Channel Drive area also hosts a recreational marina, a fisherman's supply company, and popular seafood restaurants, and nearby is a popular amusement park and beach. A Coast Guard station is at Point Pleasant (as at Cape May).

Surfclam and ocean quahog fishery

The advent of the surfclam and ocean quahog business has been very important to the survival of this fishing community. Declining finfish catches and management restrictions have hurt both the commercial and the recreational sectors of this fishing community. Many boats have left the fishery and others are for sale. Existing operations have difficulty investing in major improvements, either to the waterfront properties or to the vessels.

One of the Cape May seafood businesses has two fishing properties in Point Pleasant, one of which is now used for offloading and trucking surfclams and ocean quahogs and the other the site of a hand-shucking plant as well as dock and icehouse. From 6 to 10 boats land clams here, which are trucked to plants in New Jersey, Massachusetts, Delaware, and Maryland. There are 15 dockside workers and about 50 on the boats. About 75% of the product landed here is ocean quahogs, which are trucked to plants elsewhere. Only some of the surfclams are shucked here; most are trucked away to be shucked elsewhere. According to a manager interviewed in the fall of 2001, the captains and crew-members often live on the boats during the week and return to their homes in south Jersey or Virginia on the weekends; a few are local to the Point Pleasant area. The dock employs eight workers, four of whom are skilled (mechanics, management), the rest semi-skilled, handling forklifts. These are immigrants from Peru, Mexico, and the Ukraine. (A recent occupational track now seen as typical is where Eastern European immigrants start as forklift operators and then move onto the boats.)

A processing plant began hand-shucking surfclams in November 1999. A steam-shucking plant was on this site three decades ago, but moved to Cape May by the early 1980s as the fleet moved south, responding to changes in the abundance of clams among other factors (in 1976 there was a huge die-off of surfclams in the waters off central and northern New Jersey, because of anoxic oceanographic conditions). Now this area has a healthy surfclam population.

According to the owner, interviewed in the fall of 2001, there are 40 full-time positions in the shucking plant that he calls "the smallest in the nation." The plant manager says that between 35 and 80 people are employed at any given time, depending on the workload. They are contract laborers, and the people working at the plant have been Laotians and other Asians, from as far away as Philadelphia, and Mexicans. Now they are all Mexicans, coming from Asbury Park, a few miles north, and other local areas. Turnover is a major problem, worsened by difficulty getting enough supply to keep the plant running at least five days a week. In the hand shucking process, both men and women shuck for the first three hours, and then the women move to another line for "squeezing and separating." The shucked meats are contracted for by one of the larger clam processing firms in New Jersey or Delaware or one of the small plants in Rhode Island or New Bedford for further processing. Some of the clams "owned" by this company are also sold shell stock (straight off the boat).

The plant runs far below capacity, a not atypical situation for the smaller shucking plants. Supply is limited by access to ITQ "tags." The owner of the plant owns one surfclam boat and some ITQ allocation, which is used to attract others to harvest for the company. Much of the surfclam harvest landed at Point Pleasant goes elsewhere, to competitors, depending on who "owns" the clams. By the end of the calendar year, when "offshore" or Federal water ITQ tags are used up, the New Jersey inshore fishery becomes very important to plants like this, even though the quality and yield of the clams are lower.

Community relations and support

The fishing community has received support of various kinds, including zoning for water-dependent uses, to slow down the gentrification of the waterfront. Although few fishermen live close to the docks, they use local supermarkets, convenience stores, and bars.

The fishing community of Point Pleasant was hard struck by the January 1999 tragedies in the surfclam and ocean quahog fishery. The Adriatic, the Beth Dee Bob, and the Ellie B, all working out of Point Pleasant, went down during storms that month, as well as another vessel, the Cape Fear, formerly based in New Jersey, up in Buzzards Bay, Massachusetts. Ten lives were lost. In the aftermath, members of the fishing community, led by the dock managers at the surfclam/ocean quahog dock, began the work of designing and funding a fishermen's memorial, with support from the larger community. It was built by a local sculptor and set in a small park alongside the Manasquan inlet. The wall around it has the names of fishermen of this part of the coast who lost their lives at sea as well as the ship's bell of one of the vessels lost in January 1999. It is telling of the nature of Mid-Atlantic fisheries that some are names of people who lost their lives while running recreational fishing vessels.

Fishing community

Point Pleasant is a qualified "fishing community" under National Standard 8. The town may not meet the test of "substantial dependence" upon fishing and fish processing because of its heavy reliance on seasonal tourism and its location in a densely-populated region that provides many income opportunities. On the other hand, it has a long history of both commercial and recreational fishing, and its waterfront is critical to the prosecution of those fisheries, given the scarcity of dockage as well as access to good inlets in the region. The definition in National Standard 8 states "substantially dependent on or substantially engaged in," the latter suggesting that the existence of commercial fishing enterprises as among the major businesses of the waterfront merits the designation as fishing community. Further, although most people who work in the fisheries here do not live in the town itself, at least not during the summer rental season, they do live within convenient commuting distance and depend on the town for some socializing (local restaurants and bars) and economic activities (i.e. the fishermen's supply store). The fishermen's memorial is testimony to the strong sense of the larger community's connection to the fisheries as is the fact that a regional newspaper provides regular coverage of commercial and recreational fishing news.

2.3.3.5.3 Atlantic County

The largest surfclam/ocean quahog port in terms of landings is Atlantic City, which is in Atlantic County, NJ. According to the 2000 Census, the total population in the county was 252,552 (Table 28). This was a 12.6% increase from 1990. Rural population comprised 24.2% of the population, although of these only 1.2% lived on farms. Of the Atlantic County population, the majority was white at 68.4%. Of the population in 2000, 25.3% was under 18 years of age and 13.6% was 65 years of age or older.

In 1999, Atlantic County had a per capita personal income of $32,086. Based on a 1997 model based estimate, 10.8% of the population was classified as living in poverty. In 1997, the per capita income for Atlantic County was $30,187 and the number of people below poverty was 9.3%. In 2000, the unemployment rate in the County was 5.7%.

In 1990, of the persons 16 years of age or older, 1.3% were employed in the agriculture, forestry, and fisheries industries sector.

Atlantic City is the major commercial port but Atlantic County, like the other coastal New Jersey counties, has numerous small-scale bay and estuary fisheries as well. By far the most important for this county is the hard clam, using rakes, tongs, and "by hand" techniques such as treading. Some of this takes place through clam aquaculture. The other significant species is the blue crab, harvested with pots and dredges. Haul seines, fyke nets, gill nets, handlines, eel pots, and turtle traps are also used for white perch, menhaden, American shad, and many other bay and tidal river species (McCay and Cieri 2000). Many of the owners and crew on the surfclam and ocean quahog (mostly surfclam) vessels that work out of Atlantic City participated in the bay fisheries in the past and have their homes in bay communities.

2.3.3.5.4 Atlantic City

According to the 2000 Census for Atlantic City, the population was 40,517, a 12.6% increase from 1990 (Table 29). In 2000, 44.2% of the population was black and 26.7% were white. The Hispanic population was 24.9% of the total population. In 2000, 25.7% of the population was under 18 years of age and 14.2% of the population was 65 years of age or older. In 1990 in Atlantic City, the per capita income was 12,017. In 1990, 9.6% of the civilian labor force was unemployed. Of the persons 16 years of age or older, .8% were in the agriculture, forestry, and fisheries industries sector.

Atlantic City is better known for casino gambling and its boardwalk than for its status as a fishing port. The fishing port is on the back bay side of the barrier beach that supports the city. It is almost entirely given over to surfclam and ocean quahog fishing. Atlantic City has long been a favored port for this fishery because of ready access to dense beds of clams off the central coast of New Jersey and a fairly deep and relatively safe inlet. Ocean quahogging has moved to more northern ports, especially New Bedford, Massachusetts, in recent years; it represented only 11% of the value of Atlantic City's landings in 1998. Other fisheries in Atlantic City are minor. Gears include sink gill nets, and handlines, and in 1998, bluefish, black sea bass, weakfish, Jonah crab, lobster, and conch predominated.

As of the summer of 2001, there were three major docks in Atlantic City, used by 18 surfclam boats. The docks are in a back bay of the barrier beach that supports the large gambling casinos, restaurants, and hotels of Atlantic City. Some clam docks are on an inlet reached by Rhode Island Avenue, in an area that has recently been redeveloped with up-scale townhouses known as Gardner's Basin. It is zoned "marine commercial." Maryland Avenue runs along a second inlet, the site of another large clam dock, a company that sells bait, tackle and ice, a deep sea and wreck charter boat, a number of run-down buildings and vacant lots, and a restaurant that serves breakfast and lunch. Across this inlet are low-income housing and a playground. The resident population is predominately Black American. Very few members of the fishing industry live here.

The fisheries

The three clam docks in Atlantic City are owned by companies involved in shucking and further processing although there is no processing in Atlantic City. One is owned by the co-owner of a major clam processing and marketing company with plants in New Bedford, MA, Milford, DE, and Easton, MD. The company that runs a plant in Mappsville, VA owns another. The company that is headquartered in Burleigh, NJ, with plants in Millville, Port Norris, and Burleigh, NJ and Nanticoke, MD, owns a third.

One of the clam dock owners had six surfclam boats here in Atlantic City and six more in Oceanside, New York, which worked in the New York State surfclam fishery (McCay and Cieri 2000). According to an interview in the fall of 2001, the company also has boats going out of Cape May, NJ, New Bedford, MA, and a port in Iceland. A dock manager reported that the owner has rights to harvest ocean quahogs in Iceland's EEZ; the resource is so abundant that a boat can be filled in two hours; clams are shucked in Iceland and the meat sent to one of the processing plants co-owned by the clam dock owner. He started out as a boat captain, bought his own boat, and then began to buy up other boats during the 1980s. At the peak he had 16 boats, which he consolidated into six because of the 1990 Amendment 8 of the Federal Surfclam and Ocean Quahog management plan, which created individual transferable quotas and allowed holders of quotas to use any boats they wished. (The State of New Jersey also has limited entry management of the surfclam fishery and has allowed some degree of "consolidation"). The dock was used for many types of fishing, and then vacated for many years when the fishing industry collapsed. His family bought it in the early 1980s for clamming.

Each boat has a 4 to 5 man crew, including the captain. On the dock five full-timers, and an extra fork lifter when necessary, are always working. At a nearby location, near Whitehorse Pike Bridge, they maintain their own boat repair and maintenance facility.

This packing dock has four truck bays and is able to unload two boats at the same time. The company's boats only go for "clams" (that is, surfclams) now due to more favorable economics. As stated by a truck dispatcher in 1999, "quahog" [or ocean quahog] is "like a dirty word" because it is necessary to go much further out to sea to acquire quahogs, which creates wear and tear on the boats, for less money than for surfclams. Further, while it is only possible to harvest 2 to 3 cages of quahogs an hour, 10 to 12 cages of surfclams can be collected in the same amount of time, for the same amount of money, while only venturing out 20 miles. Typically, the surfclam fishery takes place from 3 to 45 miles (2-5 hours) from Atlantic City. In 2001, one of the boats from this dock was also fishing in NMFS area 621 off the Delmarva Peninsula. Some independent boats are also unloaded at this dock, including ocean quahog boats.

The owner and dispatcher interviewed live 35 miles away in the Barnegat Bay town of Manahawkin along with many of the other employees. They are all white males, between the ages of 30 and 60 and have been with the company for a long time. They are described as "pretty close knit." According to one of the informants there is good job security at the dock; he has been working there since 1984. The owners' children have also worked there, right out of high school. A dock manager interviewed in 2001 noted that the company has the reputation of the best boats and crew, with a somewhat better pay scale than competitors have. There is little employee turnover. Crew come from as far away as Virginia, but tend to be from places in Atlantic and Ocean County.

On the boats, the men are paid on a share per bushel basis. The percentage depends on whether the boat-owners are working shares of the ITQ which they own or ones which they have leased from others (these shares are represented by tags which are put on the 32-bushel steel cages which hold the surfclams or ocean quahogs). If leased, then the captains, mates, and deckhands get a smaller percentage of the landed value of the clams. Further, how often boats go out depends on the market. The captains basically work to fill orders. There is an inshore season from October to May 31, in New Jersey State waters. "Offshore" clamming (in Federal waters) is done year round.

Employees of the dock visited do not belong to any of the fishing associations. There are few ties to the neighborhood. There used to be a bar/hangout nearby, but not anymore. They bring in coffee from a convenience store in the town of Brigantine, on the way from Manahawkin.

A second large clam dock in Atlantic City is part of a vertically integrated firm with a processing plant in Mappsville, Virginia. It has six boats, all around 79' in length. Each boat has a crew of three who are all paid by share per bushel, according to an informant at the dock interviewed in 1999 (McCay and Cieri 2000). This man, who is now working for his third fishery, started clamming in 1989 and lives in Tuckahoe, NJ. He said that the other fishermen, all white males, live all over the region: in Cape May, Philadelphia, Tuckahoe, and Tuckerton. In the fall of 2001 there were three surfclam boats and one ocean quahog boat at the dock. A captain interviewed at that time commutes from Cape Charles, VA (the former home of the company that owns this dock); his four crew live in New Jersey in shore communities between Tuckerton and Cape May. His fishing trips are usually 24 to 30 hours, with steam-time of 5 to 5 ½ hours.

The third clam dock, owned by the company with headquarters in Burleigh, is similar to the other two.

Gardner's Basin is just adjacent to the clam docks off North Rhode Island Avenue. It is referred to as an historic area in literature regarding Atlantic City, and is now largely devoted to recreation and tourism. Located there are also a new aquarium, the Ocean Life Center, and amphitheater; a small amusement area (rides); pleasure boat slips; a cruise company; a party boat; an antique store; and two cafes, and a small fisherman's museum.

Community relations and support

There seems to be little community support for the surfclam/ocean quahog industry in Atlantic City, except that some accommodations have been made on both sides.

At the first dock described above, the dockworkers work in two shifts and now may only work from 6 a.m. to 11 p.m. due to a city ordinance. The ordinance went into effect a few years back due to the complaints of local townhouse residents about the noise. Prior to the ordinance, the dockworkers would work all the time. If there is bad weather, they may continue working until 1:30 a.m. but often must get verification from the Coast Guard that this is allowed. When the townhouses were built in 1994 they replaced a slum, where half of the houses should have been condemned and the street was unsafe at night. However, some of the buyers of the condominiums claim that the salespeople told them that the fishing dock was moving, and several of these remain vocally unhappy that this did not happen. The dock has made other accommodations, including trying to keep the trucks quiet at night and using electric rather than diesel cranes to reduce noise.

One informant said in 1999 that clamming is the second biggest industry in Atlantic City, after the casinos, and yet the city does not support the fishing industry: "They have no time for the small fries." He continued by stating, "The quality of life is bad here. They don't care. They only care about the gamblers." (McCay and Cieri 2000).

The New Jersey Fresh seafood festival is held at Gardner's Basin. At the Atlantic City Chamber of Commerce one staff emphasized that the festival generates funds that in part go for developing artificial reefs. He said that there are no commercial fishers involved in the vending at the festival and none of the exhibits are designed around the commercial fisheries as important social or economic contributors.

Fishing community

Atlantic City is a very poor and troubled city; apart from the casinos there is little other viable industry, making the fisheries more important than they might seem otherwise. This raises the question of whether Atlantic City is a "fishing community" according to National Standard 8's definition of one "... which is substantially dependent on or substantially engaged in the harvest or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such community." More information about tax revenues and employment is required to answer the question of substantial dependence. Clearly, the fisheries are not integrated into the rest of the community: very few residents of Atlantic City work in the fisheries; most of the crewmen and dockworkers come from other towns across the bay. Reportedly, they do not even buy coffee in Atlantic City, picking it up on the way in. The minimum requirements of fishing community developed by the Atlantic States Marine Fisheries Commission's Committee for Economics and Social Sciences are only partially met. Fish and shellfish are legally sold ex-vessel to a dealer or processor or the public. However, few fishing support services are provided locally, there are no public facilities providing dockage; and the fishing people satisfy their daily and weekly social and/or economic needs elsewhere, for the most part. Some fishermen and their representatives participate in fisheries resource management, but with no particular connection to this community.

2.3.3.5.5 Cape May County

Cape May County encompasses a large peninsula at the southern end of New Jersey, with the Atlantic Ocean at one side and the Delaware Bay at the other. Its beaches have long been the focus of summer tourism, principally from the Philadelphia region, and in recent years the once rural county has also become the site of commuter and vacation home housing developments. However, both commercial and recreational fishing remain critical mainstays of the year-round economy of places like Cape May and Wildwood within the county.

According to the 2000 Census for Cape May County, the population was 102,326. This was a 7.6% percent change from 1990. The largest racial group for Cape May County was white, at 92.5%. Of the total population in 2000, 22.3% were younger than 18 years of age and 20.2% were 65 years of age or older (Table 28). In 2000, the median age for Cape May County of 42.3 years was the oldest of any New Jersey county, bespeaking its increasing popularity as a retirement center.

In 1999, Cape May County had a per capita income of $29,455. Based on a 1997 model based estimate, 11% of the population was classified as living in poverty. In 2000, 4.6% of the civilian labor force was unemployed. Of the individuals in the labor force in 1990, 7.5% of the civilian labor force was unemployed. In 1990, 2.1% of the population 16 years of age or older, were in the agriculture, forestry, and fisheries industries sector.

2.3.3.5.6 Cape May/Lower Township

The area popularly thought of as "Cape May" is treated in the census separately from the area where much of the fishing activity takes place, "Lower Township." However, both are part of the effective "community" of the fisheries.

According to the 2000 Census for Cape May, the population was 4,034 (Table 29). According to the 2000 Census for Lower Township, the population was 22,945, a 10.2% increase from 1990. In Cape May, 91.3% of the population was white, while 96.3% were white in Lower Township in 2000. In 2000 in Cape May city, 16% of the population was under 18 years of age, while 28.5% of the population was 65 years of age or older. In Lower Township, 23.7% was under 18 years of age, while 20.7% of the population was 65 years of age or older.

In 1990 in Cape May city, the per capita income was $15,884. Of the 4,010 people for whom poverty status was determined in 1989, 197 were below the poverty line. Of the individuals in the labor force in 1990, 1,701 were in the civilian labor force, of which 6.3% were unemployed.

In 1990, 1.6% of the population 16 years of age or older was in the agriculture, forestry, and fisheries industries sector. The top three industries by number are retail trade (432), educational services (183), and public administration (153).

Fisheries

Commercial and recreational fishing docks are scattered around Cape May, especially, Lower Township. The major commercial docks, however, are clustered along Ocean Drive, a road that leaves the main highway and crosses the marshes toward Wildwood. Another commercial dock is found at Schellenger's Landing, just over a large bridge that connects the mainland with the center of Cape May and its beaches.

Cape May is one of the largest commercial ports on the Atlantic seaboard. When combined with neighboring Wildwood (the fishing port is often referred to as "Cape May/Wildwood"), its 1998 landings exceeded 93 million pounds, worth over $29 million. Finfishing, squid fishing, and scalloping have been very important. Cape May has a long history of combining or alternating finfishing and scalloping. It is also the home of one of the few vessels allowed to use purse seines for bluefin tuna in U.S. waters (which often lands its catch elsewhere). It is a highly diversified port (McCay and Cieri 2000).

Despite being the most important commercial fishing port in New Jersey, commercial fishing businesses and uses of the waterfront are lower priority than recreational and resort-oriented uses within the community (McCay and Cieri 2000). Private recreational boating and fishing marinas are said to be a powerful political force in the township. Cape May has a substantial recreational fishery, both "for-hire" and private boat. Whale watching and dinner cruises have emerged as a profitable alternative or adjunct to recreational fishing charters.

Ocean clamming is interwoven into a complex fabric of fishing activities in Cape May/Wildwood. The city planner estimated in 1999 that 500 people work in the company's fishing, processing, fresh fish market and restaurant enterprises (McCay and Cieri 2000).

Schellenger's Landing is the most visible center of fishing in the Cape May area. It is zoned "marine general business" with allowance for expansion of the marine industrial character. A large restaurant-fish market-packing dock complex has been expanding. There is also a marine railway near that complex. Other marine-related businesses in and around the landing include two recreational marinas, two marine suppliers, two bait and tackle shops, a whale research center, and a "marlin and tuna club." Also there are a pizza shop, a motel, a bar, a wildlife art gallery, an antique store, two restaurants, and a gasoline station. Some cater to people in the fishing industry and some do not. Further expansion of the fishing industry, commercial or recreational, is limited by the high cost of land near the waterfront.

Lower Township has three "marine development" zones, located along Ocean Drive at Two Mile Landing and at Shaw Island and Cresse Island adjacent to Wildwood Crest. Recreational boats currently use these areas. Across from Shaw Island is a new development, where 325 new slips are being built. A complex on a saltwater creek includes a marina, bait and tackle, marine supply, and charter boats. The marina itself is small, about 28 slips. Access to this particular area is now difficult for large vessels because of silting due to a canal built between Cape May and the mainland.

Ocean Drive is the location of several important commercial fishing businesses. One commercial fishing business in the Ocean Drive area owns one surfclam/ocean quahog vessel (currently at Point Pleasant) as well as a freezer trawler, 7 wet boats and 2 refrigerated seawater vessels. According to its owner, at this facility there are 15 shore employees, approximately 20 seasonal packers, and about 45 crew on the boats. The company also off-loads about 8 independent boats, including one surfclam boat, and has another clam offloading dock in Point Pleasant.

There are two other large commercial fishery companies on Ocean Drive, both of which are largely involved with finfish. One has a long history as a processor, wholesaler, and exporter; in 1999 14 vessels landed their catch here full-time, including a couple of freezer trawlers. Crew sizes are 3-5 men, and 8-9 for the freezer trawlers. There were 75-80 shoreside employees; in 1999 about 40% were Hispanic, 40% "white," and 20% African-American, Asian, and other. They lived in the Cape May and Cumberland County region; many of the Hispanics came from the agricultural town of Bridgeton (McCay and Cieri 2000). The second large firm has a retail store as well as packinghouse and processing facility. There were 15 boats in 1999. About 20 people worked on the dock and in the retail store, and in 1999 at the time of a visit to the facility, about 35-40 people were processing squid. Five or so were Black-Americans. The rest were identified as "Vietnamese," who came daily to work from Philadelphia through a labor contractor. Since then this firm has filed for Chapter 11 bankruptcy.

Surfclam and ocean quahog fishery

Historically, Cape May has been a major center of surfclamming and ocean quahogging. With changes in the distribution of productive clam beds and other factors, much of the harvesting has moved to other ports, and the major processor in Cape May County/Lower Township has diversified into other products, leasing out its clam boats to another firm. Consequently, in the summer of 2001 there were only two surfclam boats found at one of the docks in Cape May. Most of the boats in the industry were landing their catches in Atlantic City, Point Pleasant, and New Bedford instead of Cape May.

A large food processing plant is located on Ocean Drive. Until about 1992 this facility was used to steam shuck surfclams and ocean quahogs (mainly the latter), shipping the shucked meats elsewhere for cooking and canning or freezing. The company also owned and operated a fleet of ocean quahog and surfclam vessels, and it was a major player in the industry. The facility was expanded and redesigned in 1992 to be a full-scale shucking and processing plant, the ultimate in high technology and vertical integration, but engineering problems combined with wastewater management problems led to abandonment of shucking. In 1994 the parent company sold this plant as well as the vessels and some of the ITQ it held to a diversified food-processing company headquartered in the South. As of 2000, the plant was buying shucked clam meat from other plants and processing ocean quahogs and surfclams in various forms; it had begun to diversify into other food products. It employed about 130 persons in a highly automated process, and the workers were primarily from the local region (McCay and Cieri 2000). Two of its five vessels are essentially mothballed; the other three are contracted out to others in the industry.

As reported in McCay and Cieri (2000), one informant said that as far as a connection with the larger community is concerned, the fishing industry has "always been a very important and integral part of the community here. But it has also been very unrecognized, more often than not by choice. It's not like New England – people do not think of this as a fishing community -- fishing provides a lot of the jobs. If a guy or girl did not mind working hard, they could do super well. Some people used to make a lot of money, and then 80% of them blew it. Now it has changed a lot over the last 6 to 10 years. But still there are some people making money."

A fisherman's memorial exists in Cape May City that portrays a woman and a child looking out to sea. A fishermen's wives organization, now defunct, played a major role in creating this memorial. There is also a bronze plaque for fishermen lost at sea on a pedestrian mall in the center of Cape May City.

2.3.3.5.7 Wildwood

Wildwood is just north of Cape May, a barrier beach community best known for summer rentals and boardwalk amusements. In Federal fisheries statistics, Cape May and Wildwood are combined as one port. However, they are parts of separate municipalities and census areas, and thus we discuss them separately, recognizing, however, how closely they are associated with each other (less than a mile across coastal wetlands).

According to the 2000 Census for Wildwood, the population was 5,436, a 1.1% change from 1990 (Table 29). In Wildwood, 70.5% of the population was white. In 2000, 25.7% of the population was under 18 years of age, and 14.2% of the population was 65 years of age or older. In 2000, 79.5% of the vacant housing units were used for seasonal, recreational, or occasional use.

In 1990, the last date for which this information is available, the per capita income was $10,079. Of the 4,472 people for whom poverty status was determined in 1989, 1,210 were below the poverty line. The city had 3,445 persons 16 years of age or older, according to the 1990 Census. Of these individuals, 1,896 were in the labor force. In 1990, 18.6% of the civilian labor force was unemployed. In 1990, 0% of all individuals age 16 years of age or older, were in the agriculture, forestry, and fisheries industries sector.

The commercial fishing industry is at Otten's Harbor, along Montgomery Street. Most of the boats are surfclam and ocean quahog dredge vessels; there are a few finfish draggers. As of summer 2001, there were a total of six surfclam boats that used two main docks in Wildwood, one a family-based organization and the other a long-standing small cooperative. In 1998 the surfclam and ocean quahog fishery accounted for about 80% of the total value of Wildwood's landings (McCay and Cieri 2000).

The commercial fisheries appear to be in the decline, and the party-boat recreational fishery of Wildwood has also declined. In 1999 an interview was done with the owner of a small dock and surfclamming operation, who formerly owned a seafood company and a larger fishing business. "He has fished for 60 years, and his grandfather came from Sweden to Wildwood to fish. Over time, our informant has done finfishing, clamming, and long-lining for cod. Both of his current boats are used for surfclamming. He indicated that the "golden days" of this harbor was in the 1960s, when the pattern was to clam in the winter and finfish in the summer. There were party boats in the harbor as well, now gone. [Although there is one nearby, on Rio Grande Avenue] Most of the service facilities that provided ice, fuel, and trucking are also gone. He stated "The bad effects of less fishing and boats trickle down." There also used to be four bars on the street, but only one remains. The bay fishery is minor now, too; he mentioned one person who rakes for hard clams and uses pots for crabs. The smaller of his two surfclam boats takes a crew of 3, while the larger takes a crew of 4. They only go out an average of 2 days/week because they are "plant regulated," that is told by the buyer when to go out. His clams are sold to shucking operations in Delaware or in southern New Jersey, from which the clam products are sold to large food corporations such as Progresso and Campbell's" (McCay and Cieri 2000). The crewmembers have worked with these boats for many years; they have other part-time jobs and live locally.

The other surfclam/ocean quahog company in Wildwood has 4 boats, ranging from 80 to 110 feet. Three of the boats have 4-man crews and one has a 5-man crew. There are also 2 on-shore employees who run the crane that off-loads the clam cages. The two on-shore employees also engage in other types of dock work. All of the employees are local residents–including close relatives-- who have been with the company for a long time. This is also a company based on long-standing ties of kinship, friendship, and work, and the owners have Scandinavian origins.

With ITQs, this company consolidated 9 boats to 4. Total crew employment has declined from about 28 to about 20, and shoreside workers declined from 4 to 2 after ITQs came into effect and this company consolidated. The owner said that the crews now go out an average of 2 days/week and they are able to survive on that (McCay and Cieri 2000). The company also fishes for ocean quahogs, which are less valuable than surfclams and require going out further. They travel about 60 miles offshore for the ocean quahogs, while going only north to the waters off Margate (Atlantic City area) and Point Pleasant for surfclams. They sell to two processors, one in south Jersey and the other in Delaware.

Marine related businesses

Wildwood has fishing infrastructure, including a marine service company, several fishing docks, lots where trucks and equipment are kept, a seafood business with an ice and bait house. There are some recreational fishing docks and many private docks and pleasure craft. However, the fishery is in decline. According to interviews done in 1999, there used to be 20 people working full-time around the harbor in different jobs but in about 1997 that changed. Several boats left the harbor, and little fish is now landed here (McCay and Cieri 2000). However, four vessels are advertised as offering party-boat fishing and dinner cruise trips from Wildwood and neighboring Wildwood Crest.

Fishing community

Cape May and Wildwood, like Point Pleasant, meet the definition of "fishing community" in National Standard 8 with some qualifications. They are important and long-standing fishing ports and centers of seafood processing and marketing, as well as recreational fishing, and thus there is evidence of "substantial engagement" of the community in the fisheries. "Substantial dependence" is more difficult to demonstrate because of the strength of seasonal tourism on these coastal economies; however, if year-round local employment is a criterion of such dependence, then the fisheries emerge as central. However, as Cape May, in particular, becomes more diversified, with growth of retirement and commuter communities as well as retailing, the fisheries are on the verge of becoming marginalized, making them vulnerable to small changes in the fisheries themselves as well as in the local and larger economy.

Cape May and Wildwood also meet most of the Atlantic States Marine Fisheries Commission's minimum requirements for fishing communities: they are the locales for the ex-vessel sale of fish and shellfish to dealers, processors, and the public; there are many docks (although not public ones) for use by the commercial as well as recreational fishing industries; fishing people can satisfy their daily and weekly social and/or economic needs in these places, or close by; and some fishermen and their representatives participate in fisheries resource management. Indeed, Cape May has long been the center of attempts to organize both commercial and recreational fisheries.

2.3.3.5.8 Burleigh/Middle Township

Burleigh is a small inland town on Cape May's peninsula. It is the headquarters for a company that owns four processing plants (in Nanticoke, MD; Port Norris, NJ; Millville, NJ; and Burleigh, NJ), and one packing dock in Atlantic City. The company has an affiliated company that owns four ocean clam vessels and leases three more from another company.

The Burleigh plant is a hand-shucking plant for surfclams begun in 1970. The plant has 150 employees; state- and Federal-authorized contractors provide labor. Local contract labor comes from the Wildwood area, on the coast, and from Bridgeton, inland. Some workers come from a work release program at a local prison. Shuckers and other workers are paid on a piecework basis. Men shuck the clams; women have the job of separating the shucked meat from the "bellies" or guts. There are about 15 workers on the day shift when canning is done, and 25-40 people on the night shift, when they process and can conchs, usually only in the fall and winter. The company owns its own icehouse and trucks, while fishermen take the clam bellies.

As of late 2001, the plant was scheduled to move out of Burleigh within about 18 months. One of the major reasons is the township demand that the plant install pre-treatment facilities for the water used, because of the large volume of solids left after shucking clams. According to the director of the Middle Township Sewer Department, over the years there have been odor complaints associated with the plant. She said that the taxes lost by the company's decision to move rather than install pre-treatment facilities will be recovered, because the land will be rapidly purchased and converted to another use. Not far from the plant is a developing retailing area with major national consumer retail stores. The clam plant is thus a casualty of a changing economy, from industrial to consumer retailing, and of increased population density. As an owner said in an interview: "It's been smelling since 1970 but there was no one around then."

According to company managers, the Burleigh operations will be moved to the company's facility in Millville, New Jersey, which this company began operating in the summer of 2001 as a canning plant. Although the township officials are confident that the tax base will not be hurt by the loss of the clam plant, local convenience stores and other small businesses will feel the pinch when 150 people no longer work at the clam plant and buy lunch and use other facilities in the neighborhood.

Fishing community

Burleigh has never been a full-fledged "fishing community" although the clam plant has been there for many years; however, it has been part of a regional network linking harvesters, docks, and processors. Today it is moving rapidly away from the fisheries or any other rural food processing industry, as it becomes a regional consumer retail center.

2.3.3.5.9 Cumberland County

Cumberland County is New Jersey's poorest county. In this county, Port Norris/Bivalve and Millville are the sites of surfclam and ocean quahog processing.

According to the 2000 Census for Cumberland County, the population was 146,438 (Table 29). This was a 6.1% percent increase from 1990. In 1990, the rural population comprised 25.9% of the total. Of the Cumberland County population, 65.9% were White, 25.4% were younger than 18 years of age, and 16% were 65 years of age or older. Of the vacant housing units in Cumberland County, only 1.6% were used for seasonal, recreational, or occasional use.

In 1999, Cumberland County had a per capita income of $22,894. Based on a 1997 model based estimate, 15.8% of the population was classified as living in poverty. In 1999, approximately 8.6% of the civilian labor force was unemployed. In 1990, 2.5% of the persons 16 years of age or older were in the agriculture, forestry, and fisheries industries sector.

2.3.3.5.10 Port Norris/Bivalve

According to the 2000 Census for Port Norris, the population was 1,566, a 7.9% decline from 1990 (Table 29). In 2000, 58.3% of the population were white, 27.4% were under 18 years of age, and 16.9% of the population was 65 years of age or older. Port Norris is not a major tourist area. In 2000, only 1.7% of the vacant housing units in Port Norris were used for seasonal, recreational, or occasional use.

In 1990, the per capita income was $10,401 and of the people for whom poverty status was determined in 1989, 25.8% were below the poverty line. In 1990, 4.8% of the civilian labor force was unemployed. Of the persons 16 years of age or older in 1990, 1.4% were in the agriculture, forestry, and fisheries industries sector.

Port Norris and the area called Bivalve have a long history as centers of the Delaware Bay oyster industry. Today, the Rutgers University Haskin Shellfish Research Laboratory is there, as well as efforts to restore old oyster schooners.

A surfclam and ocean quahog processing plant began operating in 1991 at this location. It is part of the same company that has a plant in Burleigh and a new one in Millville. Fifteen vessels supply this plant from all of the major ports, particularly Point Pleasant and Atlantic City. There are 100 employees, working two production shifts and one clean-up shift. When shucking ocean quahogs, there are usually 24 people per shift; when shucking surfclams, 36. It appears that at least half are women. Most are said to be permanent workers. Prisoners are hired for a third shift at times. The majority of the workers are Black Americans. About 25% live in the local area, Commercial Township. The rest live within a 30-mile radius. In addition, a contractor who brings them in a van recruits about 10 workers mostly from Philadelphia, PA and Bridgeton, NJ. The contract workers are black, Asian and Hispanic.

High turnover of employees has been a major problem, but in 2001 this was reported by plant managers as less of a problem than usual. To retain employees, the company has recently added health insurance, a 401 K retirement savings plan and state unemployment insurance.

This plant like the others must be innovative in dealing with waste disposal. Here, pig farmers take the clam bellies. Someone else is paid by the plant to dispose of the shells. Wastewater is filtered and then pumped into the Maurice River, in compliance with Department of Environmental Protection standards. The township has a grant to build a wastewater facility but there is local opposition.

Fishing community

Port Norris has a long history as a fishing community, mainly as a center of oystering, including oyster-planting businesses and oyster shucking houses. Decline of oystering due to the devastating effects of oyster diseases has been only partly offset by other fishing activities such as crabbing and gillnetting. Poverty and unemployment are serious problems in Port Norris and the larger Commercial Township, and the surfclam and ocean quahog plant has become one of the few sources of local jobs.

2.3.3.5.11 Millville

Millville is a major commercial center for a large agricultural region and has also been an industrial center, i.e., for glass manufacturing and food processing. Seafood processing is part of the larger food processing industry in this part of New Jersey, and thus Millville cannot be considered a "fishing community" per se.

According to the 2000 Census for Millville, the population was 26.847, a 3.2% change from 1990 (Table 29). In 2000, 76.1% of the population were white, 27.9% were under 18 years of age, and 12.9% of the population was 65 years of age or older. In 2000, 9.4% of the vacant housing units in Millville were used for seasonal, recreational, or occasional use.

In 1990, the per capita income was $13,748 and for those whom poverty status was determined, 11.53% was determined to be below the poverty line. In 1990, the unemployment rate was 6.4%. Of the persons 16 years of age or older in 1990, 1.3% were in the agriculture, forestry, and fisheries industries sector.

Millville is the site of one of the food processing plants that cans surfclams and ocean quahogs and is owned by the company that owns the plant in Port Norris and the one in Burleigh. It began operating under this ownership in the summer of 2001. Formerly, it was a clam plant owned by a New England-based seafood company. Eventually it will be the site of a hand-shucking operation (see Burleigh, above).

2.3.3.6 Delaware

No surfclams or ocean quahogs are harvested by State of Delaware vessels, but Delaware is the site of a major processing plant in Milford, Sussex County, a rural area where clam processing is part of an agricultural system based mainly on poultry production and processing.

2.3.3.6.1 Sussex County

According to the 2000 Census, Sussex County had a population of 156,638. This was a 38.3 percent increase from 1990. In 1990, the rural population was 85.7% of the population, though only 2.7% lived on farms (Table 28). Eighty-one percent of the Sussex County population was white, while 19% were comprised of all other racial/ethnic classifications. Of the total population, 22.5% were under 18 years of age and 29,022 were 65 years of age or over.

In 1999, Sussex County had a per capita income of $23,700. Based on a 1997 model estimate, there were 17,388 people classified as living in poverty or 12.7%. In 2000, the total labor force was 74,141 and of that 70,854 were employed with 3,287 unemployed, making the unemployment rate 4.4%. In 1990, of the 52,710 employed people 16 years of age or older, 3,112, or 5.9%, were engaged in the agriculture, forestry, and fisheries industry.

2.3.3.6.2 Milford

Milford DE, is a small rural town that crosses two counties, Sussex and Kent. The clam processing plant is located on 22 acres of land within an old residential community in Sussex County. The plant is the largest facility within a company with operations in three different Atlantic coast states--Massachusetts, Maryland and Delaware—as well as clam docks in New Jersey. The Milford plant is a highly mechanized shucking and processing operation with research and development facilities. In the 1910s, it began as a vegetable cannery. In 1978, the present company was formed and the plant began frying clams. In 1984 they started shucking at the plant, and in 1986 they began steam shucking, rather than hand shucking. Today, the Milford plant is the largest facility where everything is done under one roof, from shucking to canning and frying. "Here the product goes out fresh, frozen, canned or fried." Raw product comes from docks in Atlantic City, Pt. Pleasant, Wildwood/Cape May, NJ, and New Bedford, MA, and shucked quahogs come from the New Bedford plant. The Milford plant is considered well located for transportation from these docks. Major finished products include 15 oz and 51 oz cans of New England clam chowder, and whole and chopped ocean quahogs. Frozen products are also important.

Over the 23 years the plant has been in operation among the tree-lined streets of Milford, under different owners, it has made adjustments in order to fit in better with the community. For example, when steam shucking began, the truck entrance was changed to reduce traffic problems for neighboring residences. The plant's director of human resources is a member of the city council and has been re-elected six times, opposed only once. Since the plant installed a pre-treatment system for their wastewater, the plant has had "clear sailing" in terms of community relations, he said. It is among the top four employers in the area, with chicken processing being the largest employer by far. During the summer months, the plant has trouble retaining employees because jobs in nearby beach areas lure them away. About 40 percent of the plant employees are said to live in Milford, and many of those walk to work.

According to the 2000 Census, Milford had a population of 6,732. The population increased from 6,040 in 1990 or approximately 11.4%. In Milford, 69.6% of the population was white. A strong minority (25%) identifies as African American. The 2000 census shows that 8.8 percent of Milford's population is Hispanic or Latino, with about half of those Mexican. Of the total population, 27.2% was under 18 years of age and 1,189 were 65 years of age or over.

In 1989, the average per capita income was $11,334 and there were 5,930 people for whom poverty status was determined and of that 702 were classified as below poverty status. In 1990, there were 2,528 people who were employed aged 16 and over in Milford and of those, only 6 report to be employed in the agriculture, forestry and fisheries industry.

In 1990, there were 2,681 people in the labor force, 2,652 in the civilian labor force and 29 in the armed forces. There were 2,528 people employed in the civilian labor forces and 124 unemployed in 2000, making the unemployment rate for the civilian labor force approximately 4.7%. The clam processing plant is a major employer. It employs around 300 people, with nearly 200 of those being unskilled production line workers. They work in two shucking shifts; the third shift is mostly sanitation. There are also frying shifts, mostly for clam strips but also some calamari (squid). According to the plant managers, about 55% of the plant's unskilled employees were not born in the U.S. Most are Spanish-speaking immigrants, including Guatemalans, as well as French-speaking Haitians.

In order to attract and keep a reliable labor force, the plant provides regionally good wages and benefits, including medical, dental, and vision " to keep up with Perdue." To help employees during "short-time," when there are no clams, the company relies on the state unemployment system, aided by the State of Delaware's re-hire credit program (reducing the plant's unemployment tax because of the company's performance in re-hiring employees who received unemployment during short-times at the plant). In addition, the working conditions in a steam-shucking and processing plant such as this are relatively attractive, being mostly inspection work, such as picking out debris from product on conveyor belts, rather than repetitive work that leads to injuries so common in food processing.

Fishing community

Although Milford does not identify itself as a fishery-dependent community, the clam plant is a major employer in the town and its environs, and the semi-skilled workers of the area, in particular, are "substantially" dependent on and engaged in seafood processing, as well as poultry processing.

2.3.3.7 Maryland

Worcester County, Maryland, is the locale of the port of Ocean City and the clam-processing town of Pocomoke City. It is a rural area with high unemployment and dependence on coastal tourism. Wicomico County, on the eastern shore of Maryland, is a similar region and the site of another clam processing town, Nanticoke, as is Talbot County, the locale of Easton, the headquarters of a major surfclam and ocean quahog firm.

2.3.3.7.1 Worcester County

According to the 2000 Census, the total population in Worcester County was 46,543, an increase of 32.9% from 1990 (Table 28). The largest racial/ethnic group was white at 81%. The population under 18 years of age was 20.5% of the population and 20.1% was 65 years of age or older.

The per capita income in 1998-1999 was $26,471. For 2001, the adjusted unemployment rate was 11.9%, however as data indicates there are times during the year when unemployment is much higher than others. On average, the unemployment rate for Worcester is the highest of any other county in Maryland, even though the number is reduced during summer months as seasonal employment, due to tourism, creates many more employment opportunities.

In 1990, of the 17,322 employed people 16 years of age or older in Worchester County, 1,014, or 5.9% were in the agriculture, forestry, and fisheries industry.

2.3.3.7.2 Pocomoke City

Pocomoke City is a small rural town. The seafood processing plant, which sits in an industrial park on the outskirts of town, is among the top two employers and well integrated into the community. The town, which bills itself as "the friendliest town on the Eastern Shore" (www.pocomoke.com) lies about 15 miles from the county seat, Snow Hill, in the southern portion of Worcester County. The neighboring county, Somerset, lies on the town's northern border and a short distance to the south is the border with Accomack County, Virginia. The scenic Pocomoke River starts just to the east of town and flows through the town.

Of the 46,543 people living in Worcester County, 4,098 live in Pocomoke City (Table 29). The total number of residents increased from 1990 (3,922) by approximately 4.5%. In Pocomoke City, the racial/ethnic category of "white" represented only 52.1% of the population. The population under 18 years of age was 30.5% of the population and 16.0% was 65 years of age or older.

The per capita income was $9,688. There were 3,835 individuals for whom poverty status was determined, and of them, 700 were below poverty level. In 1990, there were 2,863 people 16 years old and over and of those there were 1,762 people in the labor force. The civilian labor force was 1,757, and of that, there were 1,609 employed and 148 unemployed. Of the 1,609 people 16 years old and over, 84, or 5.2 %, were engaged in the agriculture, forestry and fishing industry.

The city manager has heard no complaints about the processing plant, whose owners are civically active members of the community. The plant employs about 75 people, most living in Pocomoke City or nearby. Some of the skilled and semi-skilled employees commute from towns about an hour's drive away, or further. There is a county bus that transports some people to and from work, others drive or carpool. Of the 50 or so hourly employees who work the production line, the company owner categorized 30 as low skilled and 15 or 20 as semi-skilled. The plant recently offered a benefits package and increased wages to their hourly employees in an effort to keep them during the summer months when high paying jobs become available in the Ocean City tourist industry.

More than 70% of the company's business is surfclam and ocean quahogs, but the owner foresees a time in the near future when they will comprise less than 50 percent of his business. This is mostly due to his inability to secure shucked clams or shell stock because of the plant's vulnerable position in the ITQ network. It is one of the plants that did not own vessels and hence was not allocated ITQ at the time the system was created. Banks did not recognize ITQs as property, making it difficult to obtain financing to obtain ITQ. This has made a big difference: "We were the largest employer in our town before ITQs." The plant is no longer able to compete for clams directly from harvesters, including those in nearby Ocean City Maryland, relying instead on shucked product from other companies.

Fishing community

Seafood processing is one of the two principal businesses in the small town of Pocomoke City, and thus it may be considered "substantially dependent upon" the surfclam and ocean quahog fishery.

2.3.3.7.3 West Ocean City

Significant harvesting of surfclams and ocean quahogs takes place from the port of Ocean City, which is largely within the municipality of West Ocean City. This port is very dependent on the industry. In 2000, surfclamming and ocean quahogging represented over half of the total landed value of commercial species. In 2000, three vessels reported Ocean City as their principal port. Since that time, at least one other vessel, most recently from New Bedford, has moved to Ocean City for surfclamming.

According to the 2000 Census, West Ocean City had a total population of 3,311 (Table 29). In 1990 the total was 1,928, meaning that the city grew by approximately 42%. Based on the 2000 Census, 97.0% of the population was white. The population under 18 years of age was 19.8% and 19.1% was 65 years of age or older.

In 1989, the per capita income was $16,833. At that time, for the 1,993 people for whom poverty status was determined, 199 were living below the poverty level. In 1990, there were 1,644 people 16 years and over and of those, there were 1,042 in the labor force. There were 977 people employed and 65 people unemployed, or 6.2%. Of the 977 people employed, 47 were engaged in the agriculture, forestry and fisheries industry, or less than 1%.

2.3.3.7.4 Ocean City

The clam docks are in West Ocean City, but it is closely involved with neighboring Ocean City. According to the 2000 census, the population for Ocean City was 7,173. The percentage of population that classified themselves as white was 95.3% and of the total population 11.9% were under the age of 18, while 20.9% were 65 and over.

In 1989, the per capita income was $20,399 and 6.59% were determined to be living below the poverty level. Unemployment was 4.69% and only 1% of the population was engaged in the fisheries industry.

Fisheries

Ocean City, on the Atlantic Coast, is the only major port in Maryland engaged in the inshore and EEZ ocean fisheries. In a state dominated by the large Chesapeake Bay fisheries, this ocean port accounted for almost 10% of the value landed in Maryland in 1998 (McCay and Cieri 2000). Surfclam and ocean quahog dredging is the major fishery but it is complemented by highly diversified gillnetting and otter-trawl fishing as well as trap fishing and pelagic longlining.

Ocean City is situated on approximately ten miles of barrier island and is next to an inlet that was created during a hurricane in the 1930s. It is a huge tourist community, with hotels, motels and condos for rent stretching for miles from south to north on the Ocean City peninsula. Ocean City has grown into a major summer resort area in the last twenty to twenty-five years. For recreational fishing, Ocean City is billed as the "White Marlin Capital of the World", and the waterfront is dominated by recreational marinas. There are several marinas in Ocean City and one in West Ocean City, at the harbor used for commercial fishing. This harbor is directly west of the inlet at the southern end of the city.

The fishing industry began with fish camps on the northern end of Assateague Island. There they fished with pound nets pulled by horses or by winches, and they had small sheds to sort the catches. A major storm in the 1930s destroyed many of them, but several were moved to West Ocean City when the harbor and inlet was dug out of the marshy, sandy land some years afterwards. A train used to come into Ocean City and would pick up the fish for market. The father of a woman who runs a fish business was responsible for starting the black sea bass, offshore lobster and inshore cod fishery in the Ocean City area. Later it became a center for surfclamming. At one time there were twenty surfclam vessels over 75 feet docked here, but as of 1998 there were only four, owned and run by members of one extended family with strong roots in the community. Most of the boats moved to New Jersey, mainly Atlantic City but also Wildwood and Point Pleasant, as yields diminished in the grounds off the Delmarva Peninsula and increased off New Jersey and New York in the late 1980s and 1990s.

Surfclams were handled by several packing houses, two of which specialized in surfclams. However, by March 2000, a vertically integrated company with processing facilities in Norfolk, VA, had begun to pack out most if not all of the clams offloaded in this port (McCay and Cieri 2000).

As with most other coastal communities in the southern New England and Mid-Atlantic region, coastal "gentrification" poses major challenges to the fishing industry of Ocean City. Issues concerning the rezoning of harbor land and dredging the shoaling waters are very important, as is competition for scarce dock space (including some resentment of the ITQ-based surfclam industry for having more capital to outbid other commercial fishermen for dock space). As one respondent said when interviewed in the summer of 1999, "Rich people are buying up all the land. It's not only the National Marine Fisheries Service but the local developers are killing us too" (McCay and Cieri 2000).

Fishing community

West Ocean City is substantially engaged in and dependent upon commercial and recreational fishing but experiencing the effects of changing values of coastal and waterfront land. The surfclam and ocean quahog fishery has declined in scale but could increase once again, if and when the industry resumes its focus on the shellfish beds off the Delmarva peninsula, the yield of which has been deemed to low to be economically worthwhile in recent years.

2.3.3.7.5 Wicomico County

Another small surfclam processing plant is located in rural Nanticoke, Wicomico County, on the eastern shore of Maryland, on the Nanticoke River, leading into Chesapeake Bay.

According to the 2000 Census, Wicomico County had a total population of 84,644, an increase of 13.9% from the 1990 population of 74,339 (Table 28). The largest racial/ethnic group was white at 73.6%. The population under 18 years of age was 24.8% of the population and 12.8% was 65 years of age or older. The per capita personal income for 1999 was $24,227. In 2000, the labor force was 47,865, of those, 45,486 were employed and 2,379 were unemployed, or 5.0%. In 1990, there were 57,915 people 16 years old and over and of that 39,134 comprised the labor force. The civilian labor force was 39,082 and of that 37,233 were employed while 1,849 were unemployed, or 4.7%. Of the 37,233 employed, 1,878 were employed in the agriculture, forestry and fisheries industry.

2.3.3.7.6 Nanticoke

U.S. Census data are unavailable for Nanticoke This small rural town lays at the southwestern edge of Wicomico County on the Nanticoke River, which feeds into Chesapeake Bay. It is more than 23 miles along state highways from Salisbury Md., the county seat. One of Maryland's 35 Wildlife Management Areas is also located along the Nanticoke River.

Nanticoke's isolation may limit employment opportunities more than the rest of the county. Nanticoke Seafood, once owned by a large diversified seafood company and now owned by a New Jersey clam company, is listed on the county website (www.swed.org) as one of the county's major manufacturing industries. It is within the food sector that comprises 31 percent of the county's manufacturing industry, dominated by poultry processing. Nanticoke's relative isolation makes it even more dependent on the seafood factory located there. Like other small towns heavily dependent on seafood as well as poultry or vegetable processing, it is more accurately designated a "food processing community" than a "fishing community."

2.3.3.7.7 Talbot County

Easton, in Talbot County, is the headquarters and site of a major clam processing company. According to the 2000 Census, Talbot County had a total population of 33,812 (Table 28). The population increased 10.7% from 1990 to 2000. Approximately 82.6% of Talbot County's population was white and the of the total population, 21.7% was under 18 years of age and 20.4% was 65 years of age or older.

In 1999, the per capita personal income for the county was $35,359. Out of the county population, 9.7% of the people were classified as living in poverty. As of 2000, there were 18,862 people in the labor force and of those 18,280 were employed and 582 were unemployed. The unemployment rate for 2000 was 3.1 percent. In 1990, 15,786 adult people were employed and of those 996, or 6.3%, were employed in the agriculture, forestry, and fisheries industry.

2.3.3.7.8 Easton

According to the 2000 Census, Easton had a total population of 11,708 (Table 29). In 1990, the population total was 9,372, so during the decade the population grew by about 25%.

Approximately 72.5% of Easton's population was white according to the 2000 Census. The population under 18 years of age was 22.6% of the population and 19.2% was 65 years of age or older.

In 1989, the per capita income was $14,517 and of that 12.5% were living below the poverty line. In 1990, the unemployment rate was 4.0% and 2.5% of the people employed were engaged in the agriculture, forestry and fisheries industry.

The clam plant in Easton is located in an industrial park close to an airport, and it has little visibility in town, according to the town planner, and has raised no complaints. Easton is a fast-growing regional center. The growth is residential spurred by better transportation routes to Annapolis (45 drive away) and Washington DC (another 20-30 minutes). The bay bridge built in the 1950s also contributes. The town has a booming service industry to accommodate the residential growth, but relatively few residents actually work here. The three main employers are an industrial tool manufacturing plant, hospitals, and government. The area is historically based on chicken farming, corn crops, and watermen fishing. Water quality is a major concern for the town but the clam plant is not seen as part of that problem.

The clam facility at Easton is both corporate headquarters and a value-added frying plant that produces crab cakes, clam strips, calamari, and tempura and breaded shrimp. 70% of what is processed in the plant is clam strips, which rely on large surfclams.

The company has been in Easton for 20 years, and many of the employees who were with the various companies that consolidated into this one stayed much longer. There are 30 people permanently employed at the corporate headquarters, 20 of them women; the majority live within 30 to 35 miles of the plant, in the Easton area, the rest live in Delaware or in Annapolis, Maryland. Employees are very active in the community, including volunteering for activities such as Little League baseball, fund-raisers, and so forth.

The Easton frying plant receives shucked clams from the company's New Bedford and Milford plants. The plant has 27 people working in the daytime and 7-8 people who work at night to clean up. Most are hourly employees who live in the local community. Seventy percent are female, and about 80% are black and/or Hispanic. Many are Guatemalan. Workers are hired through a local agency or newspaper advertisements. None are sub-contracted through an agency, and the workers all have unemployment insurance. In the Easton area it is difficult to obtain semi-skilled labor. They were fortunate to be able to hire workers from canneries that closed on the Eastern Shore. The Easton plant also does some research and development and basic laboratory work.

Fishing community

Easton cannot be considered a fishing community under National Standard 8. Two years ago (ca. 1999) the Easton plant was closed and the operation moved to the company's Milford facility. Six months or so later, business picked up and the Easton facility reopened. According to the town planner interviewed, most people in town probably do not know that the plant is there. Therefore, there would be little concern if the clam processing plant shut down for good; another industry would replace it.

2.3.3.8 Virginia

In recent years, no surfclams or ocean quahogs have been landed in Virginia ports. Chincoteague, on the Delmarva Peninsula, was once a surfclam port, and boats also landed at the port of Oyster, Virginia, which was the site of one of the vertically integrated clam plants. Today, the industry's presence in Virginia is based on a processing operation in Norfolk and one in Mappsville.

2.3.3.8.1 Norfolk City

The clam plant in Norfolk is ensconced in a large metropolitan area. Norfolk, VA, is statistically part of a larger Metropolitan Statistical Area, the Norfolk/Virginia Beach/Newport News Metropolitan Statistical Area, which includes most of the "Hampton Roads" fishing area, including Lynn haven, Hampton, Newport News, Virginia Beach, Phoebus and Norfolk. There is no county.

Norfolk has experienced significant decline. According to the 2000 census, Norfolk City had a total population of 234,403, a decrease of 10.3% from the 1990 population (Table 29). Of the total population, 50.1% were white, and 24% of the population was under 18 and 10.9% was 65 or older. In 1990, the per capita income was $11,643. There were 227,355 for whom poverty status was determined and of that 43,944 are determined to be below poverty level.

There are 141,808 people in the labor force and 8,645 are unemployed, or 6.09%. Ten percent of the population 16 years old and over were employed in the agriculture, forestry and fisheries industry, an unusually high proportion for the Atlantic coast.

No information is currently available about the clam processing plant in Norfolk because the researchers contracted to carry out this work were unable to gain access to its owner or managers.

2.3.3.8.2 Accomack County

Accomack County is located on the Delmarva Peninsula just north of Northampton County and is bounded on the east by the Atlantic Ocean and the west by the southern end of Chesapeake Bay. This county is a poor, rural part of Virginia, and the locale of a major clam processing plant in the rural town of Mappsville.

According to the 2000 Census, Accomack County had a total population of 38,305 a 20.8% increase from 1990 (Table 28). Of the total population 64.1% was white, and 24.3% was under 18 years old while 16.7% was 65 or older.

In 1999, Accomack County had a per capita personal income of $21,194. The total percentage of those living in poverty was 21.9%. The unemployment rate was 4.2%, and throughout the year (1998) it ranged from as high as 10.2% to as low as 4.9%. Of the people employed in the County, 9.1% were engaged in the agriculture, forestry and fisheries industry (was this in 1999 or what year).

2.3.3.8.3 Mappsville

Mappsville is a small inland rural village located in the northern section of Accomack County on the Eastern Shore of Virginia. No census data are available for Mappsville.

Inshore clams and the health of bay fisheries is a major concern in the area. There is an active watermen's association for bay fisheries. The city planner said that more than its economic value, the seafood industry is important to people because of its ties to a local marine harvesting tradition. "People really get upset when regulations impact watermen or local farmers", she said. However, it is unclear whether county residents associate surfclamming and ocean quahogging with traditional inshore harvesting of shellfish such as oysters, hard clams, and crabs.

There is one clam processing plant located in rural Mappsville, owned by a company that also owns vessels which fish for clams mainly out of Atlantic City. The large plant is located in the northern end of the county on a highway, route 13, that runs north and south through the Eastern Shore of Virginia. Route 13 is the major transportation artery along the Eastern Shore. This plant is one of the major employment opportunities in the area. In fact, according to the plant manager, many of the production employees once worked at the company's plant in Oyster, near Cape Charles in Northampton County, a distance of more than 50 miles. Employment opportunities in lower Northampton County are even scarcer than in Mappsville, so the employees commute from the Cape Charles area. Most employees, however, live within a 30-mile radius of the plant. There is no public transportation in the area, so employees either drive or carpool to work.

The plant eliminates its wastewater with an irrigation system over fields of winter wheat and corn. While the smell associated with this sort of system draws complaints from residents and new businesses in some areas, it seems to work well in this less developed area. The company's other plant in Oyster, near Cape Charles, shut its doors in part because of wastewater treatment issues. After large chicken processing plants and local government, the clam processing plant is the area's largest employer. Mappsville lies 14 miles north of the county seat. Like many clam processing plants, this one can only offer their production crews unstable hours. The crews tend to hold more regular jobs at nearby chicken processing plants and supplement those stable hours with extra hours from the clam plant. More research is required to discover how important these supplemental hours are to plant employees.

While the plant contributes a significant employment opportunity to less educated residents of the county, the plant manager said that hiring and retaining skilled workers for the administrative and management staff is difficult because the education system in the area is not very good. He likens the Eastern Shore to the Mississippi delta in terms of poverty, unemployment, rural character and poor schools.

The county sees only about 300 new residential homes each year. It is growing, but not quickly. The county planner said that there are no jobs that would increase residential development in the area. Though the county is within commuting distance to a larger metropolitan area, a $20 toll on the Bay-Tunnel Bridge discourages commuting. The idea of reducing the toll has surfaced lately on the Bridge-Tunnel commission's agenda. However, Mappsville is more than 60 miles north of Norfolk and may not be directly affected by future commuter-related development.

Fishing community

Mappsville may be considered a "fishing community" under National Standard 8 because of its high dependence on a seafood processing plant in an otherwise rural and low-income area. Like several other inland surfclam and ocean quahog processing plant communities, it might more accurately be considered a "food processing community" even though it meets the standards of "substantial dependence" and "engagement."

3.0 ENVIRONMENTAL IMPACTS OF THE ALTERNATIVES (FSEIS)*

3.1 THE FMP 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 SFA of 1996 added three new National Standards, including requirements that FMPs take into consideration the effects on fishing communities (National Standard 8), reduce bycatch (National Standard 9), and promote safety of life at sea (National Standard 10). In addition, the SFA requires the Councils to identify and describe essential habitat for species managed under the SFA. The following is a discussion of the National Standards and how this amendment meets them.

3.1.1 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 National Standard 1. 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.

The SFA also requires that each FMP 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 surfclams and ocean quahogs are comprised of two components: 1) a maximum fishing mortality threshold and 2) a minimum stock size threshold. Both a threshold and a target are specified for both surfclams and ocean quahogs. Each threshold and target have associated biomass and fishing mortality estimates.

Amendment 12 (MAFMC 1998) proposed an ocean quahog overfishing definition based on MSY that encompassed the entire resource within the US EEZ. This definition (Table 1) included both biomass and fishing mortality threshold and target estimates. This definition was approved by the Secretary with his approval of the amendment. The proposed surfclam overfishing definition was conservative but was not certifiable by the NEFSC and thus not approved by the Secretary because the definition was based only on the fished proportion of the surfclam population rather than all the surfclam resource in the US EEZ. This new proposed definition (Table 1) is similar to the one for ocean quahogs in that it is global, MSY based, and has both biomass and fishing mortality threshold and target estimates. Both definitions have control rules (Figure 1 for surfclams and Figure 22 for ocean quahogs).

Under the definition recommended by the SARC and unanimously approved by the Council, overfishing occurs whenever F exceeds the threshold fishing mortality rate. The threshold fishing mortality rate is F_{MSY}, but reduced in a linear fashion towards zero when stock biomass falls below the biomass threshold value (1/2B_{MSY}). The surfclam stock is overfished whenever stock biomass falls below the biomass threshold level. Estimates of fishing mortality and biomass thresholds and the biomass target based on MSY can be expected to change in each assessment as data accumulate and models improve.

The pre-SFA overfishing definitions for surfclams and ocean quahogs, as they were defined in Amendment 9 (MAFMC 1996) needed revision because those definitions were based on a fishing mortality rate that minimizes the potential for recruitment overfishing ($F_{20\%MSP}$=0.18 for surfclams and $F_{25\%MSP}$=0.042 for ocean quahogs), rather than an MSY strategy. Section 2.1.4 of Amendment 12 on maximum sustainable yield summarized the history of MSY calculations for surfclams and ocean quahogs and described how the Council has prevented overfishing in these two species for the past twenty years of Federal management.

The Council has had at least a 10 year supply horizon for surfclams and at least a 30 year supply horizon for ocean quahogs as its policy for annual quota setting for nearly a decade. The overfishing level defined in Amendment 9 was a "threshold" beyond which the long-term productive capability of the stock is jeopardized. It was concluded in Amendment 9 that the Council's quota setting process is more conservative than the rate-based overfishing levels, given the current resource conditions. The Council is no longer focused on the 10 and 30 year supply horizons for these two species as they are relying on the approved overfishing definition for ocean quahogs and the proposed definition for surfclams. The Council used these benchmarks for their annual quota setting since the 2000 stock assessments (Appendices 1 and 2) were completed.

The Amendment 12 surfclam overfishing definition was disapproved in part because of the rapid timing associated with the SFA. The SARC 26 (USDC 1998a) did not have as a "term of reference" the development of an overfishing definition for surfclams because the final SFA guidelines were not available for that SARC to consider. SARC 27 (USDC 1998b) did have as a "term of reference" the development of overfishing definitions for both surfclams and ocean quahogs, however members of SARC 27 felt that they could not constructively comment on surfclam overfishing definitions because they had not reviewed surfclam information. The SARC 27 concluded that: "No new information is available since SAW-26, at which time the SARC recommended that the catch associated with net production would maintain the population in the area(s) being fished."

With the need for a new overfishing definition to meet the SFA requirements for Amendment 12, Council staff worked with several NEFSC scientists to develop the following approach for surfclams, which became the proposed overfishing definition that was disapproved. It is important to remember that the recent SARCs declared that surfclams are"probably under-exploited overall" and ocean quahogs "would be considered under-exploited at the scale of the management unit".

The Amendment 12 overfishing definition had an estimation of MSY which required an estimate of B_{MSY}, the stock biomass that will produce MSY. Due to data limitations for surfclams involving temporal changes in survey dredge catchability as well as lack of information on the relation between productivity and stock biomass, it was not feasible to get an analytic estimate of B_{MSY} from application of quantitative fisheries models. Furthermore, the dominant factor that controlled the size and structure of this stock in the last two decades was the hypoxic event of 1976, which caused mass mortality of surfclams and surfclam predators. Year classes and resulting stock biomasses that occurred after that event were likely atypical of what could be sustained by the resource in the long-term. The current surfclam fishery has been based on harvesting the cohorts that recruited throughout the 1980's and 1990's. A hypoxic event of similar magnitude could occur again in the future, but it can neither be predicted nor controlled.

Given the above timing problems, data limitation, and lack of global coverage, it is not difficult to understand why the Secretary had to disapprove the surfclam definition proposed in Amendment 12. The Council pushed and the SARC concurred that when an additional survey was conducted in 1999, that a term of reference for a new overfishing definition be included. The 30th SARC reviewed this term of reference and recommended only the proposed overfishing definition (Appendix 1). This definition has a biomass target of roughly 1.4 billion pounds, a biomass threshold of roughly700 million pounds, fishing mortality target that is less than the fishing mortality threshold which is defined as the level of natural mortality. The Council unanimously approved the SARC recommendation (Table 1). This definition includes both biomass and fishing mortality targets and thresholds as does the approved overfishing definition for ocean quahogs.

The Amendment 12 overfishing definition for ocean quahogs is MSY based, since it is generally assumed that MSY for harvested populations occurs at one-half the virgin biomass. The 1997 surveyed biomass estimate (roughly 3 billion pounds of meats) is at about 80% of the virgin biomass (roughly 4 billion pounds of meats) and exploitation rates are below $F_{0.1}$, $F_{25\%}$, and F_{max}. The combination of current biomass and F is highly unlikely to represent overfishing, as defined by the current SFA guidelines (NEFSC 1998b). There is however, significant time to determine the exact nature of the sustainability of the resource, since total removals (which have averaged about 40 million pounds/year) over the past two decades have only reduced the virgin biomass by about 20%.

The current biomass is less than the likely carrying capacity (K) of the resource, but well above K/2. Moreover, the current fishing mortality rates are well below existing fishing mortality rate thresholds. Current status of the ocean quahog resource is schematically depicted in Figure 22. The 1997 surveyed biomass estimate (roughly three billion pounds) is at about 80% of the virgin biomass (roughly four billion pounds). This figure suggests that fishing mortality rates are below two alternative action levels and that overall population biomass exceeds levels which would require rebuilding. Nonetheless, 25 years of harvesting appear to have reduced the population in some areas. It is not yet possible to characterize the dynamic response of the population to these decreases in density. In many instances, the recruits that might have been produced as a result of prior reductions are only now becoming vulnerable to the survey dredge. Thus, some caution is necessary in the interpretation of Figure 22.

In conclusion, the overfishing definition "target" for ocean quahogs is one-half the virgin biomass and the $F_{0.1}$ level of fishing mortality for the exploited region. The overfishing definition "threshold" would be one-half B_{MSY} or one-quarter of the virgin biomass (as recommended by the Applegate *et al.* 1998 Overfishing Definition Review Panel report) with an $F_{25\%MSP}$ level of fishing mortality that should never be exceeded. The $F_{25\%}$ MSP level is the threshold level recommended by the NEFSC for Amendment 9 (MAFMC 1996) and reviewed and approved by the MAFMC Scientific and Statistical Committee. Annual quotas will be specified which correspond roughly to the target fishing mortality rate.

Quotas will be set for both of these species by the Regional Administrator according to the FMP. Currently, the quota are set annually, but this amendment allows for multi-year quotas after stock assessments. These multi-year quotas should allow for better planning by industry and reduced paperwork for the Council and NMFS, while not allowing for any additional risk of overfishing.

It must be remembered that there has been effective management of both surfclams and ocean quahogs for the past 25 years. The Council began management of these two resources with the FMP in 1977. (It was the first FMP in the country under the 1976 Magnuson Fishery Conservation and Management Act.) The surfclam resource had collapsed from overfishing (landings plummeted from 96 million pounds in 1974 to 35 million pounds in 1979; Table 1 of Amendment 8) and there was serious Council consideration given to closing the fishery for a few years entirely. A low quota was implemented and by the mid 1980s the resource was rebuilt and the quotas were increased to near what they are today. The original FMP had an MSY estimate of 50 million pounds of meats. This is near the top of the FMP's OY range of 58 million pounds.

The EEZ surfclam resource is where the vast amount of landings come from (Table 33), however all three heavily fished areas (EEZ, New Jersey and New York Territorial Seas) have roughly the same exploitation rate. All three areas appear to be currently managed on a sustainable level.

In summary, the Council has prevented overfishing of these two resources for the past 25 years and fully intends to continue doing so.

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

This FMP is based on the best and most recent scientific information available. Data used include NMFS logbook and permit files and the most recent stock assessments (USDC 2000a and 2000b, both stock assessments are attached as Appendices 1 and 2). Surfclam and ocean quahog assessments should continue to be performed after each NEFSC survey. Significant time and effort was devoted to the essential fish habitat section by NMFS scientists and staff since passage of the SFA in 1996 and the EFH background documents are attached as Appendices 5 and 6. The fishing gear impacts to EFH section of Amendment 12 was disapproved and Council staff has worked extensively with NMFS habitat personnel to thoroughly document and evaluate fishing gear impacts which have resulted in a NMFS report (Appendix 3) and a workshop proceedings (Appendix 4). All six of the above mentioned documents have been published since 1999.

3.1.3 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.

No need to change this section at this time. The management unit is all surfclams and all ocean quahogs in the Atlantic EEZ. In 1988 the American Malacological Union officially changed the common name of "surf clam" to the one word name "surfclam". This was published in the American Fisheries Society special publication 16 entitled *Common and Scientific Names of Aquatic Invertebrates from the United States and Canada: Mollusks* (American Fisheries Society 1988). The ocean quahogs managed in this FMP include a small-scale fishery in eastern Maine that harvests small ocean quahogs which are generally sold for the half-shell market. Locally these small ocean quahogs off the coast of Maine are known as "mahogany quahogs" and have been under Council management since implementation of amendment 10 (MAFMC 1998).

A southern subspecies of surfclam, *Spisula solidissima similis*, occurs south of Cape Hatteras (Walker and Heffernan 1994). Another species, *Spisula raveneli*, occurs in the southern part of the range of *S. solidissima*. This species distinction, based on distribution and morphology (Porter and Schwartz 1981), is controversial (Vecchione and Griffis 1996).

3.1.4 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 ©) carried out in such a manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

No need to change this section at this time. The FMP does not discriminate among residents of different states. It does not differentiate among US 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.

3.1.5 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.

No need to change this section at this time. The management regime of the FMP does not change and 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.

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

No need to change this section at this time. The amendment does not alter the FMP's consistency with this standard. The historical catch basis for allocation that was implemented with

Amendment 8 (MAFMC 1988) takes into account and allows variations in catch. The annual quota review process allows for adjustments to catch levels in response to the condition of the resources.

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

No need to change this section at this time. During the past decade, the ITQ nature of the fishery has minimized government and industries costs associated with the management of these resources. It is not anticipated that any new conservation or management measures will be implemented as a result of either rectifying either of the two disapproved sections from Amendment 12. The other three measures should allow for better industry planning and actually minimize costs for the Council and NMFS.

3.1.8 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.

A complete description of the ports and their reliance on various species, including Atlantic surfclams and ocean quahogs is given in Section 2.3.3. This is a large amount of new descriptive information that was not available previously. The purpose of Amendment 12 was to meet the new Congressional mandates associated with the October 1996 Sustainable Fisheries Act. Therefore, several of the fishing communities along the US east coast north of Cape Hatteras could have been positively impacted by that amendment, especially in the long run since now there is no possibility of overfishing. The major benefit to be realized through implementation of recent amendments to this FMP is that overfishing and over-capitalization in these fisheries will be avoided in the future. There are no conservation and management measures associated with the rectification of the two disapproved portions of amendment 12. The three minor measures for this amendment should not negatively impact on this standard.

The proper management of the stock complexes managed under this FMP through implementation of the management measures described in recent amendments have been beneficial to the commercial fishing communities of the Atlantic Coast. By preventing overfishing of the stocks and overcapitalization of the industry, positive benefits to the fishing communities have and will continue to be realized.

The previously proposed management measures take into account the importance of the fishery resources to the fishing communities. The impacts of the proposed actions on participants in the surfclam and ocean quahog fisheries including analyses of biological, economic, and social impacts are described previously, in the next two sections, and in section 4 of the amendment.

The recently implemented (May 1998) Amendment 10 improves the FMP to better enable it to meet this new National Standard. The major thrust of Amendment 10 was to allow small-scale fishing communities on the coast of Maine to continue to operate as they have historically and under the experimental fishery between October 1990 and September 1997. Amendment 8 regulations did not readily provide for the sustained participation of these fishermen nor their communities, nor did it minimize adverse economic impacts. If Amendment 10 had not been implemented, these small-scale fishing boats and the communities with which they are associated would have been significantly impacted.

3.1.9 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 new 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.

None of the management measures proposed in this amendment will promote or result in increased levels of bycatch relative to the no action. An ITQ program, as in these fisheries, reduces the “race to fish” and therefore significantly reduces bycatch of undesirable species.

The surfclam and ocean quahog fisheries are extremely clean, as evidenced by the 1997 NEFSC clam survey species listing (Table 34). Surfclams and ocean quahogs comprise well over 80% of the total catch from the survey, with no fish caught. Only sea scallops, representing other commercially desirable invertebrates were caught at around one-half of one percent. Commercial operations are certainly even cleaner than the scientific surveys which have liners in the dredges, as all animate and inanimate objects except for surfclams and ocean quahogs are discarded quickly before the resource is placed in the cages. The processors reduce their payments if "things" other than surfclams or ocean quahogs are in the cages.

The range of surfclams and ocean quahogs overlaps with that of marine mammals and endangered species to a large degree, and there always exists some very limited potential for an incidental kill. Except in unique situations (e.g., tuna-porpoise in the central Pacific), such accidental catches should have a negligible impact on marine mammal/endangered species abundance, and the Council does not believe that implementation of this amendment will have any adverse impact upon these populations. While marine mammals may occur near surfclam and ocean quahog beds, it is highly unlikely any significant conflict between the fishermen managed by this amendment and these species would occur. Commercial clam dredging vessels dredge at very slow speeds and healthy animals should have no difficulty avoiding these vessels. Additionally, surfclams and ocean quahogs are benthic organisms, while marine mammals and marine turtles are pelagic and spend nearly all of their time up in the water column or near the surface. The realized reduction in the number of fishing vessels resulting from Amendment 8 reduced the potential for the interaction with endangered species from a minimal to a very minimal level. Furthermore, management of these two bivalves are in the EEZ only, except for the zone in eastern Maine and the only listed endangered fish species, shortnose sturgeon, practically never ventures far from its riverine existence. Bycatch in eastern Maine clam dredges of fish species is extremely minimal (Finlayson pers. comm.). Observations made during the PSP sampling program by the Maine Department of Marine Resources indicate negligible bycatch in the Maine fishery (McGowan pers. comm.).

Relative to the new approach to fisheries management that is being discussed extensively, ecosystem management, a recent paper by Arnason (1998) suggests that an ITQs system offers a potentially fruitful approach to the problem of ecological fisheries management. All fish stocks and their associated fisheries are embedded in an ecosystem. Therefore, to obtain maximum economic benefits, fisheries management must take due account of the corresponding web of ecological interrelationships. Unfortunately, however, due to the inherent complexity of ecosystems and the scarcity of the relevant empirical information, sensible ecological fisheries management is very difficult to achieve in most cases. According to Arnason (1998) the great advantage of the ITQ regime is that it enlists market forces to bring about the optimal utilization of the ecology.

3.1.10 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 of the Magnuson-

Stevens Act. In regard to new 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 the current FMP promote or result in increased levels of unsafe behavior at sea.

None of the management measures proposed in this amendment will promote or result in increased levels of unsafe behavior at sea relative to the no action. The proposed management measures of this Amendment do not limit the times or places when or where vessels may fish. Therefore, the Council has concluded that the proposed Amendment will not affect the safety of vessels fishing in this fishery.

Currently Georges Bank is closed to fishing because of PSP problems for both surfclams and ocean quahogs. Over one quarter of each resource is located on Georges Bank and therefore perhaps the vessels do not have as large of an area to fish as they would have if Georges Bank were opened. However, the clam fishery on Georges Bank has never been extensive and is likely the location with the greatest danger to fishermen. If and when fishermen need that resource, it is anticipated that they will have the clams tested for PSP and may be able to fish there.

Amendment 8 with the implementation of ITQs went far in promoting safety at sea over the previous management regime which focused on effort restrictions. There is no reason why this ITQ fishery is anything but one of the safest commercial fisheries in the entire world.

The Council developed this FMP and subsequent Amendments with the consultation of 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.

It is possible that the proposed vessel monitoring system (VMS) will actually increase the safety at sea for this fishery as Federal officials will be have another system of updated communication with the vessels.

3.2 FISHERY IMPACT STATEMENT

The ports and communities involved in the surfclam and ocean quahog fishery are extensively described in section 2.3.3 of this document. The social impact assessment in section 5 outlines the impacts of the various management measures to the ports and communities.

The economics of the fishery are described in section 2.3, while section 4 describes the economic impacts of the various management alternatives.

3.3 ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

This section presents an analysis of the impacts of the preferred management measurers considered by the Council. These actions were described above in section 1.2. In this section each management measure is analyzed in terms of biological impacts, economic impacts, social impacts, its effects to essential fish habitat, and its effects to marine mammals, sea turtles, and seabirds. This amendment includes a new surfclam overfishing definition, an evaluation of fishing gear impacts to EFH, establishment of multi-year quotas, recommendation to RA to implement an electronic vessel tracking system that is satisfactory to both the NMFS and the industry, and add to the list of framework management measures the suspension of the surfclam minimum size limit and adjustment of the minimum size. No management measures are proposed for the new surfclam overfishing definition, the fishing gear impacts to EFH, multi-year quotas or the addition to the list of framework measures the suspension of the surfclam minimum size limit and adjustment of the minimum size. Only the electronic vessel tracking system issue may have management measures associated with it.

3.3.1 Surfclam Overfishing Definition (Revised)

SURFCLAM OVERFISHING DEFINITIONS – Alternative 1 = Council preferred			
ALTERNATIVE	DESCRIPTION	SECTION DESCRIBED	SECTION EVALUATED
1	New Proposed	1.2.1.1	3.3.1.1
2	Amendment 12 No action	1.2.1.2	3.3.1.2
3	Amendment 9	1.2.1.3	3.3.1.3
4	Amendment 8	1.2.1.4	3.3.1.4

The Council has decided that the OY range will not be changed (the status quo will be maintained) at this time, irrespective of the overfishing definition. New methodology for the stock assessment has been used during the past two assessments and large amounts of uncertainties exist currently with the new approaches (Appendix 1). Just between the last two assessments the natural mortality has been tripled while the dredge efficiency of the research/survey vessel has fallen in half. An addition clam survey was conducted in the summer of 2002 with a new assessment scheduled for June 2003. If comparable methodological approaches produce roughly similar assessment results, it is possible that the OY range may be changed in the future. Without prejudging the results of the just completed survey and upcoming assessment, the Council has decided to be risk averse and will maintain the status quo OY range at this time.

It must be remembered that there has been effective management of both surfclams and ocean quahogs for the past 25 years. The Council began management of these two resources with the FMP in 1977. (It was the first FMP in the country under the 1976 Magnuson Fishery Conservation and Management Act.) The surfclam resource had collapsed from overfishing (landings plummeted from 96 million pounds in 1974 to 35 million pounds in 1979; Table 1 of Amendment 8) and there was serious Council consideration given to closing the fishery for a few years entirely. A low quota was implemented and by the mid 1980s the resource was rebuilt and the quotas were increased to near what they are today. The original FMP had an MSY estimate of 50 million pounds of meats. This is near the top of the FMP's OY range of 58 million pounds. The Council is concerned that any large increase in the OY range at this time could lead to high landings like those experienced in the early 1970s and result in overfishing.

There are four surfclam overfishing alternatives, however only the preferred alternative is likely to meet the requirements associated with National Standard 1 guidelines. It is not an issue that alternatives 2, 3, or 4 would allow overfishing. These three alternatives have allowed rebuilding of the surfclam resource during the late 1970s and 1980s (Alternative 4), allowed the maintenance of a healthy resource during the 1990s (Alternative 3) and actually has one rejected alternative that is more conservative for the resource (Alternative 2) than is the preferred (Alternative 1). The issue is that only Alternative 1 is likely to meet the National Standard guidelines because those guidelines are very specific. Section 600.310 is very specific that the OY is based on MSY, or on MSY as it may be reduced for social, economic and ecological factors. The guidelines call for an "MSY control rule" that means a harvest strategy which, if implemented, would be expected to result in a long-term average catch approximating MSY. The guidelines identify specification of status determination criteria which include maximum fishing mortality threshold and minimum stock size threshold levels. The new National Standard 1 guidelines (after the SFA) comprise over 40% of the text associated with all ten of the national standards. Congress wanted overfishing addressed with the 1996 passage of SFA and NMFS did an extensive job in clarifying what exactly needed to be identified in order to prevent overfishing. It is because of this specificity that Alternative 1 is likely the only one of the four alternatives that can meet the current guidelines but it needs to be emphasized that the previous Council definitions successfully rebuild and then prevented overfishing of the surfclam resource for the past two and a half decades.

3.3.1.1 Alternative 1. The Council unanimously passed the following motion at its March 16, 2000 meeting. The motion establishes an overfishing definition for surfclams as follows:

> *Biomass target = ½ of current biomass as a proxy for Bmsy,*
> *Biomass threshold = ½ of proxy for Bmsy,*
> *Fishing mortality threshold should be F_{MSY}, where the current best proxy for Fmsy is M,*
> *Fishing mortality target will always be set less than the F threshold and will be the F associated with the Council selected quota.*

Finally, the overfishing definition should have an MSY control rule as identified in Figure E6 of the 30th SAW advisory report on stock status. (Figure E6 of the SAW report is Figure 1 of this document.)

Biological Impacts

Surfclams are not overfished, nor do they appear likely to be in the near future. Council policy is to set annual quotas within an OY range (where the OY never exceeds the MSY) for surfclams between 1,850,000 and 3,400,000 bushels (31.5 to 57.8 million pounds of meats) . The OY range will remain at "no action" but will be analyzed after further assessments. The Council will await the results of this summer's assessment to ascertain whether a change in the OY range is warranted. Therefore there is no reason that this new overfishing definition for surfclams will have any biological impacts. Although there is no biological impact of using this definition now because the Council in not changing the OY range, there could be potential impacts in the future because of the application of the new definition. This definition includes the entire resource and as such allows for higher catches than alternative 2 that was proposed in Amendment 12 and which was disapproved because it was not a global definition. While catches could be higher under this definition than any of the other 3 alternatives, the stock is well protected because the best proxy for the fishing mortality threshold is set equal to the natural mortality rate. Setting fishing mortality for a resource below the natural mortality level is generally considered a conservative and certainly sustainable approach in fishery management.

Economic Impacts

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this new surfclam overfishing definition will have any new economic impacts. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EA and an RIR are generated in association with the quota recommendations. Further elaboration and clarification of economic impacts of this measure are discussed in section 4. The different quotas are evaluated in section 4: 1) 2.85 million bushels which was the quota for 2001, 2) 3.135 million bushels which was the quota for 2002, and 3) 3.4 million bushels which is the maximum quota allowed by the OY. These three quotas are evaluated not in relation to the overfishing definition but for their potential economic ramifications relative to EFH restrictions. Although there is no economical impact of using this definition now because the Council in not changing the OY range, there could be potential impacts in the future because of the application of the new definition. This definition includes the entire resource and as such allows for higher catches than alternative 2 that was proposed in Amendment 12 and which was disapproved because it was not a global definition. Although catches could be higher under this definition than any of the other 3 alternatives, the economic impacts are based on both supply and demand and thus higher catches generally, but do not always translate directly to higher dollars.

Social Impacts

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this new surfclam overfishing definition will have any new social impacts. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EA and an RIR are generated in association with the quota recommendations. Further elaboration and clarification of the lack of social impacts of this measure are discussed in section 5. Although there is no social impact of using this definition now because the Council in not changing the OY range, there could be potential impacts in the future because of the application of the new definition. This definition includes the entire resource and as such allows for higher catches than alternative 2 that was proposed in Amendment 12 and which was disapproved because it was not a global definition. Although catches could be higher under this definition than any of the other 3 alternatives, the social impacts are not fully known because the impacts are based on both supply and demand and thus higher catches generally, but do not always translate directly into a better situation for either fishermen or processors.

Effects on Essential Fish Habitat

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this new surfclam overfishing definition will have any impacts on essential fish habitat. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EFH assessment is generated in association with the quota recommendations. Although there is no change to the effects on essential fish habitat of using this definition now because the Council in not changing the OY range, there could be potential impacts in the future because of the application of the new definition. This definition includes the entire resource and as such allows for higher catches than alternative 2 that was proposed in Amendment 12 and which was disapproved because it was not a global definition. Catches could be higher under this definition than any of the other 3 alternatives and thus more effort and therefore more impacts could occur to EFH.

Effects on Protected Species

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this new surfclam overfishing definition will have any impacts on marine mammals, sea turtles or seabirds. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EA is generated in association with the quota recommendations. The fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species.

Activities conducted under this amendment have not yet been considered for their impacts on endangered species in order to do a Section 7 of the Endangered Species Act consultation. The

NMFS will be performing a Section 7 consultation while the amendment 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 amendment. The fishing activities pursuant to this amendment should not affect endangered, threatened, or protected species in any manner not considered in prior consultations on this fishery.

Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

The range of surfclams, ocean quahogs, and the section 6.1.3.1 marine mammals and endangered species overlap to a large degree, and there always exists some very limited potential for an incidental kill. Except in unique situations (e.g., tuna-porpoise in the central Pacific), such accidental catches should have a negligible impact on marine mammal/endangered species abundances. The Council does not believe that implementation of this amendment will have any adverse impact upon these populations. While marine mammals and endangered species may occur near surfclam and ocean quahogs beds, it is highly unlikely any significant conflict between the fishermen managed by this FMP and these species would occur. Clam vessels dredge at very slow speeds and healthy animals should have no difficulty avoiding these vessels. Additionally, surfclams and ocean quahogs are benthic organisms, while marine mammals and marine turtles are mostly pelagic and spend nearly all of their time up in the water column or near the surface as do, of course, seabirds.

The clam dredges managed under this FMP are not listed at all for the final List of Fisheries for 2001 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. No surfclam or ocean quahog fisheries are in this category.

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. No surfclam or ocean quahog 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 mixed species trawl fishery (where most bluefish are commercially caught) is considered a Category III fishery. No surfclam or ocean quahog fisheries are currently in this category, however when these fisheries are listed, they will be most likely listed in this category (Mantzaris pers. comm.).

3.3.1.2 Alternative 2 -- The disapproved definition from Amendment 12 is included here in this amendment for comparison.

Biomass target = 1997 NNJ biomass as a proxy for Bmsy (900 million pounds),
Biomass threshold = ½ of proxy for Bmsy (450 million pounds),
Fishing mortality threshold = F_{po} *which is the equilibrium replacement rate for NNJ (0.05),*
Fishing mortality target =$F_{20\% MSP}$ *(0.18)* .

Biological Impacts

Surfclams are not overfished, nor do they appear likely to be in the near future. Council policy is to set annual quotas within an OY range (where the OY never exceeds the MSY) for surfclams between 1,850,000 and 3,400,000 bushels (31.5 to 57.8 million pounds of meats) . The OY range will remain at "status quo" but will be analyzed after further assessments. The Council will await the results of this summer's assessment to ascertain whether a change in the OY range is warranted. Therefore there is no reason that this overfishing definition for surfclams will have any biological impacts. Although there is no biological impact of using this definition now because the Council in not changing the OY range, there could be potential impacts in the future because of the application of the new definition. This definition does not include the entire resource and as such allows for lower catches than alternative 1. This definition may allow localized overfishing since it is applicable to only the New Jersey area.

Economic Impacts

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this surfclam overfishing definition will have any new economic impacts. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EA and an RIR are generated in association with the quota recommendations. Further elaboration and clarification of economic impacts of this measure are discussed in section 4. The different quotas are evaluated in section 4: 1) 2.85 million bushels which was the quota for 2001, 2) 3.135 million bushels which was the quota for 2002, and 3) 3.4 million bushels which is the maximum quota allowed by the OY. These three quotas are evaluated not in relation to the overfishing definition but for their potential economic ramifications relative to EFH restrictions. Although there is no economic impact of using this definition now because the Council in not changing the OY range, there could be potential impacts in the future because of the application of the new definition. This definition does not include the entire resource and as such allows for lower catches than alternative 1. This definition would allow for less economic gains than alternative 1.

Social Impacts

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this surfclam overfishing definition will have any new social impacts. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EA and an RIR are generated in association with the quota recommendations. Further elaboration and clarification of the lack of social impacts of this measure are discussed in section 5. Although there is no social impact of using this definition now because the Council in not changing the OY range, there could be potential impacts in the future because of the application of the new definition. This definition does not include the entire resource and as such allows for lower catches than alternative 1. This definition would allow for less social gains than alternative 1.

Effects on Essential Fish Habitat

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this surfclam overfishing definition will have any impacts on essential fish habitat. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EFH assessment is generated in association with the quota recommendations. Although there is no effects on essential fish habitat of using this definition now because the Council in not changing the OY range, there could be potential impacts in the future because of the application of the new definition. This definition does not include the entire resource and as such allows for more concentration of effort of the fishing industry in New Jersey and thus could cause more localized impacts to EFH.

Effects on Protected Species

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this surfclam overfishing definition will have any impacts on marine mammals, sea turtles or seabirds. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EA is generated in association with the quota recommendations. The fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species.

3.3.1.3 Alternative 3 -- The pre-SFA Amendment 9 (MAFMC 1996) definition also is included for comparison.

Biological Impacts

Surfclams are not overfished, nor do they appear likely to be in the near future. Council policy is to set annual quotas within an OY range (where the OY never exceeds the MSY) for surfclams between 1,850,000 and 3,400,000 bushels (31.5 to 57.8 million pounds of meats) . The OY range will remain at "status quo" but will be analyzed after further assessments. The Council will await the results of this summer's assessment to ascertain whether a change in the OY range is warranted. Therefore there is no reason that this overfishing definition for surfclams will have any biological impacts. Although there is no biological impact of using this definition now because the Council in not changing the OY range, there could be potential impacts in the future because of the application of a definition. This definition has only a fishing mortality level (F = 0.18) which will allow higher levels of catches than the preferred. While overfishing has not occurred under this definition (since 1996) it is more risky than alternative 1.

Economic Impacts

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this former surfclam overfishing definition will have any new economic impacts. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EA and an RIR are generated in association with the quota recommendations. Further elaboration and clarification of economic impacts of this measure are discussed in section 4. The different quotas are evaluated in section 4: 1) 2.85 million bushels which was the quota for 2001, 2) 3.135 million bushels which was the quota for 2002, and 3) 3.4 million bushels which is the maximum quota allowed by the OY. These three quotas are evaluated not in relation to the overfishing definition but for their potential economic ramifications relative to EFH restrictions. Although there is no economic impact of using this definition now because the Council in not changing the OY range, there could be potential impacts in the future because of the application of a definition. This definition has only a fishing mortality level (F = 0.18) which will allow higher levels of catches than the preferred. Thus, assuming a direct relationship between supply and demand, the higher the catches the higher the economic benefits.

Social Impacts

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this surfclam overfishing definition will have any different social impacts. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EA and an RIR are generated in association with the quota recommendations. Further elaboration and clarification of the lack of social impacts of this measure are discussed in section 5. Although there is no social impact of using this definition now because the Council in not changing the OY range, there could be potential impacts in the future because of the application of a definition. This definition has only a fishing mortality level (F = 0.18) which will allow higher levels of catches than the preferred. Thus, assuming a direct relationship between supply and demand, the higher the catches the greater the social benefits.

Effects on Essential Fish Habitat

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this surfclam overfishing definition will have any impacts on essential fish habitat. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EFH assessment is generated in association with the quota recommendations. Although there is no direct effects of this alternative on essential fish habitat from using this definition now because the Council in not changing the OY range, there could be potential impacts in the future because of the application of a definition. This definition has only a fishing mortality level (F = 0.18) which will allow higher levels of catches than the preferred. Thus, assuming a direct relationship between catches and effort, there could potentially be more of an impact to EFH as catches increase.

Effects on Protected Species

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this surfclam overfishing definition will have any impacts on marine mammals, sea turtles or seabirds. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EA is generated in association with the quota recommendations. The fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species.

3.1.1.4 Alternative 4 -- The Amendment 8 (MAFMC 1988) and earlier amendments all the way back to the original FMP (MAFMC 1977) had an MSY estimate of 2.9 million bushels for surfclams, which is approximately 50 million pounds of shucked meats, for the mid-Atlantic portion of the resource.

Biological Impacts

Surfclams are not overfished, nor do they appear likely to be in the near future. Council policy is to set annual quotas within an OY range (where the OY never exceeds the MSY) for surfclams between 1,850,000 and 3,400,000 bushels (31.5 to 57.8 million pounds of meats) . The OY range will remain at "status quo" but will be analyzed after further assessments. The Council will await the results of this summer's assessment to ascertain whether a change in the OY range is warranted. Therefore there is no reason that this former overfishing definition for surfclams will have any biological impacts. The OY range was initially based on this MSY definition and thus would not be able to be changed if this alternative was implemented.

Economic Impacts

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this former surfclam overfishing definition will have any new economic impacts. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EA and an RIR are generated in association with the quota recommendations. Further elaboration and clarification of economic impacts of this measure are discussed in section 4. The different quotas are evaluated in section 4: 1) 2.85 million bushels which was the quota for 2001, 2) 3.135 million bushels which was the quota for 2002, and 3) 3.4 million bushels which is the maximum quota allowed by the OY. These three quotas are evaluated not in relation to the overfishing definition but for their potential economic ramifications relative to EFH restrictions. The OY range was initially based on this MSY definition and thus would not be able to be changed if this alternative was implemented.

Social Impacts

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this surfclam overfishing definition will have any different social impacts. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EA and an RIR are generated in association with the quota recommendations. Further elaboration and clarification of the lack of social impacts of this measure are discussed in section 5. The OY range was initially based on this MSY definition and thus would not be able to be changed if this alternative was implemented.

Effects on Essential Fish Habitat

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this surfclam overfishing definition will have any impacts on essential fish habitat. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EFH assessment is generated in association with the quota recommendations. The OY range was initially based on this MSY definition and thus would not be able to be changed if this alternative was implemented.

Effects on Protected Species

The OY range will remain at "status quo" but will be analyzed after further assessments. Therefore there is no reason that this surfclam overfishing definition will have any impacts on marine mammals, sea turtles or seabirds. The quota recommendations that the Council submits to the Regional Administrator have a full evaluation of the quota and the upper and lower ranges considered. An EA is generated in association with the quota recommendations. The fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species.

3.3.2 Minimization of Fishing Gear Impacts to EFH (Revised)

FISHING GEAR IMPACTS TO EFH – Alternative 1 = Council preferred			
ALTERNATIVE	DESCRIPTION	SECTION DESCRIBED	SECTION EVALUATED
1	No Action	1.2.2.1	3.3.2.1
2	Closed – Georges Bank	1.2.2.2	3.3.2.2
3	Closed – Southern New England east	1.2.2.3	3.3.2.3
4*	Closed – Nearshore Around Estuaries	1.2.2.4	3.3.2.4
5*	Closed – Hudson Canyon	1.2.2.5	3.3.2.5
6	Closed – Tilefish HAPC	1.2.2.6	3.3.2.6
7*	Closed – Maine EEZ	1.2.2.7	3.3.2.7
8*	Closed – Maine Zone 1	1.2.2.8	3.3.2.8
9*	Surfclam Increase, Ocean Quahog Decrease	1.2.2.9	3.3.2.9

*Council considered but rejected for thorough economic, social, etc. analysis.

Although the Council has concluded that the clam fishery has an adverse effect on EFH that is no more than minimal and temporary in nature, there is enough uncertainty to warrant the evaluation of other measures that may be taken in light of this uncertainty. Based upon guidance from the Assistant Administrator (January 22, 2001), if information is inconclusive, a NEPA analysis should examine alternatives that could be taken in the face of uncertainty. For NEPA purposes, the guidance from the AA stated that the analysis of alternatives needs to consider explicitly a range of management measures for minimizing potential adverse effects, and the practicability and consequences of adopting those measures. The advise from Dr. Hogarth continues: "In other words, if there is evidence that a fishing practice may be having an identifiable adverse effect on EFH, even if there is no conclusive proof of adverse effects, it is not sufficient to conclude *prima facie* that no new management measures are necessary without first conducting a reasonably detailed alternatives analysis."

The Council evaluated nine alternatives that focused mostly on closed areas. The fishing gear impacts workshop (Appendix 4) concluded that effort reductions (i.e. harvest limits) and gear modifications (i.e. restrictions) were not workable for this fishery and that if the clam dredges were found to have significant adverse effects on EFH, then spatial closures were the only viable alternative to mitigate the adverse effects of this fishing gear. Since surfclams are underfished and the annual quotas are actually being increased (Table 27), it seems to make little sense to restrict harvest limits for EFH reasons, however there is an alternative for analysis where the ocean quahog optimum yield range would be reduced to trade off against an increase in surfclam quota. Finally, seven potential closed area alternatives were identified. These closed areas are being considered to be closed to clam dredging for 5 years. The distribution of the surfclam and ocean quahog resources based on the 1999 survey are depicted in Figures 5 through 8. Landings of the two species in 2000 are shown in Figures 9 and 10.

Of the nine alternatives that the Council considered initially relative to fishing gear impacts to EFH, four were thoroughly evaluated for their biological, economic, and social impacts. The Council did not thoroughly evaluate alternatives 5, 7, 8, and 9 for social and economic impacts because they determined that these closures were not reasonable with all of the data uncertainties associated with each alternative. The Council eliminated alternative 4 for thorough evaluation because it is in shallow water and storm events are much more significant at causing sediment disturbances in those depths than is hydraulic clamming activity.

3.3.2.1 Alternative 1 – This alternative -- no action, with additional clarification is again the preferred alternative after the fishing gear impacts workshop. The Council has implemented many regulations that have directly and indirectly acted to reduce fishing gear impacts on EFH. The foremost management regulation is that of implementing ITQs which has significantly reduced gear impacts on bottom habitat since fishing effort was so significantly reduced and there is no longer a "race to fish" as is common of so many effort restricted fisheries. With the lack of the race to fish, industry delivers a better product to the processing plants, bycatch is minimized, minimal short-term damage to habitat occurs, and fishermen become better conservationists because the ITQs are based on a percentage of the total allowable harvest. Thus, ITQs encourage fishermen to use their collective and very innovative minds to enhance future stocks and their environments.

Biological Impacts

The preferred, no action, alternative for fishing gear impacts to EFH does not have any management measures associated in this amendment and therefore will not have any new biological impacts. There is no change in the amount of fishing effort or harvest allowed. There is no known stock/recruitment relationship for either surfclams or ocean quahogs so it is very difficult to speculate or document any biological benefits for any of the alternatives.

Economic Impacts

The preferred, no action, alternative for fishing gear impacts to EFH does not have any management measures associated in this amendment and therefore will not have any new economic impacts. There is no change in the amount of fishing effort or harvest allowed. Section 4.8 describes that there would be no economic impact associated with this alternative.

Social Impacts

The preferred, no action, alternative for fishing gear impacts to EFH does not have any management measures associated in this amendment and therefore will not have any new social impacts. There is no change in the amount of fishing effort or harvest allowed. Section 5.3 describes that there would be no social impact associated with this alternative.

Effects on Essential Fish Habitat

The preferred, no action, alternative for fishing gear impacts to EFH does not have any management measures associated with it in this amendment and therefore will not have any new effects on essential fish habitat. There is no change in the amount of fishing effort or harvest allowed with this alternative. Section 2.2.5 describes the fishing activities that may adversely affect EFH.

Any mobile gear that comes into contact with the seafloor in surfclam and ocean quahog EFH may potentially have an impact to these immobile benthic organisms (MAFMC 1998). The gears expected to have the most adverse impact are hydraulic clam dredges and the scallop dredges (MAFMC 1998). EFH for surfclams and ocean quahogs is defined in section 2.2.3 and can be seen in Figures 30 and 31 for surfclams and 32 and 33 for ocean quahogs.

Section 2.2.5.4.3.2 discusses the impacts and recovery from hydraulic clam dredges. The Council considered the numerous studies identified and the fact that the surfclam and ocean quahog fisheries are ITQ fisheries. As ITQ fisheries there is no reason that fishermen have to "rush to fish". One of the great benefits of ITQ fisheries from around the world is that it instills the sense of private property rights and ownership in the resource. Fishermen in these fisheries understand that they are not time driven to rape the resource and that by protecting the resource and its environment they are protecting their long term livelihoods. Unquestionably, ITQs and the way clams are now fished alleviate some environmental damage (Wallace pers. comm.)

The numbers of surfclam and ocean quahog fishermen have also decreased significantly with the implementation of ITQs. In 1979 there were 162 permitted surfclamming vessels. That number had fallen to 135 vessels the year before (1989) implementation of the ITQ program, and by 2001 the number was only 35. For ocean quahogs the number of vessels were: 59 in 1979, 69 in 1989 and 30 in 2001. Most of these current vessels also use sorting machines which make it possible to harvest broken clams which are now not discarded.

A brief discussion on the concept of reserves, or areas where clam dredging would not be allowed, occurred at the June 1998 SARC. The idea of reserves was dismissed at this time by the SARC when it was quickly calculated that the greatest possible impact to the bottom, of all the clam dredging for an entire year, would be less than 100 square miles per year. Putting this in context, this 100 square miles is roughly the area of one ten minute by ten minute square. There are over 1200 ten minute squares in the EEZ between Cape Hatteras and Georges Bank. This also represents a small fraction of area encompassed by the vulnerable EFH described in section 2.2.5.5.2.

Under the current management regime, surfclams and ocean quahogs are well managed and certainly not near overfished. (The surfclam resource was overfished in the 1970s prior to management, but was rebuilt during the early 1980s.) Thus a sustainable fishery is possible without creating additional measures to protect surfclam and ocean quahog EFH, i.e., the measures that are currently in place are sufficient to allow for a maximum sustainable yield fishery.

The Council concluded that there may be potential adverse effects on EFH from the hydraulic clam dredge, but concurred with the workshop panel (Appendix 4) that as the clam fishery is currently prosecuted, any adverse impacts are temporary and minimal in nature. The worst case scenario would indicate that any impacts to the habitat are spread over a large uniform area of high energy sand while the fishery is effecting a relatively small proportion of this overall sandy area overall. Based upon the qualitative draft assessment approach (Stevenson *et al.* in press) of the information presented in section 2.2.5.5.2 some potentially vulnerable EFH for juvenile scup, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops could be impacted by hydraulic clam dredges with this alternative.

The clam resources are concentrated in high energy sandy sediment and the fishing gear has evolved over the past five decades to fish most efficiently in this type of sandy sediment. This evolution of the fishing gear has minimized the effect on fishery habitat (Wallace and Hoff in press). Natural events have more effect on the benthic community than this type of fishing gear since all of the fishing activity takes place in sandy shallow water. Chiarella *et al.* (2002) describing the October 2001 workshop concluded that hydraulic clam dredges were not a major concern relative to otter trawls and scallop dredges. All of the hydraulic clam dredging for an entire year, would impact about 100 square miles of bottom (Table 2). Putting this in context, this 100 square miles is roughly the area of one ten minute square, and there are over 1200 ten minute squares in the EEZ between Cape Hatteras and Georges Bank. Thus, it does not appear that either surfclam or ocean quahog EFH is effected by fishing gear.

Based upon existing information the Council concluded that there may be potential adverse effects on EFH from the hydraulic clam dredge, but concurred with the workshop panel (Appendix 4). The panel concluded that as the clam fishery is currently prosecuted, in sand habitats, there are potentially large, localized impacts to biological and physical structure, however the recovery time is relatively short. Since the recovery time is relatively short (hours to months) the adverse impacts to this high energy environment can be considered temporary. The preamble to the EFH Final Rule (50 CFR Part 600) defines temporary impacts as those that are limited in duration and that allow the particular environment to recover without measurable impact. Since these impacts are potentially effecting a relatively small portion (approximately 100 square nautical miles) of the overall large uniform area of high energy sand along the continental shelf (approximately 54,900 square nautical miles) these adverse impacts can be considered minimal. Additionally, the 100 square nautical miles impact each year (approximately 1.5 ten minute squares of latitude and longitude) represents a small fraction of the total EFH of the above listed vulnerable EFH and species. The preamble of the EFH Final Rule defines minimal impacts as those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions.

The no action alternative includes rebuilding plans that govern the management of 26 out of 42 stocks managed in the Northeast (NMFS 2002). National Standard 1 requires that the Councils "specify a time period to rebuild" overfished stocks or stock complexes. In cases where overfishing is occurring the Councils are required to "end overfishing". National Standard 1 indicates that "a stock or stock complex that is below the size that would produce MSY should be harvested at a lower rate or level of fishing mortality than if the stock or stock complex were above the size that would produce MSY." As such, reductions in fishing mortality have been and will continue to be implemented through out the rebuilding periods for these 26 overfished stocks. Reductions in fishing mortality result in decreases in fishing effort, which generally translate into less fishing effort ant thus an overall reduction in impacts of fishing gear on the EFH of the managed species, as well as other species' EFH.

Once a stock is rebuilt, the fishing mortality will remain at F_{msy} (or a proxy such as F_{max}). As stock size increases, quotas will increase under a specific fishing mortality. However, CPUE will also increase. While increases in participation in the fishery due to latent effort may accompany higher quotas for some species, a higher CPUE and a constant or decreasing target fishing mortality should mean that overall fishing effort will likely continue to decline for many species in the Northeast region.

The majority of the stocks managed in the Northeast region have experienced and/or will continue to experience declines in fish mortality while being managed under rebuilding plans. Overall reductions in fishing mortality, and thus, fishing effort, have had the beneficial impact of improving stock status and protecting EFH. In addition to reductions in fishing mortality, the two Northeast Regional Councils have proposed many other measures that have more directly acted to reduce fishing gear impacts on EFH. Such regulations include gear restricted areas, area closures, and restrictions on roller rig gear. These measures also help to improve the status of the stocks while conserving marine habitat. To date, improving stock status for numerous species in the Northeast is evidence of positive cumulative biological impacts resulting from the current management systems.

Summary of Environmental Consequences on EFH from the No Action Alternative

1. Drastic effort reductions in the surfclam and ocean quahog fishery have led to lessened impacts to bottom habitats.
2. Area affected by the fishery is predominantly high energy sand environment with rapid habitat recovery rates.
3. Area affected each year by hydraulic clam dredges is relatively small, 100 square nautical miles, compared to the total sandy areas on the continental shelf (54,900 square nautical miles) and the area encompassed by the potentially vulnerable EFH.
4. Effort reductions within other fisheries provide cumulative net benefit to EFH by reducing overall impacts by bottom-tending mobile gear.

Effects on Protected Species

The preferred, no action, alternative for fishing gear impacts to EFH does not have any management measures associated in this Amendment and therefore will not have any new impacts. There is no change in the amount of fishing effort or harvest allowed. Thus, the fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

Practicability Analysis

According to the EFH Final Rule [50 CFR Section 600.815 (2)(ii)], "...FMPs should identify a range of potential new actions that could be taken to address adverse effects on EFH, include an analysis of the practicability of potential new actions, and adopt any new measures that are necessary and practicable...." Thus, a "Practicability Analysis" was added as a subsection.

Section 600.815(2)(iii) states that "In determining whether it is practicable to minimize an adverse effect from fishing, Councils should consider the nature and extent of the adverse effect on EFH and long-term and short-term costs and benefits of potential management measures to EFH, associated fisheries, and the nation, consistent with National Standard 7...."

Under the current management regime, surfclams and ocean quahogs are well managed and certainly not near overfished. (The surfclam resource was overfished in the 1970s prior to management, but was rebuilt during the early 1980s.) Thus a sustainable fishery is possible without creating additional measures to protect surfclam and ocean quahog EFH, i.e., the measures that are currently in place are sufficient to allow for a maximum sustainable yield fishery. Although the EFH for juvenile scup, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops are potentially vulnerable to hydraulic clam dredges, the high energy sandy nature of this habitat feature makes it less susceptible to long-term impacts compared to the more structure oriented habitats also utilized by the above species.

This alternative meets the requirement of the EFH Final rule that the Council must minimize the adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely effects EFH in a manner that is more than minimal and not temporary in nature. As discussed above, although the hydraulic clam dredge utilized in this fishery may be associated with potential adverse effects to EFH, those effects are considered to be minimal and temporary. However, based upon existing information, there are some uncertainties associated with this determination.

Maintaining the no action will not require the industry to incur any additional short or long-term costs. The short-term benefit of current regulations is that the resources are not overfished which could allow quotas to increase. The long-term benefit of maintaining the current regulations will allow the resources to remain healthy and will provide with additional protection for habitat. This management alternative is consistent with National Standard 7 which requires that management measures "minimize costs and avoid unnecessary duplication." It is the determination of the Council that this management measure is practicable, relative to the criteria set forth in the EFH Final Rule [50 CFR section 600.815 (2) (iii)].

3.3.2.2 Alternative 2 -- Prohibit clam dredging on Georges Bank east of 69 degrees.
Currently harvesting of surfclams and ocean quahogs are prohibited east of 69 degrees (Figure 11) because of PSP. The possibility of PSP toxin in the clams has basically closed Georges Bank since 1990. This alternative, as are all the closed area alternatives would continue this closure for five years after implementation of the amendment. After five years, the EFH closure of the area would be removed.

Biological Impacts

Continuing the closure of Georges Bank because of PSP for the next five years would have no biological impacts because the area has been closed since 1990. Only the scientific surveys conducted by the NEFSC in the past decade have produced surfclams and ocean quahogs collected with hydraulic dredges from this area. From Figures 18 and 19, one can see that continued closure of the Georges Bank region removes 21% of the surfclam and 36% of the ocean quahog resources to fishermen. This area can certainly be considered a spawning ground that can benefit the entire range of the resource since larvae of these two species remain in the water column for weeks and even months at times. Water current movement off of Georges Banks is generally westerly and southernly along the US east coast. There is no change in the amount of fishing effort, areas fished, or harvest allowed under this alternative, and thus this is equivalent to the no action alternative in terms of impacts.

Economic Impacts

Continuing the closure of Georges Bank because of PSP for the next five years would have no economic impacts because the area has been closed since 1990. Only the scientific surveys conducted by the NEFSC in the past decade have produced surfclams and ocean quahogs collected with hydraulic dredges from this area. From Figures 18 and 19, one can see that continued closure of the Georges Bank region removes 21% of the surfclam and 36% of the ocean quahog resources to fishermen. There is no change in the amount of fishing effort, areas fished, or harvest allowed under this alternative, and thus this is equivalent to the no action alternative in terms of impacts. Section 4.8 describes that there would be no economic impact or changes in any of the economic performance measures or net benefits associated with this alternative.

Social Impacts

Continuing the closure of Georges Bank because of PSP for the next five years would have no social impacts because the area has been closed since 1990. Only the scientific surveys conducted by the NEFSC in the past decade have produced surfclams and ocean quahogs collected with hydraulic dredges from this area. From Figures 18 and 19, one can see that continued closure of the Georges Bank region removes 21% of the surfclam and 36% of the ocean quahog resources to fishermen. There is no change in the amount of fishing effort, areas fished, or harvest allowed under this alternative, and thus this is equivalent to the no action alternative in terms of impacts. Section 5.3 describes that there would be no immediate social impact associated with this alternative because they involve no specific changes.

Effects on Essential Fish Habitat

Continuing the closure of Georges Bank because of PSP for the next five years would have the same environment consequences to essential fish habitat as the no action alternative because the area has been closed since 1990. Only the scientific surveys conducted by the NEFSC in the past decade have produced surfclams and ocean quahogs collected with hydraulic dredges from this area. From Figures 18 and 19, one can see that continued closure of the Georges Bank region removes 21% of the surfclam and 36% of the ocean quahog resources to fishermen. There is no change in the amount of fishing effort, areas fished, or harvest allowed under this alternative, and thus this is equivalent to the no action alternative in terms of impacts. Section 2.2.5 describes the fishing activities that may adversely affect EFH. The equivalent section for alternative one of this issue also fully describes the information the Council used in their deliberations. Based upon the qualitative draft assessment approach (Stevenson *et al.* in press) of the information presented in section 2.2.5.5.2 some potentially vulnerable EFH for juvenile scup, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops could be impacted by hydraulic clam dredges if this area becomes accessible in the future.

Effects on Protected Species

Continuing the closure of Georges Bank because of PSP for the next five years would have no impacts because the area has been closed since 1990. Only the scientific surveys conducted by the NEFSC in the past decade have produced surfclams and ocean quahogs collected with hydraulic dredges from this area. From Figures 18 and 19, one can see that continued closure of the Georges Bank region removes 21% of the surfclam and 36% of the ocean quahog resources to fishermen. There is no change in the amount of fishing effort, areas fished, or harvest allowed under this alternative, and thus this is equivalent to the no action alternative in terms of impacts.

The fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

Practicability Analysis

Georges Bank has been closed to clam harvesting since 1990 because of PSP, and the continuation of that closure for the next five years would have no impact. Only the scientific surveys conducted by the NEFSC in the past decade have produced surfclams and ocean quahogs collected with hydraulic dredges from this area. From Figures 18 and 19, one can see that continued closure of the Georges Bank region removes 21% of the surfclam and 36% of the ocean quahog resources to fishermen. This area can certainly be considered a spawning ground that can benefit the entire range of the resource since larvae of these two species remain in the water column for weeks and even months at times. Water current movement off of Georges Banks is generally westerly and southernly along the US east coast. However, surfclams are considered underfished and for ocean quahogs, the resource is neither overfished nor is overfishing occurring. There is no change in the amount of fishing effort, areas fished, or harvest allowed under this alternative, and thus this is equivalent to the no action alternative in terms of impacts. There are no short term benefits or costs since the area has been closed for PSP for more than the past decade. The risks associated with opening this area and PSP getting to humans from clams harvested here may be small, however the potential negativity associated with this scenario is so large that industry is very reluctant to advocate reopening. Obviously, neither the resource nor the fishery is dependent on this area for sustainability.

Under the current management regime, surfclams and ocean quahogs are well managed and certainly not near overfished. (The surfclam resource was overfished in the 1970s prior to management, but was rebuilt during the early 1980s.) Thus a sustainable fishery is possible without creating additional measures to protect surfclam and ocean quahog EFH, i.e., the measures that are currently in place are sufficient to allow for a maximum sustainable yield fishery. Although the EFH for juvenile scup, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops are potentially vulnerable to hydraulic clam dredges, the high energy sandy nature of this habitat feature makes it less susceptible to long-term impacts compared to the more structure oriented habitats also utilized by the above species.

This alternative meets the requirement of the EFH Final rule that the Council must minimize the adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely effects EFH in a manner that is more than minimal and not temporary in nature. As discussed above, although the hydraulic clam dredge utilized in this fishery may be associated with potential adverse effects to EFH, those effects are considered to be minimal and temporary. However, based upon existing information, there are some uncertainties associated with this determination.

It is the determination of the Council that the adoption of this alternative is not necessary or practicable according to the criteria set forth in 50 CFR section 600.815(2)(iii).

3.3.2.3 Alternative 3 -- Prohibit hydraulic clam dredging east of 70 degrees, 20 minutes. This closed area alternative (Figure 11) is an alternative, once considered for the NEFMC Amendment 13 for groundfish. The hypothesis is that hydraulic clam dredging in southern New England may interfere with successful yellowtail flounder reproduction. Note that only hydraulic clam dredging is being prohibited and that this alternative does not affect the Maine ocean quahog fishery. This alternative, as are all the closed area alternatives would continue this closure for five years after implementation of the amendment.

Biological Impacts

Expanding the closure of Georges Bank west to 70 degrees, 20 minutes, would have major biological impacts. Weinberg (pers. comm.) estimates that an additional 12% of the ocean quahog resource and a small amount of surfclams occur in this area. Adding this closure to that of the Georges Bank region removes nearly a quarter of the surfclam and nearly half of the ocean quahog resources to fishermen. There would be major changes in the amount of fishing effort and areas fished under this alternative. The remaining open areas would have to withstand additional fishing effort and harvest. The qualitative EFH vulnerability analysis conducted by Stevenson *et al.* (in press) notes that juvenile and adult yellowtail flounder EFH is vulnerable to hydraulic clam dredges, due to the potential effects on infaunal yellowtail prey. Section 600.815 (a)(7) of the EFH Final Rule states that "loss of prey may be an adverse effect on EFH and managed species". It is possible that the closure outlined in this alternative could minimize such impacts.

Economic Impacts

Expanding the closure of Georges Bank west to 70 degrees, 20 minutes, could have economic impacts. Weinberg (pers. comm.) estimates that an additional 12% of the ocean quahog resource and a small amount of surfclams occur in this area. Adding this closure to that of the Georges Bank region removes nearly a quarter of the surfclam and nearly half of the ocean quahog resources to fishermen. There could be major changes in the amount of fishing effort, and areas fished allowed under this alternative. The remaining open areas would have to withstand additional fishing effort and harvest. Under this alternative, vessels landing ocean quahogs can switch to areas having equal or higher densities of ocean quahogs and likely take the same number of trips as before. Section 4.8 describes that there would be little economic impact or changes in any of the economic performance measures or net benefits associated with this alternative.

Social Impacts

Expanding the closure of Georges Bank west to 70 degrees, 20 minutes, would have significant social impacts. Weinberg (pers. comm.) estimates that an additional 12% of the ocean quahog resource and a small amount of surfclams occur in this area. Adding this closure to that of the

Georges Bank region removes nearly a quarter of the surfclam and nearly half of the ocean quahog resources to fishermen. There could be major changes in the amount of fishing effort, areas fished, or harvest allowed under this alternative. The remaining open areas would have to withstand additional fishing effort and harvest. Fully 60% of the ocean quahog landings in New Bedford, MA in 2000, came from the area designated in this alternative. Section 5.3 describes that there would be immediate social impacts associated with this alternative because they would result in either the processors moving east and south with the vessels or additional transportation costs would be incurred in order to keep the plants in New England operating.

Effects on Essential Fish Habitat

Expanding the closure of Georges Bank west to 70 degrees, 20 minutes, could have some beneficial effects on essential fish habitat. There would be major changes in the areas fished under this alternative. The remaining open areas would have to withstand additional fishing effort and harvest. There is no evidence to support the hypothesis that hydraulic clam dredging in southern New England is interfering with successful yellowtail flounder reproduction. However, the qualitative EFH vulnerability analysis conducted by Stevenson *et al.* (in press) notes that juvenile and adult yellowtail flounder EFH is vulnerable to hydraulic clam dredges, due to the potential effects on infaunal yellowtail prey. Section 600.815 (a)(7) of the EFH final rule states that "loss of prey may be an adverse effect on EFH and managed species". In addition, this closed area alternative would have benefits on EFH of other federally managed species. The analysis in Stevenson *et al.* (in press) notes that the EFH of seven species are vulnerable to hydraulic clam dredges. These species include black sea bass (juveniles and adults), scup (juveniles), ocean pout (all life stages), red hake (juveniles), silver hake (juveniles) winter flounder (juveniles and adults), and Atlantic sea scallops (juveniles). For this alternative, where the EFH for the species listed above with the closed area, a prohibition of hydraulic clam dredges could have a benefit to EFH. Section 2.2.5 identifies the fishing activities that may adversely affect EFH. The equivalent section for alternative one of this issue also fully describes the information the Council used in their deliberations. Based upon the qualitative draft assessment approach (Stevenson *et al.* in press) of the information presented in section 2.2.5.5.2 some potentially vulnerable EFH for juvenile scup, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops could be benefitted by this alternative. However, this alternative would only prohibit the use of hydraulic clam dredges. Other gear including otter trawls and scallop dredges would continue to be used thereby minimizing potential benefits of this alternative to EFH.

Effects on Protected Species

Expanding the closure of Georges Bank west to 70 degrees, 20 minutes, could have some impacts. Weinberg (pers. comm.) estimates that an additional 12% of the ocean quahog resource and a small amount of surfclams occur in this area. Adding this closure to that of the Georges Bank region removes nearly a quarter of the surfclam and nearly half of the ocean quahog resources to fishermen. There would be major shifts in the areas fished under this alternative. The remaining open areas would have to withstand additional fishing effort and harvest. The fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species and as such, there is no direct cost or benefits to these species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

Practicability Analysis

As stated above, there is no evidence to support the hypothesis that hydraulic clam dredging in southern New England is interfering with successful yellowtail flounder reproduction. However, the qualitative EFH vulnerability analysis conducted by Stevenson *et al.* (in press) notes that juvenile and adult yellowtail flounder EFH is vulnerable to hydraulic clam dredges, due to the potential effects on infaunal yellowtail prey.

There could be major changes in the amount of fishing effort, areas fished, or harvest allowed under this alternative. The remaining open areas would have to withstand additional fishing effort and harvest. Fully 60% of the ocean quahog landings in New Bedford, MA in 2000, came from the area designated in this alternative. Section 5.3 describes that there would be immediate social impacts associated with this alternative because they would result in either the processors moving east and south with the vessels or additional transportation costs would be incurred in order to keep the plants in New England operating.

Under the current management regime, surfclams and ocean quahogs are well managed and certainly not near overfished. (The surfclam resource was overfished in the 1970s prior to management, but was rebuilt during the early 1980s.) Thus a sustainable fishery is possible without creating additional measures to protect surfclam and ocean quahog EFH, i.e., the measures that are currently in place are sufficient to allow for a maximum sustainable yield fishery. Although the EFH for juvenile scup, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops are potentially vulnerable to hydraulic clam dredges, the high energy sandy nature of this habitat feature makes it less susceptible to long-term impacts compared to the more structure oriented habitats also utilized by the above species.

This alternative meets the requirement of the EFH Final rule that the Council must minimize the adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely effects EFH in a manner that is more than minimal and not temporary in nature. As discussed above, although the hydraulic clam dredge utilized in this fishery may be associated with potential adverse effects to EFH, those effects are considered to be minimal and temporary. However, based upon existing information, there are some uncertainties associated with this determination.

The adverse nature of the impacts of bottom tending mobile gear on habitat are described in section 2.2.5. The southern New England area encompassed by this alternative is predominantly a high energy sand environment, indicative of disturbance tolerant species. Gear impact/habitat research indicate that such habitats and species are less susceptible to gear impacts with quicker recovery rates than more stable deep water or live bottom habitats. While higher levels of data on the functional value of this habitat on the density, growth and productivity of various species of fish may be desirable, the MSA and EFH final rule require that Councils use the best science available, consistent with National Standard 2. The *Workshop on the Effects of Fishing Gear on marine Habitats off the Northeastern United States (2001)*, and the subsequent *Gear Effects Evaluation Report* by Stevenson *et al.* (in press) provides an evaluation of the impacts to EFH from various types of fishing gear. These qualitative data show that hydraulic clam dredges may have an adverse effect on EFH of other Federally managed species.

Rebuilding is occurring for all the stocks of fish managed by the MAFMC and a few (i.e., Atlantic sea scallops) of the resources managed by the NEFMC. However, in New England many stocks of fish are still in very depleted conditions and many of these depleted stocks occur in this closure area. It is possible, however, that sustainable fisheries can be attained without the imposition of additional measures to protect EFH i.e., the management measures that are currently in place are sufficient to prevent overfishing, rebuild the fishery and achieve optimum yield consistent with National Standard 1. This rebuilding of all the overfished stocks managed by the MAFMC is taking place at the current level of fishing effort that exists throughout the EFH for all fisheries involved in the area defined as the EFH for surfclams and ocean quahogs. While current management measures are in place to sustainably manage EFH for surfclams and ocean quahogs, increased EFH protection for species adversely effected by hydraulic clam dredges may be increased.

Another problem lies in the fact that all of these closure areas considered in this issue would only be closed to hydraulic clam dredges only, and other gear (scallop dredges and otter trawls) would still be impacting these other species habitat. Potential habitat benefits from this alternative are minimized with the use of other gears in this area.

Counterbalanced against the speculative benefits of this alternative for the productivity of the fish species concerned is a cost to the fishing industry that could be substantial. The cost is not so much in terms of the immediate economic impacts (section 4) which are not that extensive, but in terms of the social impacts (section 5.3) associated with processors moving or additional transportation costs incurred in order to keep the plants in New England operating.

Available information indicates that the current management measures are sufficient to attain sustainable fisheries for surfclams and ocean quahogs. Thus, it is reasonable to conclude that surfclam and ocean quahog EFH, while protected through other fishery management measures, is making significant contributions to the density, growth and productivity of the species of fish concerned at the current level of fishing effort. Consequently, given the potential social cost to the industry of closing these areas to clam dredges and the contribution of surfclam and ocean quahog EFH to rebuilding other fisheries under current levels of fishing effort, it is the determination of the Council that the adoption of this alternative is not necessary or practicable according to the criteria set forth in 50 CFR Section 600.815(2)(iii).

3.3.2.4 Alternative 4 -- Prohibit clam dredging in the nearshore areas of Albemarle Sound, Chesapeake Bay, Delaware Bay, and New York Harbor, from 3 miles offshore extending to the 60-foot depth contour. This alternative and alternative 5 were developed for the summer flounder/scup/black sea bass Amendment 13 that was out for public comment in the winter 2002. The proposed nearshore closed areas (areas 1 through 4 of Figure 12) are partly based on the results of a workshop designed to identify the priority ocean areas for protection in the mid-Atlantic (Figure 13) and partly on the concentration of non-biogenic reef habitat (Figure 14). This alternative, as are all the closed area alternatives would continue this closure for five years after implementation of the amendment. The Council did not thoroughly evaluate this option for social and economic impacts because they decided this high energy sand environment area is more likely impacted by storm events and natural disturbances than by hydraulic clam dredges.

Biological Impacts

Closing the areas off of the major mid-Atlantic estuaries could have major biological impacts. Significant amounts of surfclams are found in northern and southern New Jersey in the areas that would be closed around the New York harbor and Delaware Bay. Weinberg (pers. comm.) was unable to estimate the exact amount of surfclam resource in these four small areas. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable. Closing an area to hydraulic dredging out to 60 feet was not deemed practicable since the fishing gear workshop did not identify any impacts that were more than minimal and of short duration. Additionally, the Auster and Langton (1998) report identifies storm disturbances much greater in depth than the 60 foot depth identified in this alternative. There could be major changes in the amount of fishing effort and areas fished under this alternative. The remaining open areas would have to withstand additional fishing effort and harvest.

Economic Impacts

Closing the areas off of the major mid-Atlantic estuaries could have some economic impacts. The economic research that Drs. Kirkley, Hicks and Strand did for Amendment 13 of the Summer Flounder, Scup, and Black Sea Bass FMP did not find a significant impact of closing this area to clam dredges, but it is believed that their conclusions would be conservative because they did not use the clam vessel logbook data. The clam vessel logbook data were used in the economic analyses for this amendment, but this alternative was not evaluated in depth because of the high energy/disturbance nature of this area. Significant amounts of surfclams are found in northern and southern New Jersey in the areas that would be closed around the New York harbor and Delaware Bay. Weinberg (pers. comm.) was unable to estimate the exact amount of surfclam resource in these four small areas. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable. Closing an area to hydraulic dredging out to 60 feet was not deemed practicable since the fishing gear workshop did not identify any impacts that were more than minimal and of short duration. Additionally, the Auster and Langton (1998) report identifies storm disturbances much greater in depth than the 60 foot depth identified in this alternative. There could be major changes in the amount of fishing effort and areas fished under this alternative especially for the smaller vessels. The remaining open areas would have to withstand additional fishing effort and harvest.

Social Impacts

Closing the areas off of the major mid-Atlantic estuaries could have some significant social impacts. Significant amounts of surfclams are found in northern and southern New Jersey in the areas that would be closed around the New York harbor and Delaware Bay. Weinberg (pers. comm.) was unable to estimate the exact amount of surfclam resource in these four small areas. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable. Closing an area to hydraulic dredging out to 60 feet was not deemed practicable since the fishing gear workshop did not identify any impacts that were more than minimal and of short duration. Additionally, the Auster and Langton (1998) report identifies storm disturbances much greater in depth than the 60 foot depth identified in this alternative. There could be major changes in the amount of fishing effort and areas fished under this alternative especially for the smaller vessels. The remaining open areas would have to withstand additional fishing effort and harvest. The New Jersey and Maryland ports had significant landings in the areas proposed for closure in this alternative. Thirty-five to fifty percent of the value of surfclams and/or ocean quahogs landed in Point Pleasant, Wildwood, and Ocean City came from one or more of those areas in 2000. Section 5.4 details the social impacts of this alternative.

Effects on Essential Fish Habitat

Closing the areas off of the major mid-Atlantic estuaries could have some beneficial effects on essential fish habitat. Significant amounts of surfclams are found in northern and southern New Jersey in the areas that would be closed around the New York harbor and Delaware Bay. Weinberg (pers. comm.) was unable to estimate the exact amount of surfclam resource in these four small areas. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable. Closing an area to hydraulic dredging out to 60 feet was not deemed practicable since the fishing gear workshop did not identify any impacts that were more than minimal and of short duration. Additionally, the Auster and Langton (1998) report identifies storm disturbances much greater in depth than the 60 foot depth identified in this alternative. There could be major changes in the amount of fishing effort and areas fished under this alternative especially for the smaller vessels. The remaining open areas would have to withstand additional fishing effort and harvest. This alternative was identified for summer flounder, scup and black sea bass Amendment 13 and it made some sense in that amendment since these species use structured habitat and some bottom tending gear can destroy structured habitat. Clam dredges are not fished in structured habitat because clams are generally inhabiting sandy, non-structured bottom and the cost of a lost or damaged clam dredge is around $30,000 and 600 man hours of labor. Clam fishermen do not generally risk those costs. Section 2.2.5 identifies the fishing activities that may adversely affect EFH. The equivalent section for alternative one of this issue also fully describes the information the Council used in their deliberations.

The analysis in Stevenson *et al.* (in press) notes that the EFH of seven species are vulnerable to hydraulic clam dredges. These species include black sea bass (juveniles and adults), scup (juveniles), ocean pout (all life stages), red hake (juveniles), silver hake (juveniles) winter flounder (juveniles and adults), and Atlantic sea scallops (juveniles). For this alternative, where the EFH for the species listed above with the closed area, a prohibition of hydraulic clam dredges could have a benefit to EFH. Section 2.2.5 identifies the fishing activities that may adversely affect EFH. The equivalent section for alternative one of this issue also fully describes the information the Council used in their deliberations. Based upon the qualitative draft assessment approach (Stevenson *et al.* in press) of the information presented in section 2.2.5.5.2 some potentially vulnerable EFH for juvenile scup, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops could be benefitted by this alternative. However, this alternative would only prohibit the use of hydraulic clam dredges. Other gear including otter trawls and scallop dredges would continue to be used thereby minimizing potential benefits of this alternative to EFH.

The clam resources are concentrated in high energy sandy sediment and the fishing gear has evolved over the past five decades to fish most efficiently in this type of sandy sediment. This evolution of the fishing gear has minimized the effect on fishery habitat (Wallace and Hoff in press). Natural events have more effect on the benthic community than this type of fishing gear since all of the fishing activity takes place in sandy shallow water. Chiarella *et al.* (2002) describing the October 2001 workshop concluded that hydraulic clam dredges were not a major concern relative to otter trawls and scallop dredges. All of the hydraulic clam dredging for an entire year, would impact about 100 square miles of bottom (Table 2). Putting this in context, this 100 square miles is roughly the area of one ten minute square, and there are over 1200 ten minute squares in the EEZ between Cape Hatteras and Georges Bank. Thus, it does not appear that either surfclam or ocean quahog EFH is effected by fishing gear.

Based upon existing information the Council concluded that there may be potential adverse effects on EFH from the hydraulic clam dredge, but concurred with the workshop panel (Appendix 4). The panel concluded that as the clam fishery is currently prosecuted, in sand habitats, there are potentially large, localized impacts to biological and physical structure, however the recovery time is relatively short. Since the recovery time is relatively short (hours to months) the adverse impacts to this high energy environment can be considered temporary. The preamble to the EFH Final Rule (50 CFR Part 600) defines temporary impacts as those that are limited in duration and that allow the particular environment to recover without measurable impact. Since these impacts are potentially effecting a relatively small portion (approximately 100 square nautical miles) of the overall large uniform area of high energy sand along the continental shelf (approximately 54,900 square nautical miles) these adverse impacts can be considered minimal. Additionally, the 100 square nautical miles impact each year (approximately 1.5 ten minute squares of latitude and longitude) represents a small fraction of the total EFH of the above listed vulnerable EFH and species. The preamble of the EFH Final Rule defines minimal impacts as those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions.

Effects on Protected Species

Closing the areas off of the major mid-Atlantic estuaries would likely have no impact on protected species. Significant amounts of surfclams are found in northern and southern New Jersey in the areas that would be closed around the New York harbor and Delaware Bay. Weinberg (pers. comm.) was unable to estimate the exact amount of surfclam resource in these four small areas. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable. Closing an area to hydraulic dredging out to 60 feet was not deemed practicable since the fishing gear workshop did not identify any impacts that were more than minimal and of short duration. Additionally, the Auster and Langton (1998) report identifies storm disturbances much greater in depth than the 60 foot depth identified in this alternative. There could be major changes in the amount of fishing effort and areas fished under this alternative especially for the smaller vessels. The remaining open areas would have to withstand additional fishing effort and harvest. The fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species and as such, there is no direct cost or benefits to these species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

Practicability Analysis

The adverse nature of the impacts of bottom tending mobile gear on habitat are described in section 2.2.5. The nearshore shallow water area encompassed by this alternative is predominantly a high energy sand environment, indicative of disturbance tolerant species. Gear impact/habitat research indicate that such habitats and species are less susceptible to gear impacts with quicker recovery rates than more stable deep water or live bottom habitats. Although the above inferences to habitat impacts can be made, there are no data on the functional value of this habitat on the density, growth and productivity of various species of fish in the Northeast Region.

Under the current management regime, surfclams and ocean quahogs are well managed and certainly not near overfished. (The surfclam resource was overfished in the 1970s prior to management, but was rebuilt during the early 1980s.) Thus a sustainable fishery is possible without creating additional measures to protect surfclam and ocean quahog EFH, i.e., the measures that are currently in place are sufficient to allow for a maximum sustainable yield fishery. Although the EFH for juvenile scup, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops are potentially vulnerable to hydraulic clam dredges, the high energy sandy nature of this habitat feature makes it less susceptible to long-term impacts compared to the more structure oriented habitats also utilized by the above species.

This alternative meets the requirement of the EFH Final rule that the Council must minimize the adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely effects EFH in a manner that is more than minimal and not temporary in nature. As discussed above, although the hydraulic clam dredge utilized in this fishery may be associated with potential adverse effects to EFH, those effects are considered to be minimal and temporary. However, based upon existing information, there are some uncertainties associated with this determination.

Rebuilding is occurring for all the stocks of fish managed by the MAFMC and a few (i.e., Atlantic sea scallops) of the resources managed by the NEFMC. It is possible that sustainable fisheries can be attained without the imposition of additional measures to protect EFH i.e., the management measures that are currently in place are sufficient to prevent overfishing, rebuild the fishery and achieve optimum yield consistent with National Standard 1. This rebuilding of all the overfished stocks managed by the MAFMC is taking place at the current level of fishing effort that exists throughout the EFH for all fisheries involved in the area defined as the EFH for surfclams and ocean quahogs. While current management measures are in place to sustainably manage EFH for surfclams and ocean quahogs, increased EFH protection for species adversely effected by hydraulic clam dredges may be increased.

Another problem lies in the fact that all of these closure areas considered in this issue would only be closed to hydraulic clam dredges only, and other gear (scallop dredges and otter trawls) would still be impacting these other species habitat. Potential habitat benefits from this alternative are minimized with the use of other gears in this area.

Available information indicates that the current management measures are sufficient to attain sustainable fisheries for surfclams and ocean quahogs. Thus, it is reasonable to conclude that surfclam and ocean quahog EFH, while protected through other fishery management measures, is making significant contributions to the density, growth and productivity of the species of fish concerned at the current level of fishing effort. Consequently, given the potential cost to the industry of closing these areas to clam dredges and the contribution of surfclam and ocean quahog EFH to rebuilding other fisheries under current levels of fishing effort, it is the determination of the Council that the adoption of this alternative is not necessary or practicable according to the criteria set forth in 50 CFR Section 600.815(2)(iii).

3.3.2.5 Alternative 5 -- Prohibit clam dredging from the areas adjacent to the Hudson Canyon, between the 200-foot and 500-foot depth contour. The workshop that identified priority ocean areas in the mid-Atlantic (Figure 13) identified Hudson Canyon as the most important area north of Cape Hatteras. The Hudson Canyon area is important for its biodiversity and usage by a variety of species from marine mammals, sea turtles, highly migratory fish species, and tilefish. The Council decided to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable for this fishery. Practically no clam fishing occurs in this area.

Biological Impacts

Closing the area of the Hudson Canyon between 200 and 500 feet to clam dredging would have very little biological impact. There may be some ocean quahogs in the upper (200 to 240 feet) depths but they are few and Weinberg (pers. comm.) was unable to estimate the exact amount.

The Council decided to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable for this fishery. Practically no clam fishing occurs in this area. Clam dredges are most efficient when fished in fairly level uniform sandy sediments. The sides of the canyons are generally steep and clay-type sediments.

Economic Impacts

Closing the area of the Hudson Canyon between 200 and 500 feet would have very little economic impact on the clam fisheries. There may be some ocean quahogs in the upper (200 to 240 feet) depths but they are few and Weinberg (pers. comm.) was unable to estimate the exact amount. The Council decided to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable. Practically no clam fishing occurs in this area. Clam dredges are most efficient when fished in fairly level uniform sandy sediments. The sides of the canyons are generally steep and clay-type sediments. There are a few trips made annually to the areas identified for this alternative, but they are in the shallower (around 200 feet) more sandy sediment.

Social Impacts

Closing the area of the Hudson Canyon between 200 and 500 feet would have very little social impact on the clam fisheries. There may be some ocean quahogs in the upper (200 to 240 feet) depths but they are few and Weinberg (pers. comm.) was unable to estimate the exact amount. The Council decided to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable. Practically no clam fishing occurs in this area. Clam dredges are most efficient when fished in fairly level uniform sandy sediments. The sides of the canyons are generally steep and clay-type sediments. There are a few trips made annually to the areas identified for this alternative from Point Pleasant and Atlantic City but they accounted for hardly any of the value for these two ports. Section 5.4 provides more details on the social impacts.

Effects on Essential Fish Habitat

Closing the area of the Hudson Canyon between 200 and 500 feet to hydraulic clam dredging would have very little beneficial effect on essential fish habitat. There may be some ocean quahogs in the upper (200 to 240 feet) depths of this proposed closed area but they are few and Weinberg (pers. comm.) was unable to estimate the exact amount. The Council did not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable for this fishery. Practically no clam fishing occurs in this area. Clam dredges are most efficient when fished in fairly level uniform sandy sediments. The sides of the canyons are generally steep and clay-type sediments.

The analysis in Stevenson *et al.* (in press) notes that the EFH of seven species are vulnerable to hydraulic clam dredges. These species include black sea bass (juveniles and adults), scup (juveniles), ocean pout (all life stages), red hake (juveniles), silver hake (juveniles) winter flounder (juveniles and adults), and Atlantic sea scallops (juveniles). For this alternative, where the EFH for the species listed above with the closed area, a prohibition of hydraulic clam dredges could have a benefit to EFH. Section 2.2.5 identifies the fishing activities that may adversely affect EFH. The equivalent section for alternative one of this issue also fully describes the information the Council used in their deliberations. Based upon the qualitative draft assessment approach (Stevenson *et al.* in press) of the information presented in section 2.2.5.5.2 some potentially vulnerable EFH for juvenile scup, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops could be benefitted by this alternative. However, this alternative would only prohibit the use of hydraulic clam dredges. Other gear including otter trawls and scallop dredges would continue to be used thereby minimizing potential benefits to EFH.

The clam resources are concentrated in high energy sandy sediment and the fishing gear has evolved over the past five decades to fish most efficiently in this type of sandy sediment. This evolution of the fishing gear has minimized the effect on fishery habitat (Wallace and Hoff in press). Natural events have more effect on the benthic community than this type of fishing gear since all of the fishing activity takes place in sandy shallow water. Chiarella *et al.* (2002) describing the October 2001 workshop concluded that hydraulic clam dredges were not a major concern relative to otter trawls and scallop dredges. All of the hydraulic clam dredging for an entire year, would impact about 100 square miles of bottom (Table 2). Putting this in context, this 100 square miles is roughly the area of one ten minute square, and there are over 1200 ten minute squares in the EEZ between Cape Hatteras and Georges Bank. Thus, it does not appear that either surfclam or ocean quahog EFH is effected by fishing gear.

Based upon existing information the Council concluded that there may be potential adverse effects on EFH from the hydraulic clam dredge, but concurred with the workshop panel (Appendix 4). The panel concluded that as the clam fishery is currently prosecuted, in sand habitats, there are potentially large, localized impacts to biological and physical structure, however the recovery time is relatively short. Since the recovery time is relatively short (hours to months) the adverse impacts to this high energy environment can be considered temporary. The preamble to the EFH Final Rule (50 CFR Part 600) defines temporary impacts as those that are limited in duration and that allow the particular environment to recover without measurable impact. Since these impacts are potentially effecting a relatively small portion (approximately 100 square nautical miles) of the overall large uniform area of high energy sand along the continental shelf (approximately 54,900 square nautical miles) these adverse impacts can be considered minimal. Additionally, the 100 square nautical miles impact each year (approximately 1.5 ten minute squares of latitude and longitude) represents a small fraction of the total EFH of the above listed vulnerable EFH and species. The preamble of the EFH Final Rule defines minimal impacts as those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions.

Effects on Protected Species

Closing the area of the Hudson Canyon between 200 and 500 feet would have very little impacts to protected resources. There may be some ocean quahogs in the upper (200 to 240 feet) depths but they are few and Weinberg (pers. comm.) was unable to estimate the exact amount. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable. Practically no clam fishing occurs in this area. Clam dredges are most efficient when fished in fairly level uniform sandy sediments. The sides of the canyons are generally steep and clay-type sediments. This area is important for marine mammals and sea turtles as they migrate through the area, but most of those species are up in the water column and do not at all come in contact with a benthic clam dredge. The fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species and as such, there is no direct cost or benefits to these species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

Practicability Analysis

The Hudson Canyon area is identified as HAPC for tilefish, as well as EFH for one or more life stages of 17 managed species, including, summer flounder, scup, black sea bass, offshore hake, butterfish, squid, and Atlantic mackerel. Tilefish are a long-lived species that are dependent upon complex burrow structures. Tilefish burrows are maintained by tilefish and believed to be important to the surrounding demersal community. However, for many species with EFH in this area, it is unclear if specific habitat associations exist or if the area simply provides thermal refuge.

The adverse nature of the impacts of bottom tending mobile gear on habitat are described in section 2.2.5. Speculation was that tilefish burrows are more vulnerable to disturbance than shallower, less complex habitats. However, Council funded research by Rutgers University to evaluate the impact of mobile fishing gear on tilefish habitat indicates otherwise (Able and Muzeni 2002). Able and Muzeni (2002) reviewed archived videotapes from submersible dives in the 1970s and 1980s to look for obvious gear impacts. They concluded that there was no direct evidence of tilefish habitat being adversely impacted by otter trawls, or other bottom tending mobile gear types at that time. Additionally, the report concluded that the "most important impact on tilefish habitat has been the fishery (primarily longline) for this species [tilefish]...the impacts occur when fishing mortality removes the tilefish...individual burrows are not maintained..." Guida *et al.* (2002) summarized preliminary observations in tilefish habitat during the fall of 2001 and 2002. The authors presented a poster session at the symposium on effects of fishing activities on benthic habitats (Tampa, November 2002) which concluded: "no conclusion can be drawn from this work regarding possible gear damage to tilefish burrows or lack thereof." Able and other researchers will be revisiting tilefish habitats in a submersible in the summer of 2003. The Council thoroughly supports these scientific endeavors and eagerly awaits additional scientific evidence.

Under the current management regime, surfclams and ocean quahogs are well managed and certainly not near overfished. (The surfclam resource was overfished in the 1970s prior to management, but was rebuilt during the early 1980s.) Thus a sustainable fishery is possible without creating additional measures to protect surfclam and ocean quahog EFH, i.e., the measures that are currently in place are sufficient to allow for a maximum sustainable yield fishery. Although the EFH for juvenile scup, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops are potentially vulnerable to hydraulic clam dredges, the high energy sandy nature of this habitat feature makes it less susceptible to long-term impacts compared to the more structure oriented habitats also utilized by the above species.

This alternative meets the requirement of the EFH Final rule that the Council must minimize the adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely effects EFH in a manner that is more than minimal and not temporary in nature. As discussed above, although the hydraulic clam dredge utilized in this fishery may be associated with potential adverse effects to EFH, those effects are considered to be minimal and temporary. However, based upon existing information, there are some uncertainties associated with this determination.

Rebuilding is occurring for all the stocks of fish managed by the MAFMC and a few (i.e., Atlantic sea scallops) of the resources managed by the NEFMC. It is possible that sustainable fisheries can be attained without the imposition of additional measures to protect EFH i.e., the management measures that are currently in place are sufficient to prevent overfishing, rebuild the fishery and achieve optimum yield consistent with National Standard 1. This rebuilding of all the overfished stocks managed by the MAFMC is taking place at the current level of fishing effort that exists throughout the EFH for all fisheries involved in the area defined as the EFH for surfclams and ocean quahogs. While current management measures are in place to sustainably manage EFH for surfclams and ocean quahogs, increased EFH protection for species adversely effected by hydraulic clam dredges may be increased.

Another problem lies in the fact that all of these closure areas considered would only be closed to hydraulic clam dredges, and other gear would still be impacting these species habitat. Potential habitat benefits from this alternative are minimized with the use of other gears in this area.

Available information indicates that the current management measures are sufficient to attain sustainable fisheries for surfclams and ocean quahogs. Thus, it is reasonable to conclude that surfclam and ocean quahog EFH, while protected through other fishery management measures, is making significant contributions to the density, growth and productivity of the species of fish concerned at the current level of fishing effort. Consequently, given the potential cost to the industry of closing these areas to clam dredges and the contribution of surfclam and ocean quahog EFH to rebuilding other fisheries under current levels of fishing effort, it is the determination of the Council that the adoption of this alternative is not necessary or practicable according to the criteria set forth in 50 CFR Section 600.815(2)(iii).

3.3.2.6 Alternative 6 -- Prohibit clam dredging in Tilefish HAPC which is depths between 250 and 1200 feet between Cape Cod and Cape May. Very, very limited fishing for ocean quahogs occurs beyond 250 feet and the1999 survey indicated very limited resource abundance beyond this depth especially south of southern New England. Tilefish habitat areas of particular concern (HAPC) are defined as between 250 and 1200 feet between Cape May and Cape Cod (Figure 15).

Biological Impacts

Closing the tilefish HAPC to hydraulic clam dredging could have a minor impact on the harvesting of ocean quahogs. The NEFSC survey sampling in 1999 was extended to strata in deeper water, 240 to 300 feet in Long Island, Southern New England, and Georges Bank waters for the first time in 1999 to estimate the fraction of the resource that had not been surveyed previously. The percentage of the total regional biomass estimated in the deep strata is 0% (LI), 2% (SNE), and 13% (GBK) (Appendix 2). Georges Bank has been closed since 1990 because of PSP. Thus the only deep water area where there may be harvestable ocean quahog resources would be the Southern New England area that overlaps with the tilefish HAPC. It is very unlikely that tilefish and ocean quahogs actually overlap. Tilefish are generally associated with structured environments and are often known to build pueblo villages and burrows in clay sediments. Clam dredges are most efficient when fished in fairly level uniform sandy sediments. The sides of the canyons and the shelf edges where tilefish occur are generally steep and clay-type sediments.

Economic Impacts

Closing the tilefish HAPC to hydraulic clam dredging could have a minor impact on the harvesting of ocean quahogs. The NEFSC survey sampling in 1999 was extended to strata in deeper water, 240 to 300 feet in Long Island, Southern New England, and Georges Bank waters for the first time in 1999 to estimate the fraction of the resource that had not been surveyed previously. The percentage of the total regional biomass estimated in the deep strata is 0% (LI), 2% (SNE), and 13% (GBK) (Appendix 2). Georges Bank has been closed since 1990 because of PSP. Thus the only deep water area where there may be harvestable ocean quahog resources would be the Southern New England area that overlaps with the tilefish HAPC. It is very unlikely that tilefish and ocean quahogs actually overlap. Tilefish are generally associated with structured environments and are often known to build pueblo villages and burrows in clay sediments. Clam dredges are most efficient when fished in fairly level uniform sandy sediments. The sides of the canyons and the shelf edges where tilefish occur are generally steep and clay-type sediments.

Due to the extensive way the tilefish area was defined (Table 32) for this analyses, there appears to be some significant economic impacts to ocean quahog fishermen. Section 4.8 documents that there could be direct impacts on revenues, costs, net returns and net benefits and that between 1996 and 2000 there were approximately 461 trips per year to this delineated area. This economic impact is likely to be grossly overestimated relative to the actual area that would be specified in any regulations. The impacts are more a function of creating complete 10 minute squares for closures and attempting to minimize the jagged nature of the 250 foot contour. Again, based purely on sediment preference, ocean quahogs and tilefish should not coexist.

Social Impacts

Closing the tilefish HAPC to hydraulic clam dredging could have a minor impact on the harvesting of ocean quahogs. The NEFSC survey sampling in 1999 was extended to strata in deeper water, 240 to 300 feet in Long Island, Southern New England, and Georges Bank waters for the first time in 1999 to estimate the fraction of the resource that had not been surveyed previously. The percentage of the total regional biomass estimated in the deep strata is 0% (LI), 2% (SNE), and 13% (GBK) (Appendix 2). Georges Bank has been closed since 1990 because of PSP. Thus the only deep water area where there may be harvestable ocean quahog resources would be the Southern New England area that overlaps with the tilefish HAPC. It is very unlikely that tilefish and ocean quahogs actually overlap. Tilefish are generally associated with structured environments and are often known to build pueblo villages and burrows in clay sediments. Clam dredges are most efficient when fished in fairly level uniform sandy sediments. The sides of the canyons and the shelf edges where tilefish occur are generally steep and clay-type sediments. Boats from New Bedford, Point Pleasant, and Atlantic City appear to have some landings from the proposed tilefish closed area, but these landings did not amount to more than five percent of the total value of landings at a port. Section 5.4 provides more details on the social impacts.

Effects on Essential Fish Habitat

Closing the tilefish HAPC to hydraulic clam dredging could have a minor impact on the harvesting of ocean quahogs. The NEFSC survey sampling in 1999 was extended to strata in deeper water, 240 to 300 feet in Long Island, Southern New England, and Georges Bank waters for the first time in 1999 to estimate the fraction of the resource that had not been surveyed previously. The percentage of the total regional biomass estimated in the deep strata is 0% (LI), 2% (SNE), and 13% (GBK) (Appendix 2). Georges Bank has been closed since 1990 because of PSP. Thus the only deep water area where there may be harvestable ocean quahog resources would be the Southern New England area that overlaps with the tilefish HAPC. It is very unlikely that tilefish and ocean quahogs actually overlap. Tilefish are generally associated with structured environments and are often known to build pueblo villages and burrows in clay sediments. Clam dredges are most efficient when fished in fairly level uniform sandy sediments. The sides of the canyons and the shelf edges where tilefish occur are generally steep and clay-type sediments. Clam fishermen would not want to fish in clay-type sediments and risk the real possibility of filling their gear with clay and losing a $30,000 piece of equipment that would prevent them from fishing for the next several months.

The analysis in Stevenson *et al.* (in press) notes that the EFH of seven species are vulnerable to hydraulic clam dredges. These species include black sea bass (juveniles and adults), scup (juveniles), ocean pout (all life stages), red hake (juveniles), silver hake (juveniles) winter flounder (juveniles and adults), and Atlantic sea scallops (juveniles). For this alternative, where the EFH for the species listed above with the closed area, a prohibition of hydraulic clam dredges could have a benefit to EFH. Section 2.2.5 identifies the fishing activities that may adversely affect EFH. The equivalent section for alternative one of this issue also fully describes the information the Council used in their deliberations. Based upon the qualitative draft assessment approach (Stevenson *et al.* in press) of the information presented in section 2.2.5.5.2 some potentially vulnerable EFH for juvenile scup, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops could be benefitted by this alternative. However, this alternative would only prohibit the use of hydraulic clam dredges. Other gear including otter trawls and scallop dredges would continue to be used thereby minimizing potential benefits of this alternative to EFH.

The clam resources are concentrated in high energy sandy sediment and the fishing gear has evolved over the past five decades to fish most efficiently in this type of sandy sediment. This evolution of the fishing gear has minimized the effect on fishery habitat (Wallace and Hoff in press). Natural events have more effect on the benthic community than this type of fishing gear since all of the fishing activity takes place in sandy shallow water. Chiarella *et al.* (2002) describing the October 2001 workshop concluded that hydraulic clam dredges were not a major concern relative to otter trawls and scallop dredges. All of the hydraulic clam dredging for an entire year, would impact about 100 square miles of bottom (Table 2). Putting this in context, this 100 square miles is roughly the area of one ten minute square, and there are over 1200 ten minute squares in the EEZ between Cape Hatteras and Georges Bank. Thus, it does not appear that either surfclam or ocean quahog EFH is effected by fishing gear.

Based upon existing information the Council concluded that there may be potential adverse effects on EFH from the hydraulic clam dredge, but concurred with the workshop panel (Appendix 4). The panel concluded that as the clam fishery is currently prosecuted, in sand habitats, there are potentially large, localized impacts to biological and physical structure, however the recovery time is relatively short. Since the recovery time is relatively short (hours to months) the adverse impacts to this high energy environment can be considered temporary. The preamble to the EFH Final Rule (50 CFR Part 600) defines temporary impacts as those that are limited in duration and that allow the particular environment to recover without measurable impact. Since these impacts are potentially effecting a relatively small portion (approximately 100 square nautical miles) of the overall large uniform area of high energy sand along the continental shelf (approximately 54,900 square nautical miles) these adverse impacts can be considered minimal. Additionally, the 100 square nautical miles impact each year (approximately 1.5 ten minute squares of latitude and longitude) represents a small fraction of the total EFH of the above listed vulnerable EFH and species. The preamble of the EFH Final Rule defines minimal impacts as those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions.

Effects on Protected Species

Closing the tilefish HAPC to hydraulic clam dredging could have a minor impact on the harvesting of ocean quahogs. The NEFSC survey sampling in 1999 was extended to strata in deeper water, 240 to 300 feet in Long Island, Southern New England, and Georges Bank waters for the first time in 1999 to estimate the fraction of the resource that had not been surveyed previously. The percentage of the total regional biomass estimated in the deep strata is 0% (LI), 2% (SNE), and 13% (GBK) (Appendix 2). Georges Bank has been closed since 1990 because of PSP. Thus the only deep water area where there may be harvestable ocean quahog resources would be the Southern New England area that overlaps with the tilefish HAPC. It is very unlikely that tilefish and ocean quahogs actually overlap. Tilefish are generally associated with structured environments and are often known to build pueblo villages and burrows in clay sediments. Clam dredges are most efficient when fished in fairly level uniform sandy sediments. The sides of the canyons and the shelf edges where tilefish occur are generally steep and clay-type sediments. Clam fishermen would not want to fish in clay-type sediments and risk the real possibility of filling their gear with clay and losing a $30,000 piece of equipment that would prevent them from fishing for the next several months. The fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species and as such, there is no direct cost or benefits to these species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

Practicability Analysis

The area identified as HAPC for tilefish, is also EFH for one or more life stages of 17 managed species, including, summer flounder, scup, black sea bass, offshore hake, butterfish, squid, and Atlantic mackerel. Tilefish are a long-lived species that are dependent upon complex burrow structures. Tilefish burrows are maintained by tilefish and believed to be important to the surrounding demersal community. However, for many species with EFH in this area, it is unclear if specific habitat associations exist or if the area simply provides thermal refuge.

Under the current management regime, surfclams and ocean quahogs are well managed and certainly not near overfished. (The surfclam resource was overfished in the 1970s prior to management, but was rebuilt during the early 1980s.) Thus a sustainable fishery is possible without creating additional measures to protect surfclam and ocean quahog EFH, i.e., the measures that are currently in place are sufficient to allow for a maximum sustainable yield fishery. Although the EFH for juvenile scup, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops are potentially vulnerable to hydraulic clam dredges, the high energy sandy nature of this habitat feature makes it less susceptible to long-term impacts compared to the more structure oriented habitats also utilized by the above species.

This alternative meets the requirement of the EFH Final rule that the Council must minimize the adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely effects EFH in a manner that is more than minimal and not temporary in nature. As discussed above, although the hydraulic clam dredge utilized in this fishery may be associated with potential adverse effects to EFH, those effects are considered to be minimal and temporary. However, based upon existing information, there are some uncertainties associated with this determination.

The adverse nature of the impacts of bottom tending mobile gear on habitat are described in section 2.2.5. Speculation was that tilefish burrows are more vulnerable to disturbance than shallower, less complex habitats. However, Council funded research by Rutgers University to evaluate the impact of mobile fishing gear on tilefish habitat indicates otherwise (Able and Muzeni 2002). Able and Muzeni (2002) reviewed archived videotapes from submersible dives in the 1970s and 1980s to look for obvious gear impacts. They concluded that there was no direct evidence of tilefish habitat being adversely impacted by otter trawls, or other bottom tending mobile gear types at that time. Additionally, the report concluded that the "most important impact on tilefish habitat has been the fishery (primarily longline) for this species [tilefish]...the impacts occur when fishing mortality removes the tilefish...individual burrows are not maintained..." Guida *et al.* (2002) summarized preliminary observations in tilefish habitat during the fall of 2001 and 2002. The authors presented a poster session at the symposium on effects of fishing activities on benthic habitats (Tampa, November 2002) which concluded: "no conclusion can be drawn from this work regarding possible gear damage to tilefish burrows or lack thereof." Able and other researchers will be revisiting tilefish habitats in a submersible in the summer of 2003. The Council thoroughly supports these scientific endeavors and eagerly awaits additional scientific conclusions. It is unknown if this alternative would have any positive impacts to the EFH.

Rebuilding is occurring for all the stocks of fish managed by the MAFMC and a few (i.e., Atlantic sea scallops) of the resources managed by the NEFMC. It is possible that sustainable fisheries can be attained without the imposition of additional measures to protect EFH i.e., the management measures that are currently in place are sufficient to prevent overfishing, rebuild the fishery and achieve optimum yield consistent with National Standard 1. This rebuilding of all the overfished stocks managed by the MAFMC is taking place at the current level of fishing effort that exists throughout the EFH for all fisheries involved in the area defined as the EFH for surfclams and ocean quahogs. While current management measures are in place to sustainably manage EFH for surfclams and ocean quahogs, increased EFH protection for species adversely effected by hydraulic clam dredges may be increased.

Another problem lies in the fact that all of these closure areas considered in this issue would only be closed to hydraulic clam dredges only, and other gear (scallop dredges and otter trawls) would still be impacting these other species habitat. Potential habitat benefits from this alternative are minimized with the use of other gears in this area.

Available information indicates that the current management measures are sufficient to attain sustainable fisheries for surfclams and ocean quahogs. Thus, it is reasonable to conclude that surfclam and ocean quahog EFH, while protected through other fishery management measures, is making significant contributions to the density, growth and productivity of the species of fish concerned at the current level of fishing effort. Consequently, given the potential cost to the industry of closing these areas to clam dredges and the contribution of surfclam and ocean quahog EFH to rebuilding other fisheries under current levels of fishing effort, it is the determination of the Council that the adoption of this alternative is not necessary or practicable according to the criteria set forth in 50 CFR Section 600.815(2)(iii).

3.3.2.7 Alternative 7 -- Prohibit all clam dredging in the EEZ off the State of Maine. Maine ocean quahogs are managed as a unit north of 43 degrees 50 minutes (Figure 16). Significant amounts of ocean quahogs are landed from both state waters and the EEZ annually. The concept behind this alternative was that if the fishing gear impacts workshop (Appendix 4) identified any areas where non-hydraulic clam dredges were having an impact, the EEZ could be closed by the NMFS rather than dealing with the State of Maine. However, there were no impacts attributable to non-hydraulic clam dredges from the workshop. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable with all the data uncertainties.

Biological Impacts

When the Council developed Amendment 10 (MAFMC 1997), a quota of 100,000 bushels of ocean quahogs in Maine was established and the only way that could be increased was for the State of Maine to conduct a survey and a stock assessment. Since there has been no survey and assessment it is impossible to attempt to analyze any biological impacts. There simply is no way to know what percentage of the resource is in state versus Federal waters. Of course, there is no known relationship between stock abundance and recruitment for either surfclams or ocean quahogs for any of these closed area alternatives, but at least we have some idea of resource distribution in evaluating some of the other alternatives. Closing the EEZ off of Maine would impact nearly all the Maine fishing vessels but not all the landings are attributed to either the EEZ or state waters, so it is impossible to even know how much of the landings would actually be impacted. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable with all the data uncertainties.

Economic Impacts

When the Council developed Amendment 10 (MAFMC 1997), a quota of 100,000 bushels of ocean quahogs in Maine was established and the only way that could be increased was for the State of Maine to conduct a survey and a stock assessment. Since there has been no survey and assessment it is impossible to attempt to analyze any biological impacts. There simply is no way to know what percentage of the resource is in state versus Federal waters. Of course, there is no known relationship between stock abundance and recruitment for either surfclams or ocean quahogs for any of these closed area alternatives, but at least we have some idea of resource distribution in evaluating some of the other alternatives. Closing the EEZ off of Maine would impact nearly all the Maine fishing vessels and thus would have a fairly large negative economic impact, but not all the landings are attributed to either the EEZ or state waters, so it is impossible to even know how much of the landings would actually be impacted. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable with all the data uncertainties.

Social Impacts

When the Council developed Amendment 10 (MAFMC 1997), a quota of 100,000 bushels of ocean quahogs in Maine was established and the only way that could be increased was for the State of Maine to conduct a survey and a stock assessment. Since there has been no survey and assessment it is impossible to attempt to analyze any biological impacts. There simply is no way to know what percentage of the resource is in state versus Federal waters. Of course, there is no known relationship between stock abundance and recruitment for either surfclams or ocean quahogs for any of these closed area alternatives, but at least we have some idea of resource distribution in evaluating some of the other alternatives. Closing the EEZ off of Maine would impact nearly all the Maine fishing vessels and thus would have a fairly large negative social impact, but not all the landings are attributed to either the EEZ or state waters, so it is impossible to even know how much of the landings would actually be impacted. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable with all the data uncertainties. Section 5.4 provides more details on the social impacts.

Effects on Essential Fish Habitat

When the Council developed Amendment 10 (MAFMC 1997), a quota of 100,000 bushels of ocean quahogs in Maine was established and the only way that could be increased was for the State of Maine to conduct a survey and a stock assessment. Since there has been no survey and assessment it is impossible to attempt to analyze any biological impacts. There simply is no way to know what percentage of the resource is in state versus Federal waters. Of course, there is no known relationship between stock abundance and recruitment for either surfclams or ocean quahogs for any of these closed area alternatives, but at least we have some idea of resource distribution in evaluating some of the other alternatives. Closing the EEZ off of Maine would impact nearly all the Maine fishing vessels and thus would have a fairly large negative impact, but not all the landings are attributed to either the EEZ or state waters, so it is impossible to even know how much of the landings would actually be impacted. The small-scale distribution of sediment types where this fishery occurs in small patches of sandy sediment is also unknown. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable with all the data uncertainties.

The analysis in Stevenson *et al.* (in press) notes that the EFH of seven species are vulnerable to hydraulic clam dredges. These species include black sea bass (juveniles and adults), scup (juveniles), ocean pout (all life stages), red hake (juveniles), silver hake (juveniles) winter flounder (juveniles and adults), and Atlantic sea scallops (juveniles). For this alternative, where the EFH for the species listed above with the closed area, a prohibition of hydraulic clam dredges could have a benefit to EFH. Section 2.2.5 identifies the fishing activities that may adversely affect EFH. The equivalent section for alternative one of this issue also fully describes the information the Council used in their deliberations. Based upon the qualitative draft assessment approach (Stevenson *et al.* in press) of the information presented in section 2.2.5.5.2 some potentially vulnerable EFH for, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops could be benefitted by this alternative. However, this alternative would only prohibit the use of hydraulic clam dredges. Other gear including otter trawls and scallop dredges would continue to be used thereby minimizing potential benefits of this alternative to EFH.

The clam resources are concentrated in high energy sandy sediment and the fishing gear has evolved over the past five decades to fish most efficiently in this type of sandy sediment. This evolution of the fishing gear has minimized the effect on fishery habitat (Wallace and Hoff in press). Natural events have more effect on the benthic community than this type of fishing gear since all of the fishing activity takes place in sandy shallow water. Chiarella *et al.* (2002)

describing the October 2001 workshop concluded that hydraulic clam dredges were not a major concern relative to otter trawls and scallop dredges. All of the hydraulic clam dredging for an entire year, would impact about 100 square miles of bottom (Table 2). Putting this in context, this 100 square miles is roughly the area of one ten minute square, and there are over 1200 ten minute squares in the EEZ between Cape Hatteras and Georges Bank. Thus, it does not appear that either surfclam or ocean quahog EFH is effected by fishing gear.

Based upon existing information the Council concluded that there may be potential adverse effects on EFH from the hydraulic clam dredge, but concurred with the workshop panel (Appendix 4). The panel concluded that as the clam fishery is currently prosecuted, in sand habitats, there are potentially large, localized impacts to biological and physical structure, however the recovery time is relatively short. Since the recovery time is relatively short (hours to months) the adverse impacts to this high energy environment can be considered temporary. The preamble to the EFH Final Rule (50 CFR Part 600) defines temporary impacts as those that are limited in duration and that allow the particular environment to recover without measurable impact. Since these impacts are potentially effecting a relatively small portion (approximately 100 square nautical miles) of the overall large uniform area of high energy sand along the continental shelf (approximately 54,900 square nautical miles) these adverse impacts can be considered minimal. Additionally, the 100 square nautical miles impact each year (approximately 1.5 ten minute squares of latitude and longitude) represents a small fraction of the total EFH of the above listed vulnerable EFH and species. The preamble of the EFH Final Rule defines minimal impacts as those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions.

Effects on Protected Species

When the Council developed Amendment 10 (MAFMC 1997), a quota of 100,000 bushels of ocean quahogs in Maine was established and the only way that could be increased was for the State of Maine to conduct a survey and a stock assessment. Since there has been no survey and assessment it is impossible to attempt to analyze any biological impacts. There simply is no way to know what percentage of the resource is in state versus Federal waters. Of course, there is no known relationship between stock abundance and recruitment for either surfclams or ocean quahogs for any of these closed area alternatives, but at least we have some idea of resource distribution in evaluating some of the other alternatives. Closing the EEZ off of Maine would impact nearly all the Maine fishing vessels and thus would have a fairly large negative impact, but not all the landings are attributed to either the EEZ or state waters, so it is impossible to even know how much of the landings would actually be impacted. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable with all the data uncertainties. The fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species and as such, there is no direct cost or benefits to these species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

Practicability Analysis

Since there has been no survey and assessment it is impossible to attempt to analyze any impacts associated with this alternative. There simply is no way to know what percentage of the resource is in state versus Federal waters. Of course, there is no known relationship between stock abundance and recruitment for either surfclams or ocean quahogs for any of these closed area alternatives, but at least we have some idea of resource distribution in evaluating some of the other alternatives. Closing the EEZ off of Maine would impact nearly all the Maine fishing vessels but not all the landings are attributed to either the EEZ or state waters, so it is impossible to even know how much of the landings would actually be impacted. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable with all the data uncertainties.

Under the current management regime, surfclams and ocean quahogs are well managed and certainly not near overfished. (The surfclam resource was overfished in the 1970s prior to management, but was rebuilt during the early 1980s.) Thus a sustainable fishery is possible without creating additional measures to protect surfclam and ocean quahog EFH, i.e., the measures that are currently in place are sufficient to allow for a maximum sustainable yield fishery. Although the EFH for juvenile scup, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops are potentially vulnerable to hydraulic clam dredges, the high energy sandy nature of this habitat feature makes it less susceptible to long-term impacts compared to the more structure oriented habitats also utilized by the above species.

This alternative meets the requirement of the EFH Final rule that the Council must minimize the adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely effects EFH in a manner that is more than minimal and not temporary in nature. As discussed above, although the hydraulic clam dredge utilized in this fishery may be associated with potential adverse effects to EFH, those effects are considered to be minimal and temporary. However, based upon existing information, there are some uncertainties associated with this determination.

Rebuilding is occurring for all the stocks of fish managed by the MAFMC and a few (i.e., Atlantic sea scallops) of the resources managed by the NEFMC. It is possible that sustainable fisheries can be attained without the imposition of additional measures to protect EFH i.e., the management measures that are currently in place are sufficient to prevent overfishing, rebuild the fishery and achieve optimum yield consistent with National Standard 1. This rebuilding of all the overfished stocks managed by the MAFMC is taking place at the current level of fishing effort that exists throughout the EFH for all fisheries involved in the area defined as the EFH for surfclams and ocean quahogs. While current management measures are in place to sustainably manage EFH for surfclams and ocean quahogs, increased EFH protection for species adversely effected by hydraulic clam dredges may be increased.

Another problem lies in the fact that all of these closure areas considered in this issue would only be closed to hydraulic clam dredges only, and other gear (scallop dredges and otter trawls) would still be impacting these other species habitat. Potential habitat benefits from this alternative are minimized with the use of other gears in this area.

Available information indicates that the current management measures are sufficient to attain sustainable fisheries for surfclams and ocean quahogs. Thus, it is reasonable to conclude that surfclam and ocean quahog EFH, while protected through other fishery management measures, is making significant contributions to the density, growth and productivity of the species of fish concerned at the current level of fishing effort. Consequently, given the potential cost to the industry of closing these areas to clam dredges and the contribution of surfclam and ocean quahog EFH to rebuilding other fisheries under current levels of fishing effort, it is the determination of the Council that the adoption of this alternative is not necessary or practicable according to the criteria set forth in 50 CFR Section 600.815(2)(iii).

3.3.2.8 Alternative 8 -- Prohibit all clam dredging in the EEZ off the State of Maine west of zone 1 (Figure 16). This alternative is similar to alternative 2 in that this area is currently closed to fishing because of PSP. This alternative would codify the closure for the next 5 years and ideally provide the incentive to compare fished and unfished areas during that time. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable with all the data uncertainties.

Biological Impacts

When the Council developed Amendment 10 (MAFMC 1997), a quota of 100,000 bushels of ocean quahogs in Maine was established and the only way that could be increased was for the State of Maine to conduct a survey and a stock assessment. Since there has been no survey and assessment it is impossible to attempt to analyze any biological impacts. There simply is no way to know what percentage of the resource is in the closed versus the opened waters. Of course, there is no known relationship between stock abundance and recruitment for either surfclams or ocean quahogs for any of these closed area alternatives, but at least we have some idea of resource distribution in evaluating some of the other non Maine alternatives. Continuing the closure of the western portion of Maine should have no change to the resource or the fishery. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable with all the data uncertainties.

Economic Impacts

When the Council developed Amendment 10 (MAFMC 1997), a quota of 100,000 bushels of ocean quahogs in Maine was established and the only way that could be increased was for the State of Maine to conduct a survey and a stock assessment. Since there has been no survey and assessment it is impossible to attempt to analyze any economic impacts. There simply is no way to know what percentage of the resource is in the closed versus the opened waters. Of course, there is no known relationship between stock abundance and recruitment for either surfclams or ocean quahogs for any of these closed area alternatives, but at least we have some idea of resource distribution in evaluating some of the other non Maine alternatives. Continuing the closure of the western portion of Maine should have no change to the resource or the fishery. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable with all the data uncertainties.

Social Impacts

When the Council developed Amendment 10 (MAFMC 1997), a quota of 100,000 bushels of ocean quahogs in Maine was established and the only way that could be increased was for the State of Maine to conduct a survey and a stock assessment. Since there has been no survey and assessment it is impossible to attempt to analyze any social impacts. There simply is no way to know what percentage of the resource is in the closed versus the opened waters. Of course, there is no known relationship between stock abundance and recruitment for either surfclams or ocean quahogs for any of these closed area alternatives, but at least we have some idea of resource distribution in evaluating some of the other non Maine alternatives. Continuing the closure of the western portion of Maine should have no change to the resource or the fishery. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable with all the data uncertainties. Section 5.4 documents that no one has fished this area.

Effects on Essential Fish Habitat

When the Council developed Amendment 10 (MAFMC 1997), a quota of 100,000 bushels of ocean quahogs in Maine was established and the only way that could be increased was for the State of Maine to conduct a survey and a stock assessment. Since there has been no fishing in this area and that will not change with this alternative there will be no change to the effects on essential fish habitat. Continuing the closure of the western portion of Maine should have no change to the resource or the fishery. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable with all the data uncertainties.

The analysis in Stevenson *et al.* (in press) notes that the EFH of seven species are vulnerable to hydraulic clam dredges. These species include black sea bass (juveniles and adults), scup (juveniles), ocean pout (all life stages), red hake (juveniles), silver hake (juveniles) winter flounder (juveniles and adults), and Atlantic sea scallops (juveniles). For this alternative, where the EFH for the species listed above with the closed area, a prohibition of hydraulic clam dredges could have a benefit to essential fish habitat. Section 2.2.5 identifies the fishing activities that may adversely affect EFH. The equivalent section for alternative one of this issue also fully describes the information the Council used in their deliberations. Based upon the qualitative draft assessment approach (Stevenson *et al.* in press) of the information presented in section 2.2.5.5.2 some potentially vulnerable essential fish habitat for, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops could possibly be benefitted by this alternative. However, this alternative would only prohibit the use of hydraulic clam dredges. Other gear including otter trawls and scallop dredges would continue to be used thereby minimizing potential benefits of this alternative to EFH.

The clam resources are concentrated in high energy sandy sediment and the fishing gear has evolved over the past five decades to fish most efficiently in this type of sandy sediment. This evolution of the fishing gear has minimized the effect on fishery habitat (Wallace and Hoff in press). Natural events have more effect on the benthic community than this type of fishing gear since all of the fishing activity takes place in sandy shallow water. Chiarella *et al.* (2002) describing the October 2001 workshop concluded that hydraulic clam dredges were not a major concern relative to otter trawls and scallop dredges. All of the hydraulic clam dredging for an entire year, would impact about 100 square miles of bottom (Table 2). Putting this in context, this 100 square miles is roughly the area of one ten minute square, and there are over 1200 ten minute squares in the EEZ between Cape Hatteras and Georges Bank. Thus, it does not appear that either surfclam or ocean quahog EFH is effected by fishing gear.

Based upon existing information the Council concluded that there may be potential adverse effects on EFH from the hydraulic clam dredge, but concurred with the workshop panel (Appendix 4). The panel concluded that as the clam fishery is currently prosecuted, in sand habitats, there are potentially large, localized impacts to biological and physical structure, however the recovery time is relatively short. Since the recovery time is relatively short (hours to months) the adverse impacts to this high energy environment can be considered temporary. The preamble to the EFH Final Rule (50 CFR Part 600) defines temporary impacts as those that are limited in duration and that allow the particular environment to recover without measurable impact. Since these impacts are potentially effecting a relatively small portion (approximately 100 square nautical miles) of the overall large uniform area of high energy sand along the continental shelf (approximately 54,900 square nautical miles) these adverse impacts can be considered minimal. Additionally, the 100 square nautical miles impact each year (approximately 1.5 ten minute squares of latitude and longitude) represents a small fraction of the total EFH of the above vulnerable EFH and species. The preamble of the EFH Final Rule defines minimal impacts as those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions.

Effects on Protected Species

When the Council developed Amendment 10 (MAFMC 1997), a quota of 100,000 bushels of ocean quahogs in Maine was established and the only way that could be increased was for the State of Maine to conduct a survey and a stock assessment. Since there has been no fishing in this area and that will not change with this alternative there will be no change to the effects on protected resources. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable with all the data uncertainties. The fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species and as such, there is no direct cost or benefits to these species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude of these commercial fisheries.

Practicability Analysis

This alternative is similar to alternative 2 in that this area is currently closed to fishing because of PSP. Since there has been no survey and assessment it is impossible to attempt to analyze any impacts associated with this alternative. There simply is no way to know what percentage of the resource is in opened versus closed waters off the State of Maine. Of course, there is no known relationship between stock abundance and recruitment for either surfclams or ocean quahogs for any of these closed area alternatives, but at least we have some idea of resource distribution in evaluating some of the other alternatives. Continuing this closure off of Maine would not impact the Maine fishing vessels, but it is impossible to know how much of the landings could actually be impacted on a long term basis. The Council chose to not thoroughly evaluate this alternative for social and economic impacts because they decided that this closure was not reasonable with all the data uncertainties.

Under the current management regime, surfclams and ocean quahogs are well managed and certainly not near overfished. (The surfclam resource was overfished in the 1970s prior to management, but was rebuilt during the early 1980s.) Thus a sustainable fishery is possible without creating additional measures to protect surfclam and ocean quahog EFH, i.e., the measures that are currently in place are sufficient to allow for a maximum sustainable yield fishery. Although the EFH for juvenile scup, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops are potentially vulnerable to hydraulic clam dredges, the high energy sandy nature of this habitat feature makes it less susceptible to long-term impacts compared to the more structure oriented habitats also utilized by the above species.

This alternative meets the requirement of the EFH Final rule that the Council must minimize the adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely effects EFH in a manner that is more than minimal and not temporary in nature. As discussed above, although the hydraulic clam dredge utilized in this fishery may be associated with potential adverse effects to EFH, those effects are considered to be minimal and temporary. However, based upon existing information, there are some uncertainties associated with this determination.

Rebuilding is occurring for all the stocks of fish managed by the MAFMC and a few (i.e., Atlantic sea scallops) of the resources managed by the NEFMC. It is possible that sustainable fisheries can be attained without the imposition of additional measures to protect EFH i.e., the management measures that are currently in place are sufficient to prevent overfishing, rebuild the fishery and achieve optimum yield consistent with National Standard 1. This rebuilding of all the overfished stocks managed by the MAFMC is taking place at the current level of fishing effort that exists throughout the EFH for all fisheries involved in the area defined as the EFH for surfclams and ocean quahogs. While current management measures are in place to sustainably manage EFH for surfclams and ocean quahogs, increased EFH protection for species adversely effected by hydraulic clam dredges may be increased.

Another problem lies in the fact that all of these closure areas considered in this issue would only be closed to hydraulic clam dredges only, and other gear (scallop dredges and otter trawls) would still be impacting these other species habitat. Potential habitat benefits from this alternative are minimized with the use of other gears in this area.

Available information indicates that the current management measures are sufficient to attain sustainable fisheries for surfclams and ocean quahogs. Thus, it is reasonable to conclude that surfclam and ocean quahog EFH, while protected through other fishery management measures, is making significant contributions to the density, growth and productivity of the species of fish concerned at the current level of fishing effort. Consequently, given the potential cost to the industry of closing these areas to clam dredges and the contribution of surfclam and ocean quahog EFH to rebuilding other fisheries under current levels of fishing effort, it is the determination of the Council that the adoption of this alternative is not necessary or practicable according to the criteria set forth in 50 CFR Section 600.815(2)(iii).

3.3.2.9 Alternative 9 -- Trading a reduction in the optimum yield range for ocean quahogs as justification for increasing the surfclam annual quota increases. The optimum yield range for ocean quahogs is 4 to 6 million bushels with an annual quota of 4.5 million bushels recently. Ocean quahogs are found in deeper waters which are less susceptible to storm disturbances and they are longer-lived than surfclams which are both reasons why this trade-off may make some sense. It is highly likely that fishing for surfclams in their high energy environment may have less fishing gear impacts than fishing in the deeper, relatively more stable environment of ocean quahogs. The Council staff, Plan Development Team, and industry members were unable to strategize exactly how this alternative could be developed and implemented at this time. The Council chose to not thoroughly evaluate this alternative for impacts because they decided that this alternative was not reasonable with all the data uncertainties.

Biological Impacts

Uncertainty about exactly how this alternative would work precludes any evaluation of the biological impacts. It is likely that if actual biological risks could be calculated, that this alternative could be potentially less risky. However, without having anything like a stock/recruitment relationship for either species, the estimation of risk would be mostly hypothetical. The actual benefits and costs would mostly be hypothetical also. The Council chose to not thoroughly evaluate this alternative for impacts because they decided that this alternative was not reasonable.

Economic Impacts

Uncertainty about exactly how this alternative would work precludes any evaluation of the economic impacts. It is likely that if actual economic risks could be calculated, that this alternative could be potentially less risky. However, without having anything like a stock/recruitment relationship for either species, the estimation of risk would be mostly hypothetical. The actual benefits and costs would mostly be hypothetical also. The Council chose to not thoroughly evaluate this alternative for impacts because they decided that this alternative was not reasonable.

Social Impacts

Uncertainty about exactly how this alternative would work precludes any evaluation of the social impacts. The Council chose to not thoroughly evaluate this alternative for impacts because they decided that this alternative was not reasonable.

Effects on Essential Fish Habitat

Uncertainty about exactly how this alternative would work precludes any evaluation of the effects on essential fish habitat. The Council chose to not thoroughly evaluate this alternative for impacts because they decided that this alternative was not reasonable. Logically, it makes sense to encourage fishing in a high energy sandy surfclam environment rather than a deeper perhaps more stable ocean quahog environment. However, with the fact that clam dredges have mostly temporary and minimal impacts and without having well defined stock/recruitment relationships, characterizing this alternative was very difficult at this time.

The analysis in Stevenson *et al.* (in press) notes that the EFH of seven species are vulnerable to hydraulic clam dredges. These species include black sea bass (juveniles and adults), scup (juveniles), ocean pout (all life stages), red hake (juveniles), silver hake (juveniles) winter flounder (juveniles and adults), and Atlantic sea scallops (juveniles). For this alternative, where the EFH for the species listed above with the closed area, a prohibition of hydraulic clam dredges could have a benefit to EFH. Section 2.2.5 identifies the fishing activities that may adversely affect EFH. The equivalent section for alternative one of this issue also fully describes the information the Council used in their deliberations. Based upon the qualitative draft assessment approach (Stevenson *et al.* in press) of the information presented in section 2.2.5.5.2 some potentially vulnerable EFH for black sea bass, scup, ocean pout, juvenile red hake, juvenile silver hake, winter flounder, and juvenile scallops could be benefitted by this alternative.

The clam resources are concentrated in high energy sandy sediment and the fishing gear has evolved over the past five decades to fish most efficiently in this type of sandy sediment. This evolution of the fishing gear has minimized the effect on fishery habitat (Wallace and Hoff in press). Natural events have more effect on the benthic community than this type of fishing gear since all of the fishing activity takes place in sandy shallow water. Chiarella *et al.* (2002) describing the October 2001 workshop concluded that hydraulic clam dredges were not a major concern relative to otter trawls and scallop dredges. All of the hydraulic clam dredging for an entire year, would impact about 100 square miles of bottom (Table 2). Putting this in context, this 100 square miles is roughly the area of one ten minute square, and there are over 1200 ten minute squares in the EEZ between Cape Hatteras and Georges Bank. Thus, it does not appear that either surfclam or ocean quahog EFH is effected by fishing gear.

Based upon existing information the Council concluded that there may be potential adverse effects on EFH from the hydraulic clam dredge, but concurred with the workshop panel (Appendix 4). The panel concluded that as the clam fishery is currently prosecuted, in sand habitats, there are potentially large, localized impacts to biological and physical structure, however the recovery time is relatively short. Since the recovery time is relatively short (hours to months) the adverse impacts to this high energy environment can be considered temporary. The preamble to the EFH Final Rule (50 CFR Part 600) defines temporary impacts as those that are limited in duration and that allow the particular environment to recover without measurable impact. Since these impacts are potentially effecting a relatively small portion (approximately 100 square nautical miles) of the overall large uniform area of high energy sand along the continental shelf (approximately 54,900 square nautical miles) these adverse impacts can be considered minimal. Additionally, the 100 square nautical miles impact each year (approximately 1.5 ten minute squares of latitude and longitude) represents a small fraction of the total EFH of the above listed vulnerable EFH and species. The preamble of the EFH Final Rule defines minimal impacts as those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions.

Effects on Protected Species

Uncertainty about exactly how this alternative would work precludes any evaluation of the effects on protected resources. The Council chose to not thoroughly evaluate this alternative for impacts because they decided that this alternative was not reasonable. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude of these commercial fisheries.

Practicability Analysis

The Council staff, Plan Development Team, and industry members were unable to strategize exactly how this alternative could be developed and implemented at this time. Uncertainty about exactly how this alternative would work precludes any evaluation of the effects. The Council chose to not thoroughly evaluate this alternative for impacts because they decided that this alternative was not reasonable with all the data uncertainties. Since this alternative could never even be fully characterized, it is the determination of the Council that the adoption of this alternative is not necessary or practicable according to the criteria set forth in 50 CFR Section 600.815(2)(iii).

3.3.3 Multi-year Quotas

MULTI-YEAR QUOTAS – Alternative 1 modified = Council preferred			
ALTERNATIVE	DESCRIPTION	SECTION DESCRIBED	SECTION EVALUATED
1	Multi-year, Annual evaluation	1.2.3.1	3.3.3.1
2	No action, Annual evaluation	1.2.3.2	3.3.3.2
3	Multi-year, No annual evaluation	1.2.3.3	3.3.3.3

In order to allow multi-year quotas, the FMP needs to be amended as the regulations currently require an annual quota setting process. Given the status of the two resources (surfclams are under-exploited and ocean quahogs are not overfished and overfishing is not occurring) and the likelihood of research surveys only every three years or so, this amendment has two alternatives that propose thorough quota setting only after each survey and stock assessment.

Instead of working through the entire specification process annually (Quota recommendation paper, Industry Advisors meeting with Committee, Council recommendation then significant document preparation -- EAs, RIRs, EFH Assessments, etc.), the Council would establish specifications to be in effect for two, or three fishing years. The specifications would be the same each year of the term or could be stepped to track well-identified trends in biomass.

The RA in her comment letter to the Council Chairman (October 15, 2002) identified NMFS support for streamlining the quota specification process, as appropriate and thus supported Alternative 1. The Council voted unanimously (with RA abstaining) at its January 2003 meeting in support of Alternative 1 for multi-year quotas not to exceed three years with an annual review.

3.3.3.1 Alternative 1 -- Multi-year quotas set after each survey and stock assessment with minor annual review. Clam surveys are currently scheduled every three years and multi-year quotas would be set for the years between surveys. Staff would continue to produce the annual quota recommendation paper for the Council to review and if no changes from the previous multi-year schedule were recommended by the Council, no further work would be required by staff or NMFS. Clam surveys have been conducted in 1994, 1997, 1999, and 2002. Stock assessments for surfclams have been conducted in December 1994, December 1997, and December 1999, while ocean quahogs have been assessed in June of 1995, 1998, and 2000. The 2002 survey will form the basis for a surfclam stock assessment in June 2003 and an ocean quahog assessment in December 2003.

Biological Impacts

There should be no biological impact of allowing multi-year quota setting. This is mostly an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. If anything there is perhaps an increased risk to the resource since there may not be as thorough of a review each year as currently occurs. This risk is reduced in this alternative since the Council staff will continue to provide the annual recommendations paper for the industry and the Committee to review. The risk is greater from this point in the alternative 3, section 3.3.3.3 where there is no annual review. This alternative would simply require less of the paperwork workload that occurs for Council staff and NMFS after the Council has made their annual recommendations. The two resources are either underfished or not overfished (Section 2.1.4) and as such the risk is very minimal.

Economic Impacts

There should be slight economic benefits of allowing multi-year quota setting. This is an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. Thus, there should be administrative cost savings. Further discussion on the economic issues can be found is section 4.8.2.2. The industry should be able to plan their operations and strategy better since once the multi-year trajectory is set, it would require an act of the Council and NMFS to change the quota. Change is generally harder than continuation of the no action.

Social Impacts

There should be no discernable negative social impact of allowing multi-year quota setting. This is an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. Further discussion on the social issues can be found is section 5.6.

Effects on Essential Fish Habitat

There should be no effects to essential fish habitat as there are no restrictions on harvest implemented with this measure. This is an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. The fishing activities that could potentially affect EFH are described in section 2.2.5 and the Council has concurred with the 2001 Boston workshop that any fishing gear impacts are temporary and minimal.

Effects on Protected Species

Since this multi-year quota issue is mostly to benefit the administrative process and does not have any management measures associated it is likely that there will not be different effects on marine mammals, sea turtles, or seabirds because the overall amount of effort will not change as landings will not be effected. Thus, the fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

3.3.3.2 Alternative 2 -- No action. This alternative would continue the development of staff's annual quota recommendation paper for the Council, along with all the associated Regulatory Impact Review, Environmental Assessment, Proposed Regulations, etc. It would also continue to require significant work on NMFS part annually. Some in industry argue that for the most important commercial mid-Atlantic fishery, the MAFMC does not spend an inordinate amount of time on this FMP. In general, industry feels that the few hours spend by the Committee and Council annually brings them together to discuss common problems and concerns and evaluate where different segments of the industry sees it going in the future. In general, there are four issues the Council must take action on annually. The Council needs to recommend a surfclam quota, an ocean quahog quota, a Maine ocean quahog quota, and whether or not to suspend the surfclam minimum size limit. At the recent June 2002 Council meeting where the 2003 recommendations were made, the entire Committee meeting with Advisors and Council meeting agenda item took less than three hours. Of course, numerous man months of effort for Council staff and NMFS are then devoted to justifying and moving the recommendations through the process. These man-months of effort, after the Council makes it recommendations, is what is trying to be saved with the multi-year quotas.

Biological Impacts

There should be no biological impact of the no action alternative. This multi-year quota concept is an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. Section 3.3.3.1 identifies a small risk of multi-year quotas, but this risk is minimal as long as there is an annual review by the Committee with industry.

Economic Impacts

There should be no economic impact of the no action alternative. This multi-year quota concept is an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. Further discussion on the economic issues can be found is section 4.8.2.2.

Social Impacts

There should be no social impact of the no action alternative. This multi-year quota concept is purely an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. Further discussion on the social issues can be found is section 5.6.

Effects on Essential Fish Habitat

There should be no effects to essential fish habitat of the no action alternative. This is an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. Section 2.2.5 identifies any fishing activity that could adversely affect EFH and nothing in this issue should have an impact.

Effects on Protected Species

There should be no effects on protected resources of the no action alternative. This is an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. Thus, the fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

3.3.3.3 Alternative 3 -- Multi-year quotas set after each survey and stock assessment with no annual review. Similar to Alternative 1, but there would be no annual quota recommendation paper or Council review. Quotas would be set only after surveys and would remain on an agreed upon schedule until the next survey. The industry is very much opposed to this alternative as they feel an unforeseen event, like the 1976 anoxia event off of the coast of New Jersey, which the Council would not be able to rapidly respond to could jeopardize the resource and the fishery.

Biological Impacts

There should be no biological impact of allowing multi-year quota setting. This is an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. There is anxiety that this multi-year quota without annual review could lead to a higher level of risk which could result in resource declines if the Council could not act as expeditiously as it does presently. There is a small risk the longer the time between resource and fishery review, in the sense that if one goes down a non desirable path, one gets further with less frequent reviews and thus it is harder to return to an optimum position. The exact risk is unknown without quantification of the stock/recruitment relationship.

Economic Impacts

There should be slight economic benefits of allowing multi-year quota setting. This is an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. Thus, there should be some administrative cost savings. Further discussion is in section 4.8.2.2.

Social Impacts

There is possible social impact from this alternative due to increased vulnerability to changes in the status of the resource or the markets. This is an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. Further discussion on the social issues can be found is section 5.6.

Effects on Essential Fish Habitat

There should be no effects to essential fish habitat as there are no restrictions on harvest implemented with this measure. This is an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. Discussion of the fishing activities that may adversely affect EFH is identified in section 2.2.5, but this issue would not have effects on EFH.

Effects on Protected Species

Since this multi-year quota issue is mostly to benefit the administrative process and does not have any management measures associated it is likely that there will not be different effects on marine mammals, sea turtles, or seabirds because the overall amount of effort will not change as landings will not be effected. Thus, the fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

3.3.4 Reversal of Suspension of Size Limit

REVERSAL OF SUSPENSION OF SIZE LIMIT – Alternative 2 modified with framework measures = Council preferred			
ALTERNATIVE	DESCRIPTION	SECTION DESCRIBED	SECTION EVALUATED
1	Reverse regulatory language	1.2.4.1	3.3.4.1
2	No action	1.2.4.2	3.3.4.2
3	No action with multi-year decision after each stock assessment	1.2.4.3	3.3.4.3

NMFS needs to annually conduct a finding and publish a regulatory action to suspend the minimum surfclam size limit if the Council recommends this course of action. There has not been a minimum size limit imposed since implementation of the ITQ program in 1990. The minimum size limit is specified in the regulations as 4.75 inches, which was originally based on the size of surfclams that maximizes yield per recruit (YPR). No new YPR analyses have been conducted during the past several surfclam stock assessments, but it is highly likely that 4.75 inches is not the associated size for maximization. In the past several assessments, surfclams have been identified as spawning as early as three months which is one tenth the previously believed maturation time. Many other biological parameters, like natural mortality have also changed.

This is another issue which is mostly administrative and is intended to benefit NMFS and the Council through more efficient and effective streamlined use of manpower.

The RA in her comment letter to the Council Chairman (October 15, 2002) again identified her strong support for Alternative 1. She also recommended modifying the current regulatory language regarding surfclam size suspension (or implementation) found at section 648.72©). Specifically, the reference to using *discards or survey data* to determine if 30 percent of the surfclams are smaller than 4.75 inches should be replaced with *annually reviewed landings and biological sampling data.* She stated that this change would better reflect what is actually use to make this determination and, thus, would be more accurate. The Council would like to take the RA's (October 15 letter) suggestion about modifying the current regulatory language regarding surfclam size suspension found at section 648.72©).

The Council wrestled with this issue extensively at the January 2003 meeting because some in industry still opposed the proposed changes. Many Council members believed the system currently works well with limited effort and that should the size limit be needed in order to prevent fishermen from fishing on beds of small clams, it may be harder to implement the size limit than simply suspend. Finally, the Council voted unanimously (with RA abstaining) to add to the list of framework management measures this suspension of the surfclam minimum size limit and adjustment of the surfclam minimum size.

The framework adjustment process was established in Amendment 12. The Council can currently use a framework adjustment process to change the overfishing definition, change the description and identification of EFH, address any habitat area of particular concern, and implement a vessel tracking system. This procedure allows the Council to add or modify management measures through a streamlined public review process. Section 3.1.1.4 of Amendment 12 identifies the entire process the Council and NMFS would need to go through if it was determined that an addition or adjustment to management measures was necessary to meet the goals and objectives of the FMP. The Council would have to recommend, develop, and analyze appropriate management actions over the span of at least two Council meetings. Recent Council activities associated with the Summer Flounder, Scup, and Black Sea Bass FMP, as well as the Atlantic Mackerel, Squid, and Butterfish FMP indicate that framework management measures do not necessarily lessen the amount of work involved in a framework versus an actual FMP amendment.

3.3.4.1 Alternative 1 -- NMFS and the Council would like to reverse the process from an active regulatory action that must annually be suspended to one where the size limit could remain in the regulations, but would need a regulatory action to implement. This action would continue as part of the quota setting process. If the quota setting process becomes multi-year as proposed in section 3.3.3, then the suspension could also be for multiple years as identified in section 3.3.4.3.

Biological Impacts

There should be no biological impact of allowing for the reversal of the requirement of regulatory action to suspend the surfclam minimum size limit. This is an administrative issue where the

Council is attempting to reduce the workload for itself and most specifically for NMFS. The minimum size limit is specified in the regulations as 4.75 inches, which was originally based on the size of surfclams that maximizes yield per recruit (YPR). No new YPR analyses have been conducted during the past several surfclam stock assessments, but it is highly likely that 4.75 inches is not the associated size for maximization. In the past several assessments, surfclams have been identified as spawning as early as three months which is one tenth the previously believed maturation time. Many other biological parameters, like natural mortality have also changed. Attempting to maximize YPR is no longer a goal of this FMP.

Economic Impacts

There should be some slight economic benefits of allowing for the reversal of the requirement of regulatory action to suspend the surfclam minimum size limit, however neither the exact ramifications of this action are known nor can they be easily estimated with existing information. This is an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. Thus, there should be some administrative cost savings. Further discussion on the economic issues can be found is section 4.8.2.1.

Social Impacts

There may be some slight positive social impact of allowing for the reversal of the requirement of regulatory action to suspend the surfclam minimum size limit. This is an administrative issue where the Council is attempting to reduce the workload for itself and NMFS. Further discussion on the social issues can be found is section 5.7.

Effects on Essential Fish Habitat

There should be no effects on essential fish habitat of allowing for the reversal of the requirement of regulatory action to suspend the surfclam minimum size limit. This is an administrative issue where the Council is attempting to reduce the workload for itself and most specifically for NMFS. Section 2.2.5 describes fishing activities that may adversely affect EFH, but it is hard to fathom how this issue could impact EFH.

Effects on Protected Species

Since this issue of the reversal of the requirement of regulatory action to suspend the surfclam minimum size limit is mostly to benefit the administrative process and does not have any management measures associated with it, it is likely that there would not be any different effects on marine mammals, sea turtles, or seabirds because the overall amount of effort will not change as landings will not be effected. Thus, the fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

3.3.4.2 Alternative 2 -- No action. The Council has actively recommended suspension of the minimum size limit since implementation of the ITQ program in1990. NMFS NERO performs significant work to justify the annual suspension. At the recently completed June 2002 Council meeting, the staff, Committee, and then Council all recommended continued suspension. This issue for the Council generally only takes a few minutes, with very little debate. However, a separate *Federal Register* notice and action, with all the associated layers of review, is required annually to suspend the size limit. This notice and action is not combined with the actual specifications for the three quotas.

Biological Impacts

There should be no biological impact of the no action alternative. This is an administrative issue where the Council is attempting to reduce the workload for itself and most specifically for NMFS. The minimum size limit is specified in the regulations as 4.75 inches, which was originally based on the size of surfclams that maximizes yield per recruit (YPR). No new YPR analyses have been conducted during the past several surfclam stock assessments, but it is highly likely that 4.75 inches is not the associated size for maximization. In the past several assessments, surfclams have been identified as spawning as early as three months which is one tenth the previously believed maturation time. Many other biological parameters, like natural mortality have also changed. Attempting to maximize YPR is no longer a goal of this FMP. Section 2.1.3 identifies the ecological relationships and stock characteristics of both surfclams and ocean quahogs.

Economic Impacts

There should be no economic impacts of the no action. This is an administrative issue where the Council is attempting to reduce the workload for itself and NMFS. Further discussion on the economic issues can be found is section 4.8.2.1.

Social Impacts

There is no discernable social impact of the no action. This is an administrative issue where the Council is attempting to reduce the workload for itself and NMFS. Further discussion on the social issues can be found is section 5.7.

Effects on Essential Fish Habitat

There should be no effects on essential fish habitat of the no action. This is an administrative issue where the Council is attempting to reduce the workload for itself and most specifically for NMFS. Section 2.2.5 identifies the fishing activities that may adversely affect EFH, but it is hard to fathom any impacts to EFH of this issue.

Effects on Protected Species

There should be no effect on protected resources of the no action. Thus, the fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

3.3.4.3 Alternative 3 – No action with multi-year decision after each stock assessment. After each surfclam stock assessment the Council would recommend whether the minimum size limit should be suspended for the intervening years until the next stock assessment. The NMFS NERO would continue to perform the analyses to justify the suspension, however it would not be on an annual basis. In recent years the surfclam survey have been conducted about every third year (1994, 1997, 1999, and 2002), with associated assessments conducted in December of 1994,1997, and 1999. The surfclam stock assessment associated with the 2002 survey is scheduled to be performed in June 2003.

Biological Impacts

There should be no biological impact of the no action with multi-year decision to suspend after each stock assessment alternative. This is an administrative issue where the Council is attempting to reduce the workload for itself and most specifically for NMFS. Of course, any multi-year decision is somewhat riskier than an annual review. Surfclams are considered under-exploited and with annual removals of only about 2 to 3 percent, there should not be a significant risk. The fact that YPR is no longer a management goal, really reduces the importance of any size limit. Generally the industry pays a premium for larger clams since the main product of surfclams is clam strips. Larger clams produce larger clam strips and larger clams have had multiple opportunities to spawn before being harvested.

Economic Impacts

There should be no economic impacts of this alternative. This is an administrative issue where the Council is attempting to reduce the workload for itself and NMFS. Further discussion on the economic issues can be found is section 4.8.2.1. Generally the industry pays a premium for larger clams since the main product is clam strips. Larger clams produce larger clam strips.

Social Impacts

There is no discernable social impact of this alternative. This is an administrative issue where the Council is attempting to reduce the workload for itself and NMFS. Further discussion on the social issues can be found is section 5.7.

Effects on Essential Fish Habitat

There should be no effects on essential fish habitat of this alternative. This is an administrative issue where the Council is attempting to reduce the workload for itself and most specifically for NMFS. Section 2.2.5 documents the fishing activities that may adversely affect EFH, but with this issue it is difficult to consider how this issue would impact EFH.

Effects on Protected Species

There should be no effect on protected resources of this alternative. Thus, the fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

3.3.5 Vessel Monitoring System (VMS)

VESSEL MONITORING SYSTEM (VMS) – Alternative 1 modified = Council preferred			
ALTERNATIVE	DESCRIPTION	SECTION DESCRIBED	SECTION EVALUATED
1	Mandatory VMS	1.2.5.1	3.3.5.1
2	No action – call-in	1.2.5.2	3.3.5.2
3	Voluntary VMS	1.2.5.3	3.3.5.3
4	IVR	1.2.5.4	3.3.5.4

The Regional Administrator has had extensive experience during the past few years with a VMS system for the Atlantic Sea Scallop FMP and more recently with the Multispecies and Sea Herring FMPs. Accurate location data are used in the stock assessment and this automatic data collection will provide more accurate location data than are currently being collected through the vessel logbook system.

The fishing industry has been asking for this type of system for nearly a decade so that they could go away from the call-in system that has been in effect since the early 1980s. The specific requirements of the surfclam and ocean quahog call-in system are located at section 648.15 of 50 CFR and include the name of the vessel, NMFS permit number assigned to the vessel, expected date and time of departure from port, whether the trip will be directed on surfclams or ocean quahogs, expected time, and location of landing, and the name of the individual providing the information.

It is probable that various enforcement agencies at this time will favor the implementation of VMS because of the facilitated knowledge of legitimate activities for readily identifiable vessels, thus increasing the national security. It is because of this national security issue since September 11, 2001 that the industry and Council do not have a preferred alternative for public hearing. The Council had a presentation at the May 2002 meeting and it is likely that homeland defense will have one overall uniform electronic system for vessel identification at sea. Industry and the Council do not favor implementing a system that could be changed in some manner once a unified homeland security system in put into place. This issue of a unified national system is currently in flux, as just as recently as April 9 2002, WorldCatch News Network reported that NMFS will reimburse Alaska fishermen for their cost of a VMS.

There are several major issues that need to be resolved before implementation of a VMS-type system. First, only Boatracs is currently certified for the Northeast and this vendor is perceived as too costly both in terms of initial cost ($6,000 per unit) and monthly connection charges ($250). Second, it is desirable that a new reporting/tracking system replace the current call-in system and, at the same time, provide the potential for an electronic logbook system. However, according to the RA's October 15, 2002 letter, a prototype electronic logbook system will not be available until the end of 2003. Third, there is an equity issue if, in some regions of the country, the government purchases units for the industry and, in other areas, industry bears the cost. Last, there is some concern that homeland security issues may lead to a mandated tracking system that might prove incompatible with current VMS units in use in the Northeast.

Individuals in the NEFSC (Terry Smith), Region (Reggie Howe and Karen Mareiro in statistics and Todd Dubois and Jim St. Cyr of enforcement), industry (Dave Wallace and Dan Cohen), and Council staff (Clay Heaton and Tom Hoff) have been working as an ad hoc group (CLEAN) which has been developing approaches for electronic reporting from both clam processors and fishermen. Briefings from enforcement personnel indicates that perhaps as early as June of 2003 an additional VMS technology would be certified (other than BoatTracs) that could be about a quarter of both the initial and monthly costs associated with BoatTracs. This team believes that ultimately an electronic tracking, reporting and noticing system would be ideal, but that perhaps it is best to think about implementation of electronic two-way communication capability in three phases. Phase 1 would be to get the units onto vessels and collect information sufficient to replace the current call-in system. Phase 1 would benefit both enforcement and the industry. Phase 2 would involve the design and implementation for electronically reporting trip data to replace the current requirement to submit paper vessel logbook reports. This would benefit industry and the data collection people. Phase 3 would consider implementation of detailed "real time" information on catch information, size frequencies and other scientific information. Phase 3 would be responsive to science needs and not part of the enforcement or reporting system. A likely timeframe for implementation could be six months for Phase 1 and by the end of 2003 (as per RA letter) for Phase 2. Phase 3 could be implemented when and if it becomes appropriate to collect tow specific information under the assumption that the unit is capable of two-way communication via some e-mail type system.

The RA in her comment letter to the Council Chairman (October 15, 2002) again identified her support for Alternative 1, a mandatory vessel monitoring system.

The Council voted overwhelmingly (15 to 1 with RA abstaining) at its January 2003 meeting to adopt alternative 1, a mandatory implementation of an electronic tracking system that is satisfactory to the NMFS and industry. The council recommends that the RA implement this system when an economically viable system is available for the industry based on the advice of the Council. It is expected that the CLEAN team will continue its efforts to coordinate among the various interest groups in the government, industry, and Council staff and when additional certified systems are available, they will provide their recommendations to the Council. Specifically, the Council envisions the future process to move along the following lines.

MANDATORY VMS		
PHASE 1	PHASE 2	PHASE 3
VMS Notification System (Replacement of call-in system)	Electronic Vessel Reporting (Replacement of Vessel Logbooks or VTR)	Collection of Scientific Information
Monitoring of Closed Areas		

Once an economically viable VMS system is available, and which meets the needs of the mandatory VMS requirements of Amendment 13, this system would be implemented on the advice of the Mid-Atlantic Council through several phases, starting with the beginning of the next fishing year following the agreement to implement the VMS system, as discussed below. Once the VMS system is recommended to be implemented, the owner of a vessel intending to harvest surfclams or ocean quahogs must provide documentation to the Regional Administrator that the vessel has an operational VMS unit installed on board that meets specific criteria (identified below) when renewing its surfclam and/or ocean quahog permit for the following year. If a vessel has already been issued a permit without the owner providing such documentation, the Regional Administrator shall allow at least 30 days for the vessel to install an operational VMS unit that meets the criteria and for the owner to provide documentation of such installation to the Regional Administrator. Vessel permits would automatically be revoked if the vessel did not comply with the VMS installation requirements in the allotted time frame.

The Regional Administrator could exempt vessels that hold a limited access Maine mahogany ocean quahog permit from the VMS requirement. However, under this exemption, vessels that hold both a limited access Maine mahogany ocean quahog permit and an open access ocean quahog and/or surfclam permit would be required to use the call-in notification system when fishing under an ITQ quota.

PHASE 1 - VMS NOTIFICATION SYSTEM

Phase 1 would implement a VMS notification system to replace the current surfclam/ocean quahog call-in system. Vessels would be required to report through the VMS e-mail messaging system prior to leaving the dock to fish in the EEZ on a surfclam or ocean quahog trip, and again prior to returning to the dock to offload a surfclam or ocean quahog trip, in accordance with instructions provided by NMFS. The VMS notification system would not necessarily require that the VMS system be operational at all times but only during the time that the vessel reports beginning and ending a trip as described above.

Prior to departure from the dock to fish for surfclams and/or ocean quahogs, the vessel must report the following information via the VMS e-mail messaging system (some of this information is captured automatically by the VMS): Name of the vessel; NMFS permit number assigned to the vessel; expected date and time of departure from port; whether the trip will be directed on surfclams or ocean quahogs; expected date, time, and location of landing; and name of the individual providing notice. Prior to returning from a surfclam or ocean quahog trip, the vessel must report where the vessel will be offloading its catch, and the date and time of offloading, through the VMS e-mail messaging system.

PHASE 2 - ELECTRONIC VESSEL REPORTING

Phase 2 would implement an electronic vessel reporting system that would replace the current Vessel logbook. Unless otherwise specified under an FMP-wide vessel electronic reporting system implemented by NMFS, the electronic vessel reporting system would require that the owner or operator of any vessel conducting a surfclam or ocean quahog fishing trip, except those conducted exclusively in waters of a state that requires cage tags or when the vessel has surrendered the surfclam and ocean quahog fishing vessel permit, must report the following information through the VMS e-mail messaging system, in accordance with instructions provided by NMFS (some of this information is captured automatically by the VMS system): Name and permit number of the vessel, total amount in bushels of each species taken, date(s) caught, time at sea, duration of fishing time, locality fished, crew size, crew share by percentage, landing port, date sold, price per bushel, buyer, tag numbers from cages used, quantity of surf clams and ocean quahogs discarded, and allocation permit number. This information would need to be provided daily or upon returning to port. Electronic vessel reporting would not necessarily require that the VMS system be operational at all times but only during the time that the vessel reports its electronic trip information.

PHASE 3 - COLLECTION OF SCIENTIFIC INFORMATION

This would be similar to Phase 2 but information would be collected on a tow by tow basis. The specific information requested could include all of the information required under Phase 2, as well as any additional biological information deemed appropriate by the Council and NMFS.

For Phase 1-3, the VMS Notification System, Electronic Vessel Reporting and Collection of Scientific Information, the performance criteria for the VMS system is as follows, or as modified further by NMFS, as deemed necessary:

(1) The VMS shall be tamper proof.
(2) The VMS shall be capable of transmitting and storing information including vessel identification, date, time, and latitude/longitude.
(3) The VMS shall be capable of providing network message communications between the vessel and shore.
(4) The VMS vendor shall be capable of archiving vessel position histories for a minimum of 1 year and providing transmission to NMFS of specified portions of archived data in response to NMFS requests and in a variety of media (tape, floppy, etc.).

MONITORING OF CLOSED AREAS (INDEPENDENT OF PHASES 1-3)

Once an economically viable VMS system becomes operational, the Council could decide whether or not closed areas should be monitored to better aid enforcement, independent of implementation of Phases 1-3, if the system selected is capable of providing this information. Monitoring of closed areas would require that the VMS unit be fully automatic and operational at all times and meet all other performance criteria. To monitor closed areas, the VMS system must meet the minimum performance criteria outlined as follows, or as modified further by NMFS, as deemed necessary:

(1) The VMS shall be tamper proof, i.e., shall not permit the input of false positions; furthermore, if a system uses satellites to determine position, satellite selection should be automatic to provide an optimal fix and should not be capable of being manually overridden by any person aboard a fishing vessel or by the vessel owner.
(2) The VMS shall be fully automatic and operational at all times, regardless of weather and environmental conditions, unless the vessel is "powered-down," i.e., the vessel will be continuously out of the water for more than 72 consecutive hours; and a valid letter of exemption was obtained pursuant to 648.9(c)(2)(ii) of and issued to the vessel and is on board the vessel and the vessel is in compliance with all conditions and requirements of said letter.
(3) The VMS shall be capable of tracking vessels in all U.S. waters in the Atlantic Ocean from the shoreline of each coastal state to a line 215 nautical miles offshore and shall provide position accuracy to within 400 m (1,300 ft).
(4) The VMS shall be capable of transmitting and storing information including vessel identification, date, time, and latitude/longitude.
(5) The VMS shall provide accurate hourly position transmissions every day of the year unless the vessel is powered-down, as described above in item 2. In addition, the VMS shall allow polling of individual vessels or any set of vessels at any time and receive position reports in real time. For the purposes of this specification, "real time" shall constitute data that reflect a delay of 15 minutes or less between the displayed information and the vessel's actual position.
(6) The VMS shall be capable of providing network message communications between the vessel and shore. The VMS shall allow NMFS to initiate communications or data transfer at any time.
(7) The VMS vendor shall be capable of transmitting position data to a NMFS-designated computer system via a modem at a minimum speed of 9600 baud. Transmission shall be in a file format acceptable to NMFS.
(8) The VMS shall be capable of providing vessel locations relative to international boundaries and fishery management areas.

(9) The VMS vendor shall be capable of archiving vessel position histories for a minimum of 1 year and providing transmission to NMFS of specified portions of archived data in response to NMFS requests and in a variety of media (tape, floppy, etc.).

3.3.5.1 Alternative 1 -- Mandatory. A mandatory VMS would replace the call-in system and work similar to the scallop VMS, but could have less intensive reporting (perhaps hourly rather than every half-hour). It is estimated that 50 (non Maine) vessels who fish for surfclam and ocean quahogs in Federal waters would have to purchase and maintain the equipment from approved vendors. It is anticipated that the small-scale artisanal Maine vessels will be exempted from this requirement currently as the Regional Administrator has the authority to exempt them from the call-in system. Implementation of this mandatory system would operate as identified above.

Biological Impacts

There should be no biological impact of implementing a mandatory VMS and doing away with the vessel call-in system. There will be more accurate location effort with a VMS and that may actually provide for better analyses in the stock assessments and fishing gear impacts analyses. This is mostly an administrative issue where the Council is attempting to reduce the workload for the industry from the call-in system and provide more accurate, timely, and less expensive data for NMFS and the Council. It is possible that if an electronic data reporting system is also combined with a VMS system, there is the potential for getting very accurate tow by tow catch and location which should be useful in future stock assessments.

Economic Impacts

There will be an economic impact of a VMS. It is estimated that the initial cost to vessel owners will be around $5,000 to $6,000 with an annual maintenance fee of around $2,500 (Kirkley 2002). This is mostly an administrative issue where the Council is attempting to reduce the workload for the industry from the call-in system and provide more accurate, timely, and less expensive data for NMFS and the Council. Further discussion on the economic issues can be found is section 4.8.1.1.

Social Impacts

There should be minor social impact of a mandatory VMS because some industry members are concerned about the economic costs of acquiring and operating the VMS, especially if a system is decided upon for this fishery that would be replaced in the immediate future by a more uniform nation-wide system. The Council is attempting to reduce the workload for the industry from the call-in system and provide more accurate, timely, and less expensive data for NMFS and the Council. Further discussion on the social issues can be found is section 5.8.

Effects on Essential Fish Habitat

There should be no effects to essential fish habitat as there are no restrictions on harvest implemented with this measure. This is purely an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. Theoretically, very accurate location data could be better used to evaluate potential impacts to EFH from the fishing gear. However, clam dredges fish most efficiently in sand where the two resources occur in commercial concentrations and the fishermen do not want to fish around any type of structured environment because of the potential for destruction of the gear. Thus, accurate fishing location may not be important because of industries strong desire to and history of fishing only in homogeneous sandy bottom. Section 2.2.5 details the fishing activities that may adversely affect EFH. The Boston fishing gear impacts workshop (Appendix 4) identified the benefits of VMS for accurate location information, but again the idea was so that good accurate bottom structure could also be mapped and associated with the fishing effort data.

Effects on Protected Species

Since this issue of the VMS is mostly to benefit the administrative process and does not have any management measures associated with it, it is likely that the requirement would not have any different effects on marine mammals, sea turtles, or seabirds because the overall amount of effort will not change as landings will not be effected. Thus, the fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

3.3.5.2 Alternative 2 -- No action. Currently all fishing vessels must call into enforcement to notify them of their activities of where and when they will be landing.

Biological Impacts

There should be no biological impacts associated with the statue quo. This is mostly an administrative issue where the Council is attempting to reduce the workload for the industry from the call-in system and provide more accurate, timely, and less expensive data for NMFS and the Council.

Economic Impacts

There will be no economic impact of the no action. This is mostly an administrative issue where the Council is attempting to reduce the workload for the industry from the call-in system and provide more accurate, timely, and less expensive data for NMFS and the Council. Further discussion on the economic issues can be found is section 4.8.1.1.

Social Impacts

There should be no social impact of the no action. This is mostly an administrative issue where the Council is attempting to reduce the workload for the industry from the call-in system and provide more accurate, timely, and less expensive data for NMFS and the Council. Further discussion on the social issues can be found is section 5.8.

Effects on Essential Fish Habitat

There should be no effects to essential fish habitat as there are no restrictions on harvest implemented with this measure. This is an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. It can be argued that better location information from a VMS-type system could be better used to evaluate fishing gear impacts to EFH, but clam dredges fish in homogenous sandy environments. Section 2.2.5 defines the fishing activities that may adversely affect EFH.

Effects on Protected Species

The statue quo alternative will not have any different effects on marine mammals, sea turtles, or seabirds because the overall amount of effort will not change as landings will not be effected. Thus, the fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

3.3.5.3 Alternative 3 -- Voluntary. This alternative would combine the current call-in system with an optional VMS so that the vessels would have the choice between the two.

Biological Impacts

There should be no biological impact of implementing a voluntary VMS or allowing thee call-in system to continue. There will be more accurate location effort for those that opt for installing a VMS and that may actually provide for better analyses in the stock assessments and fishing gear impacts analyses. This is mostly an administrative issue where the Council is attempting to reduce the workload for the industry from the call-in system and provide more accurate, timely, and less expensive data for NMFS and the Council. It is possible that if an electronic data reporting system is also combined with a VMS system, there is the potential for getting very accurate tow by tow catch and location which should be useful in future stock assessments.

Economic Impacts

There will be an economic impact to those who buy a VMS. It is estimated that the initial cost to vessel owners will be around $5,000 to $6,000 with an annual maintenance fee of around $2,500 (Kirkley 2002). This is mostly an administrative issue where the Council is attempting to reduce the workload for the industry from the call-in system and provide more accurate, timely, and less expensive data for NMFS and the Council. Further discussion on the economic issues can be found is section 4.8.1.1.

Social Impacts

There should be minor social impacts to those who install a VMS because some industry members are concerned about the economic costs of acquiring and operating the VMS, but since it is voluntary, then those individuals who choose to stay with the call-in system can continue to do so. This is mostly an administrative issue where the Council is attempting to reduce the workload for the industry from the call-in system and provide more accurate, timely, and less expensive data for NMFS and the Council. Further discussion on the social issues can be found is section 5.8.

Effects on Essential Fish Habitat

There should be no effects to essential fish habitat as there are no restrictions on harvest implemented with this measure. This is an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. Theoretically, very accurate location data could be better used to evaluate potential impacts to EFH from the fishing gear. However, clam dredges fish most efficiently in sand where the two resources occur in commercial concentrations and the fishermen do not want to fish around any type of structured environment because of the potential for destruction of the gear. Thus, accurate fishing location may not be important because of industries strong desire to and history of fishing only in homogeneous sandy bottom. Section 2.2.5 details the fishing activities that may adversely affect EFH. The Boston fishing gear impacts workshop (Appendix 4) identified the benefits of VMS for accurate location information, but again the idea was so that good accurate bottom structure could also be mapped and associated with the fishing effort data.

Effects on Protected Species

Since this issue of the VMS is mostly to benefit the administrative process and does not have any management measures associated with it, it is likely that the requirement would not have any different effects on marine mammals, sea turtles, or seabirds because the overall amount of effort will not change as landings will not be effected. Thus, the fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

3.3.5.4 Alternative 4 – Interactive Voice Response (IVR). The existing IVR system allows dealers holding Federal permits to quickly and easily report their weekly fish purchases using a touch-tone telephone. This system is used for all quota-managed species in the northeast except for surfclams and ocean quahogs. Permit types that already report include: Atlantic bluefish, black sea bass, northeast multispecies, scup, spiny dogfish, squid/mackerel/butterfish, and summer flounder. This alternative is more for data reporting by the processors but could be used by the vessels. Discussions between the Council staff, NERO, NEFSC, and industry at the June Council meeting identified just how easy electronic reporting from the processors to the NERO could be accomplished. The NERO is currently exploring efficient ways of capturing processor data and substituting this capture for the processor logbooks.

Biological Impacts

There should be no biological impacts associated with the IVR. This is mostly an administrative issue where the Council is attempting to reduce the workload for the industry from the call-in system and provide more accurate, timely, and less expensive data for NMFS and the Council.

Economic Impacts

There will be minimal economic impact of the IVR, but this cost is likely offset by that of the call-in system. This is mostly an administrative issue where the Council is attempting to reduce the workload for the industry from the call-in system and provide more accurate, timely, and less expensive data for NMFS and the Council.

Social Impacts

There should be no social impact of the IVR. This is mostly an administrative issue where the Council is attempting to reduce the workload for the industry from the call-in system and provide more accurate, timely, and less expensive data for NMFS and the Council.

Effects on Essential Fish Habitat

There should be no effects to essential fish habitat as there are no restrictions on harvest implemented with this measure. This is an administrative issue where the Council is attempting to reduce the workload for itself, NMFS and the industry. Section 2.2.5 details the fishing activities that may adversely affect EFH, but certainly it is highly unlikely that this issue of replacing the call-in system and even perhaps electronic data reporting should not have an impact on EFH.

Effects on Protected Species

The implementation of an IVR system will not have any different effects on marine mammals, sea turtles, or seabirds because the overall amount of effort will not change as landings will not be effected. Thus, the fishery will continue to operate as it has in the past with minimum interaction with endangered, threatened, or protected species. Section 6.1.3.1 provides thorough background information on marine mammals and endangered species that was used to facilitate evaluations of the alternatives relative to the order of magnitude these commercial surfclam and ocean quahog fisheries may have on these threatened or endangered species.

3.4 CUMULATIVE IMPACTS

A cumulative impact analysis is required as specified by the Council on Environmental Quality's (CEQ) regulation for implementing the NEPA. Cumulative effects are defined under NEPA as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other action (40 CFR § 1508.7)."

Past actions under this FMP are described in section 1.1.2, "History of FMP Development." Overall, actions implemented by the FMP were to address the management objectives described in section 1.1.3. Amendment 8 in 1990 implemented the nation's first Federal ITQ program. Amendment 12 (1998) addressed the new and revised National Standard requirements including surfclam and ocean quahog overfishing definitions (National Standard 1), the effects on fishing communities (National Standard 8), bycatch reduction (National Standard 9), and safety at sea (National Standard 10). The amendment also identified essential fish habitat (EFH) for surfclams and ocean quahogs. Finally, Amendment 12 added a framework adjustment procedure that allowed the Council to add or modify management measures through a streamlined public review process.

The purpose of this amendment is to address the problems identified in section 1.1.1 of this amendment. This amendment proposes four alternatives to modify the overfishing definition for surfclams. This amendment proposes nine alternatives for surfclams and ocean quahogs to prevent, mitigate or minimize adverse effects on EFH from fishing to bring the FMP into compliance with Section 303(a)(7) of SFA. There were three alternatives for multi-year quotas. There were three alternatives for the suspension of the surfclam minimum size limit. Finally, there were four alternatives for a vessel monitoring - type system. The Council chose the following preferred management alternatives: a) a surfclam overfishing definition as identified in Table 1, b) maintaining the no action alternative with additional clarification for the fishing gear impacts to EFH, c) allowing for multi-year quotas not to exceed three years with an annual review, d) adding to the list of framework management items the suspension of the surfclam minimum size limit and adjustment of minimum size, and e) mandatory implementation of an electronic tracking system that is satisfactory to the Service and the industry.

Actions in the reasonable foreseeable future include the annual process establishing the commercial quotas for surfclams, ocean quahogs, Maine ocean quahogs, and continued suspension of the surfclam minimum size limit. The annual quota setting process ensures that the two resources are not overfished so the FMP remains in compliance with the MSFMCA as amended by the SFA. The cumulative impacts of this annual quota setting process are examined at that time, and thus ensures that the plan will remain in compliance with the MSFMCA as amended by SFA.

None of the Council selected alternatives will significantly change any existing management measures. It is unlikely that any of these alternatives will result in changes in landings patterns or fishing effort along the coast. Thus, the preferred alternatives are not expected to have cumulative negative impacts to protected resources or EFH, relative to past or future activity. Additionally, these fisheries are Category III fisheries as defined in the NMFS 2002 List of Fisheries. This means that these fisheries have a remote likelihood or no known serious injuries or mortalities of marine mammals. All fishing gear are required to meet gear restrictions under the LWTRP, HPTRP, MMPA, and ESA.

The affected environment is described in other sections of this amendment. The biological and physical environment, including a description of the stock, habitat, and protected species are described in sections 2.1, 2.2 and 6.1, respectively. A description of the human environment is found in section 2.3 "Description of Fishing Activities," especially section 2.3.3 "Ports and Communities".

There will be positive benefits for the stocks and the fisheries from the continuation of these commercial management measures which have prevented overfishing of these resources for nearly the past two decades. Individual biological, social, economic impacts of all the alternatives are discussed in section 3.3. However, the purpose of past, proposed, and future actions is to address the management objectives outlined in section 1.3. All present and future actions must meet the requirements of the ten National Standards outlined in section 5.1 and the other MSFCMA requirements addressed in section 5.0.

None of the proposed commercial management alternatives would change the manner in which the annual surfclam and ocean quahog quotas are derived. Therefore, a change in the overall amount of surfclam or ocean quahog landings is not anticipated. The bulk of the commercial management alternatives deal with quota allocations among users.

To continue to prevent overfishing, the Council recommends annual specifications that are intended to not exceed the specified target F's for the coming fishing year. Because each year's measures build upon the previous year's measures, the cumulative effects of the management program on the health of the stocks and the fishery are assessed from year to year. The extent of any cumulative impacts from measures established in previous years is largely dependent on how effective those measures were in meeting their intended objectives and the extent to which mitigating measures compensate. The annual nature of the management measures is intended to provide the opportunity for the Council and NMFS to assess regularly the status of the fisheries and to make necessary adjustments to ensure that there is a reasonable expectation of meeting the objectives of the FMP and the targets associated with any program under the FMP.

The management measures that have been implemented in the past 25 years have helped to improve the status of the stocks while conserving marine habitat. The addition of any specific EFH actions could add protection to the physical aspects of the environment. Some of the EFH alternatives would result in economic losses, although these losses may be offset by benefits to other stocks by protecting habitat. However, it may be impracticable to implement a habitat protection alternative that has costs to the fishing industry for some unknown or unquantified habitat benefit. As such, the cumulative impact of the EFH alternatives should also be minimal.

All FMP actions are implemented for the purpose of meeting the requirements of the MSFMCA as amended by the SFA. The human aspect of the environment are protected under National Standard 8 (ports and communities) and National Standard 10 (safety at sea). The biological aspects of the environment are protected under National Standard 1 (overfishing definition) and National Standard 4 (bycatch), and MMPA. The physical aspects of the environment are protected under the EFH requirements of the MSFCMA.

The proposed actions, together with past and future actions are not expected to result in any negative cumulative impacts on the biological, physical, and human components of the environment. The commercial management and EFH measures for surfclams and ocean quahogs that have been developed during the past 25 years by the Council represent the best compromise between the probability that the stock will not be overfished and the minimization of costs to the fishing industry.

There are many other anthropogenic activities, besides fishing that can have negative impacts to surfclam and ocean quahog EFH in addition to the EFH of other Federally managed fishery resources. The Habitat Division of NMFS, Fish and Wildlife Service, EPA, and their equivalents in the various coastal states frequently evaluate permits from Federal, state and private applicants who propose projects that could negatively impact these resources. Marine offshore activities such as aggregate and sand mining for profit and beach replenishment, the creation of safety zones around proposed windmill farms, and other activities that would either disturb the sediment and thus the resources or put large areas off limits to fishermen all could negatively impact these resources and fisheries. The numerous anthropogenic activities the Council is concerned about were identified in Amendment 12 section 2.2.5 Non-fishing activities that may adversely affect EFH. The Federal and state governments use the various EFH designations when they are reviewing and commenting on proposed activities. Projects also have to meet all the NEPA requirements, including cumulative impacts, and significantly detrimental ones are usually prohibited or modified.

3.4 ESSENTIAL FISH HABITAT ASSESSMENT

This Essential Fish Habitat (EFH) Assessment is provided pursuant to 50 CFR 600of the Essential Fish Habitat Final Rule of January 17, 2002 for the Council to initiate EFH consultation with the National Marine Fisheries Service.

Surfclams and ocean quahogs have EFH designated in many of the same bottom habitats that have been designated as EFH for most of the MAFMC managed species of summer flounder/scup/black sea bass, squid/mackerel/butterfish, bluefish, tilefish, and dogfish, as well as the NEFMC species of groundfish within the Northeast Multispecies FMP, including: Atlantic cod, haddock, monkfish, ocean pout, American plaice, pollock, redfish, white hake, windowpane flounder, winter flounder, witch flounder, yellowtail flounder, Atlantic halibut and Atlantic sea scallops. Numerous species within the NMFS Highly Migratory Species Division and the SAFMC have EFH identified in areas also identified as EFH for surfclams and ocean quahogs. Broadly, EFH is designated as the bottom habitats within the Gulf of Maine, Georges Bank, and the continental shelf off southern New England and the mid-Atlantic south to Cape Hatteras for the juveniles and adults of these two species. Specifically the definitions as approved in Amendment 12 (MAFMC 1998) are:

Surfclams

Juveniles and adults: Throughout the substrate, to a depth of three feet below the water/sediment interface, within federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ, in areas that encompass the top 90% of all the ranked ten-minute squares for the area where surfclams were caught in the NEFSC surfclam and ocean quahog dredge surveys. Surfclams generally occur from the beach zone to a depth of about 200 feet, but beyond about 125 feet abundance is low.

Ocean quahogs

Juveniles and adults: Throughout the substrate, to a depth of three feet below the water/sediment interface, within federal waters from the eastern edge of Georges Bank and the Gulf of Maine throughout the Atlantic EEZ, in areas that encompass the top 90% of all the ranked ten-minute squares for the area where ocean quahogs were caught in the NEFSC surfclam and ocean quahog dredge surveys. Distribution in the western Atlantic ranges in depths from 30 feet to about 800 feet. Ocean quahogs are rarely found where bottom water temperatures exceed 60° F, and occur progressively further offshore between Cape Cod and Cape Hatteras.

Any mobile gear that comes into contact with the seafloor in surfclam and ocean quahog EFH may potentially have an impact to these immobile benthic organisms (MAFMC 1998). The gears expected to have the most adverse impact are hydraulic clam dredges and the scallop dredges.

Hydraulic dredges are used to extract clams from the sediment. In hydraulic dredging, high pressure water jets ahead of the rake teeth or blade are used to scour out the shells which are then dug up by the blades and passed back into the bag. High pressure water is supplied to the jets through a hose from the operating vessel by a diesel pump and the bag is generally carried on a heavy sled. This gear is generally fished in relatively shallow inshore and estuarine areas (Sainsbury 1996).

In the Atlantic surfclam (*Spisula solidissima*) fishery, large vessels (> 95 feet), tow dredges up to 15 feet in width slowly across the seabed. The vessels are equipped with large pumps, connected to the dredges via flexible hoses, that use water and inject it into the sediment through a manifold with multiple nozzles, ahead of the blade of the dredge. The dredge must be towed slowly so as to not exceed the liquefaction rate. These dredges, operated correctly, are highly efficient, taking as much as 90% of clams in their path. A secondary species that is also harvested in this fishery is the ocean quahog, *Arctica islandica*.

A fishing gear impacts workshop was held in Boston in October 2001 that reviewed and discussed exactly how the hydraulic and nonhydraulic (Maine ocean quahog fishery) clam dredges operate and what their potential impacts could be. The panelists heard presentations and had discussions on: 1) the actual fishery descriptions, 2) the effects of the fishery on the environment, 3) the strength of the evidence of those effects, and 4) what potential management implications were possible. The full discussion of the clam dredge analyses from the workshop is presented here and the full workshop report evaluating all gear is included in this amendment as Appendix 4.

Mr. Dave Wallace (Wallace and Associates) presented a thorough description of the evolution and current use of the hydraulic clam dredge for the surfclam and ocean quahog fisheries. A brief discussion of "dry dredges" used in the Maine "mahogany" ocean quahog fishery was led by Wallace with contributions from the workshop panelists. Subsequent to the workshop, Wallace (pers. comm.) has additionally estimated that the average hydraulic clam dredge takes about 600 man-hours to build and constitutes an investment of almost $30,000 (without hoses and pumps). Thus, industry is quite leery of hanging the dredge up and potentially losing it. This section of the report summarizes his presentation and the panel discussion.

Hydraulic clam dredges have been used in the surfclam fishery for over five decades and in the ocean quahog fishery since its inception in the early 1970s. These dredges are highly sophisticated and are designed to: 1) be extremely efficient (80 to 95% capture rate); 2) produce a very low bycatch of other species; and 3) retain very few undersized clams.

The typical dredge is 12 feet wide and about 22 feet long and uses pressurized water jets to wash clams out of the seafloor. Towing speed at the start of the tow is 2.5 knots and declines as the dredge accumulates clams. The dredge is retrieved once the vessel speed drops below 1.5 knots, which can be only a few minutes in very dense beds. However, a typical tow lasts about 15 minutes. The water jets penetrate the sediment in front of the dredge to a depth of about 8 - 10 inches, depending on the type of sediment and the water pressure. The water pressure that is required to fluidize the sediment varies from 50 pounds per square inch (psi) in coarse sand to 110 psi in finer sediments. The objective is to use as little water as possible since too much pressure will blow sediment into the clams and reduce product quality. The "knife" (or "cutting bar") on the leading bottom edge of the dredge opening is 5.5 inches deep for surfclams and 3.5 inches for ocean quahogs. The knife "picks up" clams that have been separated from the sediment and guides them into the body of the dredge ("the cage"). If the knife size is not appropriate, clams can be cut and broken, resulting in significant mortality of clams left on the bottom. The downward pressure created by the runners on the dredge is about 1 psi.

It was pointed out by a panel member that the high water pressure associated with the hydraulic dredge can cause damage to the flora and fauna associated with bottom habitats. However, water pressure greater than that required for harvesting will reduce the quality of the clams by loading them with sand and increase the rate of clam breakage. Therefore, water pressure is usually self regulated.

There are currently two types of hydraulic dredges used in the fishery, stern rig dredges and side rig dredges. The chain bag on a side rig dredge drags behind the dredge and helps smooth out the trench created by the dredge. The chain bag results in significantly more damage to small clams and other bycatch than occurs with the stern rig dredge. With the stern rig dredge, which is basically a giant sieve, small clams and bycatch fall through the bottom of the cage into the trench and damage or injury is minimal. Improvements in gear efficiency have reduced bottom time and helped to limit the harvest of surfclams to a relatively small area in the mid-Atlantic Bight.

Prior to 1990, the resource was managed by controlling the number of hours a vessel could fish. Consequently, towing speeds were maximized to catch as many clams as possible regardless of the damage done to the clams or the habitat. Cutting and breakage of discarded clams were estimated to be as high as 90% in some locations and under some conditions decomposition of dead clams caused reduced oxygen concentrations in sediments to the point that clams were killed. Incidental mortality is currently estimated to be well under 10% because quota management has removed the need for vessels to catch as many clams as possible as quickly as possible.

Concurrent with the change in harvesting practices that occurred after 1990, there has also been a significant reduction in fishing effort and a shift to stern rig dredges. About 60 side-rig vessels pulling 80 dredges were taken out of the fishery after 1990. The number of surfclam vessels decreased from 128 in 1990 to 35 in 2001, while the number of vessels that landed ocean quahogs (excluding the Maine fishery) dropped from 56 in 1990 to 30 in 2001. Currently there are only 4 side rig vessels pulling five dredges left in the fleet.

Surfclams live mostly in sand which is disturbed and re-suspended by storms and, in some locations, by strong bottom currents. Ocean quahogs live at greater depths, mostly in finer sand and silt/clay substrates which are less affected by natural physical disturbances. Surfclams and ocean quahogs are not found in commercial quantities in gravel or mud habitats or in depths greater than about 250 feet.

Hydraulic clam dredges can be operated in areas of large grain sand, fine sand, sand and small grain gravel, sand and small amounts of mud, and sand and very small amounts of clay. Most tows are made in large grain sand. Dredges are not fished in clay, mud, pebbles, rocks, coral, large gravel greater than one half inch, or seagrass beds. Boat captains will not dredge in areas with very soft or hard substrate where they run the risk of losing or damaging the gear. The fishery is also limited to sandy sediment because the processors do not want mud blown into the clam bodies by the dredge.

The spatial scale of fishing effort varies depending on which species is the target: surfclams are harvested primarily in a small area off the New Jersey coast whereas ocean quahogs are harvested over a larger area that includes offshore waters. Areas with denser concentrations of clams would presumably be dredged more intensively, i.e., a higher percentage of the bottom would be affected. Because surfclams are concentrated in a very defined area off the New Jersey coast where the bottom is so homogeneous, a high proportion of the bottom over this large contiguous area is affected by dredging. Surfclams grow much more rapidly than ocean quahogs and surfclam beds are dredged every few years. Areas dredged for ocean quahogs are left untouched for many years. Ocean quahogs are much more likely to be dredged from a number of more or less discrete patches that are surrounded by undisturbed areas. It was noted, as a general rule, that once 50% of the harvestable clams are removed from an area, the catch rates drop to a point where it is no longer economically feasible for fishing to continue there.

In Federal waters, the amount of bottom area directly impacted by the hydraulic clam dredge fleet in 2000 was about 110 square miles (Table 2). An additional 15 square miles were dredged in state waters of New Jersey, New York, and Massachusetts. The predominant substrate on the southern New England/Mid-Atlantic Bight shelf is sand. Thus, during any given year, this fishery is conducted in a very small proportion of a habitat type that characterizes most of the 40,000 square miles of continental shelf between the Virginia/North Carolina border and Nantucket Island (69° W longitude). The Georges Bank region has been closed to clam harvesting since 1990 because of the potential of paralytic shellfish poisoning.

The dry dredge used in the Maine fishery is a cage with wide skis and a series of teeth about 6 inches long in the front. These dredges are used on smaller boats (about 30 to 40 feet long) and are pulled through the seabed using the boat's engine. The cutter bar is limited to a width of 36 inches by state law. This fishery takes place in small areas of sand and sandy mud found among bedrock outcroppings in depths of 30 to > 250 feet in state and Federal coastal waters north of 43Ķ20' N latitude. The dredges scoop up clams and sediment, and the vessel's propeller wash is used to clean out the sand and mud.

Trips reported by vessels using hydraulic clam dredges during 1991-2000 were made over a broad area of the continental shelf from Cape Cod to the Delmarva peninsula (Figures 37 and 38). Areas where fishing with this gear type was concentrated (235 trips per 100 mi2) were located off the New Jersey coast and south of Long Island. Dredging in southern New England was less intense. The concentration of the "dry" dredge in the Maine ocean quahog fishery is depicted in Figure 39.

Hydraulic clam dredges - impacts and recovery

The following information is from a draft report by Stevenson *et al.* entitled *"The Effects of Fishing on Marine Habitats of the Northeastern United States"* that is to be published in the late spring/summer of 2003. This report is an updated/expanded version of the report in Appendix 3.

Hydraulic Clam Dredges – Mud

Hall and Harding (1997) evaluated the effects of suction dredging on intertidal infaunal communities in Auchencairn Bay, on the north side of the Solway Firth, on the west coast of Scotland. Sediments were 60-90% silt/clay in the interior of the bay and 25-60% silt/clay in the center and outer parts of the bay. Commercial dredging for cockles (*Cerastoderma edule*) in the bay was prohibited four and a half months before experimental dredging began. Core samples were collected in control plots prior to dredging, and in experimental plots immediately after, and one, four, and eight weeks after dredging. Dredge tracks could not be seen after the first day. The total number of infaunal individuals and species increased in both plots over time, but were significantly lower in the experimental plots than in the control plots immediately after dredging and after four weeks. Species diversity also increased significantly over time, but was not significantly different in the two plots at any point during the experiment. Three of the five dominant species were significantly reduced by dredging over the course of the study. By the end of the study (eight weeks), much of the difference between dredged and control sites had been lost, but the disturbed plots still had a higher partial-dominance index.

Summary

Results of a single experimental study are summarized here. It examined the physical and biological effects of individual suction dredge passes in an intertidal mud habitat and monitored recovery for eight weeks. Dredging produced dredge tracks that disappeared after one day. There were significant reductions in the total number of infaunal individuals and species that lasted four weeks, and three out of five dominant species were reduced in abundance during the eight-week duration of the experiment. However, infaunal community structure recovered nearly completely by the end of the experiment.

Hydraulic Clam Dredges – Sand

(1). Hall *et al.* (1990) studied the physical and biological effects of a commercial escalator dredge used to harvest razor clams (*Ensis* spp.) in a shallow sea loch (Loch Gairloch) on the west coast of Scotland in November 1989. The depth at the study site was 22 feet and the sediment was fine sand. It was located near a recently-dredged area, but was not exploited itself. Experimental and control plots were visually inspected and sampled by divers immediately after dredging and 40 days later. Each experimental plot was dredged intensively for approximately five hours in order to simulate commercial fishing activity. After dredging, the experimental plots were crisscrossed by shallow trenches (0.5 m wide and 10 inches deep) interspersed with larger holes (up to 10 feet wide and 2 feet deep) that were presumably produced when the dredge remained stationary for a brief period. Sediment in the holes and trenches was "almost fluidized" and sand in the bottom of the trenches had a significantly higher median particle size. After 40 days, however, none of these features remained.

The number of infaunal species and individuals were reduced in the experimental plots immediately after dredging (significantly, for individuals), but there were no detectable differences between experimental and control plots 40 days later. There were no significant differences in the abundance of individual species in the control and experimental plots on either sampling occasion. The authors concluded that dredging caused a short-term, non-selective reduction in the numbers of all infaunal species and that recovery from physical effects was accelerated by a series of winter storms and considerable sediment disturbance in the study area. No attempt was made to assess the mortality of large polychaetes and crustacea that were observed to be retained on the wire mesh conveyor belt or fell off the end of the belt, or ocean quahogs (*Arctica islandica*) that were often cracked by the dredge.

(2). Kaiser *et al.* (1996b) investigated the effects of suction dredging for cultivated manila clams (*Tapes philippinarum*) on a muddy sand intertidal flat in southeast England in December 1994. Samples of benthic infauna and sediment were collected prior to, three hours after, and seven months after harvest in one cultivated plot and in nearby control locations. There were significantly higher densities of infaunal organisms in the cultivated plot prior to dredging, but no differences in the number of species or in four indices of taxonomic diversity. Large amounts of fine sand were re-suspended by the dredge, exposing the underlying clay. There were also significant reductions in the mean numbers of infaunal species and individuals in the dredged plot immediately after harvest, to values that were statistically the same as in the control locations. Crustaceans and bivalve mollusks were particularly affected. Seven months later there were no significant differences between the benthic community in the harvested plot and in the control locations and the proportion of fine sand in the harvested plot had increased significantly, indicating that recovery from the effects of clam cultivation and harvesting was complete.

(3). MacKenzie (1982) sampled benthic invertebrate assemblages in three ocean quahog beds with contrasting fishing histories located about 40 miles east of Cape May, New Jersey (USA), in the mid-Atlantic Bight, in October 1978. One bed had never been fished, one had been actively fished for two years, and one had been fished for about a year but then abandoned 4-5 months prior to this study. All three beds were in very fine to medium sand sediments in 110 feet of water. Commercial dredging was conducted with cage dredges in this area. Sampling was limited to a total of 30 grab samples from all three sites. No significant differences were found in numbers of invertebrate individuals or species, or in species composition, between previously dredged and un-dredged areas or between dredged and un-dredged sample locations at the two fished sites. Hydraulic dredging thus did not appear to have any lasting effect on the invertebrate populations in these beds. Comparison of samples from previously dredged and un-dredged sample locations also indicated that hydraulic jetting of the bottom re-sorts bottom sediments, leaving shell fragments on the surface and coarser sediments at the bottom of dredge tracks.

(4). Maier *et al.* (1995) assessed the effects of escalator dredges in four muddy sand tidal creeks in South Carolina (USA) by comparing pre- and post-dredging turbidity levels and benthic infaunal assemblages. Turbidity was monitored two weeks before, during, and two weeks after dredging at one location and during and immediately after dredging at another. Infaunal samples were collected three weeks before and two weeks after dredging in a creek that had been commercially dredged five years prior to the study and in a creek that had never been dredged before. Turbidity was elevated in the vicinity of the dredge and immediately downstream while it was operating, but the sediment plumes only persisted for a few hours. Sampling failed to detect any significant changes in the abundance of dominant infaunal taxa, or in the total numbers of individuals, after dredging.

(5). Medcof and Caddy (1971) utilized divers and a submersible to compare the physical effects of a hydraulic cage dredge and a non-hydraulic toothed scallop dredge in shallow water (20 to 35 feet) sand inlets in southern Nova Scotia (Canada). On sand and sand-mud habitats, hydraulic dredges left smooth tracks with steeply cut walls that averaged 8 inches deep and slowly filled in by slumping. The hydraulic dredge raised a sediment cloud which seldom exceeded 2 feet in height and usually settled within 1 minute. Dredge tracks were still easily recognizable after 2-3 days.

(6). Meyer *et al.* (1981) observed the effects of a small (4 feet wide) hydraulic clam cage dredge in an un-harvested surfclam bed located near Rockaway Beach on the south shore of Long Island, New York (USA). The study was conducted in 1977, three years after the area was closed to commercial clamming. The sediment in the study area was fine to medium sand covered with a 3 inch-thick layer of silt and the maximum depth was 100 feet. The study area was exposed to strong bottom currents that caused considerable movement of sand. As part of a larger study to evaluate gear performance, the effects of dredging on bottom substrate and fauna were assessed by divers during a single 2-minute tow immediately after and 2 and 24 hrs after dredging. The dredge formed trenches which were initially rectangular, as wide as the dredge, and over 8 inches deep. Mounds of sand 6 to 15 inches wide and 2 to 6 inches high were formed on either side of the trench. The dredge raised a cloud of silt 1 to 5 feet in height, which settled within four minutes. Slumping of the trench walls began immediately after the tow and became more apparent with time. Two hours after dredging, slumping of the trench walls had rounded the depression. After 24 hours the dredge track was less distinct, appearing as a series of shallow depressions, and was difficult to recognize. The dredging attracted predators, with lady and rock crab preying on damaged clams, and starfish, horseshoe crabs and moon snails attacking exposed but undamaged clams. By 24 hours after dredging, the abundance of predators appeared to have returned to normal, and the most obvious evidence of dredging was whole and broken clam shells without meat.

(7). Pranovi and Giovanardi (1994) studied the effects of an 8 foot wide hydraulic cage dredge in 5 to 7 foot depths in the Venice Lagoon (Italy, Adriatic Sea). Divers collected samples of sediment and benthic organisms from experimentally-dredged and control areas at two sites inside and outside a commercial fishing ground immediately after experimental dredging and every three weeks for two months. A single tow with a commercial dredge was made at each site. The dredge created 3 to 4 inch-deep furrows, one of which was clearly visible two months later. In this study, sediment grain size was not significantly affected by dredging, although portions of the fishing grounds which had been predominantly silt and clay 15 years earlier had a considerably higher sand content at the time of the study. Hydraulic dredging in this area often cracks the shells of bivalves. Within the fishing grounds, total numbers and biomass of benthic infauna and epifauna were significantly reduced in the experimental plot immediately following dredging. Densities, especially of small species and epibenthic species, recovered two months later, but biomass did not. Inside the fishing ground, there were also fewer species in the dredged area than in the control area immediately after, and three and six weeks after, dredging, but no differences two months afterwards. Outside the fishing ground, immediately after passage of the dredge, there were no significant faunal differences between dredged and undredged areas.

(8). Tuck *et al.* (2000) examined the effects of hydraulic dredging on the seabed and benthic community in a shallow (6 to 15 feet), sandy site in the Outer Hebrides (Sound of Ronay), on the west coast of Scotland in March 1998 that was closed to commercial dredging. Sediments in the study area consisted of moderately well-sorted medium or fine sand and tidal currents reached speeds as high as three knots. Divers collected core samples and made observations and video recordings, before, during, and after dredging inside and outside six dredge tracks and returned to re-examine the site 5 days and 11 weeks after dredging. The dredge was a commercial dredge used to harvest razor clams that employs a blade that protrudes 1 foot into the sediment with holes that direct pressurized water forward into the sediment.

Immediately after dredging the track had distinct vertical walls and a depth similar to the dredge blade. However, once the dredge was hauled, the side walls collapsed and the tracks had a flat-bottomed "V" shape. The sediment within the base of the tracks was fluidized to a depth of approximately 1 foot and within both side walls to approximately 6 inches. The tracks were still clearly visible after five days, but less pronounced, and the depth of fluidized sediment remained the same. After 11 weeks the tracks were no longer visible, but 8 inches of sand was still fluidized. Immediately after fishing, there was significantly less silt in the sediments inside the tracks than outside, but there was no difference after five days. Numerically, the infauna at the study site was dominated by polychaetes. There was a significant decrease in the proportion of polychaetes, and an increase in amphipods, in the dredge tracks within five days of dredging, but not after 11 weeks. Bivalves were not affected by dredging. Within a day of dredging the total number of species and individuals was significantly lower in the dredge tracks, but there was no difference after five days. Dredging had an immediate effect on the abundance of a number of individual species, but no effects were detected 11 weeks after dredging. Owing to the strong currents, there was a very sparse epifauna in the area: the only observed effect of dredging was the attraction of crabs into the area to scavenge on material disturbed by the dredge.

Summary

Results of eight hydraulic dredge studies in sandy substrates are summarized in this report. Five of them examined the effects of "cage" dredges of the type used in the Northeast region of the U.S. (3, 5-8) and three examined the effects of escalator and suction dredges. Three of them were published prior to 1990, and five since then. Four were performed in North America, one in the Adriatic Sea and three in the United Kingdom. One study was conducted on the U.S. continental shelf at a depth of 110 feet, five in shallower, nearshore waters (5 to 40 feet), and two in intertidal environments. Three studies were observational in nature and five were controlled experiments. Three studies compared effects in commercially-dredged and un-dredged areas and four were conducted in previously un-dredged areas. Six studies examined the effects of individual dredge passes, one evaluated the effects of repeated passes in the same area during a short period of time, and one compared infaunal communities in an actively dredged, a recently dredged, and an un-dredged location. Seven studies examined physical and biological effects and one was limited to physical effects. All of the biological studies examined effects to infauna. Recovery was evaluated in four cases for periods ranging from 40 days to seven months.

Physical effects

Hydraulic clam dredges created steep-sided trenches 3 to 12 inches deep that started deteriorating immediately after they were formed (1, 5-8). Trenches in a shallow, inshore location with strong bottom currents filled in within 24 hours (6). Trenches in a shallow, protected, coastal lagoon were still visible two months after they were formed (7). Hydraulic dredges also fluidized sediments in the bottom and sides of trenches (1, 8), created mounds of sediment along the edges of the trench (6), re-suspended and dispersed fine sediment (2, 4-6), and caused a re-sorting of sediments that settled back into trenches (3). In one study (8), sediment in the bottom of trenches was initially fluidized to a depth of 12 inches and in the sides of the trench to 6 inches. After 11 weeks, sand in the bottom of the trench was still fluidized to a depth of 8 inches. Silt clouds only last for a few minutes or hours (4-6). Complete recovery of seafloor topography, sediment grain size, and sediment water content was noted after 40 days in a shallow, sandy environment that was exposed to winter storms (1).

Biological effects

Some of the larger infaunal organisms (*e.g.*, polychaetes, crustaceans) retained on the wire mesh of the conveyor belt used in an escalator dredge, or that drop off the end of the belt, presumably die (1). Benthic organisms that are dislodged from the sediment, or damaged by the dredge, temporarily provided food for foraging fish and invertebrates (1, 6). Predator densities returned to normal within 24 hours in one study (6). Hydraulic dredging caused an immediate and significant reduction in the total number of infaunal organisms in three separate studies (1, 2, 8) (but not in another (4)) and in the number of macrofaunal organisms in a fourth study (7). There were also significant reductions in the number of infaunal species in two cases (2, 8) and in the number of macrofaunal species and biomass in a third case (7). In one study, polychaetes were most affected (7). Two studies failed to detect any reduction in the abundance of individual taxa (1, 4). Evidence from the study conducted off the New Jersey coast indicated that the number of infaunal organisms and species, and species composition, were the same in actively dredged and un-dredged locations (3).

Recovery times for infaunal communities were estimated in four studies. Three of these studies (1,7, 8) were conducted in very shallow (5 to 22 feet) water and one (2) in an intertidal environment. Total infaunal abundance and species diversity had fully recovered only five days after dredging in one location where tidal currents reach maximum speeds of three knots (8). Some species had recovered after 11 weeks. Total abundance recovered 40 days after dredging in another location exposed to winter storms, when the site was re-visited for the first time (1). Total infaunal abundance (but not biomass) recovered within two months at a protected, commercially-exploited site (7), where recovery was monitored at three-week intervals for two months, but not at a nearby unexploited site. Full recovery at the intertidal site was noted seven months after it was suction dredged when it was re-visited for the first time (2). Actual recovery times at this site and at one of the exposed sub-tidal sites (1) may have been much quicker than seven months and 40 days.

Hydraulic Clam Dredges - Mixed Substrates

Murawski and Serchuk (1989) used manned submersibles to observe effects of hydraulic dredging on sand, mud, and gravel bottom habitats in a number of offshore locations in the mid-Atlantic

Bight (U.S. Atlantic coast) between Delaware Bay and Long Island (water depths not reported). They reported that hydraulic cage dredges penetrate deeper into the sediments and, on a per-tow basis, result in greater short-term disruption of the benthic community and underlying sediments than do scallop dredges (no data were provided). In coarse gravel, the sides of hydraulic dredge trenches soon collapsed, leaving little evidence of dredge passage. There was also a transient increase in bottom water turbidity. In finer-grained, hard-packed sediments, tracks persisted for several days after dredging. Non-harvested benthic organisms (*e.g.*, sand dollars, crustaceans, polychaetes) were substantially disrupted by the dredge. Sand dollar assemblages appeared to recover quickly, but short-term reductions in infaunal biomass were considered likely. Numerous predatory fish (*e.g.*, red hake, spotted hake, and skates) and invertebrates (rock crabs and starfish) were observed in and near dredge tracks consuming broken quahogs. Densities of crabs and starfish were estimated to be 2.5 times higher in dredge tracks than in nearby undredged areas within one hour of experimental tows and >10 higher 8 hrs after dredging. Presumably, benthic infauna "tilled up" by the dredge were also being consumed, since not all predators observed foraging in the dredge paths were eating damaged shellfish.

Summary

An *in situ* evaluation of hydraulic dredge effects in sand, mud, and coarse gravel in the mid-Atlantic Bight indicated that trenches fill in quickly, within several days in fine sediment and more rapidly than that in coarse gravel. Dredging dislodged benthic organisms from the sediment, attracting predators.

Hydraulic Dredges - Biogenic Substrate

(1). Godcharles (1971) evaluated the physical effects of escalator dredging in seagrass (*Thallasia testudineum* and *Syringodinium filiforme*) beds, *Caulerpa* algae beds, and bare sand bottoms (depth not given) in Tampa Bay, Florida (USA) in 1968. Dredging was conducted with a commercial dredge at six sites. Water jets penetrated sediments to a maximum depth of 20 inches and left trenches that varied from 6 to 18 inches deep. Trenches were deeper in shallow areas where propellor wash scoured loose sediments from trenches and prevented redeposition of suspended sediments. The proportion of fine sediment in some trenches decreased immediately after passage of the dredge. Virtually all attached vegetation in the path of the dredge was uprooted, leaving open bottom areas. Trenches in grass beds remained visible longest (up to 86 days) while those in sandy areas filled in immediately. Most fluidized sediments hardened within a month, but some spots were still soft 500 days after dredging. Differences in silt/clay content between tracks and undisturbed areas became negligible after a year, but seagrasses had still not re-colonized disturbed areas. New algal growth was noted in some dredged areas after 86 days and after a year dredge tracks were completely covered.

(2). Orth *et al.* (1998) assessed damage to submerged aquatic vegetation (SAV) caused by escalator dredges in Chincoteague Bay, Virginia (USA) during 1996, 1997, and 1998. They reported a large number of circular "scars" in the vegetation, with 70-100% seagrass cover outside the scarred areas and an abrupt reduction to 15% or less at the scar edge. The percent cover of seagrass was low across the scar until a second abrupt increase in cover occurred at the center where seagrass had not been disturbed. There were no measurable differences in percent cover estimates in the scarred portions of areas that were dredged during the three years of observation, indicating that re-vegetation was proceeding very slowly. There were two factors that they believed were delaying re-vegetation: an increase in depth of 4 to 8 inches in the dredge tracks and large holes inside the un-vegetated portions of the scars made by organisms such as foraging cownose rays. The authors concluded that even the most lightly impacted areas would require a minimum of five years to fully recover.

Summary

Two studies were performed in the southeast U.S. in shallow, sub-tidal, vegetated habitats. One of them was a controlled experiment that compared the effects of escalator dredges in vegetated (seagrass and algae) and un-vegetated areas and the other evaluated damage to seagrass beds caused by commercial escalator dredging. In the experimental study (1), water jets penetrated sand substrate to a maximum depth of 18 inches, created trenches up to 12 inches deep, up-rooted vegetation, and increased the silt/clay content of sediments in dredge tracks. Recovery times were extremely variable. In some cases, trenches were visible for only a day and in other cases for three months. In most cases, sediments hardened within a month, but in some tracks sediments were still fluidized 500 days after dredging. After a year sediment composition in dredge tracks had returned to normal, but seagrass had not re-colonized disturbed areas. There were no signs of recovery of seagrass in commercially-dredged areas three years after dredging (2).

<u>Scallop dredges</u>

Scallop dredges are discussed in detail in the NMFS report (USDC 2001) that is appended (Appendix 3). The panel determined that the effects of scallop dredging were of greatest concern in the following three habitat types: high and low energy sand and high energy gravel. Surfclams and ocean quahogs are found in sandy sediment. Low energy sand habitat occurs in deeper water where the bottom is unaffected by tidal currents and where the only natural disturbance is caused by occasional storm currents. In high energy sand habitat, effects on biological structure were considered to be low, since organisms in this environment would be adapted to a high degree of natural disturbance. It is unlikely that either surfclams or ocean quahogs would be significant since the gear rides on the surface and the surfclams and ocean quahogs are buried in the sediment.

<u>Otter trawls</u>

Otter trawls are discussed in detail in the NMFS report (USDC 2001) that is appended (Appendix 3). The panel concluded that the greatest impacts from otter trawls occur in low and high energy gravel habitats and in hard clay outcroppings. Both surfclams and ocean quahogs occur almost exclusively in sandy habitat.

Other gears

Gear other than hydraulic clam dredges, scallop dredges and otter trawls are discussed in some detail in the NMFS report (USDC 2001) that is Appendix 3. The panel concluded that the degree of impact caused by pots and traps to biological and physical structure and to benthic prey in mud, sand and gravel habitats was low. The panel concluded that sink gill nets and longlines cause some low degree impacts in mud, sand, and gravel habitats. Finally, the panel concluded that no management measures were necessary for beam trawls or pelagic gear because there were no impacts at this time.

Council determination of fishing impacts to surfclam and ocean quahog EFH

Any mobile gear that comes into contact with the seafloor in surfclam and ocean quahog EFH may potentially have an impact to these immobile benthic organisms (MAFMC 1998). The gears expected to have the most adverse impact are hydraulic clam dredges and the scallop dredges (MAFMC 1998). EFH for surfclams and ocean quahogs is defined in section 2.2.3 and can be seen in Figures 30 and 31 for surfclams and 32 and 33 for ocean quahogs.

Section 2.2.5.4.3.2 discusses the impacts and recovery from hydraulic clam dredges. The Council considered the numerous studies identified above and the fact that the surfclam and ocean quahog fisheries are ITQ fisheries. As ITQ fisheries there is no reason that fishermen have a "rush to fish". One of the great benefits of ITQ fisheries from around the world is that it instills the sense of private property rights and ownership in the resource. Fishermen in these fisheries understand that they are not time driven to rape the resource and that by protecting the resource and its environment they are protecting their long term livelihoods. Unquestionably, ITQs and the way clams are now fished alleviate some environmental damage (Wallace pers. comm.)

The numbers of surfclam and ocean quahog fishermen have also decreased significantly with the implementation of ITQs. In 1979 there were 162 permitted surfclamming vessels. That number had fallen to 135 vessels the year before (1989) implementation of the ITQ program, and by 2001 the number was only 35. For ocean quahogs the number of vessels were: 59 in 1979, 69 in 1989 and 30 in 2001. Most of these current vessels also use sorting machines which make it possible to harvest broken clams which are now not discarded.

A brief discussion on the concept of reserves, or areas where clam dredging would not be allowed, occurred at the June 1998 SARC. The idea of reserves was dismissed at this time by the SARC when it was quickly calculated that the greatest possible impact to the bottom, of all the clam dredging for an entire year, would be less than 100 square miles per year. Putting this in context, this 100 square miles is roughly the area of one ten minute square. There are over 1200 ten minute squares in the EEZ between Cape Hatteras and Georges Bank.

Dr. James Weinberg (Northeast Fisheries Science Center - NEFSC) led the discussion at the fishing gear impacts workshop (Appendix 4) of the direct physical and biological effects of hydraulic clam dredging, and Dr. Roger Mann (Virginia Institute of Marine Science - VIMS) led the discussion on the available evidence. Most of the evidence for dredging impacts that was considered by the panel was from the Northeast U.S., but there are studies from other areas that show the same effects. It was noted that early studies done in the Northeast region were conducted during development of the fishery, when clam dredging was more damaging to the habitat than it is now.

According to these studies, the direct physical effects of hydraulic clam dredging are basically two-fold. First, a trench about 8 inches deep is left behind the dredge and windrows of sediment and organisms are formed on either side of the trench. The second direct physical effect is the resuspension of sediment. If a dredge goes through silt or loose sediment, it produces a sediment cloud. In the panel's judgement, fine sediment may take as long as 24 hours to resettle and would end up outside the trench, while heavier particles would settle much more rapidly, primarily back into the trench. The evidence for physical effects (trench, windrows, and sediment re-suspension) is strong because these effects are so obvious.

Physical impacts to bottom habitat last longer (months) in low energy environments than in high energy environments (hours). In sand, the sides of the trench start to erode as soon as it is cut; this happens more rapidly when bottom currents are strong. The rate at which it fills in depends on the grain size of the sediment, water depth, and the strength and frequency of storms and bottom currents. It was noted that there are permanent, longshelf, sand ridges with low elevation off the New Jersey coast, but there is no evidence to indicate that clam dredges remove them, even though they may be towed through them.

The direct biological effects of hydraulic dredges vary, depending on whether organisms are hard-bodied like clams or soft-bodied like amphipods or polychaetes. What happens when a clam dredge goes through an area is not fully known and more study is needed. It was noted that structure-forming epifauna such as anemones and sponges would clearly be removed. Emergent epifauna growing on shell beds in the mid-Atlantic Bight is known to provide cover for juvenile fish species like black sea bass. Removal of these organisms, or their burial by re-suspended sediments, could therefore cause the loss of habitat for some species of juvenile fish.

It is not clear what happens to soft-bodied organisms that are moved by the dredge or pass through the trench and are deposited back on the seafloor. Often, after an area is dredged, scavengers move in rapidly and eat broken clams and soft-bodied organisms that are removed from the substrate. However, the panel considered that evidence for effects on infaunal prey organisms was weak because there aren't many studies that link changes in benthic community structure in dredged areas to the food supply for fish, and those that do exist do not show definitive results. The panel concluded that infaunal communities would be likely to recover more quickly than emergent epifauna, and therefore removal of structure-forming organisms was judged to be more of a concern. However, one panelist noted that the potential loss of secondary production of benthic invertebrates which are prey for bottom-feeding fish is the effect that is least understood, and that any reduction in prey abundance – if it occurs – would not necessarily be limited to the dredge tracks themselves, but would affect the entire dredged area. Moreover, the effects of fluidizing the sediment on benthic infauna are unknown and may be important.

The panel noted that there may be cumulative physical and biological effects in areas that are dredged several times annually. As previously stated, surfclams grow much more rapidly than ocean quahogs and surfclam beds are dredged every few years, whereas areas dredged for ocean quahogs are left untouched for many years. It was also noted that benthic organisms that occupy muddy bottom in deep water are less adapted to physical disturbance and therefore would presumably take longer to recover from dredging than organisms in sandy bottom areas in shallower water.

The panel concluded that the habitat effects of hydraulic dredging were limited to sandy substrates, since the gear is not used in gravel and mud habitats (Table 3). Two effects -changes in physical and biological structure – were determined to occur at high levels. The evidence cited for these two effects was a combination of peer-reviewed scientific literature, gray literature, and professional judgement. There are no effects of hydraulic dredges on major physical features in sandy habitat because, in the panel's view, there are no such features on sandy bottom. Panel members evaluated changes to benthic prey as unknown.

The temporal scale of the effects varies depending on the background energy of the environment. Recovery of physical structure can range from days in high energy environments to months in low energy environments, whereas biological structure can take months to years to recover from dredging, depending on what species are affected.

The panel agreed that hydraulic dredges have important habitat effects, but even in a worse case scenario, where there were known to be severe biological impacts, only a small area is affected and therefore this gear type is less important than other gear types like bottom trawls and scallop dredges which affect much larger areas. It was also pointed out, however, that even though the effects of dredging (at least for surfclams) are limited to a relatively small area, localized effects of dredging on EFH could be very significant if the dredged area is a productive habitat for one or more managed fish resource. The same would be true if dredging in a particular area coincided with a strong settlement of larval fish. A major question for this gear that the workshop panel asked was "what are its long-term biological impacts" *i.e.*, how, and to what extent, are benthic communities altered in heavily dredged areas, particularly the prey organisms, and how long does it take for them to recover once dredging ceases?

The Council concurs with the fishing gear workshop panel in that there may be some impacts but that they are short-term and minimal.

There is minimal bycatch in the surfclam and ocean quahog fisheries (section 3.1.9). From the 1997 NEFSC clam survey species listing (Table 34), surfclams and ocean quahogs comprise well over 80% of the total caught in the scientific survey. Commercial operations are certainly even cleaner than the scientific surveys (as the surveys use liners to collect all animals), as all animate and inanimate objects except for surfclams and ocean quahogs are discarded quickly before the resource is placed in the cages. The processors reduce their payments if "things" other than surfclams or ocean quahogs are in the cages.

Given that (1) MacKenzie (1982) showed not pattern of any relationship of numbers of species or their abundance, (2) that these fisheries are ITQ fisheries and as such there was not reason for fishermen to "rush to fish", (3) that the number of vessels has significantly decreased from 168 to less than 50 vessels during the ITQ decade and (4) that abiotic waves are formed frequently during high storm events as deep as 200 to 250 feet (Auster and Langton 1998), the Council proposes no specific management measures at this time. The Council concurs with the 2001 Boston fishing gear impacts workshop that any impacts to EFH would be minimal and short-term, and thus they have concluded that there is not an adverse effect to other Federally managed species.

Two additional sources of evidence have just recently been received that also support the findings of the workshop and the concurrence of the Council. First, the National Research Council (2002) just completed a report entitled *Effects of Trawling and Dredging on Seafloor Habitat*. In addition, the Council's former Executive Director John Bryson also provided some personal thoughts from observations from the Johnson Sea Link submersible. Bryson (pers. comm.) reported that the substrate where clams are harvested tends to resettle quickly and in many areas this can be minutes not days. He also reports that he did not observe the large sediment cloud nor the deep track some authors report.

The NRC report upon review of what the Councils did to address fishing gear impacts after SFA in 1996 stated: "The regional councils found it difficult to develop criteria for designating EFH due to gaps in existing knowledge on the distribution of benthic life stages of fishes and other species and the physical and biological characteristics of the seafloor. Similarly, the councils struggled with the requirement to assess the effects of bottom trawling and dredging because they had insufficient data on the spatial scale and extent of bottom fishing effort and lacked guidelines for generalizing the results of research on specific gears and habitats." The NRC (2002) report concludes that in less consolidated coarse sediments (sandy areas where clams inhabit) in areas of high natural disturbance there are few initial effects.

Other species

Any species that could potentially be impacted by this FMP is considered part of the affected environment. General faunal assemblages specific to north and mid-Atlantic habitat types are described in Appendix 3. Species potentially impacted by this FMP can be described through predator/prey relationships, species with overlapping EFH, bycatch species of these fisheries, and marine mammals, sea turtles, and seabirds.

Predator/prey and other ecological relationships

Species that are in predator/prey and other ecological relationships with surfclams and ocean quahogs are fully described in section 2.1.3.

Bycatch

An analysis of bycatch is one way of determining other species that could be affected by this FMP. Section 3.1.9 includes a detailed description of the minimal bycatch of the surfclam and ocean quahog fisheries.

Marine mammals, sea turtles, and seabirds

Marine mammals, sea turtles, and seabirds that could have interactions with surfclam and ocean quahog fisheries are fully described in section 3.3. Any impacts that the management alternatives could have on these species are described in section 3.3, where applicable.

Options for Managing Adverse Effects from Fishing

According to section 600.815 (a)(2), fishery management options may include, but are not limited to: (A) fishing equipment restrictions, (B) time/area closures, and ©) harvest limits.

According to section 600.815(a)(2)(ii) that deals with minimizing adverse effects: Each FMP must minimize to the extent practicable adverse effects from fishing on EFH, including EFH designated under other Federal FMPs. Councils must act to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable, if there is evidence that a fishing activity adversely affects EFH in a manner that is more than minimal and not temporary in nature, based on the evaluation conducted pursuant to paragraph (a)(2)(I) of this section and/or the cumulative impacts analysis conducted pursuant to paragraph (a)(5) of this section. In such cases, FMPs should identify a range of potential new actions that could be taken to address adverse effects on EFH, include an analysis of the practicability of potential new actions, and adopt any new measures that are necessary and practicable. Amendments to the FMP or to its implementing regulations must ensure that the FMP continues to minimize4 to the extent practicable adverse effects on EFH caused by fishing. FMPs must explain the reasons for the Council's conclusions regarding the past and/or new actions that minimize to the extent practicable the adverse effects of fishing on EFH.

The Council is assuming that the panel of experts assembled at the fishing gear workshop that was held in Boston in October of 2001 has provided the best synthesis of the existing scientific knowledge and the soundest management recommendations. The workshop panel concluded that the habitat effects of hydraulic dredging were limited to sandy substrates, since the gear is not used in gravel and mud habitats (Table 3). Two effects -changes in physical and biological structure – were determined to occur at high levels. The evidence cited for these two effects was a combination of peer-reviewed scientific literature, gray literature, and professional judgement. There are no effects of hydraulic dredges on major physical features in sandy habitat because, in the panel's view, there are no such features on sandy bottom. Panel members evaluated changes to benthic prey as unknown.

Dr. William DuPaul (VIMS) led the discussion at the fishing gear impacts workshop on the types of management actions that could be taken to minimize adverse impacts of hydraulic dredging to benthic habitat. The following two paragraphs are taken from that report (Appendix 4).

The effectiveness of the Individual Transferable Quota (ITQ) management program since 1990 and the opinion that the two resources are underfished, led the panel to conclude that reductions in effort are probably not practicable. Nor is it likely that gear substitutions or modifications are practical since the current gear is highly efficient at harvesting clams. Therefore spatial area management seems to be the only practicable approach to minimizing gear impacts, if necessary.

It was emphasized that hydraulic dredges are designed to operate in sandy substrate. This gear could be destructive if fished in the wrong sediment type or in structured environments like gravel beds or SAV beds. The panel emphasized the gear should not be used in sediment types where it would cause damage. Areas of known structure-forming biota should be mapped and set aside as a priority. It was emphasized that since we really do not know what the effect of this gear is to soft-bodied benthic organisms, a possible precautionary measure would be to restrict the fishery to areas of high clam productivity. Seasonal closures were mentioned if times and areas of high recruitment were detected.

The temporal scale of the effects varies depending on the background energy of the environment. Recovery of physical structure can range from days in high energy environments to months in low energy environments, whereas biological structure can take months to years to recover from dredging, depending on what species are affected.

The workshop panel agreed that hydraulic dredges have important habitat effects, but even in a worse case scenario, where there were known to be severe biological impacts, only a small area is affected and therefore this gear type is less important than other gear types like bottom trawls and scallop dredges which affect much larger areas. It was also pointed out, however, that even though the effects of dredging (at least for surfclams) are limited to a relatively small area, localized effects of dredging on EFH could be very significant if the dredged area is a productive habitat for one or more managed fish resource. The same would be true if dredging in a particular area coincided with a strong settlement of larval fish. A major question for this gear is "what are its long-term biological impacts" *i.e.*, how, and to what extent, are benthic communities altered in heavily dredged areas, particularly the prey organisms, and how long does it take for them to recover once dredging ceases?

The Council concluded from the Effects of Fishing Gear on Marine Habitats in the Northeastern United States October 2001workshop (Appendix 4) that there is sufficient information that clam dredges could have an effect on EFH if the gear is fished improperly or in the wrong sediment type. For example, hydraulic clam dredges would have a significant impact to a coral reef or an SAV bed if such gear were used in a stable, fragile, structured, environment like one of those environments. However, the clam resources are concentrated in high energy sandy sediment and the fishing gear has evolved over the past five decades to fish most efficiently in this type of sandy sediment. This evolution of the fishing gear has minimized the effect on fishery habitat (Wallace and Hoff in press). Natural events have more effect on the benthic community than this type of fishing gear since all of the fishing activity takes place in sandy shallow water. Chiarella *et al.* (2002) describing the October 2001 workshop concluded that hydraulic clam dredges were not a major concern relative to otter trawls and scallop dredges. All of the hydraulic clam dredging for an entire year, would impact about 100 square nautical miles of bottom (Table 2). Putting this in context, this 100 square nautical miles is roughly the area of one ten minute square, and there are over 1200 ten minute squares in the EEZ between Cape Hatteras and Georges Bank. Thus, it does not appear that either surfclam or ocean quahog EFH is effected by fishing gear. Then the other question is whether hydraulic clam dredging is affecting other species?

A qualitative EFH vulnerability analysis conducted by Stevenson *et al.* (in press) suggests that the EFH of several species may be vulnerable to impacts associated with the use of hydraulic clam dredges. This includes black sea bass (juveniles and adults), scup (juveniles), ocean pout (all life stages), red hake (juveniles), silver hake (juveniles), winter flounder (juveniles and adults), and Atlantic sea scallops (juveniles). (See section 2.2.5.5.2 for more detail)

Based upon existing information the Council concluded that there may be potential adverse effects on EFH from the hydraulic clam dredge, but concurred with the workshop panel (Appendix 4). The panel concluded that as the clam fishery as currently prosecuted, in sand habitats, there are potentially large, localized impacts to biological and physical structure, however the recovery time is relatively short. Since the recovery time is relatively short (hours to months) the adverse impacts to this high energy environment can be considered temporary. The preamble to the EFH Final Rule (50 CFR Part 600) defines temporary impacts as those that are limited in duration and that allow the particular environment to recover without measurable impact. Since these impacts are potentially effecting a relatively small portion (approximately 100 square nautical miles) of the overall large uniform area of high energy sand along the continental shelf (approximately 54,900 square nautical miles) these impacts can be considered minimal. Additionally, the 100 square nautical miles impact each year (approximately 1.5 ten minute squares of latitude and longitude) represents a small fraction of the total EFH of the above listed vulnerable EFH and species. The preamble of the EFH Final Rule defines minimal impacts as those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions.

Although the Council has concluded that the clam fishery has an adverse effect on EFH that is no more than minimal and temporary in nature, a NEPA analysis was conducted in order to verify that any adverse effects from clam dredging were indeed minimized to the extent practicable. Based upon guidance from the Assistant Administrator (January 22, 2001), if information is inconclusive, a NEPA analysis should examine alternatives that could be taken in the face of uncertainty. For NEPA purposes, the guidance from the AA stated that the analysis of alternatives needs to consider explicitly a range of management measures for minimizing potential adverse effects, and the practicability and consequences of adopting those measures. The advise from Dr. Hogarth continues: "In other words, if there is evidence that a fishing practice may be having an identifiable adverse effect on EFH, even if there is no conclusive proof of adverse effects, it is not sufficient to conclude *prima facie* that no new management measures are necessary without first conducting a reasonably detailed alternatives analysis."

The Council evaluated nine alternatives that focused mostly on closed areas. The fishing gear impacts workshop (Appendix 4) concluded that effort reductions (i.e. harvest limits) and gear modifications (i.e. restrictions) were not workable for this fishery and that if the clam dredges were found to have significant adverse effects on EFH, then spatial closures were the only viable alternative to mitigate the adverse effects of this fishing gear. Since surfclams are underfished and the annual quotas are actually being increased (Table 27), it seems to make little sense to restrict harvest limits for EFH reasons, however there is an alternative for analysis where the ocean quahog optimum yield range would be reduced to trade off against an increase in surfclam quota. Finally, seven potential closed area alternatives were identified. These closed areas are being considered to be closed to clam dredging for 5 years. The distribution of the surfclam and ocean quahog resources based on the 1999 survey are depicted in Figures 5 through 8. Landings of the two species in 2000 are shown in Figures 9 and 10.

According to the EFH Final Rule [50 CFR Section 600.815 (2)(ii)], "...FMPs should identify a range of potential new actions that could be taken to address adverse effects on EFH, include an analysis of the practicability of potential new actions, and adopt any new measures that are necessary and practicable...." Thus, a "Practicability Analysis" was added as a subsection to each of these EFH alternatives.

Section 600.815(2)(iii) states that "In determining whether it is practicable to minimize an adverse effect from fishing, Councils should consider the nature and extent of the adverse effect on EFH and long-term and short-term costs and benefits of potential management measures to EFH, associated fisheries, and the nation, consistent with National Standard 7...."

Under the current management regime, surfclams and ocean quahogs are well managed and certainly not near overfished. This indicates that a sustainable fishery is possible without creating additional measures to protect EFH, i.e., the measures that are currently in place are certainly sufficient to achieve a maximum sustainable yield fishery.

The no action alternatives include rebuilding plans that govern the management of 26 out of 42 stocks managed in the Northeast (NMFS 2002). National Standard 1 requires that the Councils "specify a time period to rebuild" overfished stocks or stock complexes. In cases where overfishing is occurring the Councils are required to "end overfishing." National Standard 1 indicates that "a stock or stock complex that is below the size that would produce MSY should be harvested at a lower rate or level of fishing mortality that if the stock or stock complex were above the size that would produce MSY." As such, reductions in fishing mortality have been and will continue to be implemented through out the rebuilding periods for these 26 stocks. Reductions in fishing mortality result in decreases in fishing effort, which generally translate in an overall reduction in impacts of fishing gear on the EFH of the managed species, as well as other species' EFH.

Once a stock is rebuilt, the fishing mortality will remain at F_{msy} (or a proxy such as F_{max}). As stock size increases, quotas will increase under this specific fishing mortality. However, CPUE will also increase. While increases in participation in the fishery due to latent effort may accompany higher quotas for some species, a higher CPUE and a constant or decreasing target fishing mortality should mean that overall fishing effort will likely continue to decline for many species in the Northeast region.

The majority of the stocks managed in the Northeast region have experienced and/or will continue to experience declines in fish mortality while being managed under rebuilding plans. Overall reductions in fishing mortality, and thus, fishing effort, have had the beneficial impact of improving stock status and protecting EFH. In addition to reductions in fishing mortality, the two Northeast Regional Councils have proposed many other measures that have more directly acted to reduce fishing gear impacts on EFH. Such regulations include gear restricted areas, area closures, and restrictions on roller rig gear. These measures also help to improve the status of the stocks while conserving marine habitat. To date, improving stock status for numerous species in the Northeast is evidence of positive cumulative biological impacts resulting from the current management systems.

Maintaining the preferred alternatives will not require the industry to incur any additional short or long-term costs. The short-term benefit of current regulations is that these two species are not overfished which will allow quotas to increase. The long-term benefit of maintaining the current regulations will prevent overfishing while providing additional protection to habitat. These selected management alternatives are consistent with National Standard 7 which requires that management measures "minimize costs and avoid unnecessary duplication." It is the determination of the Council that these management measures are practicable, relative to the criteria set forth in the EFH Final Rule [50 CFR section 600.815 (2) (iii)].

Many MAFMC, NEFMC, SAFMC, and HMS FMPs for several overfished species include management actions that would effectively reduce gear impacts to bottom habitats by reducing the harvest of the managed species. This reduction in harvesting effort may indirectly benefit EFH by creating an overall reduction of disturbance by a gear type that impacts bottom habitats. Other management actions already in place should control redirection of effort into other bottom habitats. Therefore, the MAFMC has determined that this action will have no adverse impact upon the listed EFH.

4.0 REGULATORY IMPACT REVIEW (RIR) AND REGULATORY FLEXIBILITY ANALYSIS (RFA) (FSEIS)*

4.1 INTRODUCTION

Amendment 13 to the Atlantic Surfclam and Ocean Quahog Fishery Management Plan (FMP) is intended to manage the Atlantic surfclam and ocean quahog fishery pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSFMCA) of 1976, as amended by the Sustainable Fisheries Act (SFA) in October 1996. Amendment 13 is proposed to address the definition of surfclam overfishing, the impacts of fishing gear on essential fish habitat (EFH), multi-year quotas (up to three years), possible implementation of a vessel monitoring system that is satisfactory to both the NMFS and the industry, and addition to the list of framework measures the suspension of the surfclam minimum size limit and adjustment of the minimum size. Preferred and non-preferred regulatory alternatives are summarized in section 1.2.

A new definition of overfishing for surfclams and protection of essential fish habitat are of particular concern. The new definition of overfishing increases the biomass target and threshold levels, respectively, to 1.4 billion pounds (80 million bushels) and 700 million pounds (40 million bushels). The previous definition of overfishing was associated with a target and threshold biomass of, respectively, 900 and 400 million pounds. The previous definition was based on the level of fishing mortality that minimizes the potential for recruitment overfishing (F=0.18); the new definition is based on maximum sustainable yield (MSY) and equates to an F of 0.15. The definition of overfishing for ocean quahogs remains unchanged relative to the previous definition. With the higher target and threshold levels, however, the proposed allowable harvest levels for surfclams equal 3.135 million bushels in 2002 and up to 3.4 million bushels in 2003 and future years. Amendment 13 does not propose any changes in the allowable level of harvests of ocean quahogs. The Sustainable Fisheries Act of 1996 contains provisions specific for the identification and protection of habitat essential to the production of Federally managed species. Although there are nine potential alternatives for protecting EFH, only five need extensive economic analysis; the other alternatives were determined by the Council as not needing detailed economic analyses.

In this section of the FMP, the methods, procedures, and results of economic analyses necessary to support Amendment 13 are presented. Initially, the problems and objectives are discussed in section 4.2. Next, section 4.3 presents the methodology and framework for analysis. The analytical methods and data are next discussed in section 4.4. Demand models, prices, revenues, and consumer surplus are discussed in section 4.5. Costs, net returns, and producer surplus are presented in section 4.6. Section 4.7 provides a discussion of the potential losses in producer welfare that might occur if areas are closed to protect essential fish habitat. The potential impacts of the no action, preferred alternatives, and non-preferred alternatives are discussed in section 4.8. Section 4.9 provides a description and discussion of additional issues and non-quantifiable impacts.

The analysis presented in the following sections are presented in terms of three different fisheries: (1) the surfclam (*Spisula solidissima*) fishery, (2) the mid-Atlantic ocean quahog (*Arctica islandica*) fishery, which excludes the Maine "mahogany" ocean quahog fishery, and (3) the Maine "mahogany" fishery (also *Arctica islandica*). Thus, all references to the ocean quahog fishery are with respect to the ocean quahog fishery but exclude the Maine "mahogany" fishery.

Evaluation of EO 12866 Significance

None of the alternatives evaluated in this document will result in a significant regulatory action under EO 12866 for the following reasons. First, it will not have an annual effect on the economy of more than $100 million. The measures considered in this document will not affect total revenues, landings, or consumer surplus to the extent that a $100 million annual economic impact will occur.

The Amendment provides alternatives for a revised overfishing definition, for examining the effects of fishing gear impacts to essential fish habitat, for establishing multi-year quotas, for suspension of the surfclam minimum size limit, and for vessel monitoring. Of the issues addressed, essential fish habitat protection had the greatest potential for generating economic and social impacts through area based use modifications or prohibitions.

The proposed actions are necessary to enhance the management system for the surfclam and ocean quahog fisheries. The action benefits in a material way the economy, productivity, competition and jobs. The action will not adversely affect, in the long-term, competition, jobs, the environment, public health or safety, or state, local, or tribal government communities. Second, the action will not create a serious inconsistency or otherwise interfere with an action taken or planned by another agency. No other agency has indicated that it plans an action that will affect the surfclam and ocean quahog fisheries in the EEZ. Third, the actions will not materially alter the budgetary impact of entitlement, grants, user fees, or loan programs or the rights and obligations of their participants. Finally, the actions do not raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in EO 12866.

Review of Impacts Relative to the Regulatory Flexibility Analysis

The RFA requires the federal rulemaker to examine the impacts of proposed and existing rules on small businesses, small organizations, and small governmental jurisdictions. In reviewing the potential impacts of proposed regulations, the agency must either certify that the rule "will not, if promulgated, have a significant economic impact on a substantial number of small entities." The Small Business Administration (SBA) defines a small business in the commercial fishing and recreational fishing activity, as a firm with receipts (gross revenues) of up to $3.5 and $5.0 million, respectively. The proposed measures for surfclam and ocean quahog could affect any vessel holding an active federal permit for these species as well as vessels that fish for some of these species in state waters. In 2001, there were 51 non-Maine vessels that landed either surfclams (21 vessels), ocean quahogs (16 vessels) or both (14). There were 31 vessels in 2001 that fished for Maine ocean quahogs. All of these vessels readily fall within the definition of small business.

The effects of actions were analyzed by employing quantitative approaches to the extent possible. In the current analysis, effects on profitability associated with the proposed management measures should be evaluated by looking at the impact the proposed measures would have on individual vessel costs and revenues. However, in the absence of cost data for individual vessels engaged in these fisheries, changes in gross revenues are used as a proxy for profitability.

In addition, analyses were conducted to assess disproportionality issues. Specifically, disproportionality was assessed by evaluating if a regulation places a substantial number of small entities at a significant competitive disadvantage. Disproportionality is judged to occur when a proportionate affect on profits, costs, or net revenue is expected to occur for a substantial number of small entities. In the current analysis none of the evaluated alternatives were judged to have possible disproportionate effects.

None of the chosen alternatives pose any obvious negative impacts for vessels, though several of the non-preferred alternatives did. In addition, there were no obvious community impacts associated with the chosen alternatives.

4.2 PROBLEMS AND OBJECTIVES

Amendment 13 specifically addresses two issues disapproved in Amendment 12 (the surfclam overfishing definition and gear impacts to essential fish habitat (EFH); the establishment of multi-year quotas (up to three years); implementation of a vessel monitoring system that is agreeable to NMFS and industry; and adding to the list of framework management measures both the suspension of the surfclam size limit and adjustment of the minimum size.

The objectives of Amendment 13 are those specified for the fishery management plan (FMP):

(1) Conserve and rebuild Atlantic surfclam and ocean quahog resources by stabilizing annual harvest rates throughout the management unit in a way that minimizes short-term economic dislocations;

(2) Simplify to the maximum extent the regulatory requirement of surfclam and ocean quahog management to minimize the government and private cost of administering and complying with regulatory, reporting, enforcement, and research requirements of surfclam and ocean quahog management;

(3) Provide the opportunity for industry to operate efficiently, consistent with the conservation of surfclam and ocean quahog resources, which will bring harvesting capacity in balance with processing and biological capacity and allow industry participants to achieve economic efficiency including efficient utilization of capital resources by the industry; and

(4) Provide a management regime and regulatory framework which is flexible and adaptive to unanticipated short term events or circumstances and consistent with overall plan objectives and long term industry planning and investment needs.

Assessing the economic ramifications that might occur because of Amendment 13 requires consideration of the issues and goals and objectives of Amendment 13 and the FMP for surfclams and ocean quahogs. Moreover, the economic analysis to be done in support in Amendment 13 should conform to the "Guidelines for Economic Analysis of Fishery Management Actions," prepared by the Office of Sustainable Fisheries (NMFS 2000). The Guidelines state the procedures and analysis must be consistent with the requirements of Executive Order (E.O.) 12866 and the Regulatory Flexibility Act (RFA) for regulatory actions of Federally managed species. A Regulatory Impact Review is required for E.O. 12866, and a Regulatory Flexibility Act Analysis is necessary to satisfy the requirements of the Regulatory Flexibility Act. In addition to E.O. 12866 and the RFA, economic analysis may also be required under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), the National Environmental Policy Act (NEPA), the Endangered Species Act, and other applicable law. The MSFCMA requires a Fishery Impact Statement (FIS).

In the present analysis, there appear to be no issues that directly initiate analysis under the Endangered Species Act. Under E.O. 12866, there are numerous other issues, which are unrelated to endangered species. E.O. 12866 requires a benefit-cost analysis and broad consideration of the distributive effects and economic burden that may be imposed on individuals, businesses of differing sizes, as well as small communities and governmental entities. E.O. 12866 requires that both benefits and costs of regulatory alternatives from a national perspective as well as that of the private individual or firm be considered. The RFA has similar, but additional, analytical requirements.

E.O. 12866 and RFA define the economic analysis that must be done to satisfy analytical requirements. The framework requires the examination of how regulations may affect demand for fishery products, recreational opportunities, supply of fishery products, and how market interactions affect resulting fishing decisions and the underlying biological conditions. The Guidelines prepared by NMFS (2000) indicate four components of the economic framework.

Initially, it is necessary to analyze changes in prices, quantities produced or consumed, and the number of fishing or observational trips. This information should be used to assess changes in prices, revenues, and consumer surplus, which are indicators of economic changes and benefits to the nation of a management plan or regulation. In addition to examining changes in prices and revenues, changes in operating costs for firms or individuals in a fishery must be assessed. Analyses of both costs and revenues provide a framework for assessing changes in producer surplus, which is another partial measure of net benefits to the nation. Combining consumer and producer surplus yields a measure of total net benefits to the nation.

Another aspect of the analysis is the determination of how a regulation may affect fishing fleets. Fleet size and composition likely changes in response to market prices, biological conditions, and the regulatory environment. Normally, the required analysis would be amenable to industrial economics, or the determination of how an industry might restructure following changes in market and regulatory conditions. In the absence of detailed economic information, a qualitative assessment may be done in lieu of a rigorous quantitative assessment.

A remaining desired component of the economic assessment framework is the assessment of how stocks may change in response to the regulation. A primary concern is how fishing effort may change in response to a change in stocks, which might be induced via a change in the regulation.

4.3 METHODOLOGY AND FRAMEWORK FOR ANALYSIS

4.3.1 Overview of Methodology and Framework

Section 1.2 provides a listing of the proposed management measures. The proposed measures which need an economic analysis are as follows: (1) A new definition of overfishing for surfclams which results in increasing the quota from 2.85 million bushels in 2001 to 3.135 million bushels in 2002 and up to3.40 million bushels from 2003 onward; (2) maintaining the ocean quahog quota at 4.5 million bushels; (3) maintaining the Maine ocean quahog "mahogany" quota at 100 thousand bushels; (4) multi-year quotas to be set after each survey and stock assessment with minor annual review; (5) several alternatives for essential fish habitat–preferred alternative is the no action alternative of no change; alternative 2, which prohibits clam dredging on Georges Bank east of 69 degrees; alternative 3, which prohibits hydraulic clam dredging east of 70 degrees, 20 minutes; alternative 6, which prohibits clam dredging in tilefish HAPC which is characterized as the depths between 250 and 1200 feet between Cape Cod and Cape May; and alternative 8, which prohibits all clam dredging in the EEZ off the State of Maine west of Zone 1; (6) a required vessel monitoring system. The areas proposed to be closed to protect EFH are depicted in Figures 11, 12, 15, and 16

4.3.2 Analytical Framework for Economic Analysis

The economic analyses conducted in support of Amendment 13 are based on standard economic analytical procedures and theory. To assess changes in prices, revenues, and consumer surplus, various inverse ex-vessel and wholesale demand models are specified and evaluated statistically by linear regression analysis. These price models typically specify price, as the dependent variable, to be a function of the quantity landed and other variables (i.e., independent or exogenous variables). As such, they are not theoretically correct economic models; they are actually response models that permit, at least, limited estimates of the values of the economic variables of importance. A rigorous theoretically correct model would specify the demand at each market level in accordance with a dual specification optimizing behavior at a higher market level (e.g., the ex-vessel demand represents processors demand for raw materials that might maximize profits for the processor). Appropriate data for correctly specifying the derived demand models are not available; as a consequence, price response type models are all that may be estimated. By allowing quantities to change, prices, revenues, and consumer surplus may be estimated; consumer surplus is calculated as the area below the demand curve minus expenditures; calculating the area requires solving the integral of the demand curve between 0.0 and the various expected total landings or product demanded. Cost and the subsequent calculation of producer surplus are based on average cost information obtained from a survey by Brandt and McCay (2001) and estimates of equivalent variation, which may be used as an alternative measure of producer surplus and is described in section 4.4.2 "Analytical Methods". The cost information is extremely limited, but is all that is available. Brandt and McCay (2001) conducted a survey of surfclam and ocean quahog owners and processors in 2000 for the purpose of developing a profile. This information is used to assess changes in net returns or profit and costs.

The economic analysis conducted to support Amendment 13 initially examines changes in prices, revenues, and consumer and producer surpluses associated with the new overfishing definition of surfclams and the no action definition of overfishing of ocean quahogs. Initially, estimates of the values in 2001 are made and used as the baseline for comparing proposed changes in annual quotas consistent with the new overfishing definition.

The analysis of EFH alternatives is considerably more complicated than is the analysis of the proposed quotas. Under alternatives other than the no action, it is necessary to predict the likely areas that vessel operations will switch to in response to proposed EFH closures (Figure 40). The analytical framework commences with establishing a baseline for the purpose of comparing changes in the economic performance. Average annual activity between 1996 and 2000 was selected as the baseline for comparing prices, revenues, consumer surplus, costs, and net returns (Table 37). All values are expressed in terms of year 2000 values. The 1996 to 2000 average was selected to mitigate the potential influence of outliers or major changes in economic activity.

The EFH analytical framework estimates the areas most likely to receive fishing effort in response to areas closed to protect EFH. In actuality, multinomial choice models are estimated; these models permit estimation of the probability that a vessel will chose a particular area. It is assumed a vessel will fish those areas having the highest probability of being fished (e.g., if a vessel regularly fishes an area in one of the EFH areas, it is assumed it will select a different area having the next highest probability of being fished and not contained in an EFH area). Initially, it is also assumed that vessels will attempt to land the same quantity of surfclams or of ocean quahogs as they did on average between 1996 and 2000, which is the baseline. Subsequent analysis permits landings to increase relative to the catch allowed under the new overfishing definition for surfclams (3.135 million bushels in 2002 and 3.40 million bushels in 2003).

The analysis also imposes a constraint on the hours at sea per trip. Vessel time away at sea is limited because of perishability problems. Available data suggests that surfclam vessels may be at sea for up to 60 hours per trip, but industry information suggest that maximum time at sea is between 24 hours per trip in the summer months and 36 hours per trip during the winter months. The estimates provided by industry are consistent with observed data (Figure 41). Hours at sea for quahog trips are as high as 60, but most trips are well below 40 hours (Figure 42).

An issue related to the new overfishing definition and associated quotas for surfclams is whether or not the fleet will harvest the higher quotas. Between 1991 and 2001, the surfclam fleet harvested the quota only three times (1994, 1996, and 2000); preliminary information available from the Fishery Statistics Office of the Northeast Regional Office of NMFS indicates that 98.3 % of the surfclam quota was harvested in 2001. The fact that the surfclam fleet harvested the full quota in only three of 11 years raises the issue of whether or not the fleet would harvest the higher quotas proposed for 2002 and 2003. To address this issue, a tobit or limited dependent variable model was estimated that examined the relationship between change in landings and changes in the quotas between two consecutive years. This analytical framework assumes that landings are censored or limited. In actuality, for those years for which landings approximately equal the quota, it is assumed that the landings were limited by the quota levels. Estimates from a tobit model then permit estimation of the probability that the surfclam fleet will harvest the quota given different levels of the quota. In addition, probit and logit models are also estimated to assess the probability that higher quotas will result in higher landings. Results of the tobit model suggest a very low probability that landings will equal or exceed the new quota levels (Table 38). It is stressed, however, that the tobit model estimated for this analysis did not consider all possible alternatives (e.g., processing companies increasing processing capacity because of higher quotas, processors willing to purchase more product, etc.).

Additional analysis of the likelihood that landings of surfclams would increase in response to increased quotas were also conducted. These additional analyses were based on various limited-dependent variable models, or specifically, logit and probit models. Logit and probit models permit estimation of the probability of an event occurring in response to variables believed to influence the probability. In these analyses, the probability that landings would increase in response to increased quotas was examined. Data from 1979 through 2001 on landings and quotas for surfclams were comprised. The dependent variable or the variable used to depict the probability that landings would change in the same direction as the change in quotas was assigned the value 1.0 when the direction or sign of the change in landings was the same as the direction or sign of the change in the quota (e.g., if landings increased (decreased) between two years and the quota increased (decreased) between the same two years, the dependent variable was set equal to 1.0). The logit model then examined the potential relationship between the probability of change in landings and the change in the quota. Overall, the results suggested that the probability that landings would increase as the quota was increased was quite low (approximately 0.42, with 1.0 being certain). Additional follow up with individuals familiar with the fishery suggested that overall processing capacity may be limiting production responses over time, and processors would likely expand capacity in response to higher quotas.

4.3.3 Complications and Problems Relating to Economic Analysis

Even though analytical results suggested a very low probability of increased landings as a response to higher quotas, there is sufficient anecdotal information to indicate that landings would increase. The Council has increased the surfclam quotas in 2002 (3.135 million bushels) and an increase is also likely for as early as 2003 (3.40 million bushels is the maximum OY level). As part of the regulatory process that supports FMP development, the potential economic ramifications of the proposed increases must be analyzed–both with respect to simply increasing the quotas and with respect to protecting EFH. In order to provide a more thorough analysis of protecting EFH and simultaneously increasing the quota, it is necessary to determine how vessel operations and the demand for quota would change. Assessing the changes in vessel operations and the demand for quota, however, requires a detailed and complex analysis of quota exchange. Squires and Kirkley (1996) developed an analytical procedure to examine quota exchange for the U.S. Pacific groundfish fishery; the analysis, however, required more than four months of time. That same framework may or may not be applicable to the surfclam fishery. For the purposes of this analyses, it is assumed that individual operations or landings per active permit holder will increase by the ratio of the proposed quotas to the quotas in place during 2001 (i.e., 3.135/2.85=1.1 and 3.4/2.85=1.193).

Data available for assessing the potential economic ramifications of protecting EFH include landings, ex-vessel revenues, hours at sea, hours fished, area fished (ten-minute square), and vessel size class. The data are organized at the trip level. In order to predict the areas likely to be fished by vessels in response to areas closed to protect EFH, the ten minute square data had to be aggregated to a higher geographical unit. Use of the ten-minute square data posed the problem of limited observations; that is, the number of observations for some ten-minute square was too few to develop an appropriate choice model. The ten-minute square information had limited observations, and consequently, estimates of the parameters of area choice models had little precision. The ten-minute square data were subsequently aggregated to thirty minute square geographical divisions. For surfclams, the number of geographical areas to examine was reduced from 160 ten-minute square areas to 43 thirty-minute square divisions; for ocean quahogs, the number of geographical divisions was reduced from 279 to 86. The baseline analysis, however, uses data between 1996 and 2000; for this period, there are 38 thirty-minute square areas for surfclams and 76 areas for ocean quahogs.

A remaining problem with the economic analysis of protecting EFH is that the potential benefits to society of protecting or restoring EFH can not be quantitatively analyzed. The dynamics and interactions between EFH and future resource abundance, availability, and levels are unknown. Of the limited number of studies or reports available on the effects of fishing on habitat, none have clearly articulated the potential gains from protecting or restoring EFH. An International Council for the Exploration of the Sea (ICES 2000) and a National Marine Fisheries Service (NMFS 2001) report indicate that fishing activities, particularly those conducted with bottom-tending mobile gear, are likely to be detrimental to essential fish habitat. The NMFS report (p.1), in fact, states "The influence of so many factors complicates our ability to understand the effects of fishing gear on habitat and ultimately the populations of fishes and invertebrates that utilize the habitat." At the present time, there appears to be two major themes emerging among experts on the effects of fishing on habitat: (1) management should proceed along a precautionary approach and support measures to minimize the effects of fishing to habitat; and (2) a large-scale research program needs to be developed to better understand the impacts of fishing on habitat and the potential benefits of protecting or restoring habitat.

In contrast, the Administrative Procedures Act states (NMFS 2001, p. 6) "the decision to approve a measure must be supported by scientific information that suggests the measure will contribute to the conservation and management of the fishery resource so as to be neither arbitrary nor capricious." In the case of the surfclam and ocean quahog fishery, the Council and scientific community recognize that clam dredges could have an adverse effect on EFH if the gear is fished improperly or in the wrong sediment type. It also is recognized, however, that the clam resources are concentrated in sandy sediment, and the fishing gear has evolved over the past fifty years to fish most efficiently in sandy sediment. The Council, concurring with the expert panel of the

USDC (2002) Workshop on the Effects of Fishing on Marine Habitats of the Northeastern United States, concluded that the fishery, as currently prosecuted, would likely have short-term and minimal impacts on EFH. Nevertheless, the final EFH rule (January 17, 2002) states that each FMP must minimize to the extent practicable effects from fishing if there is evidence that a fishing activity adversely affects EFH in a manner that is more than minimal and not temporary in nature, and consequently, a NEPA analysis was performed. As previously stressed, however, the benefits of closing areas to surfclam or ocean quahog fishing to protect EFH cannot be assessed; it is only possible to assess the potential costs of closing areas. The underlying population dynamics and linkages to EFH are unknown. Benefits might be anticipated in the form of improved recruitment, greater densities of surfclams and ocean quahogs, enhanced growth, and higher abundance of prey species (NMFS 2001), but there is no conclusive quantitative evidence available that indicates the potential magnitude of the benefits of protecting surfclam and ocean quahog EFH.

Estimation of producer surplus, which is a measure of producer benefits, is complicated by limited information on costs. The Brandt and McCay (2001) survey is the most current information, but contains cost information for only 7 out of 48 surfclam or quahog vessels operating in 2000. Alternatively, cost information is available for only 14.6 % of the fleet operating in 2000. Brandt and McCay obtain costs on two major categories: (1) the sunk costs of capital, and (2) vessel operating costs. The capital costs include investments in gear, safety equipment, and wheelhouse equipment. Operating costs include annual fixed costs, such as insurance, permit fees, and professional fees, and costs that vary with the level of fishing activity (e.g., fuel costs and labor payments). Vessel size in the Brandt and McCay survey ranged from 70 to 120 feet in length and 40 to 190 gross registered tons (GRT). It is not known how representative the survey information is of costs by tonnage class. There are three vessel size categories: (1) small, 1-50 GRT, (2) medium, 51-104 GRT, and (3) large, 105+ GRT. The Brandt and McCay data are truncated at 40 GRT.

Cost information provided in Brandt and McCay are cumbersome to use to develop estimates of costs that could be used in assessing producer surplus. They report purchase prices of between $70 and $375 thousand, but no information on monthly or annual mortgage payments, or in what year the vessels were purchased. They also report that replacement costs of the vessels is between $700,000 and $2.5 million. Normally, many of the other capital expenditures would be included in the vessel costs, and as such, adding these other capital costs to the vessel cost might result in overstating the value of the capital costs. In addition, there is uncertainty regarding the useable life span of some of the capital equipment (e.g., a hopper with a replacement value of $7,500 has a life span between 3 and 10 years). Given the absence of information on mortgages and uncertainty about the useable life of the equipment, it is difficult to annualize the value of the equipment.

They also report estimates of average annual fixed costs and average trip costs. These estimates pose fewer problems. The total average annual fixed cost per vessel is approximately $425,456. They report that surfclam vessels consume 23.63 gallons per hour of fuel while steaming and 50.58 gallons per hour while dredging; ocean quahog vessels consume 51.78 gallons per hour while steaming and 51.19 gallons per hour while dredging. Brandt and McCay, however, indicate that they had an insufficient number of responses to report average trip costs for quahog trips.

Despite the problems with the available information, an attempt was made to use the data provided in Brandt and McCay to summarize annual net returns by surfclam and ocean quahog vessels. It was necessary to summarize cost and net returns relative to both surfclam and ocean quahog activity since many vessels land both species. It is not possible to allocate the fixed costs among the two species; there is no basis upon which to allocate the fixed cost. Net returns are defined as total revenue from surfclam and ocean quahogs less average cost information provided in Brandt and McCay less fuel costs less payments to labor (Brandt and McCay indicate that crew share equals 30.0 % of the gross stock or ex-vessel revenue). Fuel costs were calculated using hourly consumption information on steam and dredge time provided by Brandt and McCay times the price of number 2 diesel fuel. The price of number 2 diesel was obtained from the Energy Information Administration "Prices of Petroleum Products to End Users," Monthly Energy Review (EIA 2002, p. 125). Estimates of net returns, however, do not include mortgage payments, which might be quite large. All dollar figures are in year 2000 constant dollar value (Table 39). As illustrated in Table 39, size class I vessels earn negative returns in each year between 1991 and 2000. This is likely incorrect and the result of using the average or median information provided by Brandt and McCay (2001).

Amendment 13 also proposes the use of a vessel tracking (VTS) or monitoring system (VMS). There are no readily available data to assess the most likely cost of requiring surfclam and ocean quahog vessels to have VTS. Using information available from cost-earnings statements for sea scallop vessels and obtained from conversations with scallop vessel owners, an approximate annual cost for VTS is $2,500. This estimate was based on reviewing trip settlement sheets for 38 sea scallop vessels operating out of New Jersey and Virginia. This estimate was further discussed with nine vessel owners to ascertain the appropriateness of the estimate.

Even the analysis of ex-vessel demand is complicated by problems with the price information. Data on prices are available from logbook data and from the electronic data base maintained by NMFS. The electronic data base is in terms of pounds of meats and relates to total surfclam and ocean quahog landings. The logbook data relate only to the EEZ fishery. The logbook data, however, do not differentiate between landings of leased quota or owned quota. Alternatively, there are two aspects to the pricing or valuation of surfclams and ocean quahogs. First, there is the value related to harvest services or the actual cost of the vessel and crew services to produce landings. Then, there is the value of the lease. In general, the price paid per bushel of surfclams or ocean quahogs will be lower for product being harvested under a different ownership of the allocation (e.g., processor owns the allocation) than would be paid when the owner of the allocation is also the producer or fisher. For the situation in which the allocation is being harvested for other entities (e.g., processors), the price paid for surfclams or ocean quahogs likely reflects the costs of the vessel and the crew, but not the value of the allocation. The available logbook data, however, do not differentiate between the two possibilities.

There are additional problems with attempting to assess the ex-vessel demand for surfclams and ocean quahogs. Fishermen may often accept a lower price for one species in exchange for assurances that buyers or processors will purchase the allocation of the other species. This convolutes the calculation of ex-vessel prices, market conditions, and consumer surplus or consumer benefits for each individual species. An alternative might be to develop an aggregate measure of landings and prices for the combination of surfclams and ocean quahogs, and examine the ex-vessel demand for the aggregate. For the purpose of the analysis of Amendment 13, monthly aggregate output and price were constructed using a Divisia aggregation. Estimates of the inverse demand, however, still had incorrect signs; in fact, the available data for either surfclams, ocean quahogs, or the aggregate appear to be consistent with supply responses by the harvesting sector. That is, as prices increase (decrease), the quantity supplied of either product also increases (decreases).

An additional problem with estimating and analyzing the ex-vessel demand, particularly ocean quahogs, is the change or difference in product markets. The Maine "mahogany" is generally marketed as a live product that is similar to the inshore hard clam or quahog. These prices are much higher than are the prices for the Mid-Atlantic ocean quahogs (Table 40). Also, it appears that a limited number of vessels operated out of Rhode Island and also landed ocean quahogs for the live trade market prior to 1996. Ex-vessel prices for these hard clams, which were also marketed as hard clams, were substantially higher than were the ex-vessel prices of ocean quahogs. For example, while ocean quahog prices were in the $3.50-$4.50 range, the Rhode Island and Maine "mahogany" prices were in the $30-$35.00 per bushel range. Since 1996, however, the ex-vessel prices for ocean quahogs, excluding the Maine "mahoganies", have been relatively stable.

Another problem with assessing the demand for surfclams and ocean quahogs is that the two species may often be substituted for each other. For example, in 2000 and 2001, surfclam harvests increased in order to substitute for declining quantities of ocean quahogs. Normally, substitution possibilities do not pose problems for estimating and assessing demand. In the case of surfclams and ocean quahogs, however, the data likely reflect supply behavior rather than demand behavior, and estimates of the coefficient relating prices to quantities remained positive (this means that as the quantity demanded increased, the price also increased).

There is a remaining complication in assessing producer surplus. The surfclam and ocean quahog fishery is actually a multi-product fishery. Vessels can obtain quota for surfclams and/or ocean quahogs and/or land either species. Between 1991 and 1994, approximately 50% of the vessels did land both species (Table 41). Beginning in 1995, however, vessels increasingly specialized in one species–either surfclams or ocean quahogs. Since vessels do and can land either species, there is a problem with calculating producer surplus relative to each individual species. Producer surplus requires the subtraction of fixed costs (this includes mortgage payments, wheelhouse equipment, safety costs, common gear costs, vessel insurance, routine repair and maintenance, mooring/docking fees, and other expenses related to the vessel or fishery rather than the species sought). These fixed costs cannot be allocated to the various species other than by developing some arbitrary rule (e.g., assume fixed costs for surfclam fishing equals the ratio of surfclam revenues to total revenues from landing both species). In addition, the Brandt and McCay (2001) study did not provide fixed costs information specific to either species. Since it was not possible to allocate the fixed costs among the two species and appropriate cost data were not available, producer surplus was examined using only the variable costs information about fuel consumption.

4.4 DATA AND ANALYTICAL METHODS

4.4.1 Data

Data used for the economic analysis were obtained from numerous sources. Trip-level information on landings, hours at sea, hours fished, vessel size class, area fished, and port of landing was obtained from the Mid-Atlantic Fishery Management Council (MAFMC) and the Northeast Fisheries Science Center, National Marine Fisheries Service. Monthly and annual landings and ex-vessel revenue information for surfclams and ocean quahogs were obtained from the electronic data base of the National Marine Fisheries Service. Information on operating and fixed cost were obtained from Brandt and McCay (2001). Additional data on wholesale and processing activities were obtained from the Division of Fisheries Statistics and Economics, National Marine Fisheries Service. Last, wholesale price data for the New York Fulton Market was obtained from various Market News Reports. Information on vessel operations was obtained from members of industry.

4.4.2 Analytical Methods

A wide array of analytical methods were necessary to conduct the economic analysis of the proposed regulations. For most of the analysis, however, some type of regression analysis was conducted. Regression analysis is a statistical procedure that permits estimation of parameters of some underlying relationship between variables. Consider the two variables catch ©) and fishing effort (E). It is hypothesized the C is related to E as follows: $C = qE^{\beta}$. By a simple log transformation of the relationship–$\ln C = \log q + \beta \ln E$, the basic catch-effort equation is transformed such that the parameters–$\ln q = \alpha$, a constant and β – may be estimated by linear regression. Regression allows the two parameters to be statistically estimated.

The economic analysis done in support of Amendment 13 required the statistical estimation of numerous economic models. Various demand models were specified and estimated to assess changes in prices at different market levels, changes in ex-vessel revenues, and changes in consumer surplus. Other statistical models, which had to be estimated, included multinomial logit models, tobit and probit models, and production response models. The multinomial logit models were used to determine the probability that vessels would fish certain areas as a response to proposed area closures designed to protect EFH. These models also provide the basis for calculating producer surplus. The multinomial specification allows recovery of what is termed an indirect utility function, which subsequently, permits estimation of equivalent variation (EV). Equivalent variation is a measure of benefits that represent the dollar value an individual would be willing to pay to avoid the action. Relative to closing areas to protect EFH, the EV provides a measure of the amount of money a fishing firm would pay to avoid having to fish in other areas; as such, it is a measure of producer surplus because a firm would not be willing to pay more than the profit they realized from fishing a given area. Tobit and probit models were estimated to calculate the probability that vessels would land higher quantities of surfclams in response to higher annual quotas. Production models also had to be estimated to determine the potential landings of surfclams and ocean quahogs from an area on a per trip basis; subsequent analysis, however, indicated that average annual landings per trip and per hour at sea provided adequate measures of potential production for each of the thirty minute square areas. The various models are discussed in the following sections.

4.4.3 Data and Analytical Issues

In developing the database and conducting the analyses to support Amendment 13, numerous problems were encountered. First, the fact that the species are regulated by an individual transferrable quota (ITQ) program suggests the quota holders likely attempt to minimize cost per level of output. This has important ramifications for the supporting economic analyses. It would be expected that firms would make spatial choices based on quota holdings and production costs. Detailed cost data, however, were not available. Limited cost data were obtained and provided by Brandt and McCay (2001). The data provided by Brandt and McCay represent 29% of the harvesting firms in the surfclam and ocean quahog fishery; their data do not pertain to the Maine ocean quahog or "mahogany" clam fishery. In 2000, a total of 82 vessels participated in the surfclam, ocean quahog, and "mahogany" ocean quahog fishery; a total of 48 vessels landed surfclams (31 vessels) or ocean quahogs (29 vessels) in the surfclam, ocean quahog, and 34 vessels landed the "mahogany" quahog in Maine (Table 42). An additional complication is that the production of surfclams and ocean quahogs was typically joint or multiple-product production. After 1992, however, harvesters increasingly focused on one species at the trip level; the fishery, thus, became more like two single species fisheries rather than one multi-species fishery.

There are also problem associated with the way in which the ITQ program allocates cage tags. The ITQ quota is in terms of bushels of surfclams or ocean quahogs, but the quota is actually allocated in terms of number of cage tags; a cage holds 32 bushels of clams. There are also capacity limits for harvesting and shipping. Between 1996 and 2000, seven different levels of landings per trip accounted for 62.4% of the total number of observations (N= 10893) of surfclam landings; 11 different levels of landings accounted for 48.9 % of the total number of observations for the ocean quahog fishery (N=10694). As a consequence, there is little variation in landings per trip and landings can be easily predicted as a function of the number of trips. The potential problem may be illustrated by examining the statistical results of a monthly model relating number of surfclam bushels to number of trips. A simple regression of monthly number of bushels against monthly number of trips yields a highly significant relationship. There are 120 observations (ten years with 12 observations per year). The adjusted R-squared is 0.96, and all parameters are highly significant. There is no problem of serial correlation. The problem is that it is not possible to adequately predict monthly landings corresponding to months that have levels of landings different than the seven levels of landings that comprise most of the observations. There are also problems trying to relate landings of surfclams or ocean quahogs per trip to hours at sea or hours fished. A limited number of hours at sea or fished per trip characterize the data for both surfclams and ocean quahogs. It is possible that models relating landings per trip to hours at sea or hours fished, homeport, and area selected might provide more predictive power. Development and estimation of such disaggregate models, however, would be quite time consuming and might be too detailed for making predictions about changes in landings given changes in hours at sea or fished per trip. The preferred model might specify landings per trip to be a function of the vessel characteristics, area selected, homeport, distance from homeport, and hours at sea or fished. If such a model could be estimated, it would then be necessary to develop models that not only predicted area fished but also port of landing in order to provide the appropriate information.

Another problem with analyzing the potential economic ramifications of the various proposed regulations is that the ex-vessel price data are extremely limited. Extensive analyses of how ex-vessel prices might change in response to the various regulations were conducted using monthly ex-vessel price data. While it was possible to develop models for each state landing surfclams or ocean quahogs, the models tended to be highly specific to each state and with respect to each year and/or month. That is, the ex-vessel demand appeared to be quite different for each state. For example, the inverse demand for surfclams in New York appeared to represent a step function with no observable demand. Ex-vessel prices appeared to be negotiated for a year; monthly ex-vessel prices within a year were relatively constant, but then increased in the following year, but still remained relatively unchanged on a monthly basis. An analysis of the inverse demand on a per state basis revealed little, if any, monthly seasonality in demand for surfclams or ocean quahogs. The coefficients for the relationship between monthly ex-vessel price and monthly landings all equaled zero, except the reference month of January. There also was the problem that some observations likely represented demand while other observations appeared to have represented supply responses. An example of changes in annual responses and the possibility that some observations reflect supply while other observations reflect demand is presented in Table 43; estimates were derived using monthly data between 1996 and 2000 data.

Seasonality of landings and prices also presents problems for the economic analysis. Measuring seasonality in terms of seasonal indices or the ratio of monthly values to a moving average of the monthly values reveals considerable differences in seasonality of landings, number of trips, hours at sea and fish per month, and nominal and constant dollar ex-vessel prices (Table 44). First, one observes that there is a general tendency for landings to increase or decrease as ex-vessel prices increase or decrease; the coincident behavior of prices and landings changing in the same direction suggests that the data correspond to supply responses rather than demand. This is observed for both surfclams and ocean quahogs. The number of trips in a month for surfclams also appears to closely following the seasonality in either nominal or constant dollar prices; for example, the ex-vessel price tends to increase between January and February, and the number of trips also tends to increase. The number of trips taken for ocean quahogs, however, does not appear to closely change with either the nominal or real price of ocean quahogs. It is beneficial to the economic analysis to incorporate the seasonality; doing so, however, confounds supply response with demand response. Alternatively, it is difficult to differentiate whether prices are changing because of changes in demand, or supply is changing because of changes in price.

Seasonality also poses additional problems for the analysis of spatial choice. The present analysis considers 30 minute square geographical aggregations. It would be expected that harvesting firms would partly base area choices on expected abundance and on buyer/processor demand. There are 38 and 76 thirty-minute square areas for surfclams and ocean quahogs, respectively. Resource levels, as measured in terms of landings per hour of fishing, however, substantially vary among the various 30 minute square areas and among seasons. This variation substantially complicates the determination of areas that vessels are most likely to switch to as a response to EFH closures.

4.5 DEMAND MODELS, PRICES, REVENUES, AND CONSUMER SURPLUS

The proposed changes also may have consequences for other segments of the surfclam and ocean quahog market. Specifically, distributors, processors and the ultimate consumer may be affected by the management changes. A complete accounting for the changes in each component is well beyond the scope of this document. It would require obtaining confidential data from the processing sector.

The reason for needing additional information is that the surfclam industry is slightly more concentrated than most other fisheries. It was estimated that in 1992 that the largest three buyers of surf clams purchased 75% of the clams. Additionally, the ITQs were also concentrated, with the top three ITQ owners having 58 % of the market (Wang 1995). The normal method suggested by Just, Hueth and Schmitz (1982) and practiced in fisheries (e.g. Thurman and Easley 1992) estimates a "general equilibrium" or sector demand function at the ex-vessel level. This approach requires including all of the exogenous factors effecting markets above the ex-vessel level and changes in the "consumer surplus" with the sectoral demand will produce the welfare effects for all markets above the ex-vessel level. However, obtaining welfare estimates using this method requires that all markets going from the dock to the ultimate consumer (i.e. households) are competitive. With the purchasing power so concentrated in this industry, the assumption of competitive markets may be difficult to believe.

We propose to examine the demand at two market levels, the ex-vessel market and the processed product market (with many processed products). There is belief that these are sectoral demands but rather we consider these two demands independently. As such, there may be an overestimation of welfare change. That is, the ex-vessel welfare measures for a change in landings may include changes in welfare from the processed product market. Thus, we offer a conservative estimate (only the ex-vessel welfare change) and a liberal estimate (estimates from both the ex-vessel level and from the process product level.

4.5.1 Background on Surfclam and Ocean Quahog Processed Products

Sufficient information regarding dockside activity is presented above and here we briefly discussed the processing sector and the processing data that are available for our demand analysis. Data on surfclam and ocean quahog processing are provided annually to NMS. Information of individual firms is treated confidentially. All information is based on the aggregation of activity of at least three firms.

There were 20 different surfclam processed products reported sold by domestic firms during the ten-year period 1991 through 2000. The aggregate value and production (in surfclam pounds), the average price and the number of reported sales for all processed products with at least $1 million aggregate sales is shown in Table 45. These products represent over 98 % of the total of surfclam processed product sold during the ten years. Table 46 contains similar information on processed products for quahogs.

Nearly $1 billion of surfclam products were reported sold during the ten year period, with fresh shucked meats representing nearly one-quarter of the value. The values could be misleading as it is not clear as to the proportion of some processed products, such as shucked meats, are sold for further processing. For the ten years, the reported meat weight landings of surfclams was approximately 625 million pounds. The reported processed product weight for this period is about 1325 million pounds. The difference is in the amount of items added during process or in the reprocessing of some of the products. There is no way to separate these possible explanations and thus the proportion that the sample represents of all of the industry is unknown.

The level of reprocessing of ocean quahogs is probably less frequent as the Maine and many of the Rhode Island quahogs went directly into the half-shell market. The reported landings of ocean quahog meats was about 400 million pounds during the ten-year period whereas the reported processed product was about 600 million pounds. The bulk of ocean quahog processed product is in canned minced or chopped clams.

4.5.2 Demand Functions at the Ex-vessel and Processed Product Level

4.5.2.1 Ex-vessel Inverse Demand Functions

The structure of the surfclam industry makes the analysis of the dockside demand for surfclams somewhat unusual. Since 1978, the Council has established quotas. ITQ (since 1990) owners know in advance their level of production for the near future. The quotas are met as a rule and one can consider the production as being predetermined. Given this production level, the market equilibrium is attained through price. Many harvesters have pre-arranged prices on a contractual basis but these prices slowly adjust with market conditions.

The partial adjustment model (Nerlove 1956) reflects the surfclam dockside market. Specifically, at some point in time t, the processors have a "desired" price (P^*_t) based on the level of landings (q_t). Let that relationship be linear so that :

(4.5.1) $$P^*_t = \phi + \beta q_t$$

Given a slow or partial adjustment to that price that can be described by $P_t - P_{t-1} = \alpha(P^*_t - P_{t-1})$, then the response to harvests in any period can be described by:

(4.5.2) $$P_t = \phi/(1-\alpha) + \beta/(1-\alpha)q_t + (1-\alpha)P_{t-1}$$

This relationship and monthly surfclam landings and prices are used to estimate the parameters of the model. Using a real price (in constant 2000 dollars/ bushel) and quantity measured in bushels, the results are:

$$P_t = 2.560 - \underset{(.00000096)}{0.00000479} q_t + \underset{(.046)}{.858} P_{t-1} \qquad \bar{r}^2 = 0.886 \quad DW = 2.28$$

$$\text{Durbin's h-stat} = 1.81, \quad n = 120$$

The standard errors of the coefficients are shown in parenthesis. The parameters of equation 4.5.1 are ϕ = 18.0, β = -.0000335 and α = 0.14. Using the Durbin h-statistic (Judge *et al.*1980), the hypothesis of no autocorrelation can not be rejected. The adjustment coefficient suggests a slow process of adjustment, perhaps due to the contractual arrangements and the monthly data.

For quahogs, the same model is used. The results are:

$$P_t = 0.195 - .00000015q_t \quad + .96P_{t-1} \qquad \bar{r}^2 = 0.964$$
$$(.00000015) \qquad (.027) \qquad DW = 2.41$$
$$\text{Durbin's h-stat} = 2.40, \quad n = 120$$

The estimated adjustment proportion for ocean quahog price is much slower than for surfclams and the effect of landings on price is small and statistically insignificant. One can reject the hypothesis of autocorrelation.

4.5.2.2 Processed Product Inverse Demand Functions

The processed product market has different characteristics and data availability than the dockside market. The contractual arrangements between the processors and buyers are probably not as prevalent especially given that the data are available on an annual basis only. The longer period permits more time so that the slow adjustments be made and hence absorbed into the annual data.

The approach taken here is to consider a pooled cross-section/time- series of the processing industry and to examine the relationship between processed product price and the level of production. The argument is that the processed product price will adjust given the amount of product place on the market and that the amount of product place on the market is largely predetermined by the state and national total production quotas established.

Since we are looking at the purchasers' decisions, we believe that the demands are independent in the major product forms. That is, the price of minced and chowder clams likely will not be dependent on the price of breaded strips. The different product forms shown in Table 45 are aggregated for each reporting firm into four major product types: meats, minced or chopped clams, chowders and strips. In total, the groups represent over 85 % of the total processed weight reported of the reporting firms. Constant dollar prices are calculated for each year's sample using the value and volume of product aggregated over the products in the product group and the firms. The price is then calculated using the aggregate value and aggregate weight of the product groups and each reported year.

The results are shown in Table 47 for the four product types. The price response is similar across the product types with a million pound increase in sales reducing price between $.02 and $.14 per thousand pounds. The least responsive were the chowders while the other three were very similar in response, ranging from $.11/klb to $.15/klb. It is difficult to determine how much a change in surfclam landings will influence the price of processed product because we do not know how much surfclam meat in actually is in the processed product. Breading, water, or other ingredients are added during processing. However, we can determine for our group of processors the relationship between the annual level of surfclam landings and the amount of reported processed product production for each product group. We estimate a linear relationship without a constant, i.e. one has to have landings in order to have processed product. The relationships are shown in Table 48 for the years 1991 through 2000.

4.5.3 Welfare Estimation with the Inverse Demand Functions

In general, welfare estimation using linear inverse demand functions in straightforward. A welfare (consumer surplus at the ex-vessel level) change arising from a change in quotas (and implied landings) is calculated using:

$$CS = \frac{\Delta q\, \Delta p}{2} = \frac{\Delta q(\beta \Delta q)}{2} = \frac{\beta \Delta q^2}{2}$$

It should be clear from this expression that the welfare analysis requires an unbiased estimate of β and very little else except the stipulated quota change. This is the approach taken for the ex-vessel surf clam and ocean quahog ex-vessel markets.

Unfortunately, there is more involved with analyzing the processed product market. We first have to use the procedure described above to obtain the effect of landings on processed product volume and then relate the sample volume to the national volume. Since we have no better information, we assume that the sample represented a constant proportion of the total processing sector over the period 1991 to 2000. We can develop welfare estimates based on a range of proportions (25%, 50 % and 75 %) that our processor sample represents of the total processing. Thus, if we were to have 50,000 pounds of product reported and a proportion of 25%, then the total national processing would be 200,000 pounds.

To compute the consumer surplus from a change in consumption of processed product Z, the following formula applies:

$$CS_z = \frac{\Delta Z\, \Delta P_z}{2\mathrm{k}} = \frac{\theta_z(\Delta q)(\beta_z \theta_z \Delta q)}{2k} = \frac{\theta_z^2 \beta \Delta q^2}{2k}$$

where the θ represents the amount of landings going into the processing of product Z form our sample and k represents the proportion that our sample represents of the total national production. To provide a notion of the importance that the relative size of the NMFS's sample (with respect to the entire surfclam processing sector) plays, Table 49 is provided. For a 285,000 bushel increase in landings, our consumer surplus estimate for the consumers of processed product varies from \$2.26 million with 25% coverage to \$.56 million with 100 % coverage.

4.6 COSTS, NET RETURNS, AND PRODUCER SURPLUS

A major concern of the supporting analysis is concerned with changes in costs, net returns, and producer surplus. Unfortunately, the cost information is extremely limited. The only information on costs that is current are the data provided in Brandt and McCay (2001). They conducted a survey during calendar year 2000 in an effort to obtain cost information on ocean quahog and surfclam fishing vessels. Out of a total of 48 vessels operating in 2000, they obtained cost information from seven vessels. It is not known how representative these seven vessels are of the surfclam and ocean quahog vessels. Brandt and McCay (2001) stated that their sample included vessels between 70 and 120 feet in length, 40 to 190 gross registered tons (GRT), and having capacity between 20 and 88 cages. Crew sizes for their sample fleet ranged from 3 to 5 individuals. All vessels from their sample were purchased after 1980 and purchase prices ranged from $70,000 to $375,000; they did not report a mean or median purchase price or any information about the mortgage terms. Due to the extremely limited sample size, they were unable to report costs by vessel size class. Their survey also did not collect cost information from the near-shore "mahogany" ocean quahog fishery of Maine.

Brandt and McCay divided their costs into three categories: (1) capital costs, (2) operating or quasi-fixed costs, and (3) operating costs that vary with the level of fishing activity. The market values of the vessels ranged between $125,000 and $1.0 million; no information on mean or median values were reported. Information on the median value of capital and related equipment were reported as were average annual fixed costs and average trip costs (Tables 50 through 52). Two remaining components include labor costs and annualized measures of the equipment costs. According to Brandt and McCay, crew receive approximately 30% of the gross stock or ex-vessel value of the trip; this was assumed for all surfclam and ocean quahog vessels. To calculate the annual cost of the wheelhouse equipment, straight line depreciation was assumed and applied to the replacement costs. For those equipments items having ranges, the mid-point was assumed to equal the useable life. Since cost information provided by Brandt and McCay were already in terms of year 2000 constant dollar values, it was possible to construct estimates of costs by vessel and trip for all surfclam and quahog trips between 1991 and 2000; net returns are summarized in Table 39.

The analysis contained in this FSEIS uses net returns as one measure of producer surplus. The net returns measure, however, is restricted to revenue less crew payments and fuel costs. Given the fact that the vessels can and often do catch both surfclams and ocean quahogs and available data were inadequate to assess fixed cost relative to each species, it was not possible to allocate the fixed costs without imposing some arbitrary allocation rule (e.g., allocation fixed costs based on the percentage of hours at sea for each species relative to total hours for the two species). To calculate producer surplus for the no action and various proposed regulations, the cost data from Brandt and McCay were used with the detailed logbook data. The variable costs (e.g., fuel and labor) were calculated for both surfclam and ocean quahog trips using the consumption data provided in Brandt and McCay and fuel price information available from the Energy Information Administration--"Prices of Petroleum Products to End Users" and the 30% crew share payment identified in Brandt and McCay. The Brandt and McCay survey found that fuel costs approximately $0.95 per gallon in 2000; the Energy Information administration reports $0.94 per gallon, and thus, the use of the EIA fuel price information should not pose any analytical problems. Steam time was calculated by subtracting fishing time. The no action was assumed to equal the 1996-2000 annual average level of activity by the surfclam and quahog vessels. There are no data which can be used to assess producer surplus for the Maine "mahogany" ocean quahog fishery. The average annual number of trips for ocean quahog and surfclam vessels equaled 4,251 trips between 1996 and 2000; the average number of hours at sea per year equaled 97,339; the average number of hours fished equaled 52,925, the total average value of ocean quahogs and surfclams, in year 2000 constant dollar value, equaled $38.9 million; and the average annual net return equaled $8.3 million.

For some of the proposed alternatives designed to protect EFH and increasing the surfclam quotas, it is likely that the number of trips and/or the hours at sea and fishing will increase. This will increase the cost per trip, given no change in fuel prices, which for 2002 appear to be lower than they were in 2000. Producer surplus would be expected to decline for any of the EFH alternatives that increase hours or number of trips per year.

4.7 ESSENTIAL FISH HABITAT AND SPATIAL ANALYSIS

4.7.1 Fishing Gear Impacts to Essential Fish Habitat

The management plan calls for extensive economic analysis of four closed area alternatives (three other alternatives were considered but not thoroughly evaluated) that have potential impacts on commercial fishermen in the surfclam and ocean quahog fisheries. These alternatives include closing fishing areas that are deemed to be important habitat for other marine species. This section discusses the economic impacts on commercial fishermen from the spatial closures under consideration. Important issues closely related to describing economic impacts from the closures, is the likely behavior of fishermen making choices of where to fish in the presence of spatial closures, and developing a model that describes how fishermen choose fishing areas. The model relates fishing area choice to areas' expected revenues, costs, and potential congestion from other vessels.

To apply the econometric model of fishing site choice, we use the logbook data (which places fishermen in a ten minute square) to characterize historical averages by month for each area on landings per unit effort (LPUE), at sea fishing time (TIME), the variance of area-specific net revenues (VAR), and the number of trips in current month (FLEET). Further, the data are used to characterize a vessel's homeport, and the homeport information is used to calculate distances to each area under consideration by the fisherman.

Defining fishing areas is an important step in formulating the econometric model of fishing site choice. We began by considering ten minute squares as a fishing area for the model since this is the common unit of measurement used in data collection for the fishery. For the period 1996-2000, clam (quahog) fishermen were observed fishing in 160 (279) unique ten minute square areas. Monthly averages are needed for LPUE, VAR, and TIME, while monthly totals are needed for

FLEET for a total of 12 x 160 (279) area-specific data points for each variable. Clearly, increasing the number of areas that must be included in the model increases the information requirements and risks spreading historical data "too thin" when trying to characterize area-specific information. For these reasons, choice areas were defined based on thirty minute squares, thereby decreasing the number of areas. Thirty-minute squares also increased the level of geographic aggregation in the model. Further, we eliminated areas that were visited sparingly (fewer than five trips) by fishermen.

Figures 43, 44, and 45 show the distribution of trips taken from 1996-2000 by thirty minute square for each fishery analyzed in this paper: surfclam, ocean quahog, and Maine "mahogany" ocean quahog. The figures also show the definitions of the extent of the choice set (i.e. areas that could be chosen by fishermen) which are denoted by those areas labeled with numbers. Based upon the rules for defining the choice set outlined above the surfclam, ocean quahog, and Maine quahog had 21, 40, and 7 areas from which fishermen in the respective fisheries could choose.

Comparing Figures 43, 44, and 45 illustrates that the Maine fishery is the most geographically compact fishery, while the Atlantic ocean quahog fishery covers significantly more ground with major activity occurring off the coastline from Maryland to Massachusetts. The surfclam fishery on the other hand, concentrates most of its activity off the coast of New Jersey and Delaware.

Figures 46, 47, and 48 show the impact of the closures for each of the thirty minute areas. Note that because the area closure definitions overlapped some thirty minute squares, we chose to close the entire thirty minute square area. Where small parts of a thirty minute square area were affected by a closure (e.g. the Alternative 6 closure is an example), an analysis of a larger closure than mandated by the Council was undertaken. Consequently, our analysis will yield a worse case, or upper bound estimate of the impact of the various alternatives on fishermen.

Fishermen likely choose areas based upon some common sense criteria: the LPUE in an area, the expected length of time spent fishing (TIME), and the distance to the fishing site (DISTANCE). Further, the fisherman might consider variability (either in terms of LPUE, TIME, or both) when comparing one area to another. Additionally, congestion exists from having too many fishing boats on a fishing ground. Consequently, fishermen are likely to examine how many boats have been or are in the area (for a proxy, we calculate the number of vessels in the area during the current month (FLEET). The challenge is to estimate a fisherman's decision rule for choosing areas that balances these area-specific factors.

4.7.2 The area choice model

The area choice model we use was first proposed by Hanemann (1982) and adapted to fisheries by Bockstael and Opaluch (1983). The model is useful because it allows for the estimation of decision rules about fishing area choice that incorporate factors important for the choice including the relative "riskiness" of different fishing areas. This is particularly useful for quantifying the tradeoffs fishermen make with respect to factors they consider when choosing one fishing area over others. In our application of Hanemann's model, fishermen are assumed to choose the best site by considering site-specific information such as landing per unit effort (LPUE), variability of profits, distance to the site, and uncertain returns.

The work of Bockstael and Opaluch assumes economic decision-makers are expected utility maximizers whose expected utility has a mean-variance functional form. Performing a Taylor series expansion of the individual's utility function around wealth at site j yields:

$$U(W_j) = U(W^0 + E(\pi_j)) + \sum_{k=1}^{\infty} \frac{\partial^k U(W^0 + E(\pi_j))}{\partial W^k} * \frac{(W - W^0 - E(\pi_j))^k}{k!}$$

where W equals the fisherman's initial level of wealth and E() equals the mean net revenues at site j. Taking the expected value of this function allows the expected utility function to be written in terms of the moments of the distribution of W. Taking the expectation yields:

$$EU(W_j) = U(W^0 + E(\pi_j)) + \frac{1}{2} * \frac{\partial^2 U(W^0 + E(\pi_j))}{\partial W^2} * M_2(\pi_j) + \frac{1}{6} * \frac{\partial^3 U(W^0 + E(\pi_j))}{\partial W^3} * M_3(\pi_j) +$$

Restricting the utility function to depend on only the mean and variance, we can write an approximation for the expected utility function at site j as follows:

$$EU(W_j) \approx U(W^0 + E(\pi_j)) + \frac{1}{2} * \frac{\partial^2 U(W^0 + E(\pi_j))}{\partial W^2} * Var(\pi_j)$$

Choosing a log utility functional form leads to the following estimable function for an individual's expected utility at site j:

$$EU(W_j) = ln(W^0 + E(\pi_j)) - \frac{Var(\pi_j)}{2\left(W^0 + E(\pi_j)\right)^2}$$

To make the model consistent with the random utility framework, rewrite the above equation to add parameters, α and β, as well as the term ε_j, the portion of the expected utility function not observable:

$$EU(W_j) = \alpha\, ln(W^0 + E(\pi_j)) - \frac{\beta Var(\pi_j)}{2\left(W^0 + E(\pi_j)\right)^2} + \varepsilon_j \qquad (1)$$

Notice that the error term, ε_j, is site-specific. The fisherman then chooses site I if the site is the best place to fish out of the set of all possible fishing choices, S. Using mathematical notation, this condition can be written as:

$$EU(W_i) > EU(W_j)\ \forall i, j \in S$$

Welfare measurement in this context can be accomplished via numerical methods, by calculating EV for a closure of certain areas in the choice set:

$$V^0(W^0 + E(\pi)^0, Var(\pi)^0) = V^1(W^0 + E(\pi)^0 + EV, Var(\pi)^0)$$

where the maximum expected utility for a choice occasion, $V^i(W^0 + E(\pi)^0, Var(\pi)^0)$, is equal to $E\{\max[U(W^0 + E(\pi_j) + EV, VAR(\pi_j)) + \varepsilon_j, \forall j \in S^i]\}$. Notice EMAX is taken over the original set of fishing alternatives S to yield V^0 and taken over only those sites remaining open (S^1)to yield V^1. Therefore, EV is the amount of money necessary after the closure of some sites to hold utility at a level as if the closures never happened. The expectations operator of the maximum expected utility function is the researcher's expectation taken over ε_a.

EV, a measure of welfare change after a policy from some baseline condition, must relate a change in conditions to some reference level of utility. Unlike producer surplus, which is a measure of producer well-being under a condition, EV must compare one state of the world to another in order for the welfare measure to be meaningful. EV is very similar to a change in producer surplus from the imposition of a policy. Hanemann (1982) has worked out analytic forms for the maximum expected utility functions for various error structures commonly employed in discrete choice econometric analysis; however these forms can not be employed if the marginal utility of wealth is not constant. This welfare measure has been employed in other studies of fisheries closures (Curtis and Hicks 2000).

The goal of the estimation problem is to recover structural parameters of the individual's utility function that reveal information about how fishing sites are chosen. In order to operationalize more completely equation (1), we estimated vessels initial wealth, W^0; expected profits, $E(\pi_j)$ and the variance of area-specific profits -- $Var(\pi_j)$ for each area considered by the fisherman. Following Bockstael and Opaluch, we approximated W^0 by the value of the vessel, calculated using an engineering relationship that quantified vessel value to vessel size. Due to data constraints, we took average vessel size for each fishery to calculate W^0. Mean profits (net of fishing and steaming travel costs) for π_j each area was calculated by month to yield our estimate of π_j. Additionally, we calculated the variance of π_j, for each month and thirty minute square area to yield Var(). The variables FLEET and FLEET2 (which is equal to $FLEET^2$) were added to equation (1) to attempt to quantify the effect of crowding or congestion on area choice when other vessels are present in an area. The final version of the equation to be estimated (1') is given by:

$$EU(W_j) = \underbrace{\alpha\, ln(W^0 + E(\pi_j)) + \frac{\beta Var(\pi_j)}{2(W^0 + E(\pi_j))^2} + \delta FLEET + \phi FLEET2}_{write\ as\ v(w_j)} + \varepsilon_j \tag{1'}$$

Assuming that the area specific area terms, ε_j, are distributed as multinomial logistic, we can write the probability that area I is chosen as:

$$P(i) = \frac{e^{v(w_i)}}{\sum_{j \in A} e^{v(w_j)}} \qquad (2)$$

Using maximum likelihood techniques, we can recover the parameters α, β, δ, and ϕ to give an estimate of welfare changes (EV) from the closures as well as predicted redistribution of trips following the closures. A priori, we expect $\alpha > 0$, $\beta < 0$, $\delta > 0$, and $\phi < 0$, since all things equal, anglers would choose sites with higher expected profits or lower variability. We would expect that the effect of vessel activity to be positive at lower levels since the presence of other vessels might indicate to the captain that successful fishing operations are being undertaken at an area. However, when the number of trips exceeds some threshold level the effect of congestion is felt and fishermen are less likely to choose that alternative. Table 53 lists the variables and parameters used in the analysis.

The results (Table 54) confirm a priori beliefs about how fishermen balance the various factors influencing fishing site choice. Fishermen were more likely to choose sites that are more profitable (which could mean closer, less costly, or higher LPUE) or less likely to choose sites with high variability. They were also more likely to choose sites where a significant activity was occurring until the level of activity exceeded a threshold level, and then, they were less likely to choose sites. All results were significant at the 5% level of significance and the model likelihood ratio test statistic (versus a model where all parameters are equal to zero) indicate that the model is preferred at the 5% level of significance. Since one of the primary uses of the model will be for predicting where fishermen will fish once area closures are enacted using equation (2), we also construct a pseudo-R^2 by calculating the percentage of observations where the model predicts (based upon the observation with the highest calculated probability) the individuals' actual choices. Results for this statistic show that relative to a naive prediction of the inverse of the number of choices in the choice set, each choice model predicts remarkably well.

In order to understand the impact of the potential essential fish habitat regulations on each of the three fisheries, consider Table 55. First, the table illustrates some variability in landings and revenues during the years 1996-2000. We construct a status-quo or reference level of permits (number of boats), trips, landings, revenues, and prices, by taking the fleet average for the years 1996-2000. Rather than choose the latest year in the data (2000), we felt that defining the baseline level of fleet over a five year time period to be a reasonable way to eliminate noise that might cause year-to-year fluctuations that is not constructive to the analysis. The table also illustrates that the fleet activity for each of the EFH closure areas is minimal in comparison to overall totals. Only Alternative 3 has catastrophic effects- on the Maine ocean quahog fishery- by closing the entire fishing grounds of the fishery. Alternatives 3 and 6, have the potential to impact the ocean quahog fishery, since a significant number of vessels, trips, and revenues are derived from the offshore areas affected by Alternative 3. For the surfclam fishery, Alternatives 3 and 6 will impact fishing activities, but since the majority of activity does not occur so far offshore, the impact is likely to be much smaller than the ocean quahog fishery. Finally, Alternative 8 affecting only the Maine ocean quahog fishery, affects only a small number of observed trips representing a small portion of the fleet total revenues. However, recall that the Maine ocean quahog fishery is by far the most geographically compact fishery.

Analyzing the effect of closures by looking at observed activity in areas does provide context for who will be affected and how important EFH areas are for historical fishing grounds. However, this sort of analysis ignores how fishermen might respond to area closures. It is unlikely that they would completely stop fishing during times usually spent fishing in EFH areas. Rather, it is more likely that they will respond by shifting their effort to other areas.

We use the model to estimate several policy-relevant outputs that describe impacts and likely responses from the EFH closures being considered. First, we calculate equivalent variation or EV, the welfare measure that equates post-closure utility with the baseline pre-closure level of utility. This measure can be thought of as an at-the-dock payment a fisherman facing the area closures would need to be paid to compensate him for the area closure. As discussed previously, this measure focuses on the EFH closure portion of the analysis, and is different from the typically calculated producer surplus. This payment would compensate him for changing expenses relating to travel and fishing at a site, a change in LPUE and variability of profits, and changing conditions with regard to fleet congestion. Consequently, the measure embodies all of the factors underlying the decision rule estimated in Table 54. For each of the policies, we calculate EV per trip in Table 56. First, Alternatives 1 and 2 do not impact any spatial choices made by fishermen so there are no appreciable welfare changes to measure. Alternative 3 completely closes the Maine ocean quahog fishery and has some implications for the larger ocean quahog fishery, since a portion of its activity does occur a fair distance from shore (Figures 44 and 46). The surfclam fishery has small measurable impacts since fishing grounds (for the area-choice analysis) are mostly west of the cutoff line (Figures 43 and 45). The exception is for boats steaming out of the ports in the northern range of the surfclam fishery (Rhode Island and Massachusetts based vessels). These vessels have much higher impacts than vessels based out of New Jersey or points south. Alternative 6, which closes a significant area in the offshore areas of the Middle Atlantic region has significant impacts (relative to per-trip revenues) on the ocean quahog fishery and to a lesser degree the surfclam fishery. Finally Alternative 8, has significant impacts on the Maine ocean quahog fishery, but has no affect on either the surfclam or ocean quahog fisheries.

It is important to note that even though most of these alternatives had minor impacts on fleet activity based upon historical fishing patterns, EV compensates all fishermen for the EFH closures as long as they have some probability of choosing an affected fishing site. In particular, this is important for the Maine Alternative 8 closure. Even though relatively little activity is observed occurring during the period 1996-2000, the fishery is quite small and the closure affects an area where a large number of fishermen have a relatively high predicted probability of choosing.

Using equation (2), we also predict likely vessel area choices resulting from the closures. Figures 49 and 50 show predicted area choices resulting from area closure 3. For ocean quahogs (Figure

49) a significant portion of the reallocated effort occurs just west of the closure area off of the coast of southern Massachusetts and Rhode Island. The surfclam fishery, largely unaffected, is predicted to maintain effort in the Middle Atlantic region on historical fishing grounds. Alternative 6 (Figure 51), had an impact on the ocean quahog fishery, many of the Middle Atlantic offshore areas were no longer available to fishermen. The predicted response is to move activity from the offshore areas inshore, either northward toward Long Island and Rhode Island or westward toward New Jersey. For surfclam fishermen, activity is predicted to concentrate in the nearer shore areas off of New Jersey (Figure 52). Alternative 8 (Figure 53), the closure of the western extent of the Maine ocean quahog fishery is predicted to result in a higher concentration of vessels in the primary fishing grounds in the fishery.

Table 57 contains the total welfare impact for each of the EFH closures under the baseline quota levels assuming no changes in trips. These numbers demonstrate the upper bound losses associated with imposing EFH restrictions. The surfclam fishery is the least affected across all EFH alternatives relative to the other fisheries considered here. Ocean quahogs (for Alternatives 3 and 6) suffer a significant loss when compared to total fleet revenues. Alternative 8 also significantly impacts the Maine fishery with an economic welfare loss associated with the area closure to be a significant portion of no action revenues.

Recall that these welfare measures not only compensate fishermen for having to reallocate their effort into less profitable areas, but it also accounts for fleet congestion and variability of profits associated with areas. Consequently, as areas are closed and fishermen reallocate their activity resulting in a higher concentration of effort for fishing areas (e.g Alternative 8 in Maine), fishermen are affected more severely resulting in higher estimates of economic welfare loss. Similarly, EFH closures might also force fishermen to choose more variable areas, and the welfare measure will compensate them for a greater impact since it takes into account all of the factors underlying the estimated decision rule.

4.8 IMPACTS OF VARIOUS ALTERNATIVES

4.8.1 Extent of Economic Impacts

Federal Guidelines and various policies of the United States require analysis of the potential economic ramifications of fisheries regulations. In Section 4.8, changes in the potential levels of landings, ex-vessel prices, producer surplus, costs, consumer surplus, and net benefits that might result from the various essential fish habitat regulations, proposed new quotas, and other regulations are presented. The analysis of regulations proposed to protect or restore EFH are also included with the analysis of proposed other regulations, particularly the alternatives to increase the surfclam quotas to 3.135 million bushels in 2002 and 3.40 million bushels in 2003.

4.8.1.1 Vessel Monitoring System (VMS)

Amendment 13 has one of four alternatives that proposes to require all vessels with surfclam or ocean quahog permits to conform to a mandatory vessel monitoring system (VMS). This action would require vessels to purchase or lease the base unit and be subject to vessel monitoring to determine whether or not vessels are fishing or located in certain areas. It is unknown how many of the current 48 vessels that operated in 2000 had a VMS. Based on information obtained from sea scallop vessel owners, it is estimated that the annual costs of owning and operating a VMS is approximately $2,500 per vessel. This proposed action could thus possibly decrease total profitability of the surfclam and ocean quahog fleet by approximately $120,000 in year 2000 constant dollar value. Cost and earnings information by vessel are not available, and thus, it is not possible to adequately assess the actual impact of the proposed action on profits of individual vessels. The other three alternatives include the no action (call-in system), a mixed voluntary VMS/call-in and an interactive voice recognitions (IVR) system similar to all of the other quota managed species reporting system. It is likely that the Council will wait and see how the development of a national system goes in response to the tragedy of September 11, before any specific system is implemented. In fact, the Council at its January 2003 meeting, unanimously (with RA abstaining) to recommend the RA implement a mandatory electronic tracking system when an economically viable system is available for the industry.

4.8.1.2 Essential Fish Habitat and Quotas

Amendment 13 proposes several alternatives for protecting essential fish habitat. The preliminary regulatory economic evaluation, however, only thoroughly considers five EFH alternatives: (1) alternative 1 or the no action, which imposes no new restrictions on protecting EFH; (2) alternative 2, which prohibits clam dredging on Georges Bank east of 69 degrees; (3) alternative 3, which prohibits hydraulic clam dredging east of 70 degrees, 20 minutes; (4) alternative 6, which prohibits clam dredging in Tilefish HAPC – this alternative delineates areas that have depths between 250 and 1200 feet between Cape Cod and Cape May; and (5) alternative 8, which prohibits all clam dredging in the EEZ off the state of Maine west of Zone 1. Closed area alternatives 4, 5 and 7 were dismissed earlier by the Council for full evaluation. In addition to considering the alternatives to protect EFH, two alternative levels of quotas for surfclams must be considered. The surfclam quota was increased from 2.85 million bushels in 2001 to 3.135 million bushels in 2002 and may reach the maximum OY level of 3.40 million bushels as early as 2003. The potential economic ramifications of the two higher quotas and EFH restrictions must be estimated and assessed.

The analytical framework used to assess the potential economic ramifications was presented in sections 4.5-4.7. This is an integrated framework that combines production and demand analysis with the determination of area choices. For the purpose of estimating the economic ramifications of EFH alternatives, it was necessary to initially estimate the likelihood that vessels would change fishing areas in response to the EFH alternatives. Next, it was necessary to consider how the number of trips and landings might change. Then, changes in costs, net returns, ex-vessel prices, processed product production and distribution, consumer surplus, producer surplus, and net benefits were assessed. Consumer surplus is estimated for the harvesting sector and for processors of surfclams; it was not possible to obtain estimates of processed product demand for ocean quahog products.

On a per species basis, it was not possible to calculate correct measures of producer surplus and net benefits. This was because fishing vessels do or can land both species, and thus, it is not possible to allocate fixed costs. Therefore, the producer surplus and net benefit estimates pertaining to individual species are vastly overstated (i.e., they are overstated because only operating costs–fuel, oil, and labor–have been deducted; the fixed costs have not been deducted). These initial calculations, however, are informative for assessing whether or not producer surplus and net benefits are likely to increase or decrease relative to the no action.

In the following analysis, several scenarios are considered relative to potential habitat area closures and increases in the surfclam quota. For possible EFH-area closures, it is assumed that producers or holders of quota will simply redirect fishing activities to other areas predicted by the area choice models. Under this arrangement, they will continue to harvest the same levels of catch as they caught under the no action. This is the most likely scenario or outcome. For some possible closures, however, it may not be possible to maintain landings equal to ITQ holdings. A realistic worse case scenario, however, is that producers or holders of quota will simply reduce their total number of trips by the number of trips they typically took to the areas defined under the EFH alternatives. For example, 21 surfclam trips a year were typically taken to areas defined by alternative 3 between 1996 and 2000. Under the no action, surfclam trips equaled 2,114 per year between 1996 and 2000. With the worst case scenario, it is assumed that vessels will reduce their number of surfclam trips to 2,093 trips per year (2,114-21).

There are some aspects of the analyses that warrant further discussion. For example, alternative 8 does not pose a large direct economic impact for Maine ocean quahog vessels. This is because they do not make any changes in the number of trips or landings. They will, however, suffer a loss in economic welfare because they will experience more congestion on the fishing grounds and greater uncertainty about the level of catch. The greater uncertainty and congestion impose costs on harvesters that are not easily measured – that is, economic welfare. In contrast, it was not necessary to conduct an extensive analysis of alternative 3 relative to Maine ocean quahogs; this alternative essentially closes the fishery. For this alternative, we examine the losses in terms of revenues and consumer surplus. Alternatives 2 and 8 also do not change the levels of consumer surplus, ex-vessel prices, or net returns, but these two alternatives do affect producer welfare, especially producer welfare relative to Atlantic and Maine ocean quahog production.

4.8.1.2.1 Essential Fish Habitat and Surfclam Quotas

EFH Alternatives 3 and 6 have the largest direct economic impacts for surfclam harvesters (Table 58). Under alternative 3, producers or owners of ITQs redirect fishing activities and consequently land the same quantity of surfclams as under the no action alternative, but they do so at a higher cost. With Alternatives 3 and 6, landings, revenues, prices, and consumer surplus remain unchanged, but fishing vessels have to travel longer distances and take more trips during the year, and as a consequence, they experience an increase in operating costs, particularly fuel. Under alternatives 3 and 6, but with no change in overall landings, surfclam operators would have to increase their number of trips by 43 and 87, respectively (Table 59). The increased number of trips subsequently increases operating costs. Producer surplus is, thus, reduced as are net benefits to the nation. If producers decide not to make up for the losses that would occur under alternatives 3 or 6, the potential losses are even larger. That is, if owners or holders of quota decide to reduce their trips by their historical average number of trips to areas delineated under alternatives 3 or 6, they will incur larger losses than those predicted by the scenario that allows harvesters to redirect their activities to other areas. The largest potential reduction that might be induced via EFH area closures occurs with alternative 6. Under alternative 6, but allowing vessel operators to redirect fishing activities to other areas and take more and longer trips in order to maintain landings, net benefits are reduced by $84,246. The entire reduction is associated with declines in producer surplus or net returns.

If quotas are allowed to increase, there are no reductions in consumer or producer surplus under any of the EFH alternatives. In fact, there is an increase in net benefits to the nation with increased quota for surfclams. The net benefits with increased quotas and EFH protections, however, are less than the net benefits associated with just the higher quotas. Increasing just the quota, and with no restrictions to protect EFH, net benefits increase by $3.4 and $4.8 million for new quotas of 3.135 and 3.40 million bushels, respectively.

Under EFH Alternatives 2 and 8, there are no changes in any of the economic performance measures or net benefits. This is because no surfclam trips appear to have been taken in the areas delineated under Alternatives 2 and 8. Closing these areas does not apparently affect surfclam operations.

Of the various alternatives to protect EFH, alternative 6 has the largest negative impact. It potentially reduces net benefits by approximately $84,246 per year. Alternative 3 potentially reduces net benefits by $26,215 per year. These are extremely small reductions for a fleet of 31 vessels (i.e., the number of vessels landing surfclams in 2000). The average reduction in producer surplus per vessel equals $846 and $2,718 under alternatives 3 and 6, respectively. If surfclam quotas are increased, however, net benefits and net returns are increased for the fleet and, on average, per-vessel.

4.8.1.2.2 Essential Fish Habitat: Ocean Quahogs

The same four alternatives – 2, 3, 6, and 8 – have also been proposed for protecting the essential fish habitat of ocean quahogs. In this section, an analysis of the potential economic impacts on net returns and benefits of the four EFH alternatives is presented; the analysis, however, excludes the Maine ocean quahog or mahogany clam. Of the four EFH Alternatives, only Alternative 6 has any significant and direct impact on revenues, costs, net returns, and net benefits (Table 60). Between 1996 and 2000, vessels landing ocean quahogs made approximately 461 trips per year to areas delineated by Alternative 6 (Table 61). In order to maintain the 1996 to 2000 average annual level of landings (3,899,782 bushels per year), vessels will need to increase their number of trips by 143 trips per year; on a per vessel basis, that equals 4.9 trips per vessel per year. Under Alternative 6, net returns and net benefits decline by $548,032 or by $18,898 per vessel. This is a large decrease in net returns. There are, however, no declines in revenues or consumer surplus under Alternative 6; this is because operators land the same quantity of quahogs as they would under the no action.

If operators do not increase their trips to maintain the no action harvest level and instead decide to reduce their trips by the average number of trips typically taken to areas delineated by Alternative 6, the losses are even larger. In this case, there are reductions in landings, trips, revenue, consumer surplus, producer surplus, and net benefits. On average, vessels could experience reductions in net returns up to $66,864 per vessel per year. This latter outcome, however, is highly unlikely because there appear to be no reasons why vessels could not switch to other areas and maintain the historical average level of landings.

Between 1996 and 2000, however, ocean quahog vessels averaged 323 trips per year in those areas delineated by alternative 3. During this same period, ocean quahog vessels averaged a total of 2,137 trips per year in all areas. Average annual ocean quahog landings from areas associated with alternative three equaled 711,644 pounds; average annual value was $3.1 million. Total average annual landings and value between 1996 and 2000 equaled, respectively, 3.9 million pounds and $17.3 million. A potential decline of nearly 18% in ex-vessel revenue from not being able to fish areas associated with alternative 3 would normally be viewed as a large and significant impact. Ocean quahog vessels, however, may switch to other areas with equal or higher landings per unit effort and approximately the same steam time. As a consequence, they would experience no change in total landings, ex-vessel revenues, or potential net returns.

Vessel operators and owners, however, will experience losses in producer welfare, which is further discussed in section 4.1.8.3. Since operators are likely to switch to other areas, particularly areas that they may not be familiar with, they incur welfare losses associated with uncertainty about landings and congestion. Producer welfare or benefits are estimated to decline by approximately $2.28 million per year. These losses represent the potential dollar value of the losses in non-market benefits.

Overall, alternatives 2, 3, and 8 appear to have no direct economic impacts on ocean quahog operations. Under all three alternatives, vessel operators can switch to areas having equal or higher densities of ocean quahogs and take the same number of trips as before. In addition, vessels landing ocean quahogs between 1996 and 2000 had no reported ocean quahog landings from those areas associated with Alternatives 2 and 8.

4.8.1.2.3 Essential Fish Habitat: Surfclams and Ocean Quahogs

The previous two sections provided an assessment of the potential impacts on protecting EFH and increasing the quotas for surfclams. As indicated in both sections, it was not possible to provide an adequate assessment of operating costs, net returns, producer surplus, and net benefits because of difficulties with allocating fixed costs among the surfclam and ocean quahog species. In this section, a summary analysis of the potential impacts or changes in economic performance and benefits is presented for the combination of surfclams and ocean quahogs (i.e., an aggregation over surfclams and ocean quahogs). The analysis, however, still excludes the Maine ocean quahog. Fixed costs are included in the analysis but only those costs identified in the Brandt and McCay (2001) study. The fixed costs, however, do not include vessel mortgage payments; this information was not available. Fixed costs include depreciation of capital items and annual fixed costs such as vessel insurance. Tables 50, 51, and 52 provide summaries of the various estimated fixed costs.

When the two species are combined and fixed costs are included, the EFH alternatives pose considerable negative impacts (Table 62). Alternative 6 poses a potential reduction of $632.278 a year or $12,851 per vessel per year (Table 63). Alternative 3 still presents only a minimal impact of $26,215 or $533 per vessel. Most of the negative consequences of the EFH alternatives arise because of increased costs associated with more and longer trips. Under Alternative 6, vessels would have to take an additional 230 trips per year in order to land the same quantity as they did between 1996 and 2000. Alternative 3 requires 43 more trips per year to land the same quantity as landed between 1996 and 2000. Since the quota was increased in 2002 to 3.135 million bushels and may go as high as 3.40 million bushels in 2003, net benefits relative to the no action increase for all EFH alternatives.

4.8.1.2.4 Essential Fish Habitat: Maine Ocean Quahogs (Mahogany)

Of the four EFH alternatives, only Alternative 3 has a significant impact. In fact, Alternative 3 results in closure of the fishery (Table 64). Alternative 3 closes such a large area that Maine ocean quahog vessels have no alternative fishing areas. Vessel operations will have to cease. Average annual landings between 1996 and 2000 equaled 81,428 Maine bushels; the Maine bushel is smaller than the bushel baskets used in the surfclam and ocean quahog fishery. The potential impacts of alternative 3 include reduction of 81,428 bushels of landings; a reduction of $2.5 million per year in revenue; and reduction in consumer surplus equal to $831,795 per year (Table 65). Data on operating costs, which are necessary to calculate net returns and producer surplus, are not available for the Maine ocean quahog fleet. Alternatives 2, 6, and 8 have no projected impact on the fishery.

4.8.1.3 Producer Welfare and Equivalent Variation

The analysis of the various proposed regulations designed to protect essential fish habitat suggests that alternatives 2 and 8 have no impact on prices, revenues, net returns or net benefits for any of the species. The analysis, however, considers only those economic performance measures that can be easily identified and examined. Vessel captains and crew, however, might experience costs other than those directly observable (e.g., the captain might view other areas as less desirable because he/she is uncertain about fishing the area). Alternatively, the vessel captain and crew might believe that the closing of an area will increase the congestion (or number of operators) in other areas, and the captain would prefer not to experience increased congestion. This potential cost raises the issue of what might the vessel captain and crew be willing to pay to avoid the EFH closures. In general, they would not pay more than the net returns realized from their original fishing areas plus the value of the quota. Net returns are also often used as an approximation of producer surplus.

As an example the possibility of costs other than those easily identified, consider a captain getting ready to make a trip to his traditional fishing area. Just prior to departure he is informed that his traditional area will be closed, but he can fish in other areas. The captain and crew may not be familiar with these other areas; that is, they have uncertainty about the potential landings. The captain realizes that the closure of the traditional fishing grounds will likely cause other vessel operators to fish the other unregulated areas, and thus, contribute to congestion. Even if there are no increases in distance, fuel consumption, or other monetary costs, the captain views the closed areas as a cost because they increase uncertainty and congestion. The captain and crew will likely experience a reduction in welfare or benefits.

How can we measure this possible reduction in producer welfare. One way is to assess what is called "equivalent variation." This is a measure that is similar to consumer or producer surplus in that it is a benefit or welfare measure. In simple terms and relative to this case, equivalent variation is a measure of what the captain and crew would be willing to pay to retain the original fishing area or not have the closures of their traditional fishing grounds.

The method used to estimate equivalent variation and estimates of the potential loss in producer welfare were previously explained in section 4.7. These estimates are repeated in this section. Overall, alternative 2 and 8 impose no loss in producer welfare for either surfclams or ocean quahogs (Table 66). Alternative 8, however, imposes a large loss ($1.69 million) in producer welfare for Maine ocean quahog producers. Alternative 3, which was determined to have no impact on revenues and net benefits for ocean quahogs, impose a sizeable reduction ($2.28 million) on the producer welfare of ocean quahog fishermen. Alternative 6, however, imposes the largest reduction in producer welfare--$5.79 million per year relative to both ocean quahogs and surfclams.

4.8.1.4 Quotas and the Processing Sector

The proposed increases in the surfclam quotas benefit not only the primary producers (i.e., fishermen), they also may benefit the processors and consumers. More product would be expected to reduce consumer prices and yield a higher consumer surplus for consumers. An increased in the level of the raw materials (i.e., surfclams) would be expected to reduce the price of the raw materials and subsequently increase the producer surplus of processors. Federal guidelines recommend that, if possible, changes in economic performance and benefits should be assessed at all market levels. In this section, analysis of the possible benefits at the processing level of the 2002 surfclam quota and the increase to the maximum OY level are presented. Moreover, consumer surplus at the processing level is more likely to be indicative of consumer benefits at the final consuming level. Information necessary to assess producer surplus and net benefits at the processor level, however, is not available. It was, therefore, only possible to consider changes in consumer surplus that might be associated with the proposed higher surfclam quotas.

Models discussed in section 4.5 were used to examine consumer surplus for surfclams. No new quotas were proposed for ocean quahogs. The quotas were 3.135 and 3.40 million bushels; the 2001 quota was 2.85 million bushels. One problem with examining the potential change in consumer surplus because of the quotas is that the National Marine Fisheries Service does not necessarily collect information for all processors; that is, they tend to sample processors.

Alternatively, it is not known whether or not the NMFS data includes information on all the processors of surfclams or a sample of processors. It is, therefore, quite difficult to estimate consumer surplus relative to all the proposed quotas using the NMFS data. This can be done, however, by adjusting the estimates for different sample sizes. Initially, it is assumed that the NMFS data on surfclam processing activities characterizes only 25% of surfclam processors; the analysis then increases the assumption in 25% increments (i.e., 50, 75, and 100%). NMFS has indicated, however, that they believe they obtain 85-95% coverage of the surfclam and ocean quahog processing plants. If correct, consumer surplus estimates most closely correspond to the 75 and 100% coverage numbers.

Based on the models presented in section 4.5, estimates of the changes in consumer surplus adjusted for sample size and relative to the 2001 quota level (2.85 million bushels) were made (Table 67). It was only possible, however, to examine the changes in consumer surplus for shucked meats, minced meat, chowder, and strips. Overall, gains in consumer surplus were determined to be highest for shucked meats; clam chowder generated the second highest gains in consumer surplus; minced meat products yield the third highest gain in consumer surplus; and strips provided the fourth highest gain. As readily observed, increasing the quota by 550,000 bushels (3.4 million bushels less 2.85 million bushels) increases consumer surplus considerably more than does increasing the quota by 285,000 bushels (3.135 million bushels minus 2.85 million bushels)

4.8.2 Reversal of Requirement of Regulatory Action to Suspend Surfclam Size Limit and Implementation of Multiple Year Quotas

NMFS and the Mid-Atlantic Council have expressed a desire to reverse the requirement of regulatory action to suspend the surfclam size limit and to implement multi-year quotas for surfclams and ocean quahogs. Presently, NMFS needs to conduct a finding and publish a regulatory action to suspend the minimum surfclam size limit if the Council recommends this course of action. There has not been, however, a minimum size limit imposed since implementation of the ITQ program. The minimize size limit is specified by the regulations to be 4.75 inches. The current FMP and regulations require setting quotas on an annual basis. Surveys that support establishing annual quotas, however, are conducted only every three years. The two resources–surfclams and ocean quahogs–are also recognized as being underfished or fully utilized. Given that it is unlikely that NMFS will be able conduct real-time surveys and assessments each year, the Council desires to implement multi-year quotas for up to three years.

4.8.2.1 Reversal of Requirement of Regulatory Action to Suspend Surfclam Size Limit

NMFS and the Council desire to reverse the minimum size regulation such that the size limit would remain in the regulations, but would need a regulatory action to implement. This action would continue as part of the quota setting process. Neither the exact economic ramifications of this action are known nor can they be easily estimated with existing information. The proposed action should, however, reduce administrative and compliance costs for the Council, NMFS, and the industry. Moreover, this action would be expected to increase producer welfare or benefits to both fishermen and processors in the form of reduced uncertainty. The no action requires that

NMFS, NERO perform significant work to justify the present annual suspension. Alternative 1 reduces the financial burden of the agency by eliminating the routine annual evaluation by NMFS. The Council at its January 2003 meeting, unanimously (with RA abstaining) approved adding to the list of framework management measures both the suspension of the surfclam minimum size limit and adjustment of the surfclam minimum size. Full analyses will be conducted should either of these framework management measures be considered for implementation.

4.8.2.2 Multiple Year Quotas

The present regulations require an annual quota setting process for surfclams and ocean quahogs. The Council has some desire to eliminate the annual quota setting process and replace it with multiple year quotas. The Council proposes three alternatives with respect to multi-year quotas: (1) alternative 1 which requires Council staff to continue to produce the annual quota recommendation paper for the Council to review, and if no changes from the previous multi-year schedule were recommended by the Council, no additional work would be required by staff or NMFS; (2) alternative 2, the no action, which continues the development of staff's annual quota recommendation paper for the Council, along with the associated Regulatory Impact Review, Environmental Assessment, Proposed Regulations, etc; and (3) and alternative 3 multi-year quotas set after each survey and stock assessment with no annual review; for this latter case, quotas would be set only after surveys and would remain on an agreed upon schedule until the next survey. The Council at its January 2003 meeting, unanimously (with RA abstaining) approved multi-year quotas not to exceed three years with annual review.

Alternatives (1) and (3) both offer savings in the form of reduced expenditures to support establishing annual quotas. The present procedure is quite expensive because it forces compliance with numerous other regulations or may require extensive additional analysis in support of establishing new quotas. The preferred alternative offers cost savings because it reduces costs since additional supporting analysis would not be required. At the same time, however, it also maintains the ability of the Council to annually change the quotas if necessary. Alternative (3) also reduces the costs but creates the possibility for higher risk of resource declines. That is, a multi-year quota could be established for a year in which resource levels declined, and the Council might not be able to expeditiously act on a new quota.

4.9 ADDITIONAL ISSUES AND NON-QUANTIFIABLE IMPACTS

There are numerous additional issues that limit the precision and extent of the analyses of the alternatives proposed to protect essential fish habitat and the proposed changes in the quota for surfclams. Foremost among the limitations is the inability to link future resource levels and conditions to changes in essential fish habitat. In addition, there is no information available that can be used to estimate the benefits society might receive from restoring EFH. It would be expected, however, that society would receive positive net benefits from enhanced or improved EFH. A recent report by the National Research Council (NRC 2002) suggests that bottom otter trawling damages the habitat where juveniles hides from their predators, and may alter ecosystems enough to partially explain the declines in fish populations observed over the past few decades.

The NRC (2002) report also states, however, that the available information is inadequate to conduct a full evaluation of the ecosystem effects of trawling and dredging.

The NRC report offers numerous alternatives for addressing issues related to protecting and restoring EFH. The report also provides information about some of the potential benefits to marine resources of restoring or protecting EFH. The report, however, does not indicate the likely length of time required before there are improvements to resource levels and conditions relative to restoring or protecting EFH. A benefit-cost analysis of the potential net benefits from restoring EFH requires knowledge of the time horizon over which costs and benefits accrue (i.e., the chronic effects and recovery dynamics).

Regulatory requirements or guidelines also require an assessment of the potential impacts on individual entities that might be affected by a regulation or management action. The fleet is comprised of vessels of various sizes, and as a consequence, the potential impacts would likely vary in magnitude among the different size vessels. The data to adequately conduct a detailed analysis by individual vessel, and account for size and other differences, were not available at this time. For example, the available information on costs was in terms of averages, and thus, could not be used to assess impacts by vessel size. It is likely, however, that the smaller vessels would be more severely affected by the area closures than would the medium to larger size vessels. These smaller vessels may not be able to fish farther offshore or make trips during inclement weather.

Guidelines also suggest that a full accounting of net benefits should be undertaken. There simply is no information available on consumer demand and retail prices for surfclam and ocean quahog prices. It, therefore, was not possible to estimate the final demand. This was addressed by estimating the demand for processed products.

4.10 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.

The Council is not currently proposing measures under this regulatory action that require review under PRA. There are no changes to existing reporting requirements previously approved under OMB Control Nos. 0648-0202 (Vessel permits), 0648-0229 (Dealer reporting) and 0648-0212 (Vessel logbooks). Amendment 13 may eventually allow for implementation of a VMS program to replace the current call-in system (phase 1) and some type of electronic reporting to replace the current paper vessel logbooks (description in section 1.2.5). However, no current VMS/electronic reporting system currently exists in the Northeast that is acceptable to the industry and Council. The Council may recommend to the RA implementation when an electronic system is economically viable and satisfactory to the Service and the industry. The Council recognizes that if and when it recommends an electronic system, a PRA package will to be required. However, the

Council will submit the PRA package when the Council and NMFS agree to go forward with implementation of a VMS/electronic reporting system.

As stated above, this action does not implement new reporting or record keeping measures. There are no immediate changes to existing reporting requirements. Currently, all surfclam and ocean quahog Federally-permitted dealers must submit weekly reports of fish purchases. The owner or operator of any vessel issued a vessel permit for surfclams and ocean quahogs, must maintain on board the vessel, and submit, an accurate daily fishing log report for all fishing trips, regardless of species fished for or taken.

5.0 SOCIAL IMPACT ASSESSMENT (FSEIS)*

5.1 INTRODUCTION

This social impact assessment (SIA) of alternatives included in Amendment 13 of the Atlantic Surfclam and Ocean Quahog Fisheries Management Plan was carried out by Rutgers University on behalf of the Mid-Atlantic Fisheries Management Council (McCay *et al.* 2002). The SIA focuses on the social impacts of the proposed alternatives. It is complemented by a section that focuses specifically on the direct economic impacts of the proposed alternatives (section 4).

The legislative authorities for SIAs are broad. They include several sections of the Magnuson-Stevens Act [MSA 2(b)(5)(B); 303(b)(6); 303(a)(9); MSA 3 (16)][NMFS n.d.]. They also include the National Environmental Policy Act (NEPA), which requires Federal agencies to consider the social as well as economic and biological impacts of major Federal actions on the human environment [see 40 CFR 1508.14]. This includes the cumulative effects of past and present fishery management actions [40 CFR 1508.7]. Furthermore, Executive Order [EO] 12898 requires Federal agencies to analyze effects on minority populations, low-income populations, and Indian tribes. To the extent that SIAs overlap with economic impact assessments (EIAs) in addressing the impacts on social units such as small businesses, organizations, and governments, they are authorized by the Regulatory Flexibility Act too.

Finally, SIAs are authorized by National Standard 8 of the Magnuson-Stevens Act (MSA 3(16)), part of the 1996 amendments, which stipulates that "Conservation and management measures shall, consistent with the conservation requirements of this 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" [MSA 301(a)(8)]. The guidelines for National Standard 8 [MSA 301(a)(8)] define a fishing community as a geographical community that is "substantially dependent" on the harvesting or processing of fishery resources.

This SIA is designed to follow from National Standard 8, with particular attention to its requirement that FMPs, to the extent possible given the required conservation measures, provide for the "sustained participation" of the communities in the fishery and minimize adverse economic impacts. However, social impacts on minorities and low-income populations and small businesses, quite independent of community impacts, are also considered in response to NEPA, RFA, and Executive Order 12898 requirements as are cumulative impacts of past and present fishery management actions.

There is no recreational fishery for surfclams and ocean quahogs, and therefore the major foci of this SIA are the businesses and families that own and operate commercial fishing (dredging) vessels and processing plants, as well as the coastal and inland communities involved in harvesting and processing surfclams and ocean quahogs.

5.2 RATIONALE FOR UNDERSTANDING SOCIAL IMPACTS

NMFS (1994) has created guidelines to be used in social impact assessments. These guidelines require identifying baseline conditions, scoping the full range of potential impacts from each proposed alternative, projecting estimated effects from these impacts, and predicting the significance of potential responses to these impacts. Baseline conditions include population data, household and educational characteristics, community and institutional structures, political and social resources, and attitude variables such as views of the fishery.

Although the 1994 NMFS SIA guidelines are very detailed, they are not clear about what actually matters in an SIA so that it can contribute to informed decision-making. Making projections about the social impacts of different alternatives requires better articulation of what an "impact" is and what impacts mean for communities. This SIA is based on a seven-point rationale for understanding social impacts, based on prior experience (e.g., Wilson *et al.* 1998). The rationale has four kinds of impacts and three characteristics of communities that affect their vulnerability to those impacts and hence their implication for the community's "sustained participation" in a fishery.

5.2.1 Types of Impacts

Fishing regulations affect the sustained participation of communities in fisheries in several different ways. The first impact of fisheries conservation measures is on the fishing and processing operations themselves. Four kinds of impacts on commercial operations are important for understanding the impacts of regulations.

1. Fishing regulations can affect the volume of money that is going through the operation. This means the amount of product passing through the operation and the price that the operation is able to command for that product. Both of these things can be directly affected by regulations.

2. Regulations can affect the flexibility of fishing and processing operations. This is the ability of the operation to change in response to changes in the resource, the market, or their customer base. Often regulations affect the ability of fishing operations to make plans. Many systems of regulations indirectly create uncertainties for the fishing operations that make business planning more difficult. Operations may have to select more expensive, and hence less efficient, alternatives in making day-to-day decisions.

3. Regulations can impose direct costs on fishing operations by requiring them to buy something such as a license or a fishing net of a different type. These are costs beyond the increases in operational costs that result from lost flexibility.

4. Regulations can affect the safety of fishing operations by changing the risks to which vessels and people are exposed and their vulnerability to them.

5.2.2 Community Characteristics

These impacts on operations, in turn, can create impacts in the broader community. Impacts on employment and overall wealth are very important, as are changes in a community's identity as a fishing community, and its perspective on the future of fishing-related activities. Three kinds of characteristics determine the degree to which these impacts on operations become effects on the ability of fishing communities to enjoy a sustained participation in the fishery.

1. The first is the existence of alternative activities, both fishing and non-fishing. The more alternatives available to someone who must change their behavior because of a regulation, the better that person is able to deal with the change without relocation. This, in turn, determines whether or not a community is able to maintain the human capital it needs to sustain participation in the fishery when it recovers.

2. The second is economic vulnerability, meaning the amount and sources of pressure that fishing and processing operations in getting the things they need to run their operations and in selling their products. The more vulnerable these operations are, the more difficult it is for them to maintain the economic assets and capital they need to sustain participation in the fishery.

3. The third is community support, meaning the institutions and networks that make it possible for a community to be resilient in the face of stringent regulations and maintain their ability to sustain a fishery. Communities differ in how much social capital, i.e., networks of people able to lend aid, they have available to help sustain people and fishing operations affected by regulations.

In order to assess the social impacts, we present the results of this research following this rationale. The first section summarizes the general impacts expected from the proposed alternatives. The second section examines social impacts for those communities that appear to have substantial dependence on the fisheries.

5.3 FISHING GEAR IMPACTS TO EFH ALTERNATIVES 1, 2, and 9

The focus of this SIA is the set of EFH-related alternatives outlined in draft Amendment 13, particularly alternatives 3 through 8. Alternative 1 is the no action and alternative 2 is the closure of the area east of 69 degrees west, or Georges Bank, which is already closed due to PSP in the clams, and thus is functionally equivalent to the no action. We assume that both of these alternatives will have no immediate social impacts because they involve no specific changes.

The SIA also does not address alternative 9, concerning a shift of some of the ocean quahog TAC to surf clam TAC with the intent of reducing dredging pressure on the deeper, harder bottom typically used for ocean quahog harvesting. That alternative is not well-enough defined at this time to allow assessments of its impacts. Because of the complexity of the surfclam and ocean quahog industry and the importance to it of separate ITQs (individual transferable quotas) for surfclams and ocean quahogs, it is advisable that the details of this alternative be developed by representatives of the industry in concert with fishery managers and other interested parties.

5.4 FISHING GEAR IMPACTS TO EFH ALTERNATIVES 3 THROUGH 8

Alternatives 3-8 in draft Amendment 13 suggest closing some areas to clam dredging, in order to protect essential fish habitat. Two methods were used to develop the SIA.

One is to use geographic expertise and the tools of GIS (Geographic Information Systems), in this case ArcView, to determine which vessels actually caught and landed surfclams or ocean quahogs from particular areas that might be considered for closure, and to relate that information to the port where the clams or quahogs were landed. The year 2000 is used; it is the latest for which complete weighout data were available, and the key variable is the dollar value of the landings, combining both surfclams and ocean quahogs. Figures 54 to 59 show the results for each alternative in terms of the number of trips within the proposed closed area by 10-minute square, creating a rough measure of the intensity and scope of fishing activity in that area in the year 2000. They also can be used to show what percentage of the total value of surfclams and/or ocean quahogs landed in a port came from the 10-minute squares within or overlapping the proposed closed area. (Because of the need to preserve the confidentiality of business information in some ports, the dollar value details are omitted from the charts and generalized in the discussion.)

The significant findings from this method, by chart:

Figure 55: Almost 60% of the ocean quahog landings at New Bedford, MA, in 2000, came from the area designated in Alternative 3, a closure of the waters east of 70 degrees 20" west longitude to hydraulic dredging (not dry dredging, the technique used in Maine). In addition, small amounts of surfclams landed in the Barnstable area of Cape Cod came from that zone in 2000.

Figure 56: The New Jersey and Maryland ports had significant landings in the areas proposed for closure in Alternative 4, at the mouths of major bays and rivers. Thirty-five to 50% of the value of surfclams and/or ocean quahogs landed in Point Pleasant, Wildwood, and Ocean City came from one or more of those areas in 2000.

Figure 57: Although there were trips made by boats from Point Pleasant and Atlantic City in the Hudson Canyon area considered for closure by Alternative 5, they were few and accounted for hardly any of the value of the surfclams and ocean quahogs landed in the two ports.

Figure 58: There were trips made by boats from New Bedford, Point Pleasant and Atlantic City that overlapped with the proposed closed area that includes the Tilefish HAPC; in no case, however, did the landings amount to more than 5% of the total value of landings at a port.

Figure 59: Alternatives 7 and 8 pertain to the Gulf of Maine habitats of ocean quahogs. Alternative 7 would close all Federal waters to dredging. Alternative 8 would close only the waters west of a zone called Zone 1. The Figure shows that in 2000 no vessels clammed in the area designated by Alternative 8, but of course all Maine vessels clammed in the area of Alternative 7.

The second method addresses the question of so what? It uses sociological and anthropological expertise, based on the interviews and other data collected to create the port and community profiles, to project the socio-economic effects of particular alternatives. If, for example, the fishery at a particular port is found to have had a sizeable percentage of its 2000 landings in a particular proposed closed area, what difference is this likely to make to the businesses, families, and communities involved? Answering the question requires examining the impacts on fishing and processing operations and community characteristics, as outlined above.

Following are summary conclusions, organized by the seven-point criteria discussed above, beginning with the impacts of specific alternatives on surfclam and ocean quahog harvest and processing operations.

5.4.1 General Impacts

5.4.1.1 Impacts on volume

Due to the proven mobility of the surfclam and ocean quahog harvesting sector and, to some extent, the processing section, the proposed alternatives do not threaten a substantial reduction in the volume of product or money moving through the fishing operations or the processing industry. Industry members interviewed by and large volunteered that they could move to other grounds. The exception is Alternative Seven, which would prohibit all clam dredging in the EEZ off the State of Maine. This alternative would very significantly curtail the overall volume of landings in Maine. Virtually all of the ocean quahog boats in Maine fish in Federal waters, particularly in the summer months. Alternative 8, closing only the area west of Ocean Quahog Management Zone 1 for the State of Maine, would have no effect because no fishing takes place in those waters, most of which are closed because of Paralytic Shellfish Poisoning (Figure 59).

Alternative 3, closing the waters east of 70' 20" west longitude, could also affect the volume of ocean quahogs and hence money moving through the industry: almost 60% of what was landed in New Bedford in 2000 came from that area (Figure 55). However, based on industry experience, the effect of such a closure is likely to be mitigated by moves to different clamming grounds as well as further expansion abroad (i.e., Iceland). It would also be mitigated by an ongoing trend to move out of ocean quahogging and into surfclamming.

A more subtle but important effect of many of the closed area alternatives, as discussed below, is that if the closures mean that boats must go farther, increasing the steam time, this may lead to a decline in the physical volume of the product. Yield, a critical variable in the industry, is affected by the time between harvesting and processing.

5.4.1.2 Impacts on flexibility

All of the alternatives will have an impact on operational flexibility. Alternatives Three through Eight are all closed area regulations. Based on interviews, it appears that the direct effects of closed areas on the harvesting operations that had used those areas are likely increases in steaming time to the fishing areas and the possible need to relocate vessels to other ports closer to the fishing grounds. Other operations would be affected by the potential increase in the crowding of fishing vessels in the areas that remain open.

Increased steam time – to and from the surfclam and ocean quahog beds – may decrease the quality of the product and reduce its yield. Trucking and storage time, however, has a greater impact on product quality than does steam time. According to industry personnel, this relationship between steaming, trucking and storage time and product volume is much stronger with surfclams than with quahogs. It is also dependent on the water temperature, so it is more of a problem in summer than winter and in the south than the north.

An even more significant problem that closed areas would present to the processors is that it would increase the difficulty of their day-to-day buying decisions, which are both critical and difficult because of the degree to which the product loses volume while in storage. A decision to buy on one day is based on guesses about the availability of the product in the following days, and the more distance vessels are covering the more difficult such judgements become. The relocation of vessels may, in some cases, lead to the loss of employment for crew members. In some ports, experienced and reliable crew are difficult to replace. Crowding is an impact that was mentioned by respondents but there is no way to estimate the actual effect and, outside of Alternative Seven in Maine, the proposed closed areas would lead to minimal increases in crowding.

5.4.1.3 Impacts on safety

Several of the alternatives, particularly Four, which would close some inshore surfclam beds, have the potential of forcing vessels to move farther out to sea or to stay out at sea longer. This increases risks to life and property at sea; it may also increase incentives to overload vessels, a practice which has contributed in the past to major tragedies.

5.4.1.4 Direct costs

The proposed alternatives do not present substantial increases in direct costs, but rather the added operational costs associated with searching for and using new clam beds. For this reason, direct costs are not discussed below in the section on community impacts.

It must be underscored that employees in the processing sector of the industry are almost entirely from minority, low-income populations and thus may be considered particularly vulnerable to any processing plant changes that occur in response to any of the alternatives being considered.

5.4.2 Community Impacts

In the United States there are at least 26 communities that could be potentially affected by the alternatives because surfclams and/or ocean quahogs (SCOQ) are either landed or processed in these communities (Figure 54 and Table 28). (Surfclams and ocean quahogs are processed as part of multi-product food plants in other communities, which are not included in this study, which focuses on specialized processors). Port and community profiles were created for each of these communities, summarizing available census and fisheries data as well as the results of visits and interviews in the fall and winter of 2001. For communities for which there was a primae facie case that these potential effects might rise to the level of a significant social impact we did "key informant interviews" with community leaders, fishers and fish processors (Table 35).

The results of this research are reported in the community profiles (section 2.3.3). In the remainder of this section we describe the potential impacts on particular groups of geographically related and socially similar communities that the research suggests may experience some effects (not necessarily a meaningful social impact) from one or more of the alternatives being considered. For each group we describe the effects of the alternatives in terms of volume, flexibility and safety, and then assess the extent of potential social impacts in terms of alternative activities, economic vulnerability, and community support.

5.4.2.1 Downeast Maine

By far the most significant social impacts suggested by any of these alternatives are the potential impacts of Alternative Seven on the communities of Downeast Maine.

Volume

Alternative Seven would cut off access to all Maine boats to the ocean quahog resource in Federal waters, from which they draw a large majority of their landings, particularly in the summer months. Such a closure would seriously and directly threaten approximately 130 year round jobs both on fishing vessels and in processing plants, as well as a significant number of seasonal jobs. This alternative would also remove from the local economy a significant portion of the $3,300,000 that moves from the ocean quahog resource through the local economy each year, based on figures from the year 2000.

Flexibility

Alternative Seven would deny to the Downeast fishing vessels their most significant ocean quahogging areas and force them to either dredge for ocean quahogs in what would become the much more crowded state waters (if available, given paralytic shellfish poisoning problems) or to give up fishing for "mahoganies" altogether.

Alternative Activities

The most significant unknown factor is how much of the lost ocean quahog fishing could and would be made up for by shifting fishing effort from ocean quahogs in Federal waters to ocean quahogs in state waters and to other fisheries resources. Respondents describe the resource as being mainly found "just over" the thee mile state-Federal jurisdictional boundary. Much of the inshore quahog resource is already unavailable due to paralytic shellfish poisoning. Other fishery resources available to Downeast Maine vessels are already heavily exploited and their catches are limited by management. Some of the "mahogany" fishermen have lobster and other licenses and gear but others have specialized in this fishery.

Economic vulnerability

The approximately 130 year round jobs both on fishing vessels and in processing are more than 10% of the total jobs in agriculture, forestry and fisheries in Washington County, the sector that drives the entire county economy. Hence, the ripple effects of the job and income loss on the rest of the economy would be very important. The Downeast communities fit every available definition of a fishing dependent community. In addition to being among the poorest communities, they are in the most fishing-dependent subregion of New England (Hall-Arber *et al.* 2002), and the cumulative effects of resource decline and Federal fishery regulations have increased their vulnerability to any change in resource availability.

Community Support

Much of the support available is that which is inherent in small fishing communities with strong ties of kinship and friendship, as well as numerous non-government and government organizations that have emerged since the groundfish problems of the 1990s to help fishing families adapt. Nonetheless, the inescapable conclusion is that Alternative Seven would have a very heavy negative social impact on the communities and populations of Downeast Maine.

5.4.2.2 New Bedford, MA

Volume

Alternatives Three and Six would have a detectable effect on New Bedford. In the year 2000, almost 60% of the total value of New Bedford SC/OQ was caught in the proposed closed area in Alternative Three and five percent of the total value of New Bedford SC/OQ was caught in the proposed closed area in Alternative Six (Figures 55 and 58). Respondents at one of the processing plants and one of the ocean quahog fleets indicated that neither alternative would likely have a significant effect on the volume of resource moving through the community because they will be able to fish in other areas. However, added steam time would have a small effect on the quality and physical volume of the product, and hence on revenues.

Flexibility

The main impact of Alternatives Three and Six on New Bedford operations would be that vessels would be more limited in where they could fish, which would lead to added steam time and its attendant problems. Those problems include increased costs (though fuel used while steaming is not a major cost when compared to fuel used for dredging the ocean quahogs and surfclams), crowding, increased trucking and storage time for product, more complex buying decisions, safety worries, and possible relocation of vessels and job losses among crew members. Lost flexibility and increased steam time could also translate into changes in the processing plants, such as shorter or fewer shifts, but it is unlikely that impacts from the proposed alternatives would rise to the level of decreasing the number of processing jobs.

Another possible socio-economic effect of Alternative Three is reduced interest in participating in the ocean quahog fishery versus the surfclam fishery, with financial consequences for the holders of both ocean quahog and surfclam ITQs. It would particularly disadvantage those who are invested solely or primarily in ocean quahog ITQs. In addition, increased competition for surfclam quota may increase the sale or lease price of surfclam ITQs beyond the range of some of the smaller harvesting and processing operations.

Safety

Alternative Three could have a significant impact on safety for the New Bedford fleet if it encourages vessels to overload in order to compensate for declining CPUE due to increased steam time or less productive quahog beds. Safety is a very sensitive issue in the industry, particularly New Bedford, where the largest ocean quahog vessel in the fleet sank in January 1999 with the loss of two men.

Alternative Activities

The small number of crew who might lose their jobs by choosing not to go with a relocating vessel would likely be absorbed by the New Bedford fishing industry. The industry has significantly restructured since the severe decline of groundfish in the 1990s and is recovering slowly, particularly the scallop fishery. New Bedford is also a highly diversified city, adding the possibility of finding other kinds of work.

Economic Vulnerability

Two of the processing plants and several of the vessels in the SC/OQ industry in New Bedford are parts of larger operations found elsewhere in the Mid-Atlantic region. They have their own boats, other plants, direct or indirect ownership of ITQs and good access to surfclams and ocean quahogs. Thus they are not as vulnerable as the individuals and companies located only in New Bedford, especially those with very small allocations of ITQs.

Because of the relatively small impact on both volume and employment, the limits on tax revenues from this industry already in place, and the fact that many employees live outside the community and even the state, the community of New Bedford would not likely experience significant economic impacts from these alternatives.

Community Support

New Bedford has passed through devastating contractions of its fishing industry in the past. Many support systems are – or were until late 2001 – in place for fishing industry employees who have lost their jobs. People in the small number of jobs that these alternatives potentially threaten would have available to them retraining and placement services should these be necessary. Support for fish plant workers may be more difficult to find, although there is a Workers' Rights Board in Rhode Island that is concerned about the many immigrants and refugees working in the region's fish-processing industry (Providence Journal 12/20/2001).

At this point, the conclusion is that no alternatives being considered would have an effect on New Bedford that would rise to the level of a significant social impact on the community but there may be important effects on particular firms and groups of workers, as well as on the safety of crews. Low-income minority populations would be the most affected by any declines in employment opportunities at the clam plants.

5.4.2.3 Other New England ports

Other New England ports, including some in Barnstable County, on the north side of Cape Cod, and Bristol and Warren, Rhode Island, are engaged in the surfclam and ocean quahog fisheries but at a relatively small level, and within communities and regions that have highly diversified economies. With the possible exception of Warren, where a clam business has long been established, there is likely to be no significant social impact of the alternatives in these communities.

5.4.2.4 Point Pleasant, NJ

Alternative Four, closing the nearshore areas around the mouths of major rivers and bays, is the only alternative that would have a meaningful effect on Point Pleasant as a whole. In 2000, 45.5% of the total SC/OQ value landed at this port came from one or more of the proposed closed areas (Figure 56). Although SC/OQ is only part of the diversified fishery of this port, its decline or loss would contribute to the cumulative impact of economic changes in the fishery.

Volume

As with other ports, experience shows that Point Pleasant vessels will be able to shift their fishing to other areas. Therefore the volume of resource moving through the port will be reduced only through the effects of added steam and storage time, unless one or more of the vessels using this port moves to another one more convenient to productive open clamming grounds.

Flexibility

The main impact of Alternative Four on fishing industry operations in Point Pleasant is that many vessels would have to fish further from both the port and from land. This would reduce flexibility because it would lead to added steam time and its attendant problems of increased costs, crowding, increased trucking and storage time for product, and more complex buying decisions. Lost flexibility and increased steam time would also translate into fewer hours for workers in processing, hurting the small plants dependent on supply of surfclams from this port. Maintaining a trained and reliable work force is partly a function of being able to offer regular and consistent work opportunities. Several of the hand-shucking plants are therefore very vulnerable to small changes in supply. If the Point Pleasant plant closes, 40 or more jobs will be lost. The community impact would be dispersed among several shore communities although concentrated in networks of mostly immigrant and refugee labor. Other plants in the region are less dependent on supply from Point Pleasant.

Safety

Alternative Four could have a significant impact on safety, because smaller vessels may be forced to go farther and stay out longer than they now do. Safety is a very sensitive issue in Point Pleasant due to the loss of three clam vessels and nine men working out of this port in a series of storms in January 1999.

Alternative Activities

Point Pleasant is an important fishing port for both the commercial and recreational industries, and in the best case, the possible job loss from Alternative Four could be absorbed by the community. Even though Point Pleasant is the second most important SC/OQ port on the New Jersey coast, SC/OQ fishing and processing are only part of a large suite of fishing activities. However, limited entry and highly restrictive quotas and seasons permitted catches in most other fisheries limits the alternative of moving a surfclam or ocean quahog vessel into another fishery as well as reducing the opportunities for SC/OQ crew to find positions in other fisheries. It should be noted that most of the people who fish and work in the SC/OQ industry at Point Pleasant live in other places, so that the alternatives available in those other places are as relevant to their capacities to adapt to change.

Economic Vulnerability

As a fishing port, Point Pleasant has a high level of vulnerability. Recreational and commercial fishing activities have declined at Point Pleasant and neighboring Brielle , so that as of the late 1990s the surfclam and ocean quahog fisheries as well as a bait fishery for menhaden had become the major species landed, neither traditional to the port. The SC/OQ fisheries maintain a large portion of the waterfront as commercial space; if this were abandoned it would likely be converted to housing or other uses that would create an irreversible loss of opportunities for commercial and recreational fishing businesses in the port.

Community Support

Based on support given for the erection of a Fishermen's Memorial in Point Pleasant in 2000 and reports of assistance from the borough in retaining a working waterfront, there appears to be considerable support for fisheries in Point Pleasant, even though the major emphasis is beach tourism and summer rentals. The Ocean County branch of the Farm Bureau has also been supportive of the fishing industry, and there is a county program of rotating loans for fisheries development.

As noted above, Alternative Four is the only alternative that would have a meaningful effect on Point Pleasant as a whole, and that would be mitigated by the abilities of vessels to find surfclams and ocean quahogs in other places as well as the diversified nature of this port. However, any decline in or loss of vessels or revenue from this port would contribute to the downward cumulative impact of resource decline, fishery management restrictions, and competing land-use values in this community.

5.4.2.5 Southern New Jersey

Southern New Jersey encompasses the ports of Atlantic City, Wildwood, and Cape May and processing plants in those three cities plus processing centers of Port Norris/ Bivalve, Burleigh and Millville. They are closely networked and constitute the heart of the SC/OQ industry, at least in terms of landings and landed value. The area accounted for 53% of the landed value in 2000, by far the bulk of which came from Atlantic City. The New Jersey State fishery for surfclams, not counted in these figures, is also important during the winter months in this region.

The most important alternative being considered for this area is Alternative Four, which would close the area where 19% of the landed value in 2000 was caught (Figure 56). This alternative falls more heavily on Wildwood than other ports in that almost one-half of Wildwood's landed value in 2000 was caught in one or more of the proposed closed areas of Alternative Four. Alternatives Five (Hudson Canyon) and Six (Tilefish HAPC) would also affect the areas where three to four percent of Atlantic City's landed value was caught (Figures 57 and 58).

Volume

Respondents in Southern New Jersey reported that they would be able to shift their fishing to other areas, so the volume of resource moving through the port will be reduced only slightly through the effects of added steam and storage time.

Flexibility

The main impact of Alternative Four on fishing industry operations in Southern New Jersey would be that vessels would have to steam further. This would lead to added steam time and its attendant problems of increased costs, crowding, increased trucking and storage time for product, more complex buying decisions. In addition, crowding on the fishing grounds was a specific concern voiced by Southern New Jersey respondents.

Lost crew and dockside jobs from relocating fishing boats are a possibility for the port communities of South Jersey.

Lost flexibility and increased steam time could also translate into fewer hours for workers in processing, but it is unlikely that impacts from the proposed alternatives would rise to the level of decreasing the number of jobs in processing, given the fact that the processing companies in the area can obtain product from many different ports and harvesters.

Safety

As with Point Pleasant, the impact of Alternative Four on safety is an important consideration, given the historically high risks of loss of vessels and life at sea in the surfclam and ocean quahog fishing industry. Smaller and less seaworthy vessels may be forced to go farther out and stay longer, increasing the risks.

Alternative Activities

In distinct contrast to the other fishing ports being considered, including the other ports in Southern New Jersey, the Atlantic City fishing industry is heavily specialized in the SC/OQ fishery. Any loss of jobs from relocating vessels would likely mean that crew members would have to look elsewhere if they wished to stay in fishing. The few jobs that might be lost in Cape May and Wildwood would likely be absorbed by the active fishing industry in Cape May. Atlantic City also offers employment alternatives in the casino industry. Alternative fishing opportunities are, however, few due to the cumulative effects of resource decline and regulatory limits. Alternative activities in the processing towns of South Jersey are various; Port Norris has few if any alternative alternatives, and the larger Cumberland County area, of both Port Norris and Millville, is one of high unemployment and deep poverty. Burleigh, in Cape May County, is developing as a regional shopping center, creating service industry alternatives.

Economic Vulnerability

Southern New Jersey is experiencing a general decline of commercial fishing in respect to tourist-focused industries. Regulations based on the coastal area's designation as environmental sensitive are placing pressure on the industry by restricting the way coastal lots can be used. The reduction in operational flexibility for the Wildwood fishing enterprises would be one more added pressure, but would have little relative impact at the community level.

Several of the South Jersey communities involved in the SC/OQ industry are marked by high levels of poverty which increases their economic vulnerability. Atlantic City, Port Norris, and Wildwood reported over 25% of the population living in poverty and low per capita incomes in 1989-90 (Table 29). They also are the homes of large numbers of Black Americans and other minorities in 2000 (Table 29). However, linkages between the SC/OQ industry and this economic vulnerability are weak. Most people in the SC/OQ industry, including workers at the processing plants, commute from other places. Virtually none of the employees of SC/OQ firms in Atlantic City and Wildwood live in those towns, according to owners of those firms. The Port Norris plant has had to actively recruit and seek to retain workers, suggesting that a decline in work opportunities would have little effect on the community.

Community Support

Southern New Jersey displays a general pride in its maritime heritage, mainly expressed in business through the tourist industry. Property values are forcing a shift toward the more lucrative recreational uses of the waterfront. Tensions exist between the seafood industry in general, whose operations can be less than picturesque when viewed up close, and the tourism sector. Commercial fishing enjoys support from the local government, particularly from Cape May County, which has a program of low-interest, revolving loans to the commercial fishing industry. Little support is evident for the industry in Atlantic City, although accommodations have been made to lessen conflict between the packing docks and their neighbors. As "gentrification" of Atlantic City's depressed residential neighborhoods around the clam docks increases, these conflicts may be expected to increase.

Problems between the SC/OQ industry and local governments have emerged over the years, particularly over sewage treatment and waste disposal. This is an important factor in the decision of a major clam processor to relocate out of the county. Some of the local communities, at least their officials and leaders, welcome the exodus of the industry, hoping to attract other kinds of businesses instead, particularly tourist enterprises and shopping centers. The bottom line is that the SC/OQ industry in this region seems to enjoy little of the general support given by the communities to the seafood industry.

In conclusion, no alternative being considered would have an effect on Southern New Jersey that would rise to the level of a significant social impact on communities. The port communities are already heavily dependent on tourism, casino gambling, and other non-fishing activities, although fishing remains a major year-round source of employment in certain places, particularly Cape May. The inland processing communities are also diversified, although generally poor, and some of them are developing more as commercial than manufacturing centers.

Although no alternative would have a significant social impact on communities, some would have a discernable effect on the companies involved as well as their employees. Alternative Four, in particular, would have significant impacts on some firms in the industry, especially those with smaller surfclam vessels or plants dependent on those vessels, because the closure of important inshore clam beds would impose operational costs, increased risks, and other hardships. Employees in the processing sector of the industry are almost entirely from minority, low-income populations and thus may be considered particularly vulnerable to any processing plant changes that occur.

5.4.2.6 Milford, DE

An important clam processing plant in Milford DE will feel some effect from Alternatives Three, Four, Five and Six through possible increased trucking and storage time, as well as slightly increased complexity of purchasing decisions.

Volume

No alternative will have a meaningful impact on the volume of SC/OQ available to the Milford plant because of the diverse and changing sources of its raw product.

Flexibility

The plant may experience increased trucking and storage time for product and more complex buying decisions. This could translate into fewer hours for working, but it is unlikely that impacts from the proposed alternatives would rise to the level of decreasing the number of jobs.

Alternative Activities

Like most other SC/OQ plants, the Milford plant employs a low income and immigrant population. Alternatives include the poultry-processing businesses in the area, which compete with the clam plant for semi-skilled labor.

Economic Vulnerability

This plant is part of a coast-wide operation with a strong supply chain and market, which reduces its vulnerability. The local community of Milford, a semi-rural small town, has a sizeable minority population, and its poverty rate was almost 12% in the 1990 census, close to the county level (Tables 28 and 29). The larger area is somewhat diversified, with agricultural, food -processing, and service industries.

Community Support

The processing plant itself is strongly supported by the local community. The plant workers who would be vulnerable to a reduction in hours, however, are a fairly transient population who could not expect active community support in the event of a reduction in hours.

No alternatives being considered would have an effect on Milford , DE that would rise to the level of a significant social impact on the community because of the diversification of the company that owns this plant and the diversified nature of the semi-rural economy of the town. However, employees in the processing sector of the industry are almost entirely from minority, low-income populations and thus may be considered particularly vulnerable to any processing plant changes that occur.

5.4.2.7 Maryland

Alternative Four would close the areas that were the source of about one-third of the value of the landings in Ocean City MD in 2000. (The actual port is West Ocean City.) Many of those landings go to a plant in Virginia for processing, which is also vulnerable to changes in supply due to closures. Alternatives Three, Four, Five and Six may affect the processing plants in Easton, Pokomoke City and Nanticoke through effects on their suppliers in Maryland and New Jersey.

Volume

As with other ports, Ocean City vessels should be able to shift their fishing to other areas, so the volume of resource moving through the port will be reduced only through the effects of added steam and storage time. The processing plant in Pokomoke City is one of the smaller plants that does not have control over ITQs; consequently, alternatives Three, Four, Five or Six could make it more difficult for it to get enough clams to process profitably. The plants in Easton and Nanticoke are parts of much larger firms in the industry and thus should not experience significant effects from any one of the Alternative closures, except as noted through changes in yield due to changes in steam time and transportation time.

Flexibility

The main impact of Alternative Four on fishing industry operations in Ocean City would be that vessels would have to fish further from both the port and from land. This would lead to added steam time and its attendant problems of increased costs, crowding, increased trucking and storage time for product, more complex buying decisions. Lost flexibility and increased steam time would also translate into fewer hours for workers in processing, but it is unlikely that impacts from the proposed alternatives would rise to the level of decreasing the number of jobs.

Safety

Alternative Four's impact on safety would be greater than that simply derived from increased steam time because it is specifically the more inshore areas that are being closed.

Alternative Activities

Ocean City is a diversified small fishing port for both the commercial and recreational industries. The low level of possible job loss from Alternative Four could be absorbed by the community. The processing plants in Easton, Pokomoke City and Nanticoke are all important employers in rural areas with few alternative sources of income. Many of their employees are local people who had worked in the area in industries that have shut down. The region's chicken-processing industries have provided alternatives for some workers.

Economic Vulnerability

Ocean City is an important tourist destination with a seasonal economy. The SC/OQ industry provides employment year round, and its part of a diversified commercial and recreational fishing community. This industry has declined dramatically in the port, as vessels have moved to New Jersey ports during the past decade. In addition, the commercial fishing industry is vulnerable because of major pressures to convert waterfront and other lands to other uses.

All of the Maryland communities have been subject to high fluctuations in employment. The processing plants are very important to the general economic well being of the communities in which they are located, being among the few sources of relatively steady semi-skilled employment. The processing plant in Pokomoke City is one of those already facing considerable difficulty finding sources of supply because it is competing with other processors who have their own ITQS. Because their source of supply runs along the entire coast, Alternatives Three, Four, Five or Six would make this situation more difficult. Because plants like this are already in a difficult situation, any increased pressure on their supply chain could have a very heavy effect.

Community Support

Ocean City has a highly developed recreational and commercial fishing industry in which the SC/OQ industry plays a part. The community would be able to handle any slight effect from Alternative Four, but recent conflicts over land-use suggest that there is little local support for commercial fisheries (McCay and Cieri 2000). In other places, the processing plants enjoy considerable community support. These poorer semi-rural communities, however, would be very stretched in their ability to provide meaningful support, such as retraining and job placement, to a large number of residents should a processing plant shut down.

In conclusion, Alternatives Three, Four, Five and Six have the potential to have a considerable social impact on the processing communities in Maryland. Certain of the processing plants are already very vulnerable to fluctuations in supply of their product because of a lack of ITQS. The communities themselves are heavily dependent on the plants. The magnitude of the threat from any of the alternatives to the ability of these plants to maintain supply cannot be assessed because of the complexity of the coast-wide supply chain, but it is certainly real. Employees in the processing sector of the industry are almost entirely from minority, low-income populations and thus may be considered particularly vulnerable to any processing plant changes that occur.

5.4.2.8 Virginia

No Virginia ports are landing surfclams or ocean quahogs at this time. Oyster (near Cape Charles) and Chincoteaque were once SC/OQ ports, and waterfront property is still owned by industry firms in Oyster, but with a general shift of harvesting effort to the north and consolidation in the industry, all landings in these ports have ended. However, two major processing firms are located in Virginia, one in the urban area of Norfolk at the southern edge of the state, and in the small rural town of Mappsville on the Delmarva peninsula. The plant in Norfolk has a large labor force within a large, diversified, and generally poor metropolitan area. Effects of various alternatives cannot be discerned because researchers were unable to arrange a visit with the plant and its managers. The plant in Mappsville is also very large and important within the context of the poor, mostly rural region of Virginia in which it is found. In both cases, decreases in supply or yield of surfclams or ocean quahogs due to changes in allowable fishing areas may be expected to affect plant management and possibly reduce shifts or hours for workers. The effect on the Mappsville area is likely to be greater because of the lack of alternatives besides poultry processing in the area. In addition, many of the workers and managers once worked at the Oyster, VA, site of the plant and now commute 50 miles to work at this plant because of the lack of alternatives.

5.5 OVERFISHING DEFINITION FOR SURFCLAMS

The overfishing definition proposed does not change the range of the optimum yield (OY) for surfclams and thus would not in and of itself lead to a change in the annual TAC. Social and economic impacts come about through changes in the TAC; any such changes that are made under Amendment 13 come about for reasons other than the overfishing definition. Consequently, there is no social impact of the proposed overfishing definition for surfclams, although there is considerable difference within the industry about the effects of changes in the TAC.

5.6 MULTI-YEAR QUOTAS

Alternative 1. No action. No discernable social impact.

Alternative 2. Multi-year quotas set after each survey and stock assessment with minor annual review.
According to industry members interviewed during the social impact assessment, multi-year quotas are acceptable as long as there is the opportunity to make changes in response to unforeseen circumstances affecting the resource and the economic system. Consequently, there is no discernable negative social impact.

Alternative 3. Multi-year quotas set after each survey and stock assessment with no annual review. The possible social impact from alternative 3 is increased vulnerability to changes in the status of the resource or the markets. The lack of annual review reduces the flexibility of the management system which in turn increases the vulnerability of the fishing firms, workers, and fishery-dependent communities.

5.7 REVERSAL OF REQUIREMENT OF REGULATORY ACTION TO SUSPEND SURFCLAM SIZE LIMIT

Alternative 1. No action. No discernable social impact.

Alternative 2. Change the plan so that regulatory action is required to impose a surfclam size limit rather than to suspend the surfclam size limit. There is a slight positive social impact in the likely reduction in the time and effort required on the part of the fishing industry and managers to handle the required regulatory action. Industry members interviewed as part of the social impact assessment agreed that this is a logical and sensible change.

5.8 VESSEL MONITORING SYSTEM

Alternative 1. No action: continue the call-in system. Most industry members agree that the current call-in system imposes a burden on the industry as well as the enforcement agency. It is not clear what the social impact is of this burden beyond the lost opportunity to develop trust and cooperation because of communication difficulties experienced with the call-in system.

Alternative 2. Mandatory VMS system replacing the call-in system. Some industry members are concerned about the economic costs of acquiring and operating VMS and would prefer the no action. Industry members report that the majority prefer the VMS system, despite those costs. There is no further information available to estimate the social impacts of a mandatory VMS system.

Alternative 3. Voluntary VMS system with alternative of call-in system. Some industry members are concerned about the economic costs of acquiring and operating VMS and would prefer the no action. Industry members report that the majority prefer the VMS system, despite those costs. There is no further information available to estimate the social impacts of an operational VMS system.

6.0 OTHER APPLICABLE LAWS

6.1 RELATION OF RECOMMENDED MEASURES TO EXISTING APPLICABLE LAWS AND POLICIES

6.1.1 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.

6.1.2 Treaties or International Agreements

No treaties or international agreements, other than GIFAs entered into pursuant to the MSFCMA, relate to this fishery.

6.1.3 Federal Law and Policies

6.1.3.1 Marine mammals and endangered species

Numerous species of marine mammals and sea turtles occur in the northwest Atlantic Ocean. The most 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 1,000 fathom isobath.

Four hundred and seventy one large whale sightings, 1547 small whale sightings and 1172 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 (Table 36).

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.

There are numerous species which inhabit the management unit of this FMP that are afforded protection under the Endangered Species Act (ESA) of 1973 (i.e., for those designated as threatened or endangered) and/or the Marine Mammal Protection Act of 1972 (MMPA). Eleven are classified as endangered or threatened under the ESA, while the remainder are protected by the provisions of the MMPA. Marine mammals include the northern right whale, humpback whale, fin whale, minke whale, harbor porpoise, white-sided dolphin, bottlenose dolphin, common dolphin, harp seal, harbor seal and gray seal. The status of these and other marine mammal populations inhabiting the Northwest Atlantic has been discussed in detail in the U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments. Initial assessments were presented in Blaylock *et al.* (1995) and are updated in Waring *et al.* (1999). The most recent information on the stock assessment of various mammals can be found at: *www.nmfs.noaa.gov/prot_res/PR2/Stock_Assessment_program/sars.html.*

This amendment only addresses a new surfclam overfishing definition and alternatives for managing adverse effects of clam dredging which were the two disapproved sections of Amendment 12. There are three other management measures that are being considered for public hearings, but there are no preferred alternatives for these three measures and it is likely that some of the three will not be included in the final submittal. The only gear used for the surfclam and ocean quahog fisheries is clam dredges which are no included in the final List of Fisheries for 2000 for the taking of marine mammals by commercial fishing operations under Section 114 of the Marine Mammal Protection Act (MMPA) of 1972. In addition, the proposed actions will not increase fishing effort. As such, minimal interaction is expected between clam dredging gear and protected species.

The protected species found in New England and Mid-Atlantic waters are listed below.

Endangered: Right whale *(Eubalaena glacialis),* Humpback whale *(Megaptera novaeangliae),* Fin whale *(Balaenoptera physalus),* Sperm whale *(Physeter macrocephalus),* Blue whale *(Balaenoptera musculus),* Sei whale *(Balaenoptera borealis),* Kemp's ridley *(Lepidochelys kempi),* Leatherback turtle *(Dermochelys coriacea),* Green sea turtle *(Chelonia mydas),* Shortnose sturgeon *(Acipenser brevirostrum),* and the Gulf of Maine distinct population segment (DPS) of Atlantic salmon .

Threatened: Loggerhead turtle *(Caretta caretta)*

Other marine mammals: Other species of marine mammals likely to occur in the management unit include; harbor porpoise: *(Phocoena phocoena),* minke whale *(Balaenoptera acutorostrata),* white-sided dolphin *(Lagenorhynchus acutus),* white-beaked dolphin *(Lagenorhynchus albirostris),* bottlenose dolphin *(Tursiops truncatus),* [coastal stock listed as depleted under the MMPA], pilot whale *(Globicephala melaena),* Risso's dolphin *(Grampus griseus),* common dolphin *(Dephinis delphis),* spotted dolphin (Stenella spp.), striped dolphin *(Stenella* *coeruleoalba),* killer whale *(Orcinus orca),* beluga whale *(Delphinapterus leucas),* Northern bottlenose whale *(Hyperoodon ampullatus),* goosebeaked whale *(Ziphius cavirostris)* and beaked whale (Mesoplodon spp.). Pinnipeds species include harbor *(Phoca vitulina)* and gray seals *(Halichoerus grypus)* and less commonly, hooded *(Cystophora cristata)* harp *(Pagophilus groenlandicus)* and ringed seals *(Phoca hispida).*

Two other useful websites on marine mammals are:
www.nmfs.noaa.gov/prot_res/PR3/recovery.html and http://spo.nwr.noaa.gov/mfr611/mfr611.htm.

6.1.3.1.1 Protected Species of Particular Concern

6.1.3.1.1.1 North Atlantic right whale

The northern right whale was listed as endangered throughout it's range on June 2, 1970 under the ESA. The current population is considered to be at a low level and the species remains designated as endangered (Waring *et al.* 1999). A Recovery plan has been published and is in effect (NMFS 1991). This is a strategic stock because the average annual fishery-related mortality and serious injury from all fisheries exceeds the Potential Biological Removal (PBR).

North Atlantic right whales range from wintering and calving grounds in coastal waters of the southeastern US to summer feeding grounds, nursery and presumed mating grounds in New England, the Bay of Fundy and Scotian shelf (Waring *et al.* 1999). Approximately half of the species' geographic range is within the area in which these fisheries are prosecuted. In the management area as a whole, right whales are present throughout most months of the year, but are most abundant between February and June. The species uses mid-Atlantic waters as a migratory pathway from the winter calving grounds off the coast of Florida to spring and summer nursery/feeding areas in the Gulf of Maine.

NMFS designated right whale critical habitat on June 3, 1994 (59 FR 28793). Portions of the critical habitat within the action area include the waters of Cape Cod Bay and the Great South Channel off the coast of Massachusetts, where the species is concentrated at different times of the year.

The western North Atlantic population of right whales was estimated to be 295 individuals in 1992 (Waring *et al.* 1999). The current population growth rate of 2.5% as reported by Knowlton *et al.* (1994) suggests the stock may be showing signs of slow recovery. However, considerable uncertainty exists about the true size of the current stock (Waring *et al.* 1999).

6.1.3.1.1.2 Humpback whale

The humpback whale was listed as endangered throughout it's range on June 2, 1970. This species is the fourth most numerically depleted large cetacean worldwide. In the western North Atlantic humpback whales feed during the spring through fall over a range which includes the eastern coast of the US (including the Gulf of Maine) northward to include waters adjacent to

Newfoundland/Labrador and western Greenland (Waring *et al.* 1999). During the winter, the principal range for the North Atlantic population is around the Greater and Lesser Antilles in the Caribbean (Waring *et al.* 1999).

About half of the species' geographic range is within the management area of surfclams and ocean quahogs. As noted above, humpback whales feed in the northwestern Atlantic during the summer months and migrate to calving and mating areas in the Caribbean. Five separate feeding areas are utilized in northern waters after their return; the Gulf of Maine (which is within the management unit of this FMP) is one of those feeding areas. As with right whales, humpback whales also use the Mid-Atlantic as a migratory pathway. Since 1989, observations of juvenile humpbacks in that area have been increasing during the winter months, peaking January through March (Swingle *et al.* 1993). It is believed that non-reproductive animals may be establishing a winter feeding area in the Mid-Atlantic since they are not participating in reproductive behavior in the Caribbean. It is assumed that humpbacks are more widely distributed in the management area than right whales. They feed on a number of species of small schooling fishes, including sand lance and Atlantic herring.

The most recent status and trends for the Western North Atlantic stock of humpback whales are given by Waring *et al.* (1999). The current rate of increase of the North Atlantic humpback whale population has been estimated at 9.0% (CV=0.25) by Katona and Beard (1990) and at 6.5% by Barlow and Clapham (1997). The minimum population estimate for the North Atlantic humpback whale population is 10,019 animals, and the best estimate of abundance is 10,600 animals (CV=0.07; Waring *et al.* 1999).

6.1.3.1.1.3 Fin whale

The fin whale was listed as endangered throughout it's range on June 2, 1970 under the ESA. The fin whale is ubiquitous in the North Atlantic and occurs from the Gulf of Mexico and Mediterranean Sea northward to the edges of the arctic ice pack (Waring *et al.*1999). The overall pattern of fin whale movement is complex, consisting of a less obvious north-south pattern of migration than that of right and humpback whales. However, based on acoustic recordings from hydrophone arrays, Clark (1995) reported a general southward "flow pattern" of fin whales in the fall from the Labrador/Newfoundland region, south past Bermuda, and into the West Indies. The overall distribution may be based on prey availability, and fin whales are found throughout the management area for this FMP in most months of the year. This species preys opportunistically on both invertebrates and fish (Watkins *et al.* 1984). As with humpback whales, they feed by filtering large volumes of water for the associated prey. Fin whales are larger and faster than humpback and right whales and are less concentrated in nearshore environments.

Hain *et al.* (1992) estimated that about 5,000 fin whales inhabit the northeastern United States continental shelf waters. Shipboard surveys of the northern Gulf of Maine and lower Bay of Fundy targeting harbor porpoise for abundance estimation provided an imprecise estimate of 2,700 (CV=0.59) fin whales (Waring *et al.* 1999).

6.1.3.1.1.4 Loggerhead sea turtle

The loggerhead turtle was listed as "threatened" under the ESA on July 28, 1978, but is considered endangered by the World Conservation Union (IUCN) and under the Convention on International Trade in Endangered Species of Flora and Fauna (CITES). Loggerhead sea turtles are found in a wide range of habitats throughout the temperate and tropical regions of the Atlantic. These include open ocean, continental shelves, bays, lagoons, and estuaries (NMFS& FWS 1995). In the management unit of this FMP they are most common on the open ocean in the northern Gulf of Maine, particularly where associated with warmer water fronts formed from the Gulf Stream. The species is also found in entrances to bays and sounds and within bays and estuaries, particularly in the Mid-Atlantic.

Since they are limited by water temperatures, sea turtles do not usually appear on the summer foraging grounds in the Gulf of Maine until June, but are found in Virginia as early as April. They remain in these areas until as late as November and December in some cases, but the large majority leave the Gulf of Maine by mid-September. Loggerheads are primarily benthic feeders, opportunistically foraging on crustaceans and mollusks (NMFS & FWS 1995). Under certain conditions they also feed on finfish, particularly if they are easy to catch *(e.g.,* caught in gillnets or inside pound nets where the fish are accessible to turtles).

A Turtle Expert Working Group (TEWG 1998) conducting an assessment of the status of the loggerhead sea turtle population in the Western North Atlantic (WNA), concluded that there are at least four loggerhead subpopulations separated at the nesting beach in the WNA (TEWG 1998). However, the group concluded that additional research is necessary to fully address the stock definition question. The four nesting subpopulations include the following areas: northern North Carolina to northeast Florida, south Florida, the Florida Panhandle, and the Yucatan Peninsula. Genetic evidence indicates that loggerheads from Chesapeake Bay southward to Georgia appear nearly equally divided in origin between South Florida and northern subpopulations. Additional research is needed to determine the origin of turtles found north of the Chesapeake Bay.

The TEWG analysis also indicated the northern subpopulation of loggerheads may be experiencing a significant decline (2.5% - 3.2% for various beaches). A recovery goal of 12,800 nests has been assumed for the Northern Subpopulation, but current nests number around 6,200 (TEWG 1998). Since the number of nests have declined in the 1980's, the TEWG concluded that it is unlikely that this subpopulation will reach this goal given this apparent decline and the lack of information on the subpopulation from which loggerheads in the WNA originate. Continued efforts to reduce the adverse effects of fishing and other human-induced mortality on this population are necessary.

The recent 5-year ESA sea turtle status review (NMFS & USFWS 1995) highlights the difficulty of assessing sea turtle population sizes and trends. Most long-term data comes from nesting beaches, many of which occur extensively in areas outside U.S. waters. Because of this lack of information, the TEWG was unable to determine acceptable levels of mortality. This status review supports the conclusion of the TEWG that the northern subpopulation may be experiencing a decline and that inadequate information is available to assess whether its status has changed since the initial listing as threatened in 1978. NMFS & USFWS (1995) concluded that loggerhead turtles should remain designated threatened but noted that additional research will be necessary before the next status review can be conducted.

Sea sampling data from the sink gillnet fisheries, Northeast otter trawl fishery, and Southeast shrimp and summer flounder bottom trawl fisheries indicate incidental takes of loggerhead turtles. Loggerheads are also known to interact with the lobster pot fishery. The degree of interaction between loggerheads and the summer flounder, scup, and black sea bass recreational fisheries is unknown. However, by analogy with other fisheries (i.e., South Atlantic) interactions are expected to be minimal.

6.1.3.1.1.5 Leatherback sea turtle

The leatherback is the largest living sea turtle and ranges farther than any other sea turtle species, exhibiting broad thermal tolerances (NMFS& USFWS 1995). Leatherback turtles feed primarily on cnidarians (medusae, siphonophores) and tunicates (salps, pyrosomas) and are often found with jellyfish. These turtles are found throughout the management unit of this FMP. While they are predominantly pelagic, they occur annually in Cape Cod Bay and Narragansett Bay primarily during the fall. Leatherback turtles appear to be the most susceptible to entanglement in lobster gear and longline gear compared to other sea turtles commonly found in the management unit. This may be the result of attraction to gelatinous organisms and algae that collect on buoys and buoy lines at or near the surface.

Nest counts are the only reliable population information available for leatherback turtles. Recent declines have been seen in the number of leatherbacks nesting worldwide (NMFS & USFWS 1995). The status review notes that it is unclear whether this observation is due to natural fluctuations or whether the population is at serious risk. It is unknown whether leatherback populations are stable, increasing, or declining, but it is certain that some nesting populations (e.g, St. John and St. Thomas, U.S. Virgin Islands) have been extirpated (NMFS 1998).

Sea sampling data from the southeast shrimp fishery indicate recorded takes of leatherback turtles. As noted above, leatherbacks are also known to interact with the lobster pot fishery. However, by analogy with other fisheries (i.e., South Atlantic) interactions are expected to be minimal.

6.1.3.1.1.6 Kemp's ridley sea turtle

The Kemp's ridley is probably the most endangered of the world's sea turtle species. The only major nesting site for ridleys is a single stretch of beach near Rancho Nuevo, Tamaulipas, Mexico (Carr 1963). Estimates of the adult population reached a low of 1,050 in 1985, but increased to 3,000 individuals in 1997. First-time nesting adults have increased from 6% to 28% from 1981 to 1989, and from 23% to 41% from 1990 to 1994, indicating that the ridley population may be in the early stages of growth (TEWG 1998).

Juvenile Kemp's ridleys inhabit northeastern US coastal waters where they forage and grow in shallow coastal during the summer months. Juvenile ridleys migrate southward with autumnal cooling and are found predominantly in shallow coastal embayments along the Gulf Coast during the late fall and winter months.

Ridleys found in mid-Atlantic waters are primarily post-pelagic juveniles averaging 40 cm in carapace length, and weighing less than 20 kg (NMFS 1998). After loggerheads, they are the second most abundant sea turtle in Virginia and Maryland waters, arriving during May and June and then emigrating to more southerly waters from September to November (NMFS 1998). In the Chesapeake Bay, ridleys frequently forage in shallow embayments, particularly in areas supporting submerged aquatic vegetation (Lutcavage and Musick 1985; NMFS 1998). The juvenile population in Chesapeake Bay is estimated to be 211 to 1,083 turtles (NMFS 1998).

The model presented by Crouse *et al.* (1987) illustrates the importance of subadults to the stability of loggerhead populations and may have important implications for Kemp's ridleys. The vast majority of ridleys identified along the Atlantic Coast have been juveniles and subadults. Sources of mortality in this area include incidental takes in fishing gear, pollution and marine habitat degradation, and other man-induced and natural causes. Loss of individuals in the Atlantic, therefore, may impede recovery of the Kemp's ridley sea turtle population.

Sea sampling data from the northeast otter trawl fishery and southeast shrimp and summer flounder bottom trawl fisheries have recorded takes of Kemp's ridley turtles. However, by analogy with other fisheries (i.e., South Atlantic) interactions are expected to be minimal.

6.1.3.1.1.7 Green sea turtle

Green sea turtles are more tropical in distribution than loggerheads, and are generally found in waters between the northern and southern 20°C isotherms (NMFS 1998). In the western Atlantic region, the summer developmental habitat encompasses estuarine and coastal waters as far north as Long Island Sound, Chesapeake Bay, and the North Carolina sounds, and south throughout the tropics (NMFS 1998). Most of the individuals reported in U.S. waters are immature (NMFS 1998). Green sea turtles found north of Florida during the summer must return to southern waters in autumn or risk the adverse effects of cold temperatures.

There is evidence that green turtle nesting has been on the increase during the past decade. For example, increased nesting has been observed along the Atlantic coast of Florida on beaches where only loggerhead nesting was observed in the past (NMFS 1998). Recent population estimates for the western Atlantic area are not available. Green sea turtles are threatened by incidental captures in fisheries, pollution and marine habitat degradation, destruction/disturbance of nesting beaches, and other sources of man-induced and natural mortality.

Juvenile green sea turtles occupy pelagic habitats after leaving the nesting beach. At approximately 20 to 25 cm carapace length, juveniles leave pelagic habitats, and enter benthic foraging areas, shifting to a chiefly herbivorous diet (NMFS 1998). Post-pelagic green turtles feed primarily on sea grasses and benthic algae, but also consume jellyfish, salps, and sponges. Known feeding habitats along U.S. coasts of the western Atlantic include shallow lagoons and embayments in Florida, and similar shallow inshore areas elsewhere (NMFS 1998).

Sea sampling data from the scallop dredge fishery and southeast shrimp and summer flounder bottom trawl fisheries have recorded incidental takes of green sea turtles. However, by analogy with other fisheries (i.e., South Atlantic) interactions are expected to be minimal.

Websites that provide the most up to date information on sea turtles include: www.nmfs.noaa.gov/prot_res/overview/publicat.html for the Marine Turtle Expert Working Group (TEWG), www.nmfs.noaa.gov/prot_res/PR3/status_reviews.html for stock assessments and www.nmfs.noaa.gov/prot_res/PR3/recovery.html for the various turtle recovery plans.

6.1.3.1.1.8 Shortnose sturgeon

Shortnose sturgeon occur in large rivers along the western Atlantic coast from the St. Johns River, Florida (possibly extirpated from this system), to the Saint John River in New Brunswick, Canada. The species is anadromous in the southern portion of its range *(i.e.,* south of Chesapeake Bay), while northern populations are amphidromous (NMFS 1998). Population sizes vary across the species' range with the smallest populations occurring in the Cape Fear and Merrimack Rivers and the largest populations in the Saint John and Hudson Rivers (Dadswell 1979; NMFS 1998).

Shortnose sturgeon are benthic and mainly inhabit the deep channel sections of large rivers. They feed on a variety of benthic and epibenthic invertebrates including molluscs, crustaceans (arnphipods, chironomids, isopods), and oligochaete worms (Vladykov and Greeley 1963; Dadswell 1979). Shortnose sturgeon are long-lived (30 years) and mature at relatively old ages. In northern areas, males reach maturity at 5-10 years, while females reach sexual maturity between 7 and 13 years.

In the northern part of their range, shortnose sturgeon exhibit three distinct movement patterns that are associated with spawning, feeding, and overwintering periods. In spring, as water temperatures rise above 8° C, pre-spawning shortnose sturgeon move from overwintering grounds to spawning areas. Spawning occurs from mid/late April to mid/late May. Post-spawned sturgeon migrate downstream to feed throughout the summer.

As water temperatures decline below 8° C again in the fall, shortnose sturgeon move to overwintering concentration areas and exhibit little movement until water temperatures rise again in spring (NMFS 1998). Young-of-the-year shortnose sturgeon are believed to move downstream after hatching (NMFS 1998) but remain within freshwater habitats. Older juveniles tend to move downstream in fall and winter as water temperatures decline and the salt wedge recedes. Juveniles move upstream in spring and feed mostly in freshwater reaches during summer.

Shortnose sturgeon spawn in freshwater sections of rivers, typically below the first impassable barrier on the river *(e.g.,* dam). Spawning occurs over channel habitats containing gravel, rubble, or rock-cobble substrates (NMFS 1998). Additional environmental conditions associated with spawning activity include decreasing river discharge following the peak spring freshet, water temperatures ranging from 50 to 55 F, and bottom water velocities of 1.5 to 2.5 feet/sec (NMFS 1998).

The recovery plan for shortnose sturgeon is at: www.nmfs.noaa.gov/prot_res/PR3/recovery.html.

6.1.3.1.1.9 Atlantic Salmon

The last two decades mark a period of decline in stock status for all Atlantic salmon populations of the north Atlantic. In response to a petition request to list Atlantic salmon as endangered under the Endangered Species Act, the NMFS and F&WS conducted a status review of salmon populations in New England and developed a proposed rule to list several stocks in eastern Maine as threatened under the Act. Subsequently, the State of Maine developed a conservation plan to meet the goals of the proposed rule. The services withdrew the proposed rule and worked with the State of Maine to implement the conservation plan in lieu of a listing action. Despite these efforts, populations remain critically low, and with documentation of new disease threats the Gulf of Maine Distinct Population Segment has since been listed as endangered. Current management efforts focus on the recovery of natural populations and support of sustainable aquaculture to manage the population as sustainable resources.

The status review of Atlantic salmon can be found at the website: www.nmfs.noaa.gov/prot_res/PR3/status_reviews.html.

6.1.3.1.1.10 Seabirds

Most of the following information about seabirds 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. Nine species of gulls breed in eastern North America and occur in shelf waters off the northeastern US. 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.). In addition, the bald eagle is listed as threatened under the ESA and is a bird of aquatic ecosystems.

Like marine mammals, seabirds are vulnerable to entanglement in commercial and recreational fishing gear. The interaction has not been quantified in any recreational fishery, but impacts are not considered significant. Human activities such as coastal development, habitat degradation and destruction, and the presence of organochlorine contaminants are considered the major threats to some seabird populations. Endangered, threatened or otherwise protected bird species, including the roseate tern and piping plover, are unlikely to be impacted by the clam dredge gear.

There are currently no Federally threatened or endangered species critical habitat or species protected area sites in the mid Atlantic (Figure 60). Note though that there are two critical habitats in New England for Right whales. New England also has numerous closed areas for management of their multispecies (Figure 61).

The range of surfclams, ocean quahogs, and the above marine mammals and endangered species overlap to a large degree, and there always exists some very limited potential for an incidental kill. Except in unique situations (e.g., tuna-porpoise in the central Pacific), such accidental catches should have a negligible impact on marine mammal/endangered species abundances. The Council does not believe that implementation of this amendment will have any adverse impact upon these populations. While marine mammals and endangered species may occur near surfclam and ocean quahogs beds, it is highly unlikely any significant conflict between the fishermen managed by this FMP and these species would occur. Clam vessels dredge at very slow speeds and healthy animals should have no difficulty avoiding these vessels. Additionally, surfclams and ocean quahogs are benthic organisms, while marine mammals and marine turtles are mostly pelagic and spend nearly all of their time up in the water column or near the surface as do, of course, seabirds.

6.1.3.2 Marine sanctuaries

National marine sanctuaries are allowed to be established under the National Marine Sanctuaries Act of 1973. Currently there are 14 designated marine sanctuaries (Figure 62). The national marine sanctuaries create a system that protects over 14,000 square miles (National Marine Sanctuary Program 1993).

There are two 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. 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.

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. On 4 November 1992, the Sanctuary was Congressionally designated. Implementing regulations (15 CFR 940) became effective March 1994. Commercial fishing is not specifically regulated on Stellwagen Bank. The regulations do however call for consultation between Federal agencies and the Secretary on proposed actions in Sanctuary that "may affect" sanctuary resources. The process for consultation is currently 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.

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.

6.1.3.3 Indian treaty fishing rights

No Indian treaty fishing rights are known to exist in the fishery.

6.1.3.4 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.

6.1.3.5 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 business, state and local governments, and other persons as well as to maximize the usefulness of information collected by the Federal government.

The Council proposes, through this amendment, to reduce paperwork for the government and industry through the multi-year quota measures, reversal of the regulatory requirement to suspend the minimum surfclam size limit and through elimination of the vessel call-in system. Section 4.10 of this amendment details the cost savings for the fishermen and government. There will be some PRA requirements in the future if the Council decides to recommend to NMFS a VMS/electronic reporting system.

6.1.3.6 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.

6.1.4 State, Local, and Other Applicable Law and Policies

6.1.4.1 State management activities

No reason to change this section at this time.

6.1.4.2 Impact of Federal regulations on state management activities

No reason to change this section at this time.

6.1.4.3 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 amendment 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, and North Carolina. Letters will be sent to all of the states listed along with the amendment. The letters to all of the states will state that the Council concluded that the amendment 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. It should be reemphasized that management of these two species occurs in the EEZ only, except for the small zone off of the coast of Maine.

7.0 COUNCIL REVIEW AND MONITORING OF THE FMP

No reason to change this section at this time.

8.0 LIST OF PREPARERS

The majority of this amendment was prepared by Dr. Thomas B. Hoff of the Mid-Atlantic staff. Clayton E. Heaton of Council staff worked extensively with the logbook data and drafted sections of the fishery description. The economic analyses in section 4 was conducted by Drs. James Kirkley (VIMS), Rob Hicks (VIMS) and Ivar Strand (University of Maryland) under contract to the Council. The social analyses (section 5) and port and community description (section 2.3.3) were conducted by a team of researchers from Rutgers University headed by Dr. Bonnie McCay under contract to the Council. The members of Dr. McCay's social team were: Doug Wilson, Teresa Johnson, Kevin St. Martin, Johnelle Lamarque, Eleanor Bochenek, and Giovani Graziosi. In addition NEFSC scientific personnel, Drs. James Wienberg, Paul Rago, Larry Jacobson, and Steve Murawski have worked extensively on the last four new stock assessments (two each on surfclams and ocean quahogs). Lou Chiarella, NERO, provided extensive help on the fishing gear impact section. Sue Murphy, NERO and Dr. Wienberg, NEFSC, represented NMFS along with Dr. Hoff (Council) on the Plan Development Team (PDT).

9.0 AGENCIES AND ORGANIZATIONS

In preparing the amendment, the Council consulted with the NMFS, the New England Fishery Management Council, the Fish and Wildlife Service, the Department of State, and the states of New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and North Carolina through their membership on the Council and the following committees - MAFMC Surfclam and Ocean Quahog Committee, Mid-Atlantic EFH Technical Committee, Northeast Region Steering Committee, MAFMC Habitat Committee, and MAFMC Habitat Advisory Panel. In addition to the states that are members of this Council, Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut were all consulted through the Coastal Zone Management Program consistency process. As of the end of the 60 day comment period, the States of Pennsylvania, New Hampshire, North Carolina, and Delaware had concurred with the Council's conclusions and the other states had not responded.

10.0 REFERENCES

Able, K. W. and A. M. Muzeni. 2002. An evaluation of the impact of mobile fishing gear on tilefish (*Lopholatilus chamaeleonticeps*) habitat: review of archived video images from submersibles. Final report submitted to Mid-Atlantic Fishery Management Council. May. 28 p.

Able, K. W. and M. P. Fahay. 1998. The first year of life in estuarine fishes in the middle Atlantic bight. Rutgers University Press. New Brunswick, NJ. 342 p.

Abernathy, A. 1989. Description of the mid-Atlantic environment. U.S. Dept. of the Interior, Minerals Management Service. Herndon, VA. 167 p.

Alaska Sea Grant. 1993. Is it food? Addressing marine mammal and seabird declines. University of Alaska. Fairbanks, AK. 59 p.

Ambrose, W. G. J., D. S. Jones and I. Thompson. 1980. Distance from shore and growth rate of the suspension feeding bivalve, *Spisula solidissima*. Proc. Natl. Shellfish. Assoc. 70: 207-215.

American Fisheries Society. 1988. Committee on scientific and vernacular names of mollusks of the Council of Systematic Malacologists. Special Publication 16. Bethesda, MD. 277 p.

Applegate, A., S. Cadrin, J. Hoenig, C. Moore, S. Murawski, and E. Pikitch. 1998. Evaluation of existing overfishing definitions and recommendations for new overfishing definitions to comply with the sustainable fisheries act. New England Fish. Mgmt. Coun. Danvers, MA. 179 p.

Ardrizzone, G., P. Tucci, A. Somaschini, and A. Bellauscio. 2000. Is bottom trawling partly responsible for the regression of *Posidonia oceanica* meadows in the Mediterranean Sea? Pp. 37-46 in M.J. Kaiser and S.J. de Groot. The Effects of Fishing on Non-target Species and Habitats. Blackwell Science.

Arnason, R. 1998. Ecological fisheries management using individual transferable share quotas. Ecological Applications. 8(1) Supplement. 151-159.

Auster, P. 2001. Defining thresholds for precautionary habitat management actions in a fisheries context. North American Journal of Fisheries Management. 21: 1-9.

Auster, P. 1998. A conceptual model of the impacts of fishing gear on the integrity of fish habitats. Conservation Biology. 12(6): 1198-1203.

Auster, P. and N. Shackell. 2000. Marine protected areas for the temperate and boreal northwest Atlantic: the potential for sustainable fisheries and conservation of biodiversity. Northeastern Naturalist. 7(4): 419-434.

Auster, P. and R. Malatesta. 1995. Assessing the role of non-extractive reserves for enhancing harvested populations in temperate and boreal marine systems. Pp. 82-89 in N. Shackell and J.J.M. Willison, eds. Marine Protected Areas and Sustainable Fisheries. Science and Management of Protected Areas Association, Wolfville, Nova Scotia.

Auster, P. and R. Langton. 1999. The effects of fishing on fish habitat. Pp. 150-187 in L. Benaka, ed. Fish habitat: essential fish habitat and rehabilitation. American Fisheries Society. Bethesda, MD.

Auster, P. J., J. Lindholm, S. Schaub, G. Funnel, L. S. Kaufman, and P. C. Valentine. In press. Use of sand wave habitats by silver hake *Merluccius bilinearis* (Mitchill). Journal of Fish Biology.

Auster, P., L. Watling, and A. Reiser. 1997. Comment: The interface between fisheries research and habitat management. North American Journal of Fisheries Management. 17: 591-595.

Auster, P. J., R. J. Malatesta, and C. L. Donaldson. 1997. Distributional responses to small-scale habitat variability by early juvenile silver hake, *Merluccius bilinearis.* Environmental Biology of Fishes. 50: 195-200.

Auster, P., R. Malatesta, R. Langton, L. Watling, P. Valentine, C. Donaldson, E. Langton, A. Shepard, and I. Babb. 1996. The impacts of mobile fishing gear on seafloor habitats in the Gulf of Maine (northwest Atlantic): implications for conservation of fish populations. Reviews in Fisheries Science. 4(2): 185-202.

Auster, P. J., R. J. Malatesta, S. C. LaRosa, R. A. Cooper, and L. L. Stewart. 1991. Microhabitat utilization by the megafaunal assemblage at a low relief outer continental shelf site – middle Atlantic bight, USA. Journal of Northwest Atlantic Fisheries Science. 11: 59-69.

Ball, B., B. Munday, and I. Tuck. 2000. Effects of otter trawling on the benthos and environment in muddy sediments. Pp. 69-82 in M.J. Kaiser and S.J. de Groot. The Effects of Fishing on Non-target Species and Habitats. Blackwell Science.

Barlow, J., and P. J. Clapham. 1997. A new birth-interval approach to estimating demographic parameters of humpback whales. Ecology. 78: 535-546.

Barnes, D., K. Chytalo, and S. Hendrickson. 1991. Final policy and generic environmental impact statement on management of shellfish in uncertified areas program. NY Department of Environment and Conservation. 79 p.

Barnette, M. 2001. A review of the fishing gear utilized within the southeast region and their potential impacts on essential fish habitat. NOAA Technical Memorandum NMFS -SEFSC - 449.

Beardsley, R., B. Butman, W. Geyer, and P. Smith. 1996. Physical oceanography of the Gulf of Maine: an update; pp. 39-52 in Wallace, G. and E. Braasch, eds. Proceedings of the Gulf of Maine Ecosystem Dynamics: A Scientific Symposium and Workshop. Regional Association for Research on the Gulf of Maine (RARGOM) Report 97-1.

Behnken, L. 1994. Southeast Alaska trawl closure: a case study in risk-averse management. Sea Win: Ocean Voice International. 7(1): 8-14.

Bergman, M., M. Fonds, M. Hup, and A. Stam. 1990. Direct effects of beam trawl fishing on benthic fauna in the North Sea. ICES C.M. 1990/MINI:11.

Bergman, M., and J. Van Santbrink 2000. Fishing mortality of populations of megafauna in sandy sediments. Pp. 49-68 in M. Kaiser and S. de Groot. The effects of fishing on non-target species and habitats. Blackwell Science.

Bergman, M., and M. Hup. 1992. Direct effects of beam trawling on macrofauna in a sandy sediment in the southern North Sea. ICES Journal of Marine Science. 49: 5-11.

Blaber, S., D. Cyrus, J. Albaret, C. Ching, J. Day, M. Elliott, M. Fonseca, D. Hoss, J. Orensanz, I. Potter and W. Silvert. 2000. Effects of fishing on the structure and functioning of estuarine and nearshore ecosystems. ICES Journal of Marine Science. 57: 590-602.

Black, K. and G. Parry. 1994. Sediment transport rates and sediment disturbance due to scallop dredging in Port Phillip Bay. Memoirs of the Queensland Museum. 36(2): 327-341.

Black, K. and G. Parry. 1999. Entrainment, dispersal, and settlement of scallop dredge sediment plumes: field measurements and numerical modelling. Canadian Journal of Fisheries and Aquatic Science. 56: 2271-2281.

Blaylock, R. A., J. W. Hain, L. J. Hansen, D. L. Palka, and G. T. Waring. 1995. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments. NOAA Tech. Mem. NMFS, SEFSC-363.

Bockstael, N. E. And J. J. Opaluch. 1983. Discrete modeling of supply response under uncertainty: the case of the fishery. Journal of Environmental Economics and Management. 10: 125-137.

Boesch, D. 1979. Benthic ecological studies: macrobenthos. Chapter 6 in middle Atlantic outer continental shelf environmental studies. Conducted by Virginia Institute of Marine Studies under contract AA550-CT6062 with the Bureau of Land Management. 301 p.

Botsford, L., J. Castilla, and C. Peterson. 1997. The management of fisheries and marine ecosystems. Science. 277: 509-515.

Bradshaw, C., L. Veale, A. Hill, and A. Brand. 2000. The effects of scallop dredging on gravelly seabed communities. Pp. 83-104 in M. Kaiser and S. de Groot. The Effects of Fishing on Non-target Species and Habitats. Blackwell Science.

Brambati, A. and G. Fontolan. 1990. Sediment resuspension induced by clam fishing with hydraulic dredges in the Gulf of Venice (Adriatic Sea). A preliminary experimental approach. Bollettino Di Oceanologia Teorica Ed Applicata. 8(2): 113-121.

Brandt, S. and B. McCay. 2001. Cost profile of the surfclam and ocean quahog industry. Draft, December 2001. Rutgers University. New Brunswick, NJ.

Brooks, D. 1996. Physical oceanography of the shelf and slope from Cape Hatteras to Georges Bank: A brief overview; in Sherman, K., N. Jaworski, and T. Smayda, The northeast Shelf Ecosystem – Assessment, Sustainability, and Management. Blackwell Science, Cambridge, MA. 564 p.

Brown, B. 1993. A classification system of marine and estuarine habitats in Maine: An ecosystem approach to habitats. Part I: Benthic Habitats. Maine Natural Areas Program, Dept. of Economic and Community Development. Augusta, ME. 51 p.

Brylinsky, M., J. Gibson, and D. Gordon, Jr. 1994. Impacts of flounder trawls on the intertidal habitat and community of the Minas Basin, Bay of Fundy. Canadian Journal of Fisheries and Aquatic Sciences. 51: 650-661.

Bryson, J. C. Personal communications. Former Executive Director MAFMC. Dover, De.

Caddy, J. 1973. Underwater observations on tracks of dredges and trawls and some effects of dredging on a scallop ground. Journal of the Fisheries Research Board of Canada. 30: 173-180.

Caddy, J. 1968. Underwater observations on scallop (*Placopecten magellanicus*) behavior and drag efficiency. Journal of the Fisheries Research Board of Canada. 25(10): 2123-2141.

Cahoon, L. 1999. The role of benthic microalgae in neritic ecosystems. Oceanography and Marine Biology. 37: 47-86.

Cappo, M., D. Alongi, D. Williams, and N. Duke. 1998. A review and synthesis of Australian fisheries habitat research. Volume 2: Scoping Review, Issue 4: Effects of Harvesting on Biodiversity and Ecosystems. FRDC 95/055.

Cargnelli, L. , S. Griesbach, D. Packer, and E. Weissberger. 1999a. Atlantic surfclam, *Spisula solidissima,* life history and habitat characteristics. NOAA Tech. Memo. NMFS-NE-142. 13 p.

Cargnelli, L., S. Griesbach, D. Packer, and E. Weissberger. 1999b. Ocean quahog, *Arctica islandica*, life history and habitat characteristics. NOAA Tech. Memo. NMFS-NE-148. 12 p.

Carr, A. F. 1963. Panspecific convergence in Lepidochelys kempii. Ergebn. Biol., 26: 298-303.

Carr, H. and H. Milliken. 1998. Conservation engineering: options to minimize fishing's impacts to the sea floor. Pp. 100-103 in E. Dorsey and J. Pederson, editors. Effects of Fishing Gear on the Sea Floor of New England. Conservation Law Foundation. Boston, Massachusetts. 160 p.

Chesapeake Bay Program. 1995. Guidance for protecting submerged aquatic vegetation in Chesapeake Bay from physical disruption. Annapolis, Maryland. 28 p.

Chiarella, L. A., D. K. Stevenson, C. D. Stephan, M. Pentony, and T. B. Hoff. 2002. Results of a workshop on the effects of fishing gear on benthic habitats off the northeastern United States. Poster presentation. Proceedings of a Symposium on Effects of Fishing on Benthic Habitats. Tampa, FL. November, 2002.

Chintala, M., and J. Grassle. 1995. Early gametogenesis and spawning in "juvenile" Atlantic surfclams, *Spisula solidissima* (Dillwyn, 1819). J. Shellfish Res. 14: 301-306.

Churchill, J. 1989. The effect of commercial trawling on sediment resuspension and transport over the middle Atlantic bight continental shelf. Continental Shelf Research. 9(9): 841-864.

Clark, C. W. 1995. Application of U.S. navy underwater hydrophone arrays for scientific research on whales. Rep. Int. Whal. Commn. 45: 210-212.

Coen, L. 1995. A review of the potential impacts of mechanical harvesting on subtidal and intertidal shellfish resources. Unpublished Report. South Carolina Department of Natural Resources. Marine Resources Research Institute.

Collette, B. B. and G. Klein-MacPhee. 2002. Fishes of the Gulf of Maine. Smithsonian Institute Press. Washington. 748 p.

Collie, J. 1998. Studies in New England of fishing gear impacts on the sea floor. Pp. 53-62 in E. Dorsey and J. Pederson, editors. Effect of Fishing Gear on the Sea Floor of New England. Conservation Law Foundation. Boston, Massachusetts. 160 p.

Collie, J., G. Escanero, and P. Valentine. 1997. Effects of bottom fishing on the benthic megafauna of Georges Bank. Marine Ecology Progress Series. 155(1): 159-172.

Collie, J., G. Escanero, and P. Valentine. 2000(b). Photographic evaluation of the impacts of bottom fishing on benthic epifauna. ICES Journal of Marne Science. 57: 987-1001.

Collie, J., S. Hall, M. Kaiser, and I. Poiners. 2000(a.) A quantitative analysis of fishing impacts on shelf-sea benthos. Journal of Animal Ecology. 69: 785-798.

Colvocoresses, J. and J. Musik. 1983. Species associations and community composition of middle Atlantic bight continental shelf demersal fishes. Fish. Bull. 82(2): 295-313.

Connor, W. and J. Simon. 1979. The effects of oyster shell dredging on an estuarine benthos community. Estuarine and Coastal Marine Science. 9: 749-758.

Cook, S. 1988. Physical oceanography of the middle Atlantic bight. Pp. 1-50 in A.L. Pacheco, ed. - Characterization of the middle Atlantic water management unit of the northeast regional action plan. NOAA Tech. Mem. NMFS-F/NEC-56. Woods Hole, MA. 322 p.

Crouse, D. T., L. B. Crowder, H. Caswell. 1987. A stage based population model for loggerhead sea turtles and implications for conservation. Ecology. 68(5): 1412-1423.

Cowardin, L., V. Carter, F. Golet, and E. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service Publication FWS/OBS-79/31. Washington, DC. 103 p.

Curtis, R. and R. L. Hicks. 2000. The cost of sea turtle preservation: the case of Hawaii's pelagic longliners. American Journal of Agricultural Economics. 82(5): 1191-1197.

Daan, N. 1991. A theoretical approach to the evaluation of ecosystem effects of fishing in respect of North Sea benthos. ICES CM 1991/L:27. 6 p.

Dadswell, M. J. 1979. Biology and population characteristics of the shortnose sturgeon, *Acipenser brevirostrum,* LeSueur 1818 (Osteichthyes: Acipenseridae), in the Saint John River Estuary, New Brunswick, Canada. Can. J. Zool. 57: 2186-2210.

Dahlgren, T., J. Weinberg, and K. Halanych. 2000. Phylogeography of the ocean quahog (*Arctica islandica*): influences of paleoclimate on genetic diversity and species range. Marine Biology. 137: 487-495.

Davidson, M. Personal communication. NY Dept. of Environmental Conservation. East Setauket, NY.

Davis, C.V., K.C. Scully, and S. E. Shumway. 1997. Juveniles and yearling growth of Atlantic surfclams, *Spisula solidissima* (Dillwyn, 1817), in Maine. J. Shellfish Res. 116: 161-168.

Dayton, P., S. Thrush, M. Agardy, and R. Hofman. 1995. Environmental effects of marine fishing. Aquatic Conservation: Marine and Freshwater Ecosystems. 5: 205-232.

DeAlteris, J. 1998. Training manual: fisheries science and technology, prepared for the NOAA Corps Officer Program.

DeAlteris, J., L. Skrobe, and C. Lipsky. 1999. The significance of seabed disturbance by mobile fishing gear relative to natural processes: a case study in Narragansett Bay, Rhode Island. Pp. 224-237 in L. Benaka, ed. Fish habitat: essential fish habitat and rehabilitation. American Fisheries Society, Symposium 22. Bethesda, MD.

deFur, P. L. and C. P. Mangum. 1979. The effects of environmental variables on the heart rates of invertebrates. Comp. Biochem. Physiol. 62A: 283-294.

Demestre, M., P. Sanchez, and M. Kaiser. 2000. The behavioural response of benthic scavengers to otter-trawling disturbance in the Mediterranean. Pp. 121-129 in M.J. Kaiser and S.J. de Groot. The Effects of Fishing on Non-target Species and Habitats. Blackwell Science.

Doyle, S. Personal communications. NMFS Enforcement. Brielle, NJ.

Drew, S., and R. Larsen. 1994. Worldwide trawl and dredge study. Unpublished Report. Marine Data Systems. Plymouth, Massachusetts. 8p.

Dyekjaer, S., J. Jensen, and E. Hoffmann. 1995. Mussel dredging and effects on the marine environment. ICES CM 1995/E:13.

Energy Information Administration. 2002. "Prices of petroleum products to end users". Monthly Energy Review.

Engel, J. and R. Kvitek. 1998. Effects of otter trawling on a benthic community in Monterey Bay National Marine Sanctuary. Conservation Biology. 12(6): 1204-1214.

Eno, N., D. MacDonald, J. Kinnear, S. Amos, C. Chapman, R. Clark, F. Bunker, and C. Munro. 2001. Effects of crustacean traps on benthic fauna. ICES Journal of Marine Science. 58: 11-20.

Fay, C. W., R. J. Neves, and G. B. Pardue. 1983. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (mid-Atlantic): surfclam. U.S. Fish and Wildlife Service, Division of Biological Services, FWS/OBS-82/11.13. U.S. Army Corps of Engineers. TR EL-82-4, 23 p.

Finlayson, C. Personal communication. ME DMR. Augusta, ME.

Flint, R. and J. Younk. 1983. Estuarine benthos: long-term community structure variations, Corpus Christi Bay, Texas. Estuaries. 6(2): 126-141.

Floderus. S. and L. Pihil. 1990. Resuspension in the Kattegat: impact of variation in wind climate and fishery. Estuarine, Coastal and Shelf Science. 31: 487-498.

Fogarty, M. and S. Murawski. 1998. Large-scale disturbance and the structure of marine systems: fishery impacts on Georges Bank. Ecological Applications. 8(1): S6-S22.

Fonds, M. and S. Groenewold. 2000. Food subsidies generated by the beam-trawl fishery in the southern North Sea. Pp. 130-150 in M. Kaiser and S. de Groot. The Effects of Fishing on Non-target Species and Habitats. Blackwell Science.

Fonseca, M., G. Thayer, A. Chester and C. Foltz. 1984. Impact of scallop harvesting on eelgrass (*Zostera marina*) meadows: implications for management. North American Journal of Fisheries Management. 4: 286-293.

Franz, D. R. 1976. Distribution and abundance of inshore populations of surf clam *Spisula solidissima.* Middle Continental Shelf and the New York Bight. ASLO Special Symposium. Lawrence, KS.

Fraser, S., V. Gotceitas and J. Brown. 1996. Interactions between age-classes of Atlantic cod and their distribution among bottom substrates. Can J Fish Aquat Sci. 53: 305-314.

Freeland, G. and D. Swift. 1978. Surficial sediments: MESA New York bight monograph 10. New York Sea Grant Institute. Albany, NY.

Frid, C. and R. Clark. 2000. Long-term changes in North Sea benthos: discerning the role of fisheries. Pp. 198-216 in M.J. Kaiser and S.J. de Groot. The Effects of Fishing on Non-target Species and Habitat. Blackwell Science.

Frid, C. and S. Hall. 1999. Inferring changes in North Sea benthos from fish stomach analysis. Marine Ecology Progress Series. 184: 184-188.

Friedlander, A., G. Boehlert, M. Field, J. Mason, J. Gardner, and P. Dartnell. 1999. Sidescan-sonar mapping of benthic trawl marks on the shelf and slope off Eureka, California. Fishery Bulletin. 97: 786-801.

Fuller, S. and P. Cameron. 1998. Marine benthic seascapes: fishermen's perspectives. Marine Issues Committee Special Pub. Vol. 3. Ecology Action Centre. Halifax, Nova Scotia. 64 p.

Glemarec, M., Y. LeFaou, and F. Cuq. 1996. Long-term changes of seagrass beds in the Glenan Archipelago (South Brittany). Oceanologica Acta. 20(1): 217-227.

Godcharles, M. 1971. A study of the effects of a commercial hydraulic clam dredge on benthic communities in estuarine areas. State of Florida Department of Natural Resources Marine Resources Laboratory Technical Series No. 64.

Goñi, R. 1998. Ecosystem effects of marine fisheries: an overview. Ocean and Coastal Management. 40(1): 37-64.

Gordon, D., P. Schwinghamer, T. Rowell, J. Prena, K. Gilkinson, W. Vass, and D. McKeown. 1998. Studies in eastern Canada on the impact of mobile fishing gear on benthic habitat and communities. Pp. 63-67 in E. Dorsey and J. Pederson, editors. Effect of Fishing Gear on the Sea Floor of New England. Conservation Law Foundation. Boston, MA. 160 p.

Gotceitas, V. and J. Brown. 1993. Substrate selection by juvenile Atlantic cod (*Gadus morhua*): effects of predation risk. Oecologia. 93: 31-37.

Gotceitas, V., S. Fraser and J. Brown. 1995. Habitat use by juvenile Atlantic cod (*Gadus morhua*) in the presence of an actively foraging and non-foraging predator. Marine Biology. 123: 421-430.

Gotceitas, V., S. Fraser and J. Brown. 1997. Use of eelgrass beds (*Zostera marina*) by juvenile Atlantic cod (*Gadus morhua*). Canadian Journal of Fisheries and Aquatic Science. 54: 1306-1319.

Gray, J. 2000. The measurement of marine species diversity, with an application to the benthic fauna of the Norwegian continental shelf. Journal of Experimental Marine Biology and Ecology. 250(12): 23- 49.

Greenstreet, S. and S. Hall. 1996. Fishing and groundfish assemblage structure in the northwestern North Sea: an analysis of long-term and spatial trends. Journal of Animal Ecology. 65: 577-598.

Greenstreet, S., F. Spence, A. Shanks, and J. McMillan. 1999. Fishing effects in northeast Atlantic shelf seas: patterns in fishing effort, diversity and community structure. II. Trends in fishing effort in the North Sea by UK registered vessels landing in Scotland. Fisheries Research. 40: 107-124.

Gregory, R. and J. Anderson. 1997. Substrate selection and use of protective cover by juvenile Atlantic cod *Gadus morhua* in inshore waters of Newfoundland. Marine Ecology Progress Series. 146: 9-20.

Guida, V. G., P. C. Valentine, and F. Almeida. (in press). Effects of fishing on the mid-Atlantic tilefish habitat: restructuring a structured habitat. Proceedings of a Symposium on Effects of Fishing on Benthic Habitats. Tampa, FL. November, 2002.

Hain, J. H. W., M. J. Ratnaswamy, R. D. Kenney, and H. E. Winn. 1992. The fin whale, *Balaenopteraphysalus*, in waters of the northeastern United States continental shelf. Rep. Int. Whal. Comm. 42: 653-669.

Hall, S. 1999. The Effects of Fishing on Marine Ecosystems and Communities. Blackwell Science. Oxford, United Kingdom. 274 p.

Hall, S. 1994. Physical disturbance and marine benthic communities: life in unconsolidated sediments. Oceanography and Marine Biology: An Annual Review. 32: 179-239.

Hall, S., D. Basford, and M. Robertson. 1990. The impact of hydraulic dredging for razor clams *Ensis* sp. on an infaunal community. Netherlands Journal of Sea Research. 27(1): 119-125.

Hall, S., M. Robertson, D. Basford, and S. Heaney. 1993. The possible effects of fishing disturbance in the northern North Sea: an analysis of spatial patterns in community structure around a wreck. Netherlands Journal of Sea Research. 31(2): 201-208.

Hall-Arber, M., C. Dyer, J. Poggie, J. McNally, and R. Gagne. 2002. Fishing communities of New England. Cambridge, MA: Massachusetts Sea Grant College Program, Massachusetts Institute of Technology.

Hall-Spencer, M., C. Froglia, R. Atkinson, and P. Moore. 1999. The impact of rapido trawling for scallops, *Pecten jacobaeus* (L.), on the benthos of the Gulf of Venice. ICES Journal of Marine Science. 56: 111-124.

Hanemann, W. M. 1982. Applied welfare analysis with qualitative response models. Working Paper No. 241. California Agricultural Experiment Station. October 1982.

Hayes, D., G. Raymond, and T. McLellan. 1984. Sediment resuspension from dredging activities. Pp. 72-82 in Proceedings of the ASCE Specialty Conference. Dredging '84. Clearwater, FL.

Hayes, M. 1983. Active fish capture methods in fisheries techniques. Nielson, L.A. and D.L. Johnson, eds. American Fisheries Society. Bethesda, MD.

Heiftez, J. 1997. Workshop of the potential effects of fishing gear on benthic habitat. NMFS AFSC Processed Report 97-04. 17 p.

Henderson, J. T. 1929. Lethal temperatures of *Lamellibranchiata.* Contributions to Canadian Biology and Fisheries. 4: 399-411.

Hewitt, J., S. Thrush, V. Cummings, and S. Turner. 1998. The effect of changing sampling scales on our ability to detect effects of large-scale processes on communities. Journal of Experimental Marine Biology and Ecology. 227(2): 251- 264.

Hutchings, P. 1990. Review of the effects of trawling on macrobenthic epifaunal communities. Australian Journal of Marine and Freshwater Research. 41: 111-120.

ICES. 1991. Report of the study group on ecosystem effects of fishing activities, Copenhagen, Denmark, International Council for the Exploration of the Sea. Study Group on Ecosystem Effects of Fishing Activities. ICES CM 1991/G:7.

ICES. 1995. Report of the study group on ecosystem effects of fishing activities, Copenhagen, Denmark, 7-14 April 1992. ICES Cooperative Research Report. Number 200. 120 p.

ICES. 1973. Effects of trawls and dredges on the seabed. ICES, Gear and Behavior Committee. ICES CM 1973 /B:2.

ICES. 1992. Report of the Study Group on Ecosystem Effects of Fishing Activities, Copenhagen, 7-14 April, 1992. International Council for the Exploration of the Sea. Study Group on Ecosystem Effects of Fishing Activities. ICES CM 1992/G:11. 144 p.

ICES. 1993. Report of the working group on ecosystem effects of fishing activities. International Council for the Exploration of the Sea. Working Group on Ecosystem Effects of Fishing Activities ICES CM 1993/G:4. 9 p.

ICES. 1999. Report of the working group on fishing technology and fish behavior. ICES, Fisheries Technology Committee. ICES CM 1999. 51 p.

Ismail, N. 1985. The effects of hydraulic dredging to control oyster drills on benthic macrofauna of oyster grounds in Delaware Bay, New Jersey. Internationale Revue der Gesamten Hydrobiologie. 70(3): 379-395.

Jenning, S., J. Alvsvag, A. Cotter, S. Ehrich, S. Greenstreet, A. Jarre-Teichmann, N. Mergardt, A. Rijnsdorp, and O. Smedstad. 1999. Fishing effects in northeast Atlantic shelf seas: patterns in fishing effort, diversity and community structure. Fisheries Research. 40: 125-134.

Jennings, S. and A. Cotter. 1999. Fishing effects in northeast Atlantic shelf seas: patterns in fishing effort, diversity and community structure. I. Introduction. Fisheries Research. 40: 103-106.

Jennings, S. and M. Kaiser. 1998. The effects of fishing on marine ecosystems. Advances in Marine Biology. 34: 201-352.

Jolley, J. 1972. Exploratory fishing for the sunray venus clam, *Macrocallista nimbosa*, in northwest Florida. Florida Department of Natural Resources Technical Series. No. 67: 1-42.

Jones, D. S. 1980. Annual cycle of shell growth increment formation in two continental shelf bivalves and its paleoecologic significance. Paleobiol. 6: 331-340.

Jones, D. S. 1983. Sclerochronolgy: Reading the record of the molluscan shell. Amer. Scient. 71: 384-391.

Judge, G., W. Griffiths, R. Hill, and T. C. Lee. 1980. The theory and practice of econometrics. John Wiley and Sons.

Just, R. E., D. L. Hueth, and A. Schmitz. 1982. Applied welfare economics and public policy. Englewood Cliffs, NJ. Prentice-Hall, Inc.

Kaiser, M. 1996. Starfish damage as an indicator of trawling intensity. Marine Ecology Progress Series. 134: 303-307.

Kaiser, M. 2000. The implications of the effects of fishing on non-target species and habitats. Pp. 383-392 in M. Kaiser and S. de Groot. The Effects of Fishing on Non-target Species and Habitats. Blackwell Science.

Kaiser, M. 1998. Significance of bottom-fishing disturbance. Conservation Biology. 12(6): 1230-1235.

Kaiser, M. and B. Spencer. 1994. Fish scavenging behavior in recently trawled areas. Marine Ecology Progress Series. 112: 41-49.

Kaiser, M. and B. Spencer. 1993. A preliminary assessment of the immediate effects of beam trawling on a benthic community in the Irish Sea. ICES CM 1993/B:38. 9 p.

Kaiser, M. and B. Spencer. 1996. Behavioural responses of scavengers to beam trawl disturbance. Pp. 116-123 in S. Greenstreet and M. Tasker, editors. Aquatic Predators and Their Prey. Blackwell Scientific Publications, Oxford.

Kaiser, M. and K. Ramsay. 1997. Opportunistic feeding by dabs within areas of trawl disturbance: possible implications for increased survival. Marine Ecology Progress Series. 152: 307-310.

Kaiser, M., A. Hill, K. Ramsay, B. Spencer, A. Brand, L. Veale, K. Pruden, E. Rees, B. Munday, B. Ball, and S. Hawkins. 1996a. Benthic disturbance by fishing gear in the Irish Sea: A comparison of beam trawling and scallop dredging. Aquatic Conservation: Marine and Freshwater Ecosystems. 6(4): 269-285.

Kaiser, M., D. Edwards and B. Spencer. 1996b. Infaunal community changes as a result of commercial clam cultivation and harvesting. Aquatic Living Resources. 9: 57-63.

Kaiser, M., D. Edwards, P. Armstrong, K. Radford, N. Lough, R. Flatt, and H. Jones. 1998. Changes in megafaunal benthic communities in different habitats after trawling disturbance. ICES Journal of Marine Science. 55: 353-361.

Kaiser, M., K. Cheney, F. Spence, D. Edwards, and K. Radford. 1999. Fishing effects in northeast Atlantic shelf seas: patterns in fishing effort, diversity and community structure. VII. The effects of trawling disturbance on the fauna associated with the tubeheads of serpulid worms. Fisheries Research. 40: 195-205.

Kaiser, M., K. Ramsay, C. Richardson, F. Spence, and A. Brand. 2000a. Chronic fishing disturbance has changed shelf sea benthic community structure. Journal of Animal Ecology. 69: 494-503.

Kaiser, M., B. Spencer, and P. Hart. 2000b. Fishing-Gear Restrictions and Conservation of Benthic Habitat Complexity. Conservation Biology. 14(5): 1512-1525.

Katona, S. K., and J. A. Beard. 1990. Population size, migrations, and feeding aggregations of the humpback whale (Megaptera novaeangliae) in the Western North Atlantic Ocean. Rep. Int. Whal. Comm. Special Issue 12: 295-306.

Keats, D., S. Steele and G. South. 1987. The role of fleshy macroalgae in the ecology of juvenile cod (*Gadus morhua* L.) in inshore waters off eastern Newfoundland. Can J Zool. 65: 49-53.

Kenchington, T. 1995. A summary of the published evidence relating to habitat modification by fish draggers. Pp. 109-116 in The Canadian Maritimes Fishing: Let's Fix It, An Action Plan. SW Nova Scotia Fixed Gear Association. Shelburne, Nova Scotia, Canada.

Kirkley, J. E., R. Hicks, and I. Strand. 2002. Economic ramifications of amendment 13 to the surfclam and ocean quahog fishery management plan. Report prepared for Mid-Atlantic Fishery Management Council. Dover, DE.

Koslow, J. and K. Garrett-Holmes. 1998. The seamount fauna off southern Tasmania: benthic communities, their conservation and impacts of trawling. Final report to Environment Australia and the Fisheries Research Development Corporation. FRDC Project 95/058.

Knowlton, A. R., S. D. Kraus, and R. D. Kenney. 1994. Reproduction in north Atlantic right whales (*Eubalaena glacialis*). Can. J. Zool. 72: 1297-1305.

Kroencke, I. 1995. Long-term changes in North Sea benthos. Senckenbergiana Maritima. 26(1-2): 73-80.

Krost, P., M. Bernard, F. Werner, and W. Hukriede. 1990. Otter trawl tracks in Kiel Bay (Western Baltic) mapped by side-scan sonar. Meeresforschung. 32: 344-353.

Langton, R. and J. Uzmann. 1990. A photographic survey of megafauna of the central and eastern Gulf of Maine. Fish. Bull. 87(4): 945-954.

Langton, R. and P. Auster. 1999. Marine fishery and habitat interactions: to what extent are fisheries and habitat interdependent? Fisheries. 24(6): 14-21.

Langton, R. and W. Robinson. 1990. Faunal associations on scallop grounds in the western Gulf of Maine. Journal of Experimental Marine Biology and Ecology. 144: 157-171.

Langton, R., P. Auster, and D. Schneider. 1995. A spatial and temporal perspective on research and management of groundfish in the northwest Atlantic. Reviews in Fisheries Science. 3(3): 201-229.

Langton, R., R. Steneck, V. Gotceitas, F. Juanes, and P. Lawton. 1996. The interface between fisheries research and habitat management. North American Journal of Fisheries Management. 16(1): 1-7.

Larsen, P. F. and R. M. Lee. 1978. Observations on the abundance, distribution and growth of post-larval sea scallops, *Palcopecten magellanicus,* on Georges Bank. Nautilus. 92: 112-116.

LaSalle, M.W. 1990. Physical and chemical alterations associated with dredging: an overview. Pages1-12 in Effects of Dredging on anadromous Pacific Coast Fishes. Workshop Proceedings, Seattle, September 8 and 9, 1988. Wash. Sea Grant.

Levin, L. 1984. Life history and dispersal patterns in a dense infaunal polychaete assemblage: community structure and response to disturbance. Ecology. 65(4): 1185-1200.

Lindeboom, H., and S. De Groot, 1998. Impact II. The effects of different types of fisheries on the North Sea and Irish Sea benthic ecosystems. NIOZ Rapport 1998-1. 404 p.

Lindholm, J., P. Auster, and L. Kaufman. 1999. Habitat-mediated survivorship of juvenile (0-year) Atlantic cod *Gadus morhua*. Mar. Ecol. Prog. Ser. 180: 247-255.

Lindholm, J. , P. Auster, M. Ruth and L. Kaufman. 2001. Modeling the effects of fishing and implications for the design of marine protected areas: juvenile fish response to variations in seafloor habitat. Conservation Biology. 15: 424-437.

Linehan, J., R. Gregory and D. Schneider. 2001. Predation risk of age-0 cod (*Gadus*) relative to depth and substrate in coastal waters. J Exp Mar Biol Ecol. 263: 25-44.

Loesch, J. G. and J. W. Ropes. 1977. Assessment of surf clam stocks in nearshore waters along the Delmarva Peninsula and in the fishery south of Cape Henry. Proc. Nat. Shellfish. Assoc. 67: 29-34.

Lough, R., P. Valentine, D. Potter, P. Auditore, G. Bolz, J. Neilson, and R. Perry. 1989. Ecology and distribution of juvenile cod and haddock in relation to sediment type and bottom currents on eastern Georges Bank. Mar. Ecol. Prog. Ser. 56: 1-12.

Lutcavage, M. and J. A. Musick. 1985. Aspects of the biology of sea turtles in Virginia. Copeia. 1985(2): 449-456.

MacDonald, J. Personal communication. NOAA General Counsel. Gloucester, MA.

MacKenzie, C. 1982. Compatibility of invertebrate populations and commercial fishing for ocean quahogs. North American Journal of Fisheries Management. 2: 270-275.

Maier, P., P. Wendt, W. Roumillat, G. Steele, M. Levisen, and R. Van Dolah. 1995. Effects of subtidal mechanical clam harvesting on tidal creeks. South Carolina Department of Natural Resources, Marine Resources Division. Final Report. 38 p.

Mann, R. 1989. Larval ecology of *Arctica islandica* on the inner continental shelf of the eastern United States. J. Shellfish Res. 8: 464.

Mann, R. 1982. The seasonal cycle of gonadal development in *Arctica islandica* from the southern New England shelf. Fishery Bulletin. 80(2): 315-326.

Mann, R. 1985. Seasonal changes in the depth-distribution of bivalve larvae on the southern New England shelf. Journal Shellfish Research. 5: 57-64.

Mann, R., and C. Wolf. 1983. Swimming behaviour of larvae of the ocean quahog *Arctica islandica* in response to pressure and temperature. Marine Ecology Progress Series 13:211-218.

Manning, J. and E. Dunnington. 1955. The Maryland soft-shell clam fishery: a preliminary investigational report. Proceedings of the National Shellfisheries Association. 46: 100-110.

Mantzaris, C. Personal communication. NMFS, NERO. Gloucester, MA.

Margetts, A. and J. Bridger. 1971. The effect of a beam trawl on the sea bed. ICES Council Meeting. 1971/B:8.

McAllister, D. 1991. Questions about the impact of trawling. Sea Wind: Ocean Voice International. 5(2): 28-32.

McAllister, D. and G. Spiller. 1994. Trawling and dredging impacts on fish habitat and bycatch. Conference Proceedings, Volume 4. Coastal Zone Canada Association, Dartmouth, Nova Scotia.

McCay, B. and M. Cieri. 2000. Fishing ports of the mid-Atlantic. Report to the Mid-Atlantic Fisheries Management Council. Dover, DE.

McCay, B., J. Lamarque, E. Bochenek, T. Johnson, B. Stoffle, and D. Wilson. 2002. Social impact assessment for amendment 13, surfclam and ocean quahog fishery management plan: a report to the Mid-Atlantic Fishery Management Council. Dover, DE.

McConnaughey, R., K. Mier and C. Dew. 2000. An examination of chronic trawling on soft bottom benthos of the eastern Bering Sea. ICES Journal of marine Science. 57: 1388-2000.

McGowan, J. Personal communication. ME DMR, Augusta, ME.

Medcof, J. C. 1958. Stock-taking of molluscan shellfish resources and prospects for improvement. Fish. Res. Bd. Canada Prog. Rept. Atl. Coast Sta. No. 71. 21-25.

Medcof, J. and J. Caddy. 1971. Underwater observations on the performance of clam dredges of three types. ICES CM 1971/B:10.

Merrill, S., J. L. Chamberlin and J. W. Ropes. 1969. Ocean quahog fishery, p. 125-129. In F. E. Firth (ed.), Encyclopedia of marine resources. Van Nostrand Reinhold Publishing Co., New York.

Merrill, A. S. and J. W. Ropes. 1969. The general distribution of the surf clam and ocean quahog. Proc. Natl. Shellfish. Assoc. 59: 40-45.

Messieh, S., T. Rowel, D. Peer, and P. Cranford. 1991. The effects of trawling, dredging and ocean dumping on the eastern Canadian continental shelf seabed. Continental Shelf Research. 11(8-10): 1237-1263.

Meyer, T., R. Cooper and K. Pecci. 1981. The performance and environmental effects of a hydraulic clam dredge. Marine Fisheries Review. 43(9): 14-22.

Mid-Atlantic Fishery Management Council (MAFMC). 1977. Surfclam and ocean quahog fishery management plan. Dover, DE.

_____. 1979a. Amendment #1 to the surfclam and ocean quahog fishery management plan. Dover, DE.

_____. 1979b. Amendment #2 to the surfclam and ocean quahog fishery management plan. Dover, DE.

_____. 1981. Amendment #3 to the surfclam and ocean quahog fishery management plan. Dover, DE.

_____. 1984. Amendment #5 to the fishery management plan for the Atlantic surfclam and ocean quahog fisheries. Dover, DE.

_____. 1986. Amendment #6 to the fishery management plan for the Atlantic surfclam and ocean quahog fisheries. Dover, DE.

_____. 1987. Amendment #7 to the fishery management plan for the Atlantic surfclam and ocean quahog fisheries. Dover, DE.

_____. 1988. Amendment #8 to the Atlantic surfclam and ocean quahog fishery management plan. Dover, DE.

_____. 1996. Amendment #9 to the Atlantic surfclam and ocean quahog fishery management plan. Dover, DE.

_____. 1997. Amendment #10 to the Atlantic surfclam and ocean quahog fishery management plan. Dover, DE.

____. 1998. Amendment #12 to the Atlantic surfclam and ocean quahog fishery management plan. Dover, DE.

____. 2002. Amendment #13 to the fishery management plan for the summer flounder, scup and black sea bass fisheries. Dover, DE.

Mid-Atlantic Regional Marine Research Program (MARMRP). 1994. Mid-Atlantic Research Plan. University of MD. College Park, MD. 163 p.

Mirarchi, F. 1998. Bottom trawling on soft substrates. Pp. 80-84 in E.M. Dorsey and J. Pederson, editors. Effects of Fishing Gear on the Sea Floor on New England. Conservation Law Foundation. Boston, Massachusetts. 160 p.

Moran, M. and P. Stephenson. 2000. Effects of otter trawling on macrobenthos and management of demersal scalefish fisheries on the continental shelf of north-western Australia. ICES Journal of Marine Science. 57: 510-516.

Morse, W. W., D. L. Johnson, P. L. Berrien, and S. J. Wilk. 1999. Essential fish habitat source document: silver hake, *Merluccius bilinearis,* life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-135. NMFS. Woods Hole, MA. 42 p.

Morgan, M., E. DeBlois, and G. Rose. 1997. An observation on the reaction of Atlantic cod (*Gadus morhua*) in a spawning shoal to bottom trawling. Canadian Journal of Fisheries and Aquatic Sciences. 54(Supplement1): 217-223.

Mountain, D., R. Langton, and L. Watling. 1994. Oceanic processes and benthic substrates: influences on demersal fish habitats and benthic communities; pp. 20-25 in Langton, R.W., J.B. Pearce, and J.A. Gibson, eds. Selected Living Resources, Habitat Conditions, and Human Perturbations of the Gulf of Maine: Environmental and Ecological Considerations for Fishery Management. NOAA Tech. Memo. NMFS-NE-106. Woods Hole, MA. 70 p.

Murawski, S. A. 1986. Assessment updates for Middle Atlantic, New England, and Georges Bank offshore Surf Clam, *Spisula solidissima* populations, summer 1986. NEFSC, Woods Hole Lab. Ref. Doc. 86-11.

Murawski, S. A. and F. M. Serchuk. 1979. Shell length - meat weight relationships of ocean quahogs, *Arctica islandica*, from the middle Atlantic shelf. Nat. Shell. Assoc. 69: 40-46.

Murawski, S. A. and F. M. Serchuk. 1984. Assessment update for Middle Atlantic Surf Clam, *Spisula solidissima*, populations - Autumn 1984. NEFSC, Woods Hole Lab. Ref. Doc. 84-32.

Murawski S.A. and F.M. Serchuk, 1989. Environmental effects of offshore dredge fisheries for bivalves. ICES 1989 Statutory Meeting The Hague Netherlands. 12p. 7 figs.

Murawski, S.A., J.W. Ropes and F.M. Serchuk. 1982. Growth of the ocean quahog, Arctica islandica, in the Middle-Atlantic Bight. Fish. Bull. 80(1): 21-34.

National Marine Fisheries Service (NMFS). 1994. The guidelines and principles for social impact assessment. NMFS-TM-SPO-16, May 1994 (being revised 2003).

National Marine Fisheries Service. 1991. Final recovery plan for the northern right whale (*Eubalaena glacialis*). Prepared by the Right Whale Recovery Team. 86 p.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1995. Status reviews for sea turtles listed under the Endangered Species Act of 1973. NMFS. Silver Spring, MD. 139 p.

National Marine Fisheries Service. 1998. Endangered Species Act Section 7 consultation, biological opinion, and conference. Consultation in accordance with Section 7(a) of the Endangered Species Act Regarding the Federal Monkfish Fishery. Northeast Regional Office. Gloucester, MA.

National Marine Fisheries Service. 2000. Guidelines for regulatory analysis of fishery management actions. Silver Spring, MD.

National Marine Fisheries Service. 2001. Guidelines for economic analysis of fishery management actions, (Revised). Silver Spring, MD.

National Marine Fisheries Service. N.d. The council operational guidelines, Appendix 2(g): Proposed guidelines for assessment of the social impact of fishery management actions, under revision. Silver Spring, MD.

National Research Council (NRC). 1994. Restoring and protecting marine habitat. The role of engineering and technology. Washington, DC. 193 p.

National Research Council (NRC). 2002. Effects of bottom trawling and dredging on seafloor habitats. Washington, DC.

Natural Resources Defense Council (NRDC). 2001. Priority ocean areas for protection in the mid-Atlantic. NY, NY. 59 p.

Nerlove, M. 1956. Estimates of elasticities of supply of selected agricultural commodities. Journal of Farm Economics. 38: 496-509.

New England Fishery Management Council (NEFMC). 1998. Amendment #11 to the northeast multispecies fishery management plan (FMP), Amendment #9 to the Atlantic sea scallop FMP, Amendment #1 to the monkfish FMP, Amendment #1 to the Atlantic Salmon FMP, components of the proposed Atlantic herring FMP for essential fish habitat. Volume 1. Newburyport, MA. 388 p.

New Jersey Division of Fish and Wildlife. 2000. Inventory of New Jersey's surfclam (*Spisula solidissima*) resource. Report of the Interjurisdictional Fisheries Act 3-IJ-131.

Norse, E. and L. Watling. 1999. Impacts of mobile fishing gear: the biodiversity perspective. Pp. 31-40 in L. Benaka, ed. Fish habitat: essential fish habitat and rehabilitation. American Fisheries Society, Symposium 22. Bethesda, MD.

Orth, R., K. Moore, D. Wilcox and J. Fishman. 1998. Chincoteague Bay, Virginia: effectiveness of the SAV sanctuary and revegetation of SAV habitat disturbed by clam dredging. Unpublished Report to the Virginia Marine Resources Commission. 6 p.

Overholtz, W. and A. Tyler. 1985. Long-term responses of the demersal fish assemblages of Georges Bank. Fish. Bull. 83(4): 507-520.

Packer, D. B., L. M. Cargnelli, S. J. Griesbach, and S. E. Shumway. 1999. Essential fish habitat source document: Atlantic sea scallop, *Placopecten magellanicus,* life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-134. NMFS. Woods Hole, MA. 21 p.

Parker, P. S. and E. D. McRae. 1970. The ocean quahog, *Arctica islandica*, resource of the Northwestern Atlantic. Fish. Ind. Res. 6(4): 185-195.

Pacheco, A. 1988. Characterization of the middle Atlantic water management unit of the northeast regional action plan. NOAA Tech. Mem. NMFS-F/NEC-56. Woods Hole, MA. 322 p.

Pederson, J. and M. Hall-Arber. 1999. Fish habitat: a focus on New England fishermen's perspectives. Pp. 188-211 in L. Benaka, ed. Fish habitat: essential fish habitat and rehabilitation. American Fisheries Society, Symposium 22. Bethesda, MD.

Pereira, J. J., R. Goldberg, J. J, Ziskowski, P. L. Berrien, W. W. Morse, and D. L. Johnson. 1999. Essential fish habitat source document: winter flounder, *Pseudopleuronectes americanus,* life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-138. NMFS. Woods Hole, MA. 39 p.

Peterson, R. E. 1963. A field guide to the birds. Houghton, Mifflin Company. Boston, MA. 290 p.

Pickett, G. 1973. The impact of mechanical harvesting on the Thames Estuary cockle fishery. MAFF Laboratory Leaflet. No. 29. 21 p.

Porter, H. and F. Schwartz. 1981. Trawl collections of *Macoma constricta* and *Spisula raveneli* (Bivalvia: Tellinidae and Mactridae) in vicinity of Cape Fear River, NC and their relationship to periods of environmental stress. Bull. Am. Malacol. U. 1981: 15-19.

Powell, E. Personal communication. Rutgers University. Bivalve, NJ.

Pranovi, F. and O. Giovanardi. 1994. The impact of hydraulic dredging for short-necked clams, *Tapes spp.*, on an infaunal community on the lagoon of Venice. Scientia Marina. 58(4): 345-353.

Pratt, S. 1973. Benthic fauna. Pp. 5-1 to 5-70 in Coastal and offshore environmental inventory, Cape Hatteras to Nantucket Shoals. University of Rhode Island, Marine Publication Series No. 2. Kingston, RI.

Ramsay, K., M. Kaiser, and R. Hughes. 1998. Responses of benthic scavengers to fishing disturbance by towed gears in different habitats. Journal of Experimental Marine Biology and Ecology. 224: 73-89.

Ramsay, K., M. Kaiser, and R. Hughes. 1996. Changes in hermit crab feeding patterns in response to trawling disturbance. Marine Ecology Progress Series. 144(1-3): 63-72.

Reid, R. and F. Steimle. 1988. Benthic macrofauna of the middle Atlantic continental shelf. Pp. 125-160 in A.L. Pacheco, ed. - Characterization of the middle Atlantic water management unit of the northeast regional action plan. NOAA Tech. Mem. NMFS-56. Woods Hole, MA. 322 p.

Reimann, B. and E. Hoffman. 1991. Ecological consequences of dredging and bottom trawling in the Limfjord, Denmark. Marine Ecology Progress Series. 69: 171-178.

Rester, J. 2000. Annotated bibliography of fishing impacts on habitat. Gulf States Marine Fisheries Commission. Number 73. Ocean Springs, MS. 168 p.

Riesen, W. and K. Reise. 1982. Macrobenthos of the subtidal Wadden Sea: revisited after 55 years. Helgolander Meeresunters. 35: 409-423.

Rijnsdorp, A. and P. Van Leeuwen. 1996. Changes in growth of North Sea plaice since 1950 in relation to density, eutrophication, beam trawl effort, and temperature. ICES Journal of Marine Science. 53: 1199-1213.

Rijnsdorp, A., A. Buys, F. Storbeck, and E. Visser. 1998. Micro-scale distribution of beam trawl effort in the southern North Sea between 1993 and 1996 in relation to the trawling frequency of the sea bed and the impact on benthic organisms. ICES Journal of Marine Science. 55: 403-419.

Rogers, S., D. Maxwell, A. Rijnsdorp, U. Damm, and W. Vanhee. 1999. Fishing effects in northeast Atlantic shelf seas: patterns in fishing effort, diversity and community structure. IV. Fisheries Research. 40: 135-152.

Rogers, S., M. Kaiser, and S. Jennings. 1998. Ecosystem effects of demersal fishing: a European perspective. Pp. 68-78 in E.M. Dorsey and J. Pederson, editors. Effect of Fishing Gear on the Sea Floor of New England. Conservation Law Foundation. Boston, MA. 160 p.

Ropes, J. W. 1978. Biology and distribution of surf clams (*Spisula solidissima*) and ocean quahogs (*Arctica islandica*) off the northeast coast of the United States. In Proceedings of northeast clam industries: management for the future. April 27-28, 1978, Hyannis, MA.

Ropes, J. W. 1979. Shell length at sexual maturity of surf clams, *Spisula solidissima*, from an inshore habitat. Proc. Natl. Shellfish. Assoc. 69: 85-91.

Ropes, J. W. 1980. Biological and fisheries data on the surf clam, *Spisula solidissima* (Dillwyn). Tech. Ser. Rep. No. 24. Woods Hole Laboratory, MA. 88 p.

Ropes, J. W. and S. Merrill. 1970. Marking surf clams. Proc. Natl. Shellfish. Assoc. 60: 99-106.

Ropes, J. W., S. Merrill, S. Murawski, S. Chang and C. MacKenzie. 1979. Chapter 11. Impact on clams and scallops, Part 1: field survey assessments. In R.L. Swanson and C.J. Sindermann (eds.), Oxygen depletion and associated benthic mortalities in New York Bight, 1976. NOAA Professional Paper 11.

Ropes, J. W. and S. Murawski. 1983. Maximum shell length and longevity in ocean quahogs, *Arctica islandica* Linné. ICES CM 1983/K:32.

Rosenberg, A., P. Mace, G. Thompson, G. Darcy, W. Clark, J. Collie, W. Gabriel, A. MacCall, R. Methot, J. Powers, V. Restrepo, T. Wainwright, L. Botsford, J. Hoenig, and K. Stokes. 1994. Scientific review of definitions of overfishing in U. S. Fishery Management Plans. NOAA Tech. Memo. NMFS-F/SPO-17. 205 p.

Ruffin, K. 1995. The effects of hydraulic clam dredging on nearshore turbidity and light attenuation in Chesapeake Bay, MD. Master's Thesis. University of Maryland. 79 p.

Rumohr, H. 1998. Information on impact of trawling on benthos in Kiel Bay. Annex to Eighth Report of the Benthos Ecology Working Group. ICES CM 1989/L:19. p. 80.

Rumohr, H. and P. Krost. 1991. Experimental evidence of damage to benthos by bottom trawling with special reference to *Arctica islandica*. Meeresforschung. 33(4): 340-345.

Safina, C. 1990. Foraging habitat partitioning in roseate and common terns. Auk. 107(2): 351-358.

Safina, C. Personal communication. National Audubon Society. Islip, NY.

Safina, C., J. Burger, M. Gochfeld, and R. Wagner. 1988. Evidence for prey limitation of common and Roseate tern production. The Condor. 90: 852-859.

Safina, C., R. Wagner, D. Witting, and K. Smith. 1990. Prey delivered to Roseate and common tern chicks; composition and temporal variability. J. Field Ornithol. 61(3): 331-338.

Saila, S. and S. Pratt. 1973. Fisheries. In: Coastal and offshore environmental inventory. Univ. of Rhode Island. Marine Publication Series No. 2.

Sainsbury, J. 1996. Commercial fishing methods: an introduction to vessels and gears, 3rd Ed. Fishing News Books. Oxford, England.

Sainsbury, K. 1988. The ecological basis of multispecies fisheries and management of a demersal fishery in tropical Australia. Pp. 349-382 in J.A. Gulland, ed. Fish Population Dynamics, 2nd edition. John Wiley and Sons. London.

Sainsbury, K., R. Campbell, and A. Whitelaw. 1993. Effects of trawling on the marine habitat on the north west shelf of Australia and implications for sustainable fisheries management. Pp. 137-145 in D.A. Hancock, ed. Sustainable fisheries through sustaining fish habitat. Canberra, Australia, Australian Government Publishing Service.

Sainsbury, K., R. Campbell, R. Lindholm, and A. Whitelaw. 1997. Experimental management of an Australian multispecies fishery: examining the possibility of trawl-induced habitat modification. Pp. 107-112 in E.K. Pikitch, D.D. Huppert, and M.P. Sissenwine, editors. Global trends: fisheries management. American Fisheries Society, Symposium 20. Bethesda, MD.

Sanchez-Jerez, P. and A. Ramos Espla. 1996. Detection of environmental impacts by bottom trawling on *Posidonia oceanica* (L.) Delile meadows sensitivity of fish and macroinvertebrate communities. Journal of Aquatic Ecosystem Health. 5(4): 239-253.

Schoellhamer, D. 1996. Anthropogenic sediment resuspension mechanisms in a shallow microtidal estuary. Estuarine, Coastal and Shelf Science. 45(5): 533-548.

Scott, J. 1982. Selection of bottom type by groundfishes of the Scotian shelf. Can. J. Fish. Aquat. Sci. 39: 943-947.

Serchuk, F. M., S. A. Murawski and J. W. Ropes. 1982. Ocean quahog *Arctica islandica,* p. 144-146. In M. D. Grosslein and T. R. Azarovitz (eds.), Fish distribution: MESA New York Bight Atlas Monograph 15. New York Sea Grant Institute, Albany.

Serchuk, F. M. and S. A. Murawski. 1980. Assessment and status of surf clam *Spisula solidissima* (Dillwyn) populations in offshore middle Atlantic waters of the United States. NEFSC, Woods Hole Lab. Ref. Doc. 80-33.

Sheehan, E. and R. Moore. 1998. "Perspectives from five ports." Prepared for the Maine Dept. of Marine Resources by Coastal Enterprises, Inc.

Sherman, K., N. Jaworski, T. Smayda. 1996. The Northeast shelf ecosystem – assessment, sustainability, and management. Blackwell Science, Inc. Cambridge, MA. 564 p.

Simenstad, C. 1990. Summary and conclusions from workshop and working group discussions. Pp. 144-152 in Simenstad, C., ed. Effects of dredging on anadromous Pacific coast fishes. Workshop Proceedings, University of Washington.

Sindermann, C. J. 1992. Disease risks associated with importation of nonindigenous marine animals. *Marine Fisheries Review* 54(3): 1-9.

Snelgrove, P., J. Grassle, J. Butman. 1998. Sediment choice by settling larvae of the bivalve, *Spisula solidissima* (Dillwyn), in flow and still water. J. Exp. Mar. Biol. Ecol. 231(2): 171-190

Snelgrove, P., J. Grassle, R. Petrecca, H. Ma. 1999. In situ habitat selection by settling larvae of marine soft-sediment invertebrates. Limnol. Oceanogr. 44(5): 1341-1347.

Sokolic, W. 2001. Census shows retirees flocking to coastal towns. Courierpost Online, Monday, May 28, 2001.

Spruck, C. R., R. L. Walker, M. Sweeney and D. Hurley. 1995. Gametogenic cycle in the non-native Atlantic surf clam, *Spisula solidissima* (Dillwyn, 1817), cultured in the coastal waters of Georgia. Gulf Res. Rep. 9(2): 131-137.

Squires, D. and J.E. Kirkley. 1996. Individual transferable quotas in a multiproduct common property industry. Canadian Journal of Economics. 29 (2): 318-342.

Steimle, F. and C. Zetlin. 2000. Reef habitats in the middle Atlantic bight: abundance, distribution, associated biological communities, and fishery resource use. Marine Fisheries Review. 62(2): 24-42.

Steimle, F., C. Zetlin, P. Berrien, D. Johnson, and S. Chang. 1999. Tilefish, *Lopholatilus chamaeleonticeps*, life history and habitat characteristics. NOAA Tech. Mem. NMFS-NE-152. 30 p.

Stephan, C., R. Peuser, and M. Fonseca. 2000. Evaluating fishing gear impacts to submerged aquatic vegetation and determining mitigation strategies. ASMFC Habitat Management Series #5. 38 p.

Stevenson, J. and N. Confer. 1978. Summary of available information on Chesapeake Bay submerged vegetation. FWS/OBS - 78/66.

Stevenson, D. H. Personal communication. NERO. Gloucester, MA.

Stevenson, D.H., L. Chiarella, D. Stephan, R. Reid, and M. Pentony. In press. The effects of fishing on marine habitats of the northeastern United States. NMFS.

Stewart, P. 1999. Gear modification as a management tool to limit ecosystem effects of fishing. ICES/SCOR Symposium, Ecosystem Effects of Fishing, April 1999. St. John's, Newfoundland. 20 p.

Stone, S. L., T. A. Lowery, J. D. Field, S. H. Jury, D. M. Nelson, M. E. Monaco, C. D. Williams, and L. Andreasen. 1994. Distribution and abundance of fishes and invertebrates in mid-Atlantic estuaries. ELMR Report No 12. NOAA/NOS Strategic Environmental Assessments Division. Silver Spring, MD. 280 p.

Stumpf, R. and R. Biggs. 1988. Surficial morphology and sediments of the continental shelf of the middle Atlantic bight, pp. 51-72 in A.L. Pacheco, ed., Characterization of the middle Atlantic water management unit of the northeast regional action plan. NOAA Tech. Mem. NMFS-F/NEC-56. Woods Hole, MA. 322 p

Swingle, W. M., S. G. Barco, T. D. Pitchford, W. A. McLellan, and D. A. Pabst. 1993. Appearance of juvenile humpback whales in the nearshore waters of Virginia. Mar. Mamm. Sci. 9: 309-315.

Thompson, G. 1993. Impacts of trawling on the seabed and benthic community. Appendix F. Amendment 24, Bering Sea/Aleutian Islands Groundfish Fishery Management Plan. 5 p.

Thompson, I., D.S. Jones, and J.W. Ropes. 1980. Advanced age for sexual maturity in the ocean quahog *Arctica islandica* (Mollusca: Bivalvia). Mar. Biol. 57: 35-39.

Thrush, S., J. Hewitt, V. Cummings, and P. Dayton. 1995. The impact of habitat disturbance by scallop dredging on marine benthic communities: What can be predicted from the results of experiments? Marine Ecology Progress Series. 129(1-3): 141-150.

Thrush, S., J. Hewitt, V. Cummings, P. Dayton, M. Cryer, S. Turner, G. Funnell, R. Budd, C. Milcurn, and M. Wilkinson. 1998. Disturbance of the marine benthic habitat by commercial fishing: impacts at the scale of the fishery. Ecological Applications. 8(3): 866-879.

Thurman, W. N. and J. Easley. 1992. Valuing changes in commercial fishery harvests: a general equilibrium derived demand analysis. J. of Environmental Economics and Management. 22 (3).

Townsend, D. 1992. An overview of the oceanography and biological productivity of the Gulf of Maine; pp. 5-26 in Townsend, D. and P. Larsen, eds. The Gulf of Maine, NOAA Coastal Ocean Program Regional Synthesis Series Number 1. Silver Spring, MD 135 p.

Tupper, M. and R. Boutilier. 1995a. Size and priority at settlement determine growth and competitive success of newly settled Atlantic cod. Mar Ecol Prog Ser. 118: 295-300.

Tupper, M. and R. Boutilier. 1995b. Effects of habitat on settlement, growth, and postsettlement survival of Atlantic cod (*Gadus morhua*). Can J Fish Aquat Sci. 52: 1834-1841.

Turner, S., S. Thrush, J. Hewitt, V. Cummings, and G. Funnell. 1999. Fishing impacts and the degradation or loss of habitat structure. Fisheries Management and Ecology. 6: 401-420.

Turtle Expert Working Group (TEWG). 1998. An assessment of the Kemp's ridley (*Lepicochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the Western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-409. 96 p.

U.S. Department of Commerce (USDC). 1985. Regional action plan: northeast regional office and northeast fisheries center. NOAA. NMFS. Tech. Memo. F/NEC-37. 20 p.

_____. 1998a. Report of the 26th Northeast Regional Stock Assessment Workshop (26th SAW), Stock Assessment Review Committee (SARC). NEFSC Ref. Doc. 98-03.

_____. 1998b. Report of the 27th Northeast Regional Stock Assessment Workshop (27th SAW), Stock Assessment Review Committee (SARC). NEFSC Ref. Doc. 98.

_____. 2000a. 30th Northeast Regional Stock Assessment Workshop. NEFSC Ref. Doc.00-03.

_____. 2000b. 31st Northeast Regional Stock Assessment Workshop. NEFSC Ref. Doc.00-15.

_____. 2001. The effects of fishing on marine habitats of the northeastern United States. NMFS/NERO. Gloucester, MA.

_____. 2002. Report of the workshop on the effects of fishing gear on marine habitats of the northeastern United States. NMFS/NERO. Gloucester, MA.

University of Rhode Island. 1982. A characterization of marine mammals and turtles in the Mid and North Atlantic areas of the US outer continental shelf. Final Report. Prepared for USDI under contract #AA551-CT8-48.

Valentine, P. and R. Lough. 1991. The influence of geological and oceanographic environmental factors on the abundance and distribution of fisheries resources of the northeastern United States continental shelf: The seafloor environment and the fishery of eastern Georges Bank. Open File Report 91-439. US Geol. Surv. 25 p.

Valentine, P., E. Strom, R. Lough, and C. Brown. 1993. Maps showing the sedimentary environment of eastern Georges bank. U.S. Geol. Surv. Misc. Invest. Ser., Map I-2279-B, scale 1:250,000.

Van der Knapp, M. 1993. Physical damage to corals caused by trap fishing on reefs of Bonaire, Netherlands Antilles. Environmental Conservation. 20(3): 265-267.

Van Dolah, R., P. Wendt, and N. Nicholson. 1987. Effects of a research trawl on a hard-bottom assemblage of sponges and corals. Fisheries Research. 5: 39-54.

Veale, L., A. Hill, S. Hawkins, and A. Brand. 2000. Effects of long-term physical disturbance by commercial scallop fishing on subtidal epifaunal assemblages and habitats. Marine Biology. 137(2): 325 337.

Vecchione, M. and R. Griffis. 1996. How many species of surf clams? Oceanog. 9: 48-49.

Vladykov, V. D. and J. R. Greeley. 1963. Order Aciperseroidei. *In:* Fishes of the western North Atlantic. Part III. Mem. Sear Found. Mar. Res. 1: 24-60.

Walker, R. and P. Heffernan. 1994. Age, growth rate, and size of the southern surfclam, *Spisula solidissima similis* (Say, 1822). J. Shellfish Res. 13: 433-441.

Wallace, D. Personal communication. Wallace and Associates, Inc. Salisbury, MD.

Wallace, D. H. and T. B. Hoff. (in press). Use of hydraulic clam dredges on benthic habitat off the northeast United States. Proceedings of a Symposium on Effects of Fishing on Benthic Habitats. Tampa, FL. November, 2002.

Walker, R. W. and P. B. Heffernan. 1994. Age, growth rate, and size of the southern surfclam, *Spisula solidissima similis* (Say, 1822). J. Shellfish Res. 13: 433-441.

Wang, S. 1995. The surfclam ITQ management: an evaluation. Marine Resource Economics. 10(1): 93-98.

Waring, G. T., D. L. Palka, P. J. Clapham, S. Swartz, M. C. Rossman, T. V. N. Cole, K. D. Bisack, and L. J. Hansen. 1999. U.S. Atlantic Marine Mammal Stock Assessments – 1998. NOAA Technical Memorandum NMFS-NE-116.

Watling, L. and E. Norse. 1998. Disturbance of the seabed by mobile fishing gear: a comparison to forest clearcutting. Conservation Biology. 12(6): 1180-1197.

Watling, L., J. Dearborn, and L. McCann. 1988. General distribution of macrobenthic assemblages in the Gulf of Maine. Pp. 109-119 in I. Babb and M. Deluca, eds. Benthic Productivity and Marine Resources of the Gulf of Maine. U.S. Dept. Commerce, Natl. Undersea Res. Prog. Res. Rep. 88-3.

Watkins, W.A., K.E. Moore, J. Sigurjonsson, D. Wartzok, and G. Notarbartolo di Sciara. 1984. Fin whale (*Balaenoptera physalus*) tracked by radio in the Irminger Sea. Rit. Fisk. 8(1): 1-14.

Weinberg, J. Personal communication. NEFSC. Woods Hole, MA.

Weinberg, J. 1999. Age-structure, recruitment, and adult mortality in populations of the Atlantic surfclam, *Spisula solidissima*, from 1978-1997. Mar. Biol. 134: 113-125.

Weinberg, J. 1998. Density-dependent growth in the Atlantic surfclam, *Spisula solidissima*, off the coast of the Delmarva Peninsula, USA. Marine Biology. 130: 621-630.

Weinberg, J., and T. Helser. 1996. Growth of the Atlantic surfclam, *Spisula solidissima*, from Georges Bank to the Delmarva Peninsula, USA. Marine Biology 126:663-674.

Weissberger, E., L. Cargnelli, S. Griesbach, and D. Packer. 1998a. EFH Source Document, Atlantic Surfclam, *Spisula solidissima*, Life History and Habitat Requirements. NEFSC, NMFS, Highlands, NJ.

Weissberger, E., L. Cargnelli, S. Griesbach, and D. Packer. 1998b. EFH Source Document, Ocean Quahog, *Arctica islandica*, Life History and Habitat Requirements. NEFSC, NMFS, Highlands, NJ.

Wilson, D., B. McCay, D. Estler, M. Perez-Lugo, J. Lamarque, S. Seminski, and A Tomczuk. 1998. A social and cultural impact assessment of the highly migratory species fisheries management plan and the amendment to the Atlantic billfish fisheries management plan. National Marine Fisheries Service, Highly Migratory Species Office. Silver Spring, MD.

Wion, D. and R. McConnaughey. 2000. Mobile fishing gear effects on benthic habitats: A bibliography. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-116. 163 p.

Witbaard, R. and R. Klein. 1993. A method to estimate the bottom trawl intensity independently from fisheries itself by using internal molluscan growth lines ICES CM 1993/K:16. 8 p.

Yancey, R. M. and W. R. Welch. 1968. The Atlantic coast surf clam- with a partial bibliography. U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries, Circular 288.

Table 1. Proposed surfclam overfishing definition and approved ocean quahog overfishing definition.

Reference Point	Basis	Estimated Value
Surfclams		
Biomass Target	½ Current (1999) biomass* (proxy for B_{MSY})	1.4 billion pounds (80 million bushels)
Biomass Threshold	½ Proxy for B_{MSY}*	700 million pounds (40 million bushels)
Fishing Mortality Target	$F_{target} < F_{threshold}$	Set by Council selected quota
Fishing Mortality Threshold	F=M	0.15
Current F		0.02
Ocean Quahogs		
Biomass Target	½ Virgin Biomass	2 billion pounds (200 million bushels)
Biomass Threshold	1/4 Virgin Biomass	1 billion pounds (100 million bushels)
Fishing Mortality Target	$F_{0.1}$	0.02
Fishing Mortality Threshold	$F_{25\%MSP}$	0.042
Current F, exploited area		0.021

*The surfclam biomass estimate in 1999 is from the KLAMZ model which is a "lower bound" estimate for B_{msy} because the stock has been fished for some time and the biomass has been somewhat reduced from the virgin level.

Table 2. Estimated area in Federal waters towed by hydraulic clam dredges in 2000.

	Quahogs	Surfclams
Hours at sea per year	28,440[a]	19,907[a]
Setting & hauling gear (25%)	7,110	4,977
Hours fished per year	21,330	14,930
Average speed/tow (nmi/hr)	2	2
Total distance towed (nmi)	42,660	29,860
Ft per nmi	6076	6076
Total distance towed (ft)	2.385×10^9	1.814×10^9
Average dredge width (ft)	9.2	9.2
Area towed per year (ft²)	2.385×10^{10}	1.669×10^{10}
Square ft per n mile	3.69×10^7	3.69×10^7
Area towed per year (nmi²)	64.6	45.2
a = From clam vessel logbook data, excludes Maine quahog fishery		

Source: USDC 2002.

Table 3. Impact of clam dredges on benthic habitat.

TYPE OF IMPACT	DEGREE OF IMPACT	DURATION	TYPE OF EVIDENCE	COMMENTS
MUD				
Removal of Major Physical Features	N/A			
Impacts to Biological Structure	N/A			
Impacts to Physical Structure	N/A			
Changes in Benthic Prey	N/A			
SAND				
Removal of Major Physical Features	Unknown			
Impacts to Biological Structure	XXX	Months - Years[1]	PR, GL, PJ	[1] Dependent upon species composition (eg. Amphipod tubes < 1 yr recovery)
Impacts to Physical Structure	XXX[2]	Days - Months	PR, GL, PJ	[2] Represents major alteration to regime for soft bodied organisms
Changes in benthic prey	Unknown			
GRAVEL				
Removal of Major Physical Features	N/A			
Impacts to Biological Structure	N/A			
Impacts to Physical Structure	N/A			
Changes in benthic prey	N/A			

KEY: X = Effect can be present, but is rarely large; XX = Effect is present and moderate; XXX = Effect is often present and can be large; N/A = Effect is not present or not applicable; Unknown = effects are not currently known; (H) = High energy environment; (L) = Low energy environment; PR = Peer reviewed literature; GL = Grey literature; PJ = Professional judgement. For definitions of Substrate Type and Type of Impact see Appendix D.
NOTE: Ongoing Canadian studies for clam dredges are near completion and will contribute substantially to this discussion.

Source: USDC 2002.

Table 4. Surfclam forecasts from SARC 30.

Stock Assessment Region[1,2]	Biomass 1999	CV	Recent Mean Catch+ 20%	Recent Mean Recruitment	Biomass 2002	% Change in Biomass
SVA	2,500	71%	2	0	1,600	-36%
DMV	320,000	52%	900	23,000	331,000	3%
SNJ	68,000	114%	4,000	12,000	81,000	19%
NNJ	480,000	26%	16,000	42,000	441,000	-8%
LI	47,000	72%	100	3,000	48,000	1%
SNE	84,000	40%	90	4,900	82,000	-3%
GBK	265,000	34%	0	29,000	334,000	26%
Total	1,268,000	19%	21,000	114,000	1,319,000	4%

[1] SVA = southern Virginia, DMV = Delmarva, NNJ = Northern New Jersey, SNJ= Southern New Jersey, LI = Long Island, SNE = southern New England, GBK = Georges Bank
[2] Source: KLAMZ assessment model, USDC 2000a.

Table 5. Ocean quahog forecasts from SARC 31.

Projections (weights in mt of meats):

	SVA[1]	DMV	NJ	LI	SNE	GBK	EEZ
Estimated Biomass in 1999 (000 mt meats)[2]	0.079	60	260	530	330	620	1,800
CV[3]	10%	18%	24%	17%	13%	37%	14%
Projected Recruitment (000 mt meats)[2,4]	0.0035	1.5	3.9	6.5	4.1	6.8	23
Projected Catch (000 mt meats)[5]	0.0	1.2	3.3	6.0	7.3	0.0	18
Projected Biomass in 2002 (000 mt meats)[2]	0.089	62	250	512	310	620	1,760
% Change	12%	0%	-1%	-3%	-6%	0%	-2%

[1]Estimates for SVA not reliable. [2]From KLAMZ delay-difference biomass dynamics model for quahog 70+ mm shell length. [3]Bootstrap, 500 iterations. [4]Constant over time. [5]Mean 1997-1999.

Source: USDC 2000b.

Table 6. Gulf of Maine benthic community types as identified by Watling et al. 1988.

Benthic Community Type	**Benthic Community Description**
Nearshore Shallow	All combinations of sediment type. Most diverse community with greatest total number of individuals. Depth: 0-50m. Organic input from terrestrial sources, attached macroalgae, and phytoplankton. Many species reproduce in summer; some boreal forms reproduce in winter (e.g. *Unciola*).
Boreal Mud	Fine sediments influenced by cold Maine intermediate water mass. Seasonal reproductive cue is input of spring phytoplankton bloom since temperature is seasonally uniform. Species diversity is high but number of individuals is reduced because of reduced organic inputs. Representative megafauna include sea pen (*Pennatula aculeata*) and cerianthid anemone (probably *Cerianthus borealis*).
Sand Bank	Sediment is sand and gravel with little or no fine material. Predominately Maine intermediate water mass. Jeffreys and Fippenies Ledges are typical habitats. Megafauna include sea scallops (*Placopecten magellanicus*), other filter feeders (e.g. *Myxicola infundibulum*) and sponges. Banks protrude into photic zone, and are subject to localized upwelling.
Rock Ledge	Substrate mostly rocky outcrops. Predominately Maine intermediate water. Filter feeders do not cover available surfaces since quality and quantity of food particles are low.
Boreal-Slope Transition	Sediment is primarily mud veneer overlying sand and gravel. Transition zone between boreal mud and upper continental slope. Located in Jordan Basin, swells west of Georges Basin, and limited in Wilkinson Basin. Maine bottom & intermediate water mix here, so bottom temperatures vary. Characteristic species include brittle star (*Ophiura sarsi*) and amphipod *Erichthonius*.
Upper Slope Mimic	Sediments are generally sand mixed with both fine particles and gravel. Upwelling brings in upper slope water and the species representative of this community. Deepest part of GOM where slopwater is not strongly diluted with Maine intermediate water. Characteristic species include foraminiferan *Bathysiphon* and deepwater isopods.

Source: USDC 2001.

Table 7. Sedimentary provinces of Georges Bank, as defined by Valentine *et al.* (1993.).

Sedimentary Province	Depth (m)	Description
Northern edge	40-200	Dominated by gravel with portions of sand, common boulder areas, and tightly packed pebbles. Epifauna (bryozoa, hydrozoa, and worm tubes) are abundant in areas of boulders where bottom trawling is low.
Northern slope & northeast channel	200-240	Variable sediment type (gravel, gravel-sand, and sand) with ripples and scattered bedforms. This is a transition zone between the northern edge and southern slope.
North/central shelf	60-120	Highly variable sediment type (ranging from gravel to sand) with rippled sand, large bedforms, and patchy gravel lag deposits.
Central & south-western shelf; shoal ridges	10-80	Dominated by sand (fine and medium grain) with large sand ridges, dunes, waves, and ripples. Small bedforms in southern part.
Shoal troughs	40-60	Gravel (including gravel lag) and gravel-sand between large sand ridges. Patch large bedforms. Strong currents. (Few samples – submersible observation noted presence of gravel lag, rippled gravel-sand, and large bedforms.
Southeastern shelf	80-200	Rippled gravel-sand (medium and fine-grained sand) with patchy large bedforms and gravel lag. Weaker currents.
Southeastern slope	400-2000	Dominated by silt and clay with portions of sand (medium and fine) with rippled sand on shallow slope and smooth silt-sand deeper.

Source: USDC 2001.

Table 8. Demersal fish assemblages of Georges Bank and Gulf of Maine identified using trawl survey data dating 1963-1978 (Overholtz and Tyler 1985).

Assemblage	Species
Slope & Canyon	whiting, white hake, red hake, offshore hake, monkfish
Intermediate	whiting, red hake, Atlantic cod, haddock, monkfish, ocean pout, yellowtail flounder
Shallow	whiting, white hake, red hake, Atlantic cod, haddock, pollock, monkfish, ocean pout, yellowtail flounder, windowpane
Gulf of Maine-Deep	whiting, white hake, Atlantic cod, haddock, American plaice, witch flounder
Northeast Peak	white hake, Atlantic cod, haddock, pollock, ocean pout, winter flounder

Source: USDC 2001.

Table 9. Mid-Atlantic habitat types as described by Pratt (1973) and Boesch (1979) with characteristic macrofauna as identified in Boesch 1979.

Habitat Type (after Boesch 1979)	**Description**		
	Depth (m)	**Characterization (Pratt faunal zone)**	**Characteristic Benthic Macrofauna**
Inner shelf	0-30	characterized by coarse sands with finer sands off MD and VA (sand zone)	Polychaetes: *Polygordius, Goniadella, Spiophanes*
Central shelf	30-50	(sand zone)	Polychaetes: *Spiophanes, Goniadella* Amphipod: *Pseudunciola*
Central and inner shelf swales	0-50	occurs in swales between sand ridges (sand zone)	Polychaetes: *Spiophanes, Lumbrineris, Polygordius*
Outer shelf	50-100	(silty sand zone)	Amphipods: *Ampelisca vadorum, Erichthonius* Polychaetes: *Spiophanes*
Outer shelf swales	50-100	occurs in swales between sand ridges (silty sand zone)	Amphipods: *Ampelisca agassizi, Unciola, Erichthonius*
Shelf break	100-200	(silt-clay zone)	not given
Continental slope	>200	(none)	not given

Source: USDC 2001.

Table 10. Major recurrent demersal species assemblages of the Mid-Atlantic bight during spring and fall as determined by Colvocoresses and Musik (1983).

Season	Species Assemblage				
	Boreal	Warm temperate	Inner shelf	Outer shelf	Slope
Spring	Atlantic cod little skate sea raven monkfish winter flounder longhorn sculpin ocean pout whiting red hake white hake spiny dogfish	black sea bass summer flounder butterfish scup spotted hake northern searobin	windowpane	fourspot flounder	shortnose greeneye offshore hake blackbelly rosefish white hake
Fall	white hake whiting red hake monkfish longhorn sculpin winter flounder yellowtail flounder witch flounder little skate spiny dogfish	black sea bass summer flounder butterfish scup spotted hake northern searobin smooth dogfish	windowpane	fourspot flounder fawn cusk eel gulf stream flounder	shortnose greeneye offshore hake blackbelly rosefish white hake witch flounder

Source: USDC 2001.

Table 11. Summary of life history and habitat parameters of the Atlantic surfclam. Information is presented for each life stage (eggs, larvae, juveniles/adults, and spawning adults).

Life Stage	Size and Growth	Distribution / Density	Substrate	Temperature	Salinity
EGGS[1]	Unfertilized eggs are 56 μm in diameter.			6 - 24°C optimal for fertilization.	Sperm and eggs can withstand salinities as low as 40% diluted seawater for 2-3 h. Hypo- or hypertonicity may cause parthenogenesis
LARVAE[2]	At 22°C: 28 hr to straight hinge veligers. At 21.7°C: trochophore larvae 9hrs post-fertilization, veligers 19-20hrs, pediveligers at 18d. At 14°C: 40 hr to trochophore, 72 hr to straight hingeveligers. Metamorphosis: 35d at 14°C, 19 d at 22°C. Most larvae metamorphose at 230-250 μm, although one study reports 303 μm.	One study in Massachusetts found the highest concentration of larvae (823 larvae/m^3) at 30 m in early October. In NJ, high concentrations of larvae occur from May-June and Sept-Oct; minor peaks sometimes occur in July. spring larvae were derived from inshore clams, while fall larvae were derived from offshore clams.		Larvae tolerate 14-30°C; optimum 22°C, mortality >30°C. Larvae reared at lower temps were smaller than those at warmer temps. In New England, high larval concentrations are associated with 14-18°C water.	Larvae in the lab can survive and grow at 16 ppt; with acclimation as low as 8 ppt. Larvae starting at 30 ppt crossed a salinity gradient of 5 ppt and 10 ppt, but not 15 ppt. Upward swimming rate increased with salinity, larvae stayed in high salinity.
JUVENILES / ADULTS[3]	Growth rates are similar for the first 3-5 years of life, then offshore clams grow more rapidly than inshore clams. High population density reduces growth rate and maximun lengths of 226 mm and 37 yrs of age.	Range from the Gulf of Maine south to Cape Hatteras, NC. Oceanic, most turbulent areas beyond breaker zone, from 8-66m. Distribution of beds ranges from even aggregations to localized or patchy dense beds.	Adults burrow in medium to coarse sand and gravel substrates, also found in silty to fine sand, do not borrow in mud. Substrate type does not affect growth rate.	37°C is lethal in the lab. Clams survive temps as low as 2°C in the field; clams are more active >15°C. Burrowing is fastest at 16-26°C; inhibited ≥30°C. Growth rate is positively correlated with temperature, growth most rapid in spring/early summer.	Adults in lab tolerated 14-52 ppt. Surfclams at 28 ppts in the field survived in the lab at 12.5 ppt for several days, suggesting that a variable other than salinity controls distribution.
SPAWNING ADULTS[4]				Spawning occurs from 19.5-30°C; detrimental > 30°C. Laboratory: burrowing increased up to 20°C, but decreased >20°C. Temperature important for initiation and timing of both gonadal development and spawning. Off NJ, spawning heaviest in summer/fall when temperatures are at their highest; may be a minor Oct spawning, brought about by breakdown of thermocline. Delayed spawning and single annual cycle may be related to cold temps. Abrupt temp. changes not a clear cause of spawning in nature.	

[1] Allen (1953), Schechter (1956), Yancey and Welch (1968), Castagna and Chanley (1973), Wright *et al.* (1983), Roosenberg *et al.* (1984), Clotteau and Dubé (1993)
[2] Loosanoff and Davis (1963), Yancey and Welch (1968), Ropes (1980), Tarnowski (1982), Fay *et al.* (1983), Wright *et al.* (1983), Roosenberg *et al.* (1984), Mann (1985), Mann *et al.* (1991), Ma (1997)
[3] Henderson (1929), Clarke (1954), Yancey and Welch (1968), Merrill and Ropes (1969), Ogren and Chess (1969), Ropes and Merrill (1970), Castagna and Chanley (1973), Flowers (1973), Franz (1976), Savage (1976), Loesch and Ropes (1977), Ropes and Ward (1977), Goldberg (1978), Jones *et al.* (1978, 1983), Ropes (1978, 1980), Boesch (1979), Prior *et al.* (1979), Ambrose *et al.* (1980), Garlo (1980), Jones (1980, 1981a), Meyer *et al.* (1981), Fay *et al.* (1983), Wagner (1984), MacKenzie *et al.* (1985), Fogarty and Murawski (1986), Howe *et al.* (1988), Murawski and Serchuk (1989), Goldberg and Walker (1990), Sephton and Bryan (1990), Walker and Heffernan (1990, 1994), Cerrato and Keith (1992), Dames and Moore (1993), Weinberg (1995, 1998), Weinberg and Helser (1996), Chintala (1997)
[4] Loosanoff and Davis (1963), Ropes (1968a,b, 1980, 1982), Jones (1981b), Fay *et al.* (1983), Sephton (1987), Kanti *et al.* (1993), Chintala and Grassle (1995)

Table 11 (continued). Summary of life history and habitat parameters of the Atlantic surfclam. Information is presented for each life stage (eggs, larvae, juveniles/adults, and spawning adults).

Life Stage	Dissolved Oxygen	Currents	Prey	Predators	Spawning Period	Notes
EGGS[1]					*spawning adults section*	Fertilization occurs in water column above spawning beds; pH 7.8-10 optimal for fertilization.
LARVAE[2]		Larval settlement coincides with relaxation of upwelling events. Dispersal via water currents, swimming and crawling occur during larval stages. Convergence of tidal and longshore currents may trap larvae off western Long Island.				
JUVENILES / ADULTS[3]	Hypoxia may be lethal, or lower growth rate and maximum size in the field. In the lab, burrowing time was slower at 1.45 mg/l than at higher D.O. levels. Clams died after 5 d at a D.O. of 0.9 mg/l. anoxic event in 1976 off NJ and Long Island killed 62% of NJ surfclam resource; lower lethal limit of 2 ppm D.O. assumed.	Currents important in determining eventual patterns of distribution and settlement of developing juveniles. Oceanic storms and currents may displace adults considerable distance from burrows; survivors reburrow at new site.	Planktivorous siphon feeders. Food varies with season, geographic location and depth of bed; feed primarily on phytoplankton, especially diatoms and ciliates. Retain particles ≥ 4 μm diameter.	Primarily moon snails, also sea stars, horseshoe crabs, lady crabs, Jonah crabs, sea gulls, & shrimp. Predation rate of moon snails lowered by low temps. and salinities, ceased feeding at <2 and 5°C respectively, and <10 and 6 ppt salinity respectively. Haddock and cod prey on injured clams after storms.		Metamorphosis to juveniles and settlement to substrate ranges from 18-35d (varies with temp.). The age of maturity ranges from 3 months to 4 yrs post-settlement. Without examining the gonads of small clams, one can't assume level of maturity. Longevity up to 25 yrs; largest individual recorded 226 mm.
SPAWNING ADULTS[4]					Surfclams can reach sexual maturity and spawn as early as 3 months post settlement. Off NJ: major spawning early July-mid Aug; in some years second major spawning occurs mid-Oct. Spawning is earlier in more southern areas.	Rate of temperature change may be a more important stimulus for spawning than ambient temperature.

Source: Cargnelli *et al.* 1999a.

Note: 1 mm = 0.04 in; 1 m = 39.37 in; 1 cm = 0.39 in; 1 kg = 2.2046 lbs

[1] Allen (1953), Fay *et al.* (1983), Clotteau and Dubé (1993)

[2] Ropes (1980), Mann (1985), Ma (1997)

[3] Leidy (1878), Ropes and Merrill (1966, 1973), Yancey and Welch (1968), Ogren and Chess (1969), Jacobson (1972), Savage (1976), Franz (1977), Goldberg (1978), Garlo *et al.* (1979), Prior *et al.* (1979), Ropes *et al.* (1979), Thurberg and Goodlett (1979), Garlo (1980, 1982), Ropes (1980), Fay *et al.* (1983), Botton and Haskin (1984), Robinson *et al.* (1984), MacKenzie *et al.* (1985), Howe *et al.* (1988), Riisgård (1988), Walker and Heffernan (1990), Stehlik (1993), Viscido (1994), Chintala and Grassle (1995), Weinberg and Helser (1996), Dietl and Alexander (1997)

[4] Allen (1951), Loosanoff and Davis (1963), Ropes (1968a,b, 1979, 1980, 1982), Yancey and Welch (1968), Jones (1981b), Meyer *et al.* (1981), Tarnowski (1982), Fay *et al.* (1983), Mann (1985), Sephton (1987), Kanti *et al.* (1993), Chintala and Grassle (1995)

Table 12. Summary of the life history and habitat parameters of the ocean quahog. Information is presented for each life stage (larvae, juveniles, adults, and spawning adults).

Life Stage	Size and Growth	Habitat	Substrate	Temperature	Salinity
LARVAE[1]	Larval period (hatching to settlement) is 32 days long at 13°C and 55 days at 8.5-10°C. Size at metamorphosis ranges from 175-240 μm.	Larval settlement believed to occur throughout adult distribution range. Larvae present in New England waters in May and July-Nov.		Larvae abundant at temperatures of 14-18°C.	Found at oceanic salinities.
JUVENILES[2]	Metamorphosis occurs at 175-240 μm. Growth is relatively fast during juvenile period: in the field, individuals 9-20 mm long grew 9.5 mm/year; in the lab, individuals 2-5 years old grew 18 mm/year.		Medium to fine grain sand, sandy mud, silty sand.	Capable of surviving laboratory experiments at temperatures of 1-20°C.	Found at oceanic salinities.
ADULTS[3]	One of the longest-lived bivalves. Maximum age of 225 years. When >50 mm, growth very slow (<1 mm/year), or not at all. Growth is negatively correlated with density.	Although capable of surviving in shallower sites, most commercial concentrations found at 25-61 m depth. Occur shallower in Gulf of Maine, and deeper south of Cape Cod.	Medium to fine grain sand, sandy mud, silty sand.	Restricted to cooler waters where temps rarely exceed 20°C. Optimal temperature range: 6-16°C. Inshore limit appears to be the 16°C bottom isotherm in summer.	Found at oceanic salinities, but kept successfully in the lab at salinities as low as 22 ppt.
SPAWNING ADULTS[4]	Earliest age of maturity is 7 years, but mean is 13.1 years and 49.9 mm for males, and 12.5 years and 49.2 mm for females.		Medium to fine grain sand, sandy mud, silty sand	Spawning may occur when a critical temperature is reached (13.5°C), but other stimuli (DO, pH, food availability) may also be important. Lab studies have shown no effect of temperature on spawning.	Role of salinity as a stimulus for spawning unclear. Changes in salinity did not induce spawning in the lab.

[1] Landers (1972, 1976), Lutz *et al.* (1981, 1982), Mann (1985, 1989), Mann and Wolf (1983)

[2] Murawski *et al.* (1980, 1982), Fogarty (1981), Lutz *et al.* (1982, 1989), Ropes *et al.* (1984), Kraus *et al.* (1989, 1991, 1992), Kennish *et al.* (1994), Witbaard *et al.* (1997)

[3] Merrill and Ropes (1969), Merrill *et al.* (1969), Medcof and Caddy (1971), Golikov and Scarlato (1973), Ropes (1978), Jones (1980), Murawski *et al.* (1980, 1982), Thompson *et al.* (1980a), Fogarty (1981), Ropes and Pyoas (1982), Serchuk *et al.* (1982), Turekian *et al.* (1982), Ropes and Murawski (1983), Ropes *et al.* (1984a,b), Beal and Kraus (1989), Fritz (1989, 1991), Kennish *et al.* (1994), Weidman and Jones (1994), Kennish and Lutz (1995)

[4] Loosanoff (1953), Medcof and Caddy (1971), Landers (1976), Fogarty (1981), Jones (1981), Mann (1982), Beal and Kraus (1989), Rowell *et al.* (1990)

Table 12 (continued). Summary of the life history and habitat parameters of the ocean quahog. Information is presented for each life stage (larvae, juveniles, adults, and spawning adults).

Life Stage	Currents	Prey	Predators	Notes
LARVAE[1]	Eggs and larvae are planktonic, drifting with currents until larvae metamorphose and settle to bottom.	Unicellular algae		Three larval stages: trochophore, veliger and pediveliger.
JUVENILES[2]		Unicellular algae	Predators include rock crabs, sea stars, boring snails and teleost fish (cod, haddock, sculpin, and ocean pout).	Age at first maturity varies from 6 to >14 years, and may depend on growth rate and locality.
ADULTS[3]		Suspension feeders on phytoplankton. Pump water using their siphons.	Predators include rock crabs, sea stars, boring snails and teleost fish (cod and haddock).	Occur in dense beds over level bottoms. Capable of surviving low oxygen levels; can burrow into the substrate and respire anaerobically for up to a week. Critical O_2 tension 5-7 kPa.
SPAWNING ADULTS[4]		N/A	N/A	Extended spawning period, from May through December, with several peaks during this time. Multiple spawnings likely.

Source: Cargnelli *et al.* 1999b.

Note: 1 mm = 0.04 in
1 cm = 0.39 in
1 m = 39.37 in
1 kg = 2.2046 lbs

[1] Mann (1985)
[2] Clarke (1954), Thompson *et al.* (1980b), Lutz *et al.* (1982), Kraus *et al.* (1989, 1991, 1992), Rowell *et al.* (1990), Kennish *et al.* (1994), Witbaard (1997)
[3] Clarke (1954), Winter (1969, 1970), Medcof and Caddy (1971), Ropes *et al.* (1979), Stehlik (1993)
[4] Loosanoff (1953), Landers (1976), Jones (1981), Mann (1982, 1985), Rowell *et al.* (1990), Fritz (1991)

Table 13. Percentage of landings for each fishing gear type used in Northeast Region in 1999.

	NORTHEAST SPECIES																													
GEAR	BLUEFISH	BUTTERFISH	SURFCLAM	OCEAN QUAHOG	ATLANTIC COD	RED CRAB	SUMMER FLNDR	WINDOW FLNDR	WINTER FLNDR	WITCH FLNDR	YTAIL FLNDR	MONKFISH	HADDOCK	HAKE, RED	HAKE, SILVER	HAKE, WHITE	HALIBUT, ATL.	HERRING, ATL.	MACKEREL, ATL	PLAICE, AMERICAN	POLLOCK	POUT, OCEAN	REDFISH	SCALLOP, SEA	SCUP	BLK. SEABASS	SKATES	SQUID LOLIGO	SQUID ILLEX	TILEFISH
Bag Nets		-																											-	
Beam Trawls, Other	-	-		-					-	-	-	-		-	-									-	-			-		
Cast Nets	-						-																		-					
Combined Gears	-																									-				-
Diving Outfits, Other																								-	-					
Dredge Clam			92	100			-		-			-												-	-					
Dredge Conch							-																				-			
Dredge Scallop, Bay									-	-		-												-						
Dredge Scallop, Sea	-	-			-		2	-	-	-	1	16			-	-				-	-			90	-	-	-	-	-	-
Floating Traps (Shallow)	1	-			-		-		-			-			-			-	2		-				9	-	-	-		
Fyke And Hoop Nets, Fish	-	-					-	-	-	-	-	-															-			
Gill Nets, Drift, Other	9	-					-		-		-	-		-	-			-	-			-			-	-	-	-		
Gill Nets, Drift, Runaround	5	-																												
Gill Nets, Other	5	-					-					-							-							-	-			
Gill Nets, Sink/Anchor, Other	16	-			20		-	-	4	2	6	29	7	-	-	35	8	-	1	2	55	3	16	-	-	-	12	-	-	-
Gill Nets, Stake	-	-					-					-						-	-											
Haul Seines, Beach	1	-					-		-					-	-			-	-								-			
Haul Seines, Long	-	-																												
Haul Seines, Long(Danish)					-				-	-	-	-	-		-	-				-	-		-				-			
Lines Hand, Other	5	-			5		2	-	-	-	-	-	-	-	-	-		-	-	-	-	4	-		12	14	-	-		2
Lines Long Set With Hooks	-	-			17		-		-	-	-	-	2	-	-	5	-		-	-	2	7	-	-	-	-	-	-		61
Lines Long, Reef Fish																														32
Lines Troll, Other	-	-					-																			-				-
Lines Troll With Baits							-																							

Table 13 (continued). Percentage of landings from each fishing gear type used in Northeast Region in 1999.

GEAR	BLUEFISH	BUTTERFISH	SURFCLAM	OCEANQUAHOG	ATLANTIC COD	RED CRAB	SUMMER FLNDR	WINDOW FLNDR	WINTER FLNDR	WITCH FLNDR	YTAIL FLNDR	MONKFISH	HADDOCK	HAKE, RED	HAKE, SILVER	HAKE, WHITE	HALIBUT, ATL.	HERRING, ATL.	MACKEREL, ATL	PLAICE, AMERICAN	POLLOCK	POUT, OCEAN	REDFIS	SCALLOP, SEA	SCUP	BLK. SEABASS	SKATES	SQUID LOLIGO	SQUID ILLEX	TILEFISH
Otter Trawl Bottom, Fish	20	93			57		92	98	95	97	92	53	91	98	99	58	89	2	93	97	42	77	83	-	66	25	86	99	100	4
Otter Trawl Bottom, Scallop	-				-		-		-	-	-	-	-							-	-			9		-	-	-		
Otter Trawl Midwater																		53	-											
Pots And Traps, Conch	-	-			-																	-				-				
Pots And Traps, Crab, Blue	-	-					-																			-				
Pots and Traps, Crab, Blue Peeler	-																													
Pots And Traps, Crab, Other	-					60	-																							
Pots And Traps, Fish	-	-			-		-		-			-		-	-	-		-	-		-	7	-		5	53	-	-		-
Pots And Traps, Lobster Inshore	-	-			-		-		-			-	-	-	-	-			-		-	-	-	-	-	-	-	-		
Pots And Traps, Lobster Ofshore	-	-			-	40	-		-			-		-		-						-	-		-	-		-		-
Pots And Traps, Other	-						-																		-	3				
Pound Nets, Crab	-						-																							
Pound Nets, Fish	5	3			-		2	-	-		-	-		-	-			-	-						-	-	-	-		
Pound Nets, Other	-	-					-		-										2						2	-		-		
Purse Seines, Herring																		31												
Purse Seines, Other	3																													
Reel, Electric or Hydraulic																										-				
Rod and Reel																										-				
Scottish Seine	-	-			-		-	-	-	-	-	-	-	-	-	-			-	-	-	-			-	-	-	-		
Scrapes							-																							
Spears	-																									-				
Stop Seines																		-												
Trawl Midwater, Paired																		14												
Weirs																		-												

"#" Indicates percent landings associated with this gear type for this species
"-" Indicates there was less than 1% landings associated with this gear type for this species
"Blank" Indicates there were no landings recorded for this gear type for this species
"Shading" Indicates gear that caught 1% or greater of the landings for any species.

Source: USDC 2001.

Table 14. Gear reported to land 1% or greater of total landings for each state in 1999.

	Percent of Landings for All Species by State											
Gear	CT	DE	MA	MD	ME	NC	NH	NJ	NY	RI	VA	% All States Combined
By Hand, Other		18										
Diving Outfits, Other					5							1
Dredge Clam			9	10				39	1	1		6
Dredge Crab		11									1	
Dredge Mussel					1							
Dredge Other					3							
Dredge Scallop, Sea	7		10		1		1	2			1	2
Dredge Urchin, Sea					1							
Floating Traps (Shallow)										1		
Fyke And Hoop Nets, Fish				2								
Gill Nets, Drift, Other		4		3				2				1
Gill Nets, Drift, Runaround						1						
Gill Nets, Other						14						1
Gill Nets, Sink/Anchor,			12	5	1		42	5	5	4	3	4
Gill Nets, Stake		7										
Haul Seines, Beach				2							1	
Haul Seines, Long						1						
Hoes					1							
Lines Hand, Other		1	2	1		1	1		1			1
Lines Long Set With Hooks			4			1		1	4			1
Lines Long, Shark						1						
Lines Troll, Other						1						
Lines Trot With Baits				17								1
Not Coded	16				1			1	30			2
Otter Trawl Bottom, Shrimp					1	6	3					1
Otter Trawl Midwater			11		21		8			18		6
Pots And Traps, Conch		2										
Pots And Traps, Crab, Blue		51		36		36		3			6	8
Pots And Traps, Crab, Other			2							1		
Pots And Traps, Eel		2		1								
Pots And Traps, Fish		1		3								
Pots And Traps, Lobster Inshore	13		5		25		9			4		5
Pots And Traps, Lobster Offshore	2		4				9	1		2		1
Pots And Traps, Other			1		1							
Pound Nets, Crab				1								
Otter Trawl Bottom, Crab						1						
Otter Trawl Bottom, Fish	61		38	3	9	7	26	26	58	56	2	18
Pound Nets, Fish				14		1			1		4	2
Purse Seines, Herring			1		23							4
Purse Seines, Menhaden						27		18			74	28
Purse Seines, Other											7	2

Source: USDC 2001.

Table 15. Fishing gears used in estuaries and bays, coastal waters, and offshore waters of the EEZ, from Maine to North Carolina. Includes all gear responsible for 1% or greater of any state's total landings and all gear that harvested any amount of federally managed species. Includes gear used in estuarine waters as identified by ASMFC. Based upon 1999 NMFS landings data and 2000 ASMFC Gear Report.

GEAR	Estuary or Bay	Coastal 0-3 Miles	Offshore 3-200 Miles
Bag Nets	X	X	X
Beam Trawls	X	X	X
By Hand	X	X	
Cast Nets	X	X	X
Clam Kicking	X		
Diving Outfits	X	X	X
Dredge Clam	X	X	X
Dredge Conch	X		
Dredge Crab	X	X	
Dredge Mussel	X	X	
Dredge Oyster, Common	X		
Dredge Scallop, Bay	X		
Dredge Scallop, Sea		X	X
Dredge Urchin, Sea		X	X
Floating Traps (Shallow)	X	X	
Fyke And Hoop Nets, Fish	X	X	
Gill Nets, Drift, Other			X
Gill Nets, Drift, Runaround			X
Gill Nets, Sink/Anchor, Other	X		X
Gill Nets, Stake	X		X
Haul Seines, Beach	X		
Haul Seines, Long	X		
Haul Seines, Long(Danish)		X	X
Hoes	X		
Lines Hand, Other	X	X	X
Lines Long Set With Hooks			X
Lines Long, Reef Fish			X
Lines Long, Shark			X
Lines Troll, Other		X	X
Lines Trot With Baits		X	X
Otter Trawl Bottom, Crab	X		X
Otter Trawl Bottom, Fish	X	X	X
Otter Trawl Bottom, Scallop		X	X
Otter Trawl Bottom, Shrimp		X	X
Otter Trawl Midwater		X	X
Pots And Traps, Conch	X		
Pots and Traps, Crab, Blue Peeler	X		
Pots And Traps, Crab, Blue	X		
Pots And Traps, Crab, Other	X	X	X

Table 15 (continued). Fishing gears used in estuaries and bays, coastal waters, and offshore waters of the EEZ, from Maine to North Carolina, Includes all gear responsible for 1% or greater of any state's total landings and all gear that harvested any amount of federally managed species. Includes gear used in estuarine waters as identified by ASMFC. Based upon 1999 NMFS landings data and 2000 ASMFC Gear Report.

GEAR	Estuary or Bay	Coastal 0-3 Miles	Offshore 3-200 Miles
Pots And Traps, Eel	X		
Pots and Traps, Lobster Inshore	X	X	
Pots and Traps, Lobster Offshore			X
Pots and Traps, Fish	X	X	X
Pound Nets, Crab	X		
Pound Nets, Fish	X	X	
Purse Seines, Herring		X	X
Purse Seines, Menhaden		X	X
Purse Seines, Tuna		X	X
Rakes	X		
Reel, Electric or Hydraulic		X	X
Rod and Reel	X	X	X
Scottish Seine		X	X
Scrapes	X		
Spears	X	X	X
Stop Seines	X		
Tongs and Grabs, Oyster	X		
Tongs Patent, Clam Other	X		
Tongs Patent, Oyster	X		
Trawl Midwater, Paired		X	X
Weirs	X		

Source: USDC 2001.

Table 16. Number of vessel trip reports received, analyzed, and displayed (in GIS plots) and the percentage of total reported trips analyzed and displayed for 18 gear types used in the Northeast region of the U.S. during 1995-2000.

Gear type	**Total number of trips reported**	**Number of trips analyzed**	**Number of trips displayed**	**Percent trips analyzed**	**Percent trips displayed**
Otter trawl – fish	218,668	177,594	174,617	81.2	79.9
Otter trawl – shrimp	43,353	31,571	30,865	72.8	71.2
Otter trawl- scallops	1,952	1,702	1,702	87.2	87.2
Beam trawl	1,926	1,112	1,112	57.7	57.7
All bottom trawls□	**266,686**	**212,629**	**209,468**	**79.7**	**78.5**
Hydraulic clam dredge	26,476	26,476	26,256	100.0	99.2
Quahog dredge	10,386	10,386	10,383	100.0	100.0
Scallop dredge	32,248	24,232	23,206	75.1	72.0
Mussel dredge	571	440	440	77.1	77.1
Sea urchin dredge	1,675	968	968	57.8	57.8
All dredges□□	**73,537**	**64,641**	**63,311**	**87.9**	**86.1**
Lobster pots	241,725	180,746	177,879	74.8	73.6
Fish pots	10,486	7,898	7,697	75.3	73.4
Crab pots	1,609	1,050	1,050	65.3	65.3
Conch/whelk pots	2,448	1,700	1,700	69.4	69.4
All pots□□□	**270,559**	**199,051**	**197,732**	**73.6**	**73.1**
Sink gill nets	86,580	67,402	66,096	77.8	76.3
Bottom longlines	18,261	13,855	13,614	75.9	74.6
Handlines	200,291	166,178	163,058	83.0	81.4
Danish seines	897	276	276	30.8	30.8
Scottish seines	827	520	520	62.9	62.9
TOTAL	**946,783**	**752,681**	**740,578**	**79.5**	**78.2**

□ Includes bottom pair trawls and other bottom trawls
□□ Includes other dredges
□□□ Includes hagfish, shrimp, mixed, and other pots

Source: USDC 2001.

Table 17. Surfclam commercial landings by region for 1999 and 2000.

Surfclam Landings: Both State and Federal Waters					
Region	1999			2000	
	Bushels	Value		Bushels	Value
New England States	52,262	$678,116		43,180	$581,102
Mid-Atlantic States	3,410,232	$29,765,459		3,969,062	$36,477,136
Total	3,462,494	$30,443,575		4,012,242	$37,058,238

Source: NMFS Unpublished Landings Data, Woods Hole, MA.

Table 18. New Jersey surflcam quota and landings for past six years.

New Jersey Surfclam Fishery				
Season (Oct - May)	Quota (bu)	Landings (bu)	Bushels Unharvested	Percent Unharvested
FY 95/96	600,000	566,120	33,880	6%
FY 96/97	600,000	468,377	131,623	22%
FY 97/98	600,000	467,569	132,431	22%
FY 98/99	600,000	570,852	29,148	5%
FY 99/00	700,000	699,649	351	.05%
FY 00/01	700,000	700,256	(256)	(.04%)

Source: New Jersey Division of Fish and Wildlife.

Table 19. New York surfclam quota and landings from 1990.

Year	Quota (bu)	Harvest (bu)	Percent Over or Under Quota
1990	(none)	720,473	
1991	(none)	713,019	
1992	(none)	719,351	
1993	(none)	856,366	
1994	500,000	523,281	5 % over
1995	500,000	420,855	16 % under
1996	500,000	451,492	10 % under
1997	500,000	389,014	22 % under
1998	500,000	227,000	55% under
1999	500,000	266,795	47% under
2000	500,000	327,442	35% under
2001	500,000	177,710 (through May)	

Source: NY Dept. of Environmental Conservation.

Table 20. Surfclam fishery in the EEZ: Number of vessels, trips, hours at sea, hours fishing, landings (bushels), landings per unit effort (bu/hour fishing), and average landings per vessel.

Year	Class	Vessels	Trips	Hours at Sea	Hours Fishing	Surfclam Landings	LPUE*	Ave. Bu. per Boat
1979	1	26	584	9,080	5,787	103,665	17	3,987
	2	61	1,992	39,369	22,670	484,151	21	7,937
	3	75	2,622	59,298	34,326	1,086,393	32	14,485
	All	162	5,198	107,747	62,783	1,674,209	26	10,335
1980	1	14	406	5,674	3,650	79,621	19	5,687
	2	54	2,164	38,743	23,996	597,646	24	11,068
	3	59	2,323	53,098	31,153	1,246,766	40	21,132
	All	127	4,893	97,515	58,799	1,924,033	32	15,150
1981	1	16	328	4,701	2,927	64,942	22	4,059
	2	48	1,502	25,029	14,507	572,063	37	11,918
	3	59	2,198	47,664	23,555	1,339,433	56	22,702
	All	123	4,028	77,394	40,989	1,976,438	47	16,069
1982	1	15	511	7,535	4,908	97,833	20	6,522
	2	47	2,037	32,906	20,916	614,069	28	13,065
	3	53	2,734	55,855	29,721	1,290,928	42	24,357
	All	115	5,282	96,296	55,545	2,002,830	35	17,416
1983	1	14	408	6,323	4,025	113,753	28	8,125
	2	48	2,035	30,354	19,302	818,966	40	17,062
	3	55	2,341	48,934	25,279	1,479,221	58	26,895
	All	117	4,784	85,611	48,606	2,411,940	48	20,615
1984	1	15	319	4,897	3,142	126,421	40	8,428
	2	50	1,763	27,341	16,755	1,152,763	66	23,055
	3	54	1,638	34,893	16,499	1,687,842	96	31,256
	All	119	3,720	67,131	36,396	2,967,026	77	24,933
1985	1	13	217	2,075	1,089	87,791	78	6,753
	2	49	1,307	15,986	7,415	962,313	122	19,639
	3	68	1,582	32,533	11,840	1,859,226	149	27,342
	All	130	3,106	50,594	20,344	2,909,330	135	22,379
1986	1	13	164	1,986	984	81,895	83	6,300
	2	54	1,037	14,679	6,094	964,583	143	17,863
	3	77	1,540	34,724	10,676	2,134,164	189	27,716
	All	144	2,741	51,389	17,754	3,180,642	167	22,088
1987	1	11	159	2,709	1,234	68,006	55	6,182
	2	54	1,143	17,432	7,771	923,127	113	17,095
	3	77	1,433	31,303	8,840	1,828,686	199	23,749
	All	142	2,735	51,444	17,845	2,819,819	151	19,858
1988	1	10	207	3,466	1,895	93,740	49	9,374
	2	51	1,304	19,392	8,743	1,023,364	106	20,066
	3	73	1,527	33,221	9,487	1,914,577	196	26,227
	All	134	3,038	56,079	20,125	3,031,681	143	22,624

Table 20 (continued). Surfclam fishery in the EEZ: Number of vessels, trips, hours at sea, hours fishing, landings (bushels), landings per unit effort (bu/hour fishing), and average landings per vessel.

Year	Class	Vessels	Trips	Hours at Sea	Hours Fishing	Landings	LPUE*	Ave Bu/Boat
1989	1	9	185	3,148	1,904	87,151	44	9,683
	2	50	1,186	15,481	7,357	947,092	117	18,942
	3	76	1,508	26,324	9,610	1,804,165	182	23,739
	All	135	2,879	44,953	18,871	2,838,408	143	21,025
1990	1	8	237	3,931	2,470	69,376	28	8,672
	2	45	1,086	12,450	6,233	961,195	138	21,360
	3	75	1,636	25,067	11,043	2,083,405	184	27,779
	All	128	2,959	41,448	19,746	3,113,976	150	24,328
1991	1&2	25	971	13,853	6,300	808,893	120	32,356
	3	50	1,470	24,942	12,765	1,864,520	144	37,290
	All	75	2,441	38,795	19,065	2,673,413	136	35,646
1992	1&2	19	834	10,682	4,873	738,640	142	38,876
	3	40	1,747	29,874	17,521	2,073,630	117	51,841
	All	59	2,581	40,556	22,394	2,812,270	123	47,666
1993	1&2	17	770	9,294	4,713	778,766	164	45,810
	3	36	1,697	28,538	16,333	2,055,951	126	57,110
	All	53	2,467	37,832	21,046	2,834,717	134	53,485
1994	1&2	15	808	9,778	5,597	826,366	148	55,091
	3	32	1,668	30,844	17,980	2,020,304	112	63,135
	All	47	2,476	40,622	23,577	2,846,670	121	60,567
1995	1&2	13	793	10,800	5,739	810,125	141	62,317
	3	24	1,453	26,169	15,622	1,735,180	111	72,299
	All	37	2,246	36,969	21,361	2,545,305	119	68,792
1996	1&2	12	892	12,821	7,482	958,937	128	79,911
	3	22	1,286	24,570	15,551	1,610,382	104	73,199
	All	34	2,178	37,391	23,033	2,569,319	112	75,568
1997	1&2	11	803	11,509	6,509	837,198	129	76,109
	3	22	1,316	24,643	15,220	1,576,377	104	71,654
	All	33	2,119	36,152	21,729	2,413,575	111	73,139
1998	1&2	11	736	10,558	5,633	764,551	136	69,505
	3	20	1,340	24,810	15,390	1,600,823	104	80,041
	All	31	2,076	35,368	21,023	2,365,374	113	76,302
1999	1&2	10	671	9,857	4,737	766,833	162	76,683
	3	23	1,484	26,019	15,214	1,771,046	116	77,002
	All	33	2,155	35,876	19,951	2,537,879	127	76,905
2000	1	3	57	979	392	15,869	40	5,290
	2	8	743	11,845	6,155	985,248	160	123,156
	3	20	1,241	21,755	13,360	1,559,904	117	77,995
	All	31	2,041	34,579	19,907	2,561,021	129	82,614

* LPUE values are computed from only those trips which have both Hours Fished and Landings data reported. The Hours Fished and Landings values displayed in this table are gross reported totals, and hence may not be divided to calculate LPUE. Hours Fished values are thought to be under-reported in the Northern New Jersey region between 1986 and 1990, due to strict limits on surfclam fishing time in the management regime prior to Amendment #8.
Source: NMFS Clam Vessel Logbook Files.

Table 21. Surfclam landings by degree square - Class 3 vessels only.
Years: 1987, 1991-2000.

Location	Degree	Year	Surfclam Bushels	LPUE
Georges Bank - Outer	4167	1987	68,439	121
Georges Bank - Central	4168	1987	14,200	71
Nantucket Shoals - Upper	4169	1987	31,631	47
		1995	6,048	34
		1998	2,784	24
		1999	1,216	20
Nantucket Shoals - Lower	4069	1987	4,537	93
Martha's Vineyard - Nant.	4170	1987	15,755	44
		1998	5,632	28
South of Martha's Vineyard	4070	1998	1,344	28
LI - East	4072	1991	832	139
		1992	7,008	113
		1994	3,040	109
		1997	3,968	96
		2000	**2,880**	**113**
Northern NJ - LI West	4073	1987	2,816	117
		1991	4,040	99
		1992	5,952	67
		1993	10,796	141
		1994	12,224	93
		1995	56,032	97
		1996	133,472	96
		1997	141,342	106
		1998	174,392	94
		1999	124,770	90
		2000	**260,084**	**112**
NJ Inshore*	3974	1987	1,148,227	170*
		1991	666,792	142
		1992	655,694	116
		1993	242,050	121
		1994	193,680	106
		1995	161,244	91
		1996	177,448	96
		1997	66,528	87
		1998	31,616	67
		1999	108,256	100
		2000	**133,204**	**119**

Table 21 (continued). Surfclam landings by degree square - Class 3 vessels only. Years: 1987, 1991-2000.

Location	Degree	Year	Surfclam Bushels	LPUE
NJ Nearshore*	3973	1987	275,370	153*
		1991	927,334	135
		1992	1,153,817	108
		1993	1,415,200	117
		1994	1,498,594	102
		1995	1,247,748	105
		1996	1,136,216	99
		1997	1,136,663	96
		1998	1,093,651	94
		1999	1,150,976	108
		2000	**814,250**	**110**
NJ Offshore	3972	1993	6,208	102
		1999	1,568	112
		2000	**2,176**	**109**
DE - MD Inshore	3875	1998	896	149
		1999	1,152	230
		2000	**4,256**	**161**
DE - MD Nearshore	3874	1987	73,324	219
		1991	183,794	251
		1992	216,578	241
		1993	288,873	209
		1994	286,854	267
		1995	251,148	224
		1996	160,334	197
		1997	191,180	185
		1998	263,404	258
		1999	370,692	192
		2000	**263,164**	**136**
DE - MD Offshore	3873	1991	3,136	108
		1993	29,428	138
		1994	4,376	237
		1995	896	50
		1998	10,272	473
		1999	5,920	63
		2000	**11,456**	**98**
DE - MD Dist. Offshore	3872	1998	1,024	205
		1999	4,608	384
		2000	**5,408**	**155**
VA - Inshore	3775	1987	76,763	260
		1991	28,384	187
		1992	5,824	214
		1993	12,992	116
		1994	3,584	256
		2000	**2,688**	**192**

Table 21 (continued). Surfclam landings by degree square - Class 3 vessels only.
Years: 1987, 1991-2000.

Location	Degree	Year	Surfclam Bushels	LPUE
VA - Nearshore	3774	1987	63,173	267
		1991	50,208	120
		1992	28,757	125
		1993	48,612	135
		1994	14,336	145
		1995	12,064	126
		1996	2,912	81
		1997	34,840	237
		1998	15,808	444
		1999	480	60
		2000	**58,994**	**194**
VA - Offshore	3773	1997	1,248	101
		2000	**1,344**	**103**
VA - NC Inshore	3675	1987	48,895	187
VA - NC Offshore	3673	1997	608	152

*NJ LPUE adjusted by 0.745 in 1987 due to under-reporting of effort prior to Amendment #8.

Source: NMFS Clam Vessel Logbook Files.

Table 22. Ocean quahog commercial landings by region for 1999 and 2000.

Ocean Quahog Landings: Both State and Federal Waters (Excludes Maine fishery)				
Region	1999		2000	
	Bushels	Value	Bushels	Value
New England States	1,835,383	$7,634,346	1,413,635	$6,051,262
Mid-Atlantic States	1,936,735	$8,273,702	1,747,014	$7,603,510
Total	3,772,118	$15,908,048	3,160,649	$13,654,772

Source: NMFS Unpublished Landings Data, Woods Hole, MA

Table 23. Ocean quahog fishery in the EEZ: Number of vessels, trips, hours at sea, hours fishing, landings (bushels), landings per unit effort (bu/hour fishing), and average landings per vessel.

Year	Class	Vessels	Trips	Hours at Sea	Hours Fishing	Quahog Landings	LPUE*	Ave Bu. per Boat
1979	1 & 2	22	735	10,325	4,333	477,346	109	21,698
	3	37	1,966	35,635	19,545	2,557,350	127	69,118
	All	59	2,701	45,960	23,878	3,034,696	124	51,436
1980	1 & 2	19	561	7,836	3,528	354,110	95	18,637
	3	33	1,950	39,488	22,025	2,607,679	114	79,021
	All	52	2,511	47,324	25,553	2,961,789	111	56,957
1981	1 & 2	12	399	5,965	2,793	248,498	88	20,708
	3	35	2,011	37,914	20,859	2,639,789	125	75,423
	All	47	2,410	43,879	23,652	2,888,287	121	61,453
1982	1 & 2	12	274	4,414	2,391	187,447	77	15,621
	3	31	2,146	39,956	21,515	3,053,328	136	98,494
	All	43	2,420	44,370	23,906	3,240,775	130	75,367
1983	1 & 2	8	225	3,561	1,936	159,214	81	19,902
	3	29	2,243	40,718	21,072	3,056,426	142	105,394
	All	37	2,468	44,279	23,008	3,215,640	137	86,909
1984	1 & 2	16	467	7,266	3,873	369,529	92	23,096
	3	41	2,738	51,563	26,845	3,593,438	129	87,645
	All	57	3,205	58,829	30,718	3,962,967	124	69,526
1985	1 & 2	17	611	9,352	4,756	483,004	99	28,412
	3	47	3,101	58,462	28,988	4,086,505	138	86,947
	All	64	3,712	67,814	33,744	4,569,509	133	71,399
1986	1 & 2	16	471	8,795	4,159	441,192	103	27,575
	3	56	2,714	51,648	25,292	3,726,013	146	66,536
	All	72	3,185	60,443	29,451	4,167,205	140	57,878
1987	1 & 2	16	333	7,359	3,405	359,042	105	22,440
	3	55	2,995	59,220	29,482	4,383,983	146	79,709
	All	71	3,328	66,579	32,887	4,743,025	142	66,803
1988	1 & 2	11	221	4,555	2,088	251,674	114	22,879
	3	51	2,818	60,554	31,213	4,217,699	133	82,700
	All	62	3,039	65,109	33,301	4,469,373	132	72,087
1989	1 & 2	13	540	9,823	4,945	650,059	124	50,005
	3	56	3,055	66,364	34,671	4,280,221	121	76,433
	All	69	3,595	76,187	39,616	4,930,280	122	71,453
1990	1 & 2	14	496	11,002	6,470	623,346	96	44,525
	3	42	2,753	62,569	34,614	3,999,071	115	95,216
	All	56	3,249	73,571	41,084	4,622,417	112	82,543

Table 23 (continued). Ocean quahog fishery in the EEZ: Number of vessels, trips, hours at sea, hours fishing, landings (bushels), landings per unit effort (bu/hour fishing), and average landings per vessel.

Year	Class	Vessels	Trips	Hours at Sea	Hours Fishing	Quahog Landings	LPUE*	Ave. Bu. per Boat
1991 - Excludes Maine Fishery								
	1&2	11	545	11,889	6,343	731,634	115	66,512
	3	38	2,824	68,002	39,531	4,108,190	103	108,110
	All	49	3,369	79,911	45,874	4,839,824	104	98,772
1992 - Excludes Maine Fishery								
	1&2	9	527	11,267	5,464	693,971	127	77,108
	3	34	2,563	61,914	31,678	4,244,729	132	124,845
	All	43	3,090	73,181	37,142	4,938,700	131	114,853
1993 - Excludes Maine Fishery								
	1&2	8	535	12,764	6,442	720,702	112	90,088
	3	28	2,655	67,549	38,860	4,091,239	105	146,116
	All	36	3,190	80,313	45,302	4,811,941	106	133,665
1994 - Excludes Maine Fishery								
	1&2	7	444	10,748	5,580	580,198	104	82,885
	3	29	2,683	65,734	38,764	4,031,197	104	139,007
	All	36	3,127	76,482	44,344	4,611,395	104	128,094
1995 - Excludes Maine Fishery								
	1&2	6	480	12,168	7,116	692,491	97	115,415
	3	30	2,496	60,216	32,752	3,935,832	120	131,194
	All	36	2,976	72,384	39,868	4,628,323	116	128,565
1996 - Excludes Maine Fishery								
	1&2	5	429	11,439	6,026	678,804	113	135,761
	3	31	2,116	52,328	27,104	3,712,624	137	119,762
	All	36	2,545	63,767	33,130	4,391,428	133	121,984
1997 - Excludes Maine Fishery								
	1&2	6	413	12,570	6,860	684,684	100	114,114
	3	25	1,881	52,535	27,154	3,594,375	132	143,775
	All	31	2,294	65,105	34,014	4,279,059	126	138,034
1998 - Excludes Maine Fishery								
	1&2	5	375	11,491	6,371	587,228	92	117,446
	3	19	1,582	49,236	25,331	3,310,259	131	174,224
	All	24	1,957	60,727	31,702	3,897,487	123	162,395
1999 - Excludes Maine Fishery								
	1&2	5	382	10,817	5,952	559,200	94	111,840
	3	18	1,696	50,612	25,748	3,211,088	125	178,394
	All	23	2,078	61,429	31,700	3,770,288	119	163,926
2000 - Excludes Maine Fishery								
	1&2	6	270	7,933	4,330	429,686	99	71,614
	3	23	1,541	48,369	24,110	2,730,963	113	118,738
	All	29	1,811	56,302	28,440	3,160,649	111	108,988

Table 24. Quahog landings by degree square - Class 3 vessels only.
Years: 1987, 1991, 1994-2000.

Location	Degree Square	Year	Bushels of Quahogs	LPUE
Nantucket Shoals - Upper	4169	1995	3,040	80
		1997	576	96
		1999	16,352	195
Nantucket Shoals - Lower	4069	1995	267,000	214
		1996	227,624	233
		1997	542,046	222
		1998	275,836	171
		1999	151,390	182
		2000	**276,920**	**147**
Martha's Vineyard - Nant.	4170	1987	896	90
		1991	170,234	135
		1994	133,356	135
		1995	309,436	126
		1996	227,752	126
		1997	99,040	128
		1998	88,673	110
		1999	71,744	80
		2000	**67,264**	**86**
South of Martha's Vineyard	4070	1994	2,368	125
		1995	86,944	129
		1996	527,584	169
		1997	333,130	149
		1998	206,730	157
		1999	367,533	118
		2000	**388,008**	**99**
Block Island	4171	1987	67,429	130
		1991	20,432	111
		1994	39,936	123
		1995	419,812	141
		1996	270,153	140
		1997	198,448	118
		1998	181,760	130
		1999	115,936	103
		2000	**59,711**	**90**
South of Block Island	4071	1987	78,950	124
		1994	22,900	128
		1995	149,308	125
		1996	503,808	146
		1997	615,211	131
		1998	492,927	137
		1999	671,785	128
		2000	**285,846**	**109**

Table 24 (continued). Quahog landings by degree square - Class 3 vessels only.
Years: 1987, 1991, 1994-2000.

Location	Degree Square	Year	Bushels of Quahogs	LPUE
LI - East	4072	1987	2,048	341
		1991	155,336	211
		1994	1,620,483	146
		1995	1,405,566	146
		1996	946,709	136
		1997	833,078	146
		1998	1,367,994	155
		1999	1,125,569	166
		2000	**833,074**	**156**
Northern NJ - LI West	4073	1987	651,425	174
		1991	709,360	146
		1994	1,166,837	109
		1995	536,715	98
		1996	240,917	111
		1997	181,874	114
		1998	81,856	102
		1999	76,290	114
		2000	**67,232**	**105**
NJ Inshore	3974	1987	9,776	170
		1991	74,266	75
		1994	77,415	55
		1995	58,240	57
		1996	5,472	91
		1997	2,784	121
		1999	2,396	60
		2000	**7,904**	**100**
NJ Nearshore	3973	1987	38,880	125
		1991	698,282	125
		1994	214,334	61
		1995	266,553	87
		1996	395,551	127
		1997	446,667	109
		1998	274,646	81
		1999	244,802	87
		2000	**282,268**	**94**
NJ Offshore	3972	1991	8,672	90
		1994	6,016	140
		1995	16,832	162
		1996	41,792	157
		1997	49,728	120
		1998	30,496	106
		1999	9,760	124
		2000	**42,464**	**134**
NJ Distant Offshore	3971	1998	6,336	165
		1999	8,672	161
		2000	**1,664**	**111**

Table 24 (continued). Quahog landings by degree square - Class 3 vessels only. Years: 1987, 1991, 1994-2000.

Location	Degree Square	Year	Bushels of Quahogs	LPUE
DE - MD Nearshore	3874	1987	1,246,936	134
		1991	1,434,077	88
		1994	248,600	62
		1995	67,488	67
		1996	18,112	90
		1997	41,056	66
		1998	55,888	114
		1999	21,248	76
		2000	**78,880**	**104**
DE - MD Offshore	3873	1987	573,918	135
		1991	454,982	90
		1994	334,408	68
		1995	205,728	87
		1996	149,440	93
		1997	56,128	80
		1998	69,984	84
		1999	105,771	84
		2000	**178,030**	**82**
DE - MD Dist. Offshore	3872	1995	1,824	122
		1998	1,792	128
VA - Inshore	3775	1996	1,248	62
VA - Nearshore	3774	1987	1,705,394	153
		1991	382,549	80
		1994	161,120	108
		1995	141,346	96
		1996	156,462	108
		1997	194,609	89
		1998	173,549	92
		1999	218,032	92
		2000	**155,810**	**86**
VA - Offshore	3773	1998	1,792	85
		2000	**3,136**	**91**

Source: NMFS Clam Vessel Logbook Files.

Table 25. Maine ocean quahog fishery.

Year	Class	Vessels	Trips	Hours at Sea	Hours Fishing	Quahog Landings	LPUE*	Ave. Bu. per Boat
1991	All	45	2,221	23,465	17,162	36,679	2.0	815
1992	All	53	1,677	17,711	13,469	24,839	1.8	469
1993	All	33	685	9,732	5,748	17,144	3.0	520
1994	All	30	792	7,189	5,102	21,480	4.2	716
1995	All	30	1,052	8,233	5,747	37,912	6.6	1,264
1996	All	25	1,374	11,811	8,483	47,025	5.5	1,881
1997	All	34	1,945	16,285	11,829	72,706	6.1	2,138
1998	All	39	1,820	18,452	11,777	72,466	6.2	1,858
1999	All	38	1,998	16,188	11,455	93,938	8.2	2,472
2000	All	34	2,197	18,015	12,739	120,767	9.5	3,552

NOTE 1: This table includes ocean quahog landings records from the Clam logbooks ONLY, and does NOT include landings submitted in the Multispecies logbooks until 1998.
NOTE 2. The bushel unit used in the Maine fishery measures 1.2445 cubic feet. The standard bushel unit used in the industrial ITQ fishery outside Maine is 1.88 cubic feet.
* LPUE values are computed from only those trips which have both Hours Fished and Landings data reported. The Hours Fished and Landings values displayed in this table are gross reported totals, and hence may not be divided to calculate LPUE.

Source: NMFS Clam Vessel Logbook Files

Table 26. Surflcam and ocean quahog Federal fleet profile.

Federal Fleet Profile					
Non-Maine Vessels	1996	1997	1998	1999	2000
Harvests BOTH surfclams & ocean quahogs	14	14	8	11	12
Harvests only surfclams	20	19	23	22	19
Harvests only ocean quahogs	22	17	16	12	17
Total Non-Maine Vessels	56	50	47	45	48
Maine Ocean Quahog Vessels	25	34	39	38	34

Source: NMFS Clam Vessel Logbooks

Table 27. Quota setting for the Federal surfclam and ocean quahog fisheries.

Federal Surfclam & Ocean Quahog Quotas and Landings: 1979 - 2000								
Surfclams (Thou Bushels)					Ocean Quahogs (Thou. Bushels)			
* Georges Bank first closed for PSP in 1990					* Maine ocean quahog fishery excluded 1991 - 2000			
Year	**Landings**	**Quota**	**Percent Harvested**		**Year**	**Landings**	**Quota**	**Percent Harvested**
1979	1,674	1,800	93%		1979	3,035	3,000	101%
1980	1,924	1,825	105%		1980	2,962	3,500	85%
1981	1,976	1,825	108%		1981	2,888	4,000	72%
1982	2,003	2,400	83%		1982	3,241	4,000	81%
1983	2,412	2,450	98%		1983	3,216	4,000	80%
1984	2,967	2,750	108%		1984	3,963	4,000	99%
1985	2,909	3,150	92%		1985	4,570	4,900	93%
1986	3,181	3,225	99%		1986	4,167	6,000	69%
1987	2,820	3,120	90%		1987	4,743	6,000	79%
1988	3,032	3,385	90%		1988	4,469	6,000	74%
1989	2,838	3,266	87%		1989	4,930	5,200	95%
1990 *	3,114	2,850	109%		1990	4,622	5,300	87%
1991	2,673	2,850	94%		1991*	4,840	5,300	91%
1992	2,812	2,850	99%		1992*	4,939	5,300	93%
1993	2,835	2,850	99%		1993*	4,812	5,400	89%
1994	2,847	2,850	100%		1994*	4,611	5,400	85%
1995	2,545	2,565	99%		1995*	4,628	4,900	94%
1996	2,569	2,565	100%		1996*	4,391	4,450	99%
1997	2,414	2,565	94%		1997*	4,279	4,317	99%
1998	2,365	2,565	92%		1998*	3,897	4,000	97%
1999	2,538	2,565	99%		1999*	3,770	4,500	84%
2000	2,561	2,565	100%		2000*	3,161	4,500	70%
2001	N/A	2,850	N/A		2001	N/A	4,500	N/A

Source: NMFS Clam Logbook Reports, Woods Hole, MA

Table 28. Summary of County Census Data for 2000.

		Cape May, NJ	Atlantic, NJ	Ocean, NJ	Cumberland, NJ	Sussex, DE	Nassau, NY	Bristol, MA	Barnstable, MA
Population									
	Total (2000)	102,326	252,552	510,916	146,438	150,638	1,334,544	534,678	222,230
	% Change from 1990	7.6	12.6	8.6	6.1	38.3	3.6	5.6	19.1
	% Rural (1990)	33.3	24.2	20.4	25.9	85.7	> 1	16.3	38.4
Racial/Ethnic Composition (2000)									
	White	92.5	68.4	93	65.9	81	80.8	91	95.6
	Non-White	7.5	31.6	7	34.1	19	19.2	9	4.4
Age Structure									
	% over 65	20.2	13.6	22.2	13	18.5	15	14.1	23.1
	% under 18	22.3	25.3	23.3	25.4	22.5	24.7	24.6	20.4
Income									
	Per capita income (1999)	$29,455	$32,086	$27,694	$22,894	$23,700	$43,997	$27,461	$34,470
	% living in poverty (1997)	11	10.8	7.8	15.8	12.7	5.8	11.9	8.90%
Employment									
	Unemployment rate (2000)	8.6	5.7	3.9	7.2	4.4	2.7	3.9	3.6
	Seasonal range (1998)	4.3-18.3	7.1-8.6	4.1-6.4	10.5-7.7	3.4-5.5	2.4-3.5	3.9-7.2	
	% employment in agriculture, forestry, and fisheries (1990)	2.1	1.3	1.5	2.5	5.9	>1	1.5	3.2
Housing									
	% for seasonal, recreational or occasional use (2000)	47.4	10.3	13.3	1.6	26.8	0.7	17.7	32

		Worcester, MD	Wicomico, MD	Talbot, MD	Accomack, VI	Virgina MSA	Bristol, RI	Washington, ME
Population								
	Total (2000)	46,543	84,644	33,812	38,305		50,648	33,941
	% Change from 1990	32.9	13.9	10.7	20.8		3.7	3.9
	% Rural (1990)	54.6	67.5	69.3	88.7		3	91
Racial/Ethnic Composition (2000)								
	White	81	73.6	82.6	64.1		96.8	93.5
	Non-White	19	26.4	17.4	35.9		3.2	6.5
Age Structure								
	% over 65	20.1	12.8	20.4	16.7		16.7	17.3
	% under 18	20.5	24.8	21.7	24.3		22.9	22.9
Income								
	Per capita income (1999)	$26,471	$24,227	$35,359	$21,194		$33,901	$19,098
	% living in poverty (1997)	11.9	13.5	9.7	21.9		6.9	17.7
Employment								
	Unemployment rate (2000)	11.9	5	3.1	4.2		3.3	3.2
	Seasonal range (1998)	3.6-18.8	4.8-6.4	2.2-6.9	4.9-10.2		2.8-5.4	6.6-13.8
	% employment in agriculture, forestry, and fisheries (1990)	5.9	2.4	6.3	9.1		1.5	3.7
Housing								
	% for seasonal, recreational or occasional use (2000)	64	13.2	50.3	60.8		33	24.8

Source: McCay *et al.* 2002.

Table 29. Summary of City Census Data for 2000.

	New Jersey							Delaware	Maine	Massachusetts	
	Cape May City	**Lower Township**	**Wildwood**	**Port Norris**	**Atlantic City**	**Point Pleasant***	**Millville**	**Milford**	**Jonesport****	**New Bedford**	**Barnstable*****
Population (00)											
Total	4,034	22,945	5,436	1,566	40,517	24,620	26,847	6,732	1,408	93,768	47,821
% Change from 1990	-13.5	10.2	1.15	7.9	12.6	5.7	3.2	11.4		-6.2	
% Rural (1990)	0	56.3	0	100	0	0	0	0		0	0
Racial/Ethnic Composition (00)											
White	91.3	96.3	70.5	58.3	44.2	97.42	76.1	70	97.8	83	91.9
Non-White	8.7	3.7	29.5	41.7	55.8	2.58	23.9	30	2.2	17	8.1
Age Structure (00)											
% over 65	28.5	20.7	14.2	16.9	14.2	15.82	12.9	17.7	22.7	16.7	20.1
% under 18	16	23.7	25.7	27.4	25.7	22.7	27.9	27.8	21	34	22
Income (90)											
Per capita (1989)	15,884	12,671	10,079	10,401	12,017	18770/16542	13,748	11,334		10,923	
% living in poverty (1990)	4.9	8.80%	27	25.8	25	3.1/5.1	11.53	11.8		16.8	
Employment (90)											
Unemployment rate (1990)	6.3	8	18.6	4.8	9.6	4.5/3.9	6.41	4.7 (1989)		12.2	
% employment in agriculture, forestry, and fisheries	25		0	1.4	0.8	.9/.3	1.3	0.2		1.3	
Housing (00)											
% for seasonal, recreational or occasional use (2000)	93	29.6	79.5	1.7	44.4	72.8	9.4	<1	6.4	3.2	

	Maryland					Virginia		Rhode I.		New York
	Nanticoke	**Pocomoke City**	**Ocean City**	**W. Ocean City**	**Easton**	**Mappsville**	**Norfolk City**	**Bristol**	**Warren****	**Freeport Village**
Population (00)										
Total	NA	4,098	7,173	3,311	1,708	NA	234,403	22,469	11,360	43,783
% Change from 1990	NA	4.5	NA	42	24.9	NA	-10.3	3.9	-0.22	9.7
% Rural	NA	0	0	100	0	NA	0	0		0
Racial/Ethnic Composition (00)										
White	NA	52	95.3	97	72.5	NA	50.1	97.1	96.8	46.8
Non-White	NA	48	NA	3	27.5	NA	49.9	2.9	3.2	53.2
Age Structure (00)										
% over 65	NA	16	20.9	19.1	19.2	NA	10.9	17.7	17.9	10.5
% under 18	NA	30.5	11.9	19.8	22.6	NA	24	19.6	22.6	26.4
Income (90)										
Per capita (1990)	NA	9,688	20,399	16,833	14,517	NA	11,643	14,108		17,018
% living in poverty (1990)	NA	18.3	6.59	9.98	12.5	NA	19.33	5.79		7.4
Employment (90)										
Unemployment rate (1990)	NA	8.4	4.69	6.2	3.95	NA	8.8	7.24	8.1	4.8
% employment in agriculture, forestry, and fisheries	NA	5.2	1	4.8	2.52	NA	9.91	1.64	0.05	1.1
Housing (00)										
% for seasonal, recreational or occasional use (2000)	NA	<1	54.3	13.2	9.7	NA	3.34	1.5	1.8	0.3

*** Point Pleasant Bourough/Point Pleasant Beach Borough; otherwise data were pooled.**
**** Census data for 1990 not available.**
***** In 1990, Census describes Barnstable Village (population 2,409).**

Source: McCay *et al.* 2002.

Table 30. Latitude and longitude coordinates of nearshore gear restricted areas (EFH Option 4).

Block 1

Point	N. lat.	W. long
1	40°	74°
2	40°	73° 20'
3	40° 35'	73° 20'
4	40° 35'	74°
5	40°	74°

Block 2

Point	N. lat.	W. long
1	38° 20'	75°
2	38° 20'	74° 30'
3	39° 10'	74° 30'
4	39° 10'	74° 50'
5	39°	74° 50'
6	39°	75°
7	38° 20'	75°

Block 3

Point	N. lat.	W. long
1	36° 30'	76°
2	36° 30'	75° 20'
3	37° 30'	75° 20'
4	37° 30'	75° 50'
5	37° 10'	75° 50'
6	37° 10'	76°
7	36° 30'	76°

Block 4

Point	N. lat.	W. long
1	35° 20'	75° 30'
2	35° 20'	75° 10'
3	36° 10'	75° 10'
4	36° 10'	75° 40'
5	35° 50'	75° 40'
6	35° 50'	75° 30'
7	35° 20'	75° 30'

Table 31. Latitude and longitude coordinates of gear restricted area surrounding the head of the Hudson Canyon. (EFH Option 5).

Block 5

Point	**N. lat.**	**W. long**
1	39° 10'	73°
2	39° 10'	72° 30'
3	39° 40'	72° 30'
4	39° 40'	72° 10'
5	39° 50'	72° 10'
6	39° 50'	73°
7	39° 10'	73°

Table 32. Latitude and longitude coordinates for analyses of Tilefish HAPC-Option 6.

Point	N. lat.	W. long
1	39°	73° 10'
2	39°	72° 40'
3	39° 50'	71° 30'
4	39° 50'	70°
5	40° 30'	70°
6	40° 30'	71° 50'
7	39°	73° 10'

Table 33. Surfclam catches, biomass and exploitation estimates for the EEZ and New Jersey and New York territorial sea.

AREA RESOURCE COMPARISON

AREA	BIOMASS	QUOTA	CATCH	EXPLOITATION
EEZ	168MIL. BUSHELS	2.85 MIL. BUSHELS	2.85 MIL. BUSHELS	0.02
NEW JERSEY TERRITORIAL SEA	24 MIL. BUSHELS	700 K BUSHELS	7000 K BUSHELS	0.03
NEW YORK TERRITORIAL SEA	12 MIL. BUSHELS	500 K BUSHELS	350 K BUSHELS	0.03

Table 34. List of number of animals, by species, captured during the 1997 NMFS Clam Survey. All tows are included. The list is ordered by total number caught.

Total #	Animal	Species
6	Sea Scallop (Clapper)	*Placopecten magelanicus*
6	Southern Quahog (Clapper)	*Mercenaria campechianus*
12	Ten-Ridged Whelk	*Neptunea decemcostata*
67	Spider Crab (Unclassified)	*Majidae* spp.
75	Knobbed Whelk	*Busycon carica*
81	Horseshoe Crab	*Limulus polyphemus*
101	Stimpson's Whelk	*Colus stimpsoni*
104	Dog Whelk	*Nassaruis* spp.
121	Horse Mussel	*Modiolus modiolus*
154	Northern Cardita	*Venercardia borealis*
155	False Quahog	*Pitar morrhuana*
167	Pastel Swimming Crab	*Ovalipes guadalupensis*
198	Channeled Whelk	*Busycon Canaliculatum*
245	Shark's Eye or Lobed Moonshell	*Polinices duplicatus*
303	Waved Whelk	*Buccunum undatum*
351	Southern Quahog (Live)	*Mercenaria campechianus*
423	Jonah Crab	*Cancer borealis*
441	Lady Crab	*Ovalipes ocellatus*
647	Hermit Crab (Unclassified)	*Diogenidae/Paguridae* spp.
679	Chestnut Astarte	*Astarte castanea*
787	Sea Scallop (Live)	*Placopecten magelanicus*
1,052	Northern Moon Shell	*Lunatia heros*
1,630	Common Razor Clam	*Ensis directus*
1,873	Surfclam (Clapper)	*Spisula solidissima*
2,206	Starfish (Unclassified)	*Asteriidae* spp.
2,233	Boreal Asterias	*Asterias vulgaris*
2,593	Ocean Quahog (Clapper)	*Arctica islandica*
3,073	Margined Seastar	*Astropecten* spp.
3,486	Rock Crab	*Cancer irroratus*
36,221	Surfclam (Live)	*Spisula solidissima*
66,682	Ocean Quahog (Live)	*Arctica islandica*
126,172	Total	

Source: Weinberg pers. comm.

Table 35. Communities potentially affected by fishing gear impacts to EFH Options 3-8.

ME	MA	RI	NY	NJ	DE	MD	VA
Addison	Barnstable Area	Warren	Freeport	Atlantic City	Milford	Easton	Mappsville
Beals Island	New Bedford	Bristol		Cape May		Nanticoke	Norfolk
Bucks Harbor		Tiverton		Point Pleasant		West Ocean City	
Eastern Harbor				Wildwood		Pokomoke	
Jonesport				Burleigh			
South Addison				Millville			
Steuben				Port Norris			

Source: McCay *et al.* 2002.

Table 36. Cetaceans and turtles found in survey area.

Scientific name	Common name	Est. Minimum Number in Study Area	Endangered	Threatened
LARGE WHALES				
Balaenoptera physalus	fin whale	1,102	X	
Megaptera novaeangliae	humpback whale	684	X	
Balaenoptera acutorostrata	minke whale	162		
Physeter catodon	sperm whale	300	X	
Eubalaena glacialis	right whale	29	X	
Balaenoptera borealis	sei whale	109	X	
Orcinus orca	killer whale	unk		
SMALL WHALES				
Tursiops truncatus	bottlenose dolphin	6,254		
Globicephala spp.	pilot whales	11,448		
Lagenorhynchus acutus	Atl. white-sided dolphin	24,287		
Phocoena	harbor porpoise	2,946		
Grampus griseus	grampus (Risso's) dolphin	10,220		
Delphinus delphis	saddleback dolphin	17,606		
Stenella spp.	spotted dolphin	22,376		
Stenella coeruleoalba	striped dolphin	unk		
Lagenorhynchus albirostris	white-beaked dolphin	unk		
Ziphius cavirostris	Cuvier's beaked dolphin	unk		
Stenella longirostris	spinner dolphin	unk		
Steno bredanensis	rough-toothed dolphin	unk		
Delphinapteras leucas	beluga	unk		
Mesoplodon spp.	beaked whales	unk		
TURTLES				
Caretta caretta	loggerhead turtle	4,017		X
Dermochelys coriacea	leatherback turtle	636	X	
Lepidochelys kempi	Kemp's ridley turtle	unk	X	
Chelonia mydas	green turtle	unk		X

Source: University of Rhode Island 1982.

Table 37. Annual and average annual activity by surfclam and ocean quahog vessels, 1996-2000.

YEAR	Surfclams						Ocean Quahogs					
	Landings	Nominal Value	Hours at Sea	Hours Fishing	Number of Trips	Constant Dollar Value	Landings	Nominal Value	Hours at Sea	Hours Fishing	Number of Trips	Constant Dollar Value
1996	2,569,319	25,222,388	37,391	23,033	2,178	27,716,910	4,438,453	19,517,253	75,579	41,612	3,919	21,447,531
1997	2,413,575	24,130,282	36,152	21,728	2,119	25,909,951	4,351,765	19,702,991	81,390	45,843	4,239	21,132,403
1998	2,365,374	20,178,486	35,367	21,022	2,076	21,349,492	3,969,953	18,350,285	79,180	43,479	3,777	19,381,739
1999	2,537,879	21,341,124	35,876	19,951	2,155	22,057,825	3,864,226	18,487,974	77,617	43,155	4,076	19,112,343
2000	2,561,021	21,771,814	34,578	19,907	2,041	21,771,814	3,281,416	16,960,347	74,318	41,178	4,008	16,960,347
Average	2,489,434	22,528,819	35,873	21,128	2,114	23,761,198	3,981,163	18,603,770	77,616	43,053	4,004	19,608,872

Source: Kirkley *et al.* 2002.

Table 38. Probability that harvesters will increase landings in response to higher quotas.

Year	Landings	Quota	Probability of Harvesting Quota
1991	2,673	2,850	0.11
1992	2,812	2,850	0.13
1993	2,835	2,850	0.15
1994	2,847	2,850	0.17
1995	2,545	2,565	0.32
1996	2,569	2,565	0.30
1997	2,414	2,565	0.27
1998	2,365	2,565	0.25
1999	2,538	2,565	0.23
2000	2,561	2,565	0.21
2001	2,800	2,850	0.37

Source: Kirkley *et al.* 2002.

Table 39. Summary activity and net returns for surfclam and ocean quahog vessels, 1991-2000, year 2000 constant dollar value.

Year	Vessel Class	Number of Trips	Hours at Sea	Hours Fishing	Ex-vessel Value–Total	Net Returns
1991	1	46	571	435	106,444	(811,305)
	2	1,470	25,171	12,208	11,356,752	(2,885,276)
	3	4,294	92,967	52,298	36,520,124	(556,740)
	Total	5,810	118,709	64,941	47,983,320	(4,253,321)
1992	1	20	233	168	68,193	(392,647)
	2	1,341	21,716	10,169	10,696,870	(1,453,933)
	3	4,310	91,787	49,199	38,604,575	2,947,177
	Total	5,671	113,736	59,535	49,369,638	1,100,597
1993	1	17	212	135	76,211	(385,346)
	2	1,288	21,846	11,019	12,234,760	498,138
	3	4,352	96,087	55,193	35,193,789	1,448,749
	Total	5,657	118,145	66,347	47,504,760	1,561,542
1994	1	25	305	198	142,333	(340,931)
	2	1,227	20,220	10,980	13,836,400	2,171,758
	3	4,351	96,578	56,744	37,512,945	5,137,098
	Total	5,603	117,104	67,921	51,491,679	6,967,925
1995	1	19	236	171	106,027	(364,716)
	2	1,254	22,732	12,684	13,876,261	2,144,628
	3	3,949	86,385	48,375	34,660,959	2,614,736
	Total	5,222	109,353	61,229	48,643,248	4,394,649
1996	1	27	317	218	144,942	(341,020)
	2	1,294	23,943	13,289	15,104,783	3,711,298
	3	3,402	76,898	42,655	32,359,509	2,159,206
	Total	4,723	101,158	56,162	47,609,234	5,529,484
1997	1	26	342	237	135,546	(347,565)
	2	1,190	23,737	13,132	13,363,862	2,988,606
	3	3,197	77,178	42,374	31,483,778	3,922,708
	Total	4,413	101,257	55,742	44,983,185	6,563,749
1998	1	31	272	178	133,467	(344,908)
	2	1,080	21,777	11,826	10,593,179	1,280,727
	3	2,922	74,046	40,721	27,973,180	3,463,933
	Total	4,033	96,095	52,724	38,699,825	4,399,752
1999	1	28	263	159	87,849	(377,334)
	2	1,025	20,411	10,530	10,047,111	2,160,798
	3	3,180	76,631	40,962	28,358,245	2,954,735
	Total	4,233	97,304	51,650	38,493,206	4,738,200
2000	1	57	979	392	192,940	(1,193,909)
	2	1,013	19,778	10,485	11,445,162	2,455,745
	3	2,782	70,124	37,470	23,788,484	(1,198,490)
	Total	3,852	90,881	48,347	35,426,586	63,346
1996-2000	1	34	434	237	138,949	(520,947)
Annual	2	1,120	21,929	11,852	12,110,819	2,519,435
Average	3	3,097	74,975	40,836	28,792,639	2,260,419
	Total	4,251	97,339	52,925	41,042,407	4,258,906

Source: Kirkley *et al.* 2002.

Table 40. Nominal ex-vessel prices per bushel for surfclams, ocean quahogs, and Maine/Rhode Island quahogs (mahoganies), 1991-2000[a].

Year	Surfclams	Ocean	Maine and Rhode Island
1991	8.07	3.39	41.79
1992	8.07	3.50	38.09
1993	7.67	3.68	37.15
1994	9.40	3.70	36.24
1995	9.51	3.97	33.66
1996	9.61	4.13	29.38
1997	9.89	4.19	26.43
1998	8.43	4.23	26.11
1999	8.23	4.23	27.39
2000	8.39	4.30	27.44

[a]A Maine bushel of quahogs is a standard US bushel and equals 1.2445 cubic feet; the ITQ bushel, which is used for measuring output of surfclams and ocean quahogs, equals 1.88 cubic feet. Alternatively, one Maine bushel is 66% of the size of an ITQ bushel. No information was available on the size of a Rhode Island clam bushel.

Source: Kirkley *et al.* 2002.

Table 41. Number of vessels in surfclam and quahog fishery and vessels landing both species.

Year	Number of Vessels in Surfclam/Quahog	Vessels Landing Both Surfclams and	Percent of Fleet Landing Both Species
1991	77	47	0.61
1992	68	34	0.50
1993	64	25	0.39
1994	59	25	0.42
1995	61	12	0.20
1996	56	14	0.25
1997	50	14	0.28
1998	47	8	0.17
1999	45	11	0.24
2000	48	12	0.25

Source: Kirkley *et al.* 2002.

Table 42. Number of vessels and landings of surfclams, ocean quahogs, and mahogany clams, 1991-2000.

Year	Number of Vessels				Landings–Bushels		
	Total	Surfclam	Ocean Quahog	Maine Mahogany	Surfclam	Ocean Quahog	Maine Mahogany
1991	121	75	49	45	2,673,413	4,839,824	36,679
1992	121	59	43	53	2,812,270	4,938,700	24,839
1993	97	53	36	33	2,834,717	4,811,941	17,144
1994	89	48	36	30	2,846,670	4,611,395	21,480
1995	91	37	36	30	2,545,305	4,628,323	37,912
1996	81	34	36	25	2,569,319	4,391,428	47,025
1997	84	33	31	34	2,413,575	4,279,059	72,706
1998	86	31	24	39	2,365,374	3,897,487	72,466
1999	83	33	23	38	2,537,879	3,770,288	93,938
2000	82	31	29	34	2,561,021	3,160,649	120,767

[a]Maine bushels are standard U.S. bushels; 32 ITQ bushels equal 48 Maine bushels.

Source: Kirkley *et al.* 2002.

Table 43. Estimated coefficients of inverse demand for New Jersey surfclams.

Variable	Coefficient	T-Statistics
Intercept	0.5873465	27.442549
1996ld[a]	1.593E-08	2.9371422
1997ld	1.342E-08	2.3330434
1998ld	-1.128E-08	-1.9212737
1999ld	-1.319E-08	-2.4783631
2000ld	-9.54E-09	-2.1045169
N=60		
Adjusted R Square=0.86		

[a]Variables with ld extensions represent dummy slope variables (e.g., 1996ld represents the influence on landings in 1996 on the 1996 level of ex-vessel prices).

Source: Kirkley *et al.* 2002.

Table 44. Seasonal indices of trips, landings, and nominal and constant dollar ex-vessel prices, 1991-2000.

Month	Surfclams						Ocean Quahogs[a]					
	Landings	Trips	Hours At Sea	Hours Fishing	Nominal Price	Constant Dollar Price	Landings	Trips	Hours At Sea	Hours Fishing	Nominal Price	Constant Dollar Price
January	66.4	63.4	64.9	67.7	94.6	93.0	77.3	58.6	67.0	66.3	97.8	96.1
February	70.1	68.2	69.9	70.7	97.8	96.5	86.3	70.6	74.4	71.9	96.9	95.7
March	84.6	82.0	84.2	85.7	98.6	98.1	105.4	82.4	87.4	87.2	96.2	95.7
April	77.5	78.3	81.9	83.5	96.4	95.7	104.7	87.6	91.3	90.7	96.4	95.7
May	82.3	83.8	87.1	88.9	97.7	97.3	110.8	133.8	120.8	125.9	106.0	105.6
June	112.6	116.0	116.3	113.2	102.5	102.6	116.4	160.1	137.9	144.0	108.9	109.0
July	110.1	113.7	114.4	113.5	99.6	100.0	95.7	131.9	119.8	120.0	106.8	107.2
August	121.1	124.5	123.1	121.7	102.0	102.2	112.8	147.4	131.5	130.2	105.1	105.4
September	123.5	123.5	120.9	120.0	102.3	103.0	110.4	103.8	108.4	105.0	98.6	99.3
October	133.6	132.6	130.6	128.3	102.3	103.3	109.5	87.0	102.1	100.9	95.4	96.3
November	117.3	114.1	110.8	110.3	103.7	104.7	89.8	70.2	83.3	81.45	95.6	96.5
December	100.8	99.9	95.8	96.6	102.5	103.8	80.9	66.6	76.2	76.5	96.3	97.5

[a]Excludes Maine Mahogany clams.

Source: Kirkley *et al.* 2002.

Table 45. Aggregate surfclam processed product value[1], production and price, by product type, 1991-2000.

Processed Product[2]	Total Value (Millions of $)	Total Surfclam Weight (Millions of lbs)	Product Price ($/lb)	Frequency Reported
Fresh Shucked Meat	243.65	151.55	1.92	69
Chowders in Can	199.35	386.68	0.81	161
Minced or Chopped in Can	190.21	118.41	1.90	115
Fresh Breaded Cooked Strips	136.32	118.80	1.60	21
Frozen Shucked Meat	97.75	127.60	1.40	48
Frozen Breaded Strips	85.32	61.97	1.65	11
Canned In Sauce	50.06	98.98	1.13	73
Canned Juices	48.00	166.29	0.42	72
Frozen Minced or Chopped	32.68	36.51	1.72	14
Frozen Breaded Whole	29.24	20.01	1.61	10
Canned Minced	13.90	15.58	1.74	30
Frozen Breaded Cooked Whole	5.83	10.63	1.31	3
Frozen Cooked Chowders	5.07	3.79	1.14	10
Canned Stews	2.70	3.21	1.58	1
Frozen Strips	2.38	2.01	1.94	5
Fresh Breaded Strips	1.33	.76	1.84	2

[1]All prices and values are reported in constant 2000 dollars.
[2]Only products with aggregate value greater than $1 million are shown. Four other products are reported.

Source: Kirkley *et al.* 2002.

Table 46. Aggregate ocean quahog processed product value[1], production and price, by product type, 1991-2000.

Processed Product[2]	Total Value (Millions of $)	Total Surf Clam Weight (Millions of lbs)	Product Price ($/lb)	Frequency Reported
Minced or Chopped in Can	407.14	268.36	2.42	124
Fresh Shucked Meat	155.50	131.15	2.84	34
Chowders in Can	92.27	109.42	1.30	43
Canned Juices	38.27	78.72	0.93	65
Frozen Shucked Meat	22.29	19.83	1.87	13
Canned In Sauce	7.07	5.14	1.86	14
Canned Whole	2.87	1.30	3.57	37

[1]All prices and values are reported in constant 2000 dollars using Northeast CPI for all food.
[2]Only products with aggregate value greater than $1 million are shown. Four other products are reported.

Source: Kirkley *et al.* 2002.

Table 47. Estimated firm level inverse demand, by product type.

Product Type	Mean Price ($/lb, constant $dollars_{2000}$)	Estimated Coefficients (standard errors) Intercept	Quantity (lbs)	Observations, R^2
Meats	1.75	2.01 (.120)	-.000116 (.000038)	109, 0.075
Minced or Chopped	1.96	2.21 (.162)	-.000144 (.000062)	94, 0.04
Chowders	.80	0.957 (.036)	-.000022 (.000004)	64, 0.32
Strips	1.75	2.47 (.17)	-.000133 (.000030)	33, 0.36

Source: Kirkley *et al.* 2002.

Table 48. Estimated relationship between sample aggregate processed product and surfclam landings, by product type, 1991-2000.

Product Type	Mean Annual Production (Million Pounds)	Estimated Coefficients Quantity (millions of lbs)	Observations, Psuedo-R^2 DW
Meats	27.91	0.473 (11.29)	10, 0.93, 2.07
Minced or Chopped	15.49	0.257 (15.32)	10, 0.96, 1.32
Chowders	38.67	0.65 (18.16)	10, 0.97 1.09
Strips	18.15	0.20 (17.55)	10, 0.97 1.08

Source: Kirkley *et al.* 2002.

Table 49. Estimated annual consumer surplus to processed product consumers ($2000) from A 285,000 bushel increase in landings, by product type and proportion of industry represented by NMFS voluntary sample.

Proportion	Shucked Meats	Minced or Chopped Meats	Chowders	Breaded Strips	Sum Processed Products
25%	1,218,422	359,701	436,382	249,763	2,264,268
50%	609,211	179,850	218,191	124,881	1,132,133
75%	406,140	119,900	145,460	83,254	754,754
100%	304,605	89,925	109,095	62,440	566,065

Source: Kirkley *et al.* 2002.

Table 50. Capital, fixed, and variable costs of surfclam and ocean quahog vessels, 2000.

Cost Category	Number on Board	Useable Life (Years)	Replacement Costs-$
Radar	2	10	8000
Loran C	2	10	1000
GPS	1	7	1500
Plotter	1	8	3000
Echo Sounder	1	7	2000
Video Sounder	1	10	1000
VHF Radio	2	8	1000
Cellular Phone	1	5	200
Life Raft	1	10	5000
EPIRB	1	5	2000
Survival Suits	5	5	1000
Flares	9	3	300
Alarm Systems	3	5	3000
Transducers	2	5-10	500
Grading/Sorting Machine	1	3-10	6000
Hopper	1	3-10	7500
Conveyer Belt	2	2-3	3000
Total Value			$74,900

Source: Kirkley *et al.* 2002.

Table 51. Average annual fixed costs.

Cost Category	Dollar Amount
Insurance	31,895
Repair and Maintenance	64,444
Mooring/Docking	4,156
Regulatory Fees	1,836
Permit & Cage Tag Fees	128,095
Professional Fees	10,982
Business Use of Vehicle and Travel	9,874
Non-Crew Share and Onshore Employees	129,449
Business Organization Fees	43,060
Advertising/Promotion	1,665

Source: Kirkley *et al.* 2002.

Table 52. Average trip costs.

Item	Surfclam	Ocean Quahog
Fuel-Gallons per hour steaming	23.63	51.78
Fuel-Gallons per hour dredging	50.58	51.19
Oil-Gallons per hour at sea	0.30	NA
Rope/Wire-Feet per Trip	450	NA

Source: Kirkley *et al.* 2002.

Table 53. Variable definitions.

Parameter Estimated	Variable	Definition
α	lnw_i	$\log(W^0 + \pi_j)$
β	varw	$.5(Var(\pi_j)/(W^0 + \pi_j)^2)$
δ	fleet	Number of trips in current month at site i
ϕ	fleet2	$fleet^2$

Source: Kirkley *et al.* 2002.

Table 54. Site choice model parameter estimates (t statistics reported in parenthesis).

Parameter	Clams	Quahogs	ME Quahogs
b_lnw	11.23 (19.01)	25.05 (29.29)	30.35 (11.23)
b_varw	-682.72 (14.13)	-50.77 (3.67)	-95.28 (4.32)
b_fleet	.11 (84.67)	.16 (69.96)	.05 (57.36)
b_fleet2	-.00071 (52.11)	-.0018 (37.97)	-.00011 (42.04)
χ^2(all parms=0)	21843.22	16673.36	18738.66
Average # Choices	14.33	21.92	7
% Predicted Correctly	37.74	25.74	74.01

*All parameter significant at the 5% level.

Source: Kirkley *et al.* 2002.

Table 55. Summary of activity, landings, prices, and revenues associated with each policy option relative to baseline quotas (Option summaries based on yearly averages 1996-2000).

Options	Permits			Trips			Landings			Revenues			Prices		
	Surfclams	Quahogs	ME Quahogs	Surfclams	Quahogs	ME Quahogs	Surfclams	Quahogs	ME Quahogs	Surfclams	Quahogs	ME Quahogs	Surfclams	Quahogs	ME Quahogs
1996	34	36	25	2,178	2,545	1,375	2,569,319	4,391,428	47,025	27,705,187	19,934,634	1,494,332	$10.78	$4.54	$31.78
1997	33	31	34	2,119	2,294	1,949	2,413,575	4,279,059	72,706	25,931,856	19,093,240	2,046,248	$10.74	$4.46	$28.14
1998	31	24	39	2,076	1,957	1,823	2,365,374	3,897,487	72,466	21,347,979	17,378,545	2,005,194	$9.03	$4.46	$27.67
1999	33	23	38	2,155	2,078	2,084	2,537,879	3,770,288	94,175	22,074,244	16,438,214	2,683,811	$8.70	$4.36	$28.50
2000	31	29	34	2,041	1,811	2,259	2,561,021	3,160,649	120,767	21,771,814	13,654,772	3,305,575	$8.50	$4.32	$27.37
Status Quo (96-00 avg)	32	29	34	2,114	2,137	1,898	2,489,434	3,899,782	81,428	23,766,216	17,299,881	2,307,032	$9.55	$4.44	$28.33
Option 2	0	0.2	0	0	0	0	0	397	0	0	1,686	0	$0.00	$4.25	$0.00
Option 3	2	10	34	21	323	1,898	7,568	711,644	81,428	105,706	3,079,358	2,307,032	$13.97	$4.33	$28.33
Option 6	4	17	0	24	461	0	33,038	835,709	0	317,313	3,743,184	0	$9.60	$4.48	$0.00
Option 8	0	0	1	0	0	14	0	0	639	0	0	17,231	$0.00	$0.00	$26.95

Source: Kirkley *et al.* 2002.

Table 56. Mean welfare change (EV) per trip.

Policy	Clams	Quahogs	ME Quahogs
Option 1: Status Quo	No Impact	No Impact	No Impact
Option 2: Close Georges Bank	No Impact	No Impact	No Impact
Option 3: Close waters east of 70d20m	$2.01	$1064.89	Complete Closure of Fishery
Option 6: Close Tilefish Area	$70.89	$2,636.62	No Impact
Option 8: West of ME Zone 1	No Impact	No Impact	$888.06
Average Revenue per Trip	$10,908.94	$8,088.59	$1,215.88

Source: Kirkley *et al.* 2002.

Table 57. Yearly economic impact from EFH options: no trip changes and no change in quotas.

Species	Option	Per Trip Equivalent Variation	Trips	Total Equivalent Variation
Surfclam	Status Quo	0	2,114	0
	Option 2	0	2,114	0
	Option 3	$2	2,114	$4,228
	Option 6	$71	2,114	$150,094
	Option 8	0	2,114	0
Quahog	Status Quo	0	2,137	0
	Option 2	0	2,137	0
	Option 3	$1065	2,137	$2,275,905
	Option 6	$2,637	2,137	$5,635,269
	Option 8	0	2,137	0
ME Quahog	Status Quo	0	1,898	0
	Option 2	0	1,898	0
	Option 3	Complete Closure	0	Complete Closure
	Option 6	0	1,898	0
	Option 8	$888	1,898	$1,685,424

Source: Kirkley *et al.* 2002.

Table 58. Economic impacts of proposed essential fish habitat regulations and new surfclam quotas.

Surfclams	Landings	Number of Trips	Price	Revenue	Consumer Surplus	Operating Costs	Producer Surplus	Net Benefits
Status Quo	2,489,434	2,114	9.55	23,766,216	1,676,960	8,589,110	15,177,106	16,854,066
Q1-3.135 Million Bushels	3,135,000	2,662	9.30	29,154,224	1,826,470	10,583,927	18,570,297	20,396,767
Q2-3.40 Million Bushels	3,400,000	2,887	9.20	31,273,547	1,853,820	11,375,060	19,898,487	21,752,307
Option 2–No Impact	2,489,434	2,114	9.55	23,766,216	1,676,960	8,589,110	15,177,106	16,854,066
Option 3	2,489,434	2,157	9.55	23,766,216	1,676,960	8,615,325	15,150,891	16,827,851
Option 3, Reduce Trips as Response to Option 3	2,415,941	2,093	9.57	23,132,589	1,652,488	8,344,899	14,787,690	16,440,178
Option 3, Q=3.135	3,135,000	2,716	9.30	29,154,224	1,826,470	10,616,941	18,537,283	20,363,753
Option 3, Q=3.40	3,400,000	2,946	9.20	31,273,547	1,853,820	11,410,865	19,862,682	21,716,502
Option 6	2,489,434	2,201	9.55	23,766,216	1,676,960	8,673,356	15,092,860	16,769,820
Option 6, Reduce Trips as Response to Option 6	2,363,691	2,090	9.59	22,679,597	1,634,163	8,075,604	14,603,993	16,238,156
Option 6, Quota=3.135 Million Bushels	3,135,000	2,772	9.30	29,154,224	1,826,470	10,690,021	18,464,203	20,290,673
Option 6, Quota=3.40 Million Bushels	3,400,000	3,006	9.20	31,273,547	1,853,820	11,490,122	19,783,425	21,637,245
Option 8–No Impact	2,489,434	2,114	9.55	23,766,216	1,676,960	8,589,110	15,177,106	16,854,066

Source: Kirkley *et al.* 2002.

Table 59. Changes in economic impacts induced by proposed essential fish habitat regulations and new surfclam quotas.

	Change						
Surfclams	Landings	Trips	Price	Revenue	Consumer Surplus	Producer Surplus	Net Benefits
Status Quo							
Q1-3.135 Million Bushels	645,566	548	-0.24	5,388,008	149,510	3,393,191	3,542,701
Q2-3.40 Million Bushels	910,566	773	-0.35	7,507,331	176,860	4,721,381	4,898,241
Option 2–No Impact	0.0	0.0	0.00	0.0	0.0	0.0	0.0
Option 3	0.0	43	0.00	0.0	0.0	-26,215	-26,215
Option 3, Reduce Trips as Response to Option 3	-73,493	-21	0.03	-633,627	-24,472	-389,416	-413,888
Option 3, Q=3.135	645,566	602	-0.24	5,388,008	149,510	3,360,177	3,509,687
Option 3, Q=3.40	910,566	832	-0.35	7,507,331	176,860	4,685,576	4,862,436
Option 6	0	87	0.00	0.0	0.0	-84,246	-84,246
Option 6, Reduce Trips as Response to Option 6	-125,743	-24	0.04	-1,086,619	-42,797	-573,113	-615,910
Option 6, Quota=3.135 Million Bushels	645,566	658	-0.24	5,388,008	149,510	3,287,097	3,436,607
Option 6, Quota=3.40 Million Bushels	910,566	892	-0.35	7,507,331	176,860	4,606,319	4,783,179
Option 8--No Impact	0.0	0.0	0.00	0.0	0.0	0.0	0.0

Source: Kirkley *et al.* 2002.

Table 60. Economic impacts of regulations proposed to protect the essential fish habitat of ocean quahogs[a].

Mid-Atlantic Ocean Quahogs	Landings	Number of Trips	Price	Revenue	Consumer Surplus	Operating Costs	Producer Surplus	Net Benefits
Status Quo	3,899,782	2,137	4.44	17,299,881	702,476	11,378,890	5,920,991	6,623,467
Option 2–No Impact	3,899,782	2,137	4.44	17,299,881	702,476	11,378,890	5,920,991	6,623,467
Option 3–No Impact	3,899,782	2,137	4.44	17,299,881	702,476	11,378,890	5,920,991	6,623,467
Option 6	3,899,782	2,280	4.44	17,299,881	702,476	11,926,922	5,372,959	6,075,435
Option 6, Reduce Trips as Response to Option 6	2,866,709	1,676	4.45	12,763,191	527,677	8,781,260	3,981,932	4,509,609
Option 8–No Impact	3,899,782	2,137	4.44	17,299,881	702,476	11,378,890	5,920,991	6,623,467

[a]Analysis excludes Maine ocean quahogs (mahoganies).

Source: Kirkley *et al.* 2002.

Table 61. Changes in economic impacts induced by proposed essential fish habitat regulations for ocean quahogs.

	Change						
Mid-Atlantic Ocean Quahogs	Landings	Trips	Price	Revenue	Consumer Surplus	Producer Surplus	Net Benefits
Status Quo							
Option 2–No Impact	0	0	0.00	0	0	0	0
Option 3–No Impact	0	0	0.00	0	0	0	0
Option 6	0	143	0.00	0	0	-548,032	-548,032
Option 6, Reduce Trips as Response to Option 6	-1,033,073	-461	0.02	-4,536,690	-174,799	-1,939,059	-2,113,858
Option 8–No Impact	0	0	0.00	0	0	0	0

[a]Analysis excludes Maine ocean quahogs (mahoganies).

Source: Kirkley *et al.* 2002.

Table 62. Combined economic impacts of proposed essential fish habitat regulations and new surfclam quotas, surfclams and ocean quahogs[a].

Surfclams and Ocean Quahogs	Landings	Number of Trips	Revenue	Consumer Surplus	Fuel and Labor Operating Costs	Fixed Cost	Producer Surplus	Net Benefits
Status Quo	6,389,216	4,251	41,066,097	2,379,436	19,968,000	16,636,220	4,338,877	6,718,313
Q1-3.135 Million Bushels	7,034,782	4,799	46,454,105	2,528,946	21,962,817	16,636,220	7,732,068	10,261,014
Q2-3.40 Million Bushels	7,299,782	5,024	48,573,428	2,556,296	22,753,950	16,636,220	9,060,258	11,616,554
Option 2–No Impact	6,389,216	4,251	41,066,097	2,379,436	19,968,000	16,636,220	4,338,877	6,718,313
Option 3	6,389,216	4,294	41,066,097	2,379,436	19,994,215	16,636,220	4,312,662	6,692,098
Option 3, Reduce Trips as Response to Option 3	6,315,723	4,230	40,432,470	2,354,964	19,723,789	16,636,220	3,949,461	6,304,425
Option 3, Q=3.135	7,034,782	4,853	46,454,105	2,528,946	21,995,831	16,636,220	7,699,054	10,228,000
Option 3, Q=3.40	7,299,782	5,083	48,573,428	2,556,296	22,789,755	16,636,220	9,024,453	11,580,749
Option 6	6,389,216	4,481	41,066,097	2,379,436	20,600,278	16,636,220	3,706,599	6,086,035
Option 6, Reduce Trips as Response to Option 6	5,230,400	3,766	35,442,788	2,161,840	16,856,864	16,636,220	1,826,704	3,988,544
Option 6, Quota=3.135 Million Bushels	7,034,782	5,052	46,454,105	2,528,946	22,616,943	16,636,220	7,077,942	9,606,888
Option 6, Quota=3.40 Million Bushels	7,299,782	5,286	48,573,428	2,556,296	23,417,044	16,636,220	8,397,164	10,953,460
Option 8–No Impact	6,389,216	4,251	41,066,097	2,379,436	19,968,000	16,636,220	4,338,877	6,718,313

[a]Excludes Maine ocean quahogs (Mahoganies).

Source: Kirkley *et al.* 2002.

Table 63. Changes in economic impacts induced by proposed essential fish habitat regulations and new surfclam quotas, surfclams and ocean quahogs[a].

	Change					
Surfclams and Ocean Quahogs	Landings	Trips	Revenue	Consumer Surplus	Producer Surplus	Net Benefits
Status Quo						
Q1-3.135 Million Bushels	645,566	548	5,388,008	149,510	3,393,191	3,542,701
Q2-3.40 Million Bushels	910,566	773	7,507,331	176,860	4,721,381	4,898,241
Option 2–No Impact	0.0	0.0	0.0	0.0	0.0	0.0
Option 3	0.0	43.0	0.0	0.0	-26,215.0	-26,215.0
Option 3, Reduce Trips as Response to Option 3	-73,493	-21	-633,627	-24,472	-389,416	-413,888
Option 3, Q=3.135	645,566	602	5,388,008	149,510	3,360,177	3,509,687
Option 3, Q=3.40	910,566	832	7,507,331	176,860	4,685,576	4,862,436
Option 6	0	230	0	0	-632,278	-632,278
Option 6, Reduce Trips as Response to Option 6	-1,158,816	-485	-5,623,309	-217,596	-2,512,173	-2,729,769
Option 6, Quota=3.135 Million Bushels	645,566	801	5,388,008	149,510	2,739,065	2,888,575
Option 6, Quota=3.40 Million Bushels	910,566	1,035	7,507,331	176,860	4,058,287	4,235,147
Option 8–No Impact	0.0	0.0	0.0	0.0	0.0	0.0

[a]Excludes Maine ocean quahogs (mahoganies).

Source: Kirkley *et al.* 2002.

Table 64. Economic impacts of regulatory options designed to protect essential fish habitat, Maine ocean quahogs (mahoganies).

Regulatory Option	Landings	Number of Trips	Revenue	Consumer Surplus
Status Quo	81,428	1,898	2,536,457	831,795
Option 2--No Impact	81,428	1,898	2,536,457	831,795
Option 3[a]	0	0	0	0
Option 6--No Impact	81,428	1,898	2,536,457	831,795
Option 8--No Impact	81,428	1,898	2,536,457	831,795

[a]Option 3 closes the fishery.

Source: Kirkley *et al.* 2002.

Table 65. Change in economic impacts of regulations proposed to protect essential fish habitat, Maine ocean quahogs (mahoganies).

Regulatory Option	Change			
	Landings	Number of Trips	Revenue	Consumer Surplus
Status Quo				
Option 2--No Impact	0	0	0	0
Option 3[a]	-81,428	-1,898	-2,536,457	-831,795
Option 6--No Impact	0	0	0	0
Option 8--No Impact	0	0	0	0

[a]Option 3 closes the fishery.

Source: Kirkley *et al.* 2002.

Table 66. Annual economic impact on producer welfare (equivalent variation-EV) of proposed essential fish habitat regulations.

Species	Option	Potential Producer Welfare Loss-Equivalent Variation ($)
Surfclam	Status Quo	0
	Option 2	0
	Option 3	4,228
	Option 6	150,094
	Option 8	0
Ocean Quahogs	Status Quo	0
	Option 2	0
	Option 3	2,275,905
	Option 6	5,635,269
	Option 8	0
Maine Quahog	Status Quo	0
	Option 2	0
	Option 3	Closure of Fishery
	Option 6	0
	Option 8	1,685,424

Source: Kirkley *et al.* 2002.

Table 67. Changes in consumer surplus for 3.135 and 3.40 million bushel surfclam quotas[a].

Quota Million Bushels	Product	Consumer Surplus-25%	Consumer Surplus-50%	Consumer Surplus-75%	Consumer Surplus-100%
3.135	Shucked Meats	1,218,400	609,210	406,140	304,610
3.135	Minced Product	359,700	179,850	119,900	88,925
3.135	Chowder	436,380	218,190	145,460	109,100
3.135	Strips	249,760	124,880	83,255	62,440
3.40	Shucked Meats	4,537,700	268,800	1,512,600	1,134,400
3.40	Minced Product	1,339,600	669,800	446,540	334,900
3.40	Chowder	1,625,200	812,590	541,730	406,300
3.40	Strips	930,180	465,090	310,060	232,540

[a]% indicates the approximate percentage of total firms included in the NMFS sample. Thus, if the sample size used to estimate consumer surplus was based on information obtained from 25% of the firms, consumer surplus for all firms would be higher than it would if the sample size consisted of 50% of the total number of firms engaged in processing surfclams.

Source: Kirkley *et al.* 2002.

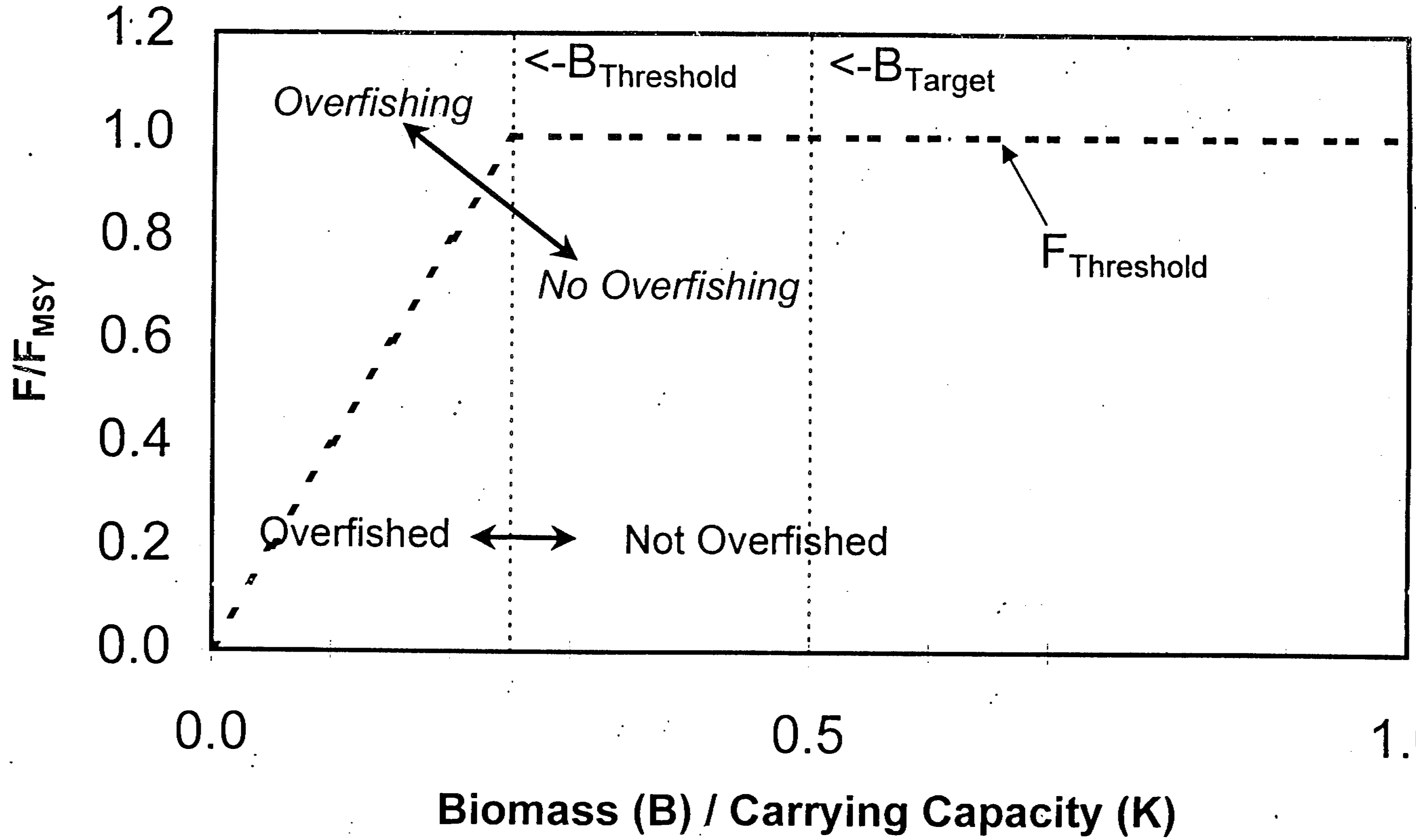


Figure 1. Default MSY control rule for surfclams with $B_{Threshold} = B_{MSY}/2$.

Source: USDC 2000a.

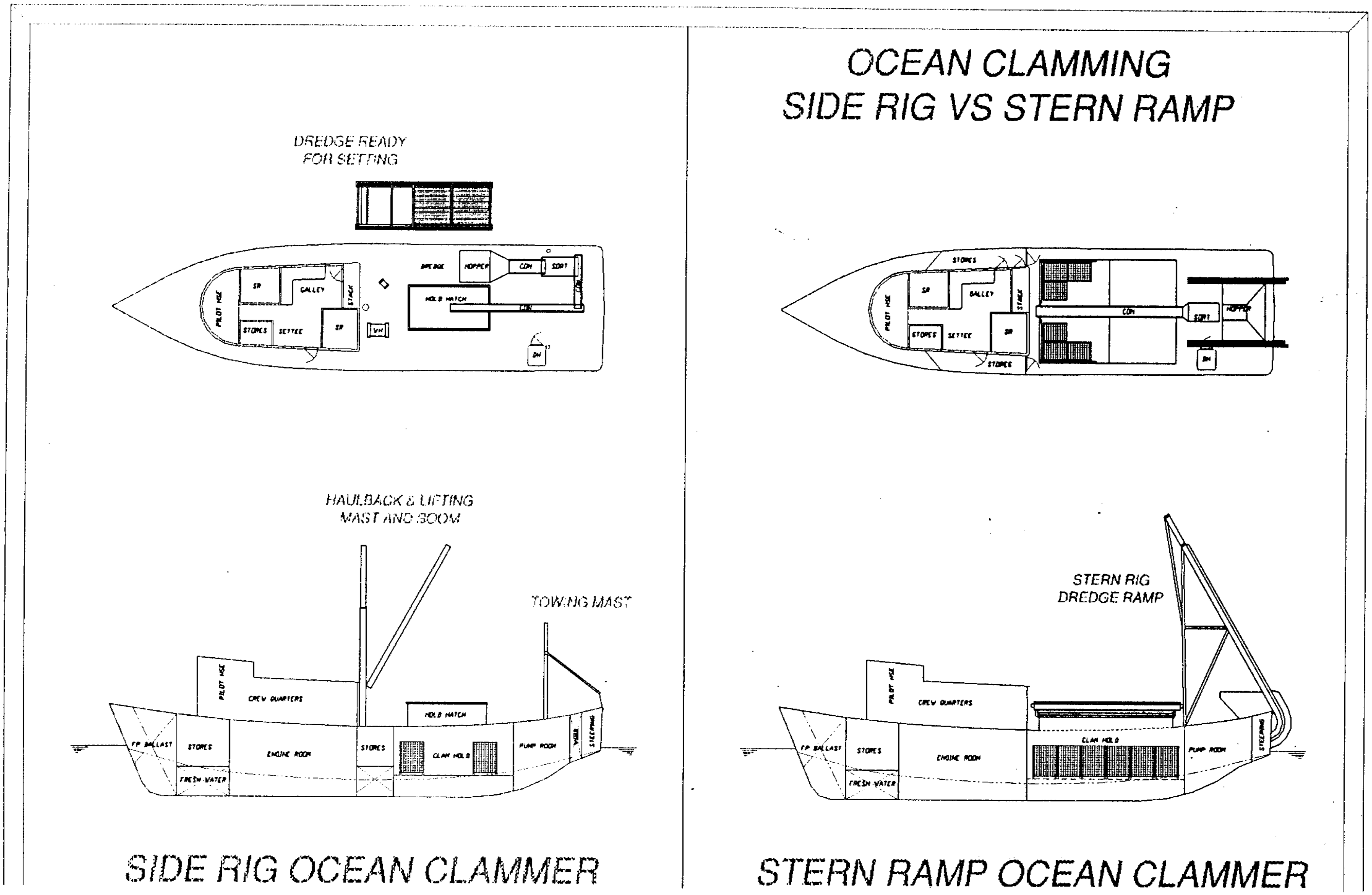


Figure 2. Types of hydraulic clam gear.

Source: Wallace pers. comm.

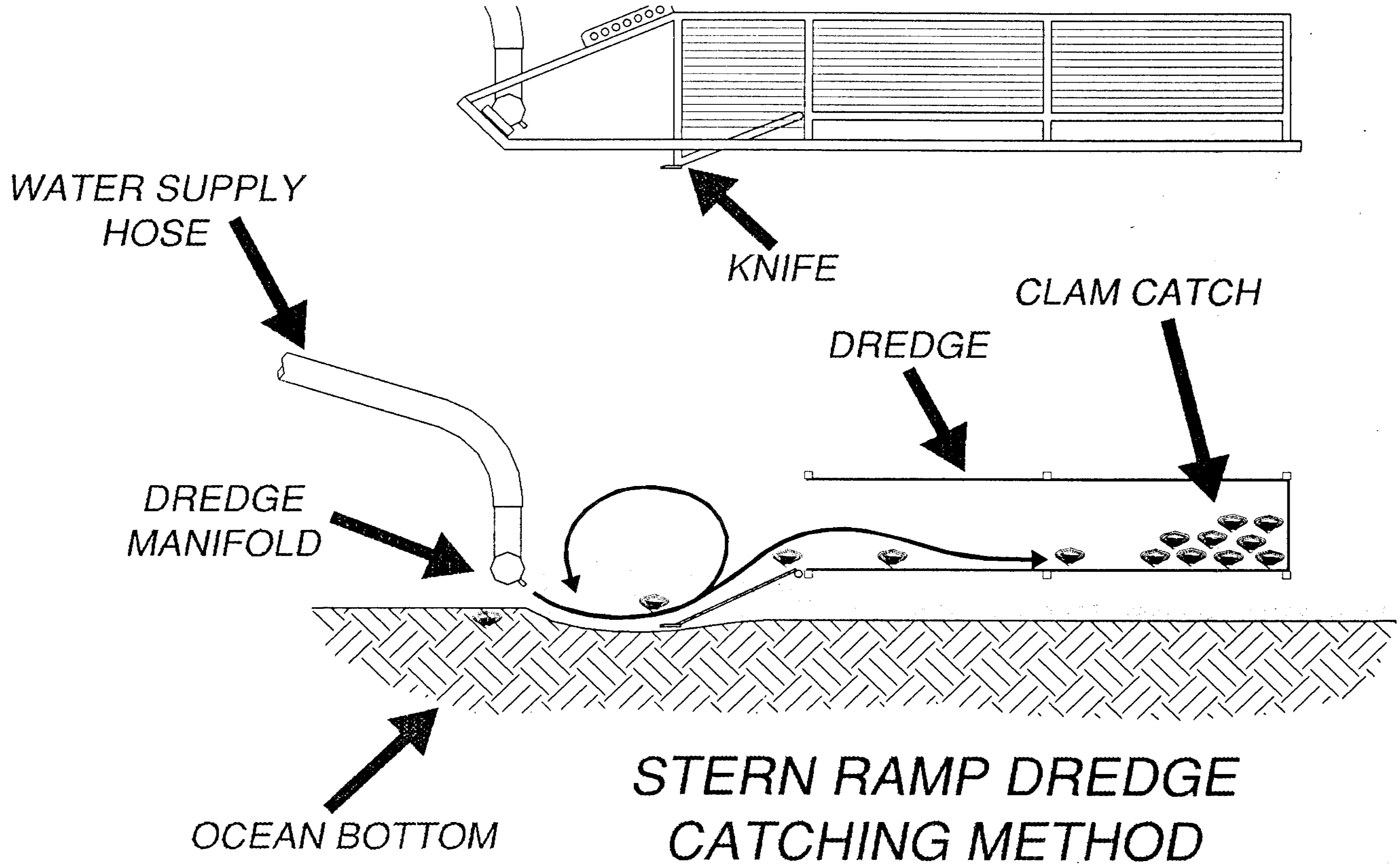


Figure 3. Details of hydraulic clam gear.

Source: Wallace pers. comm.

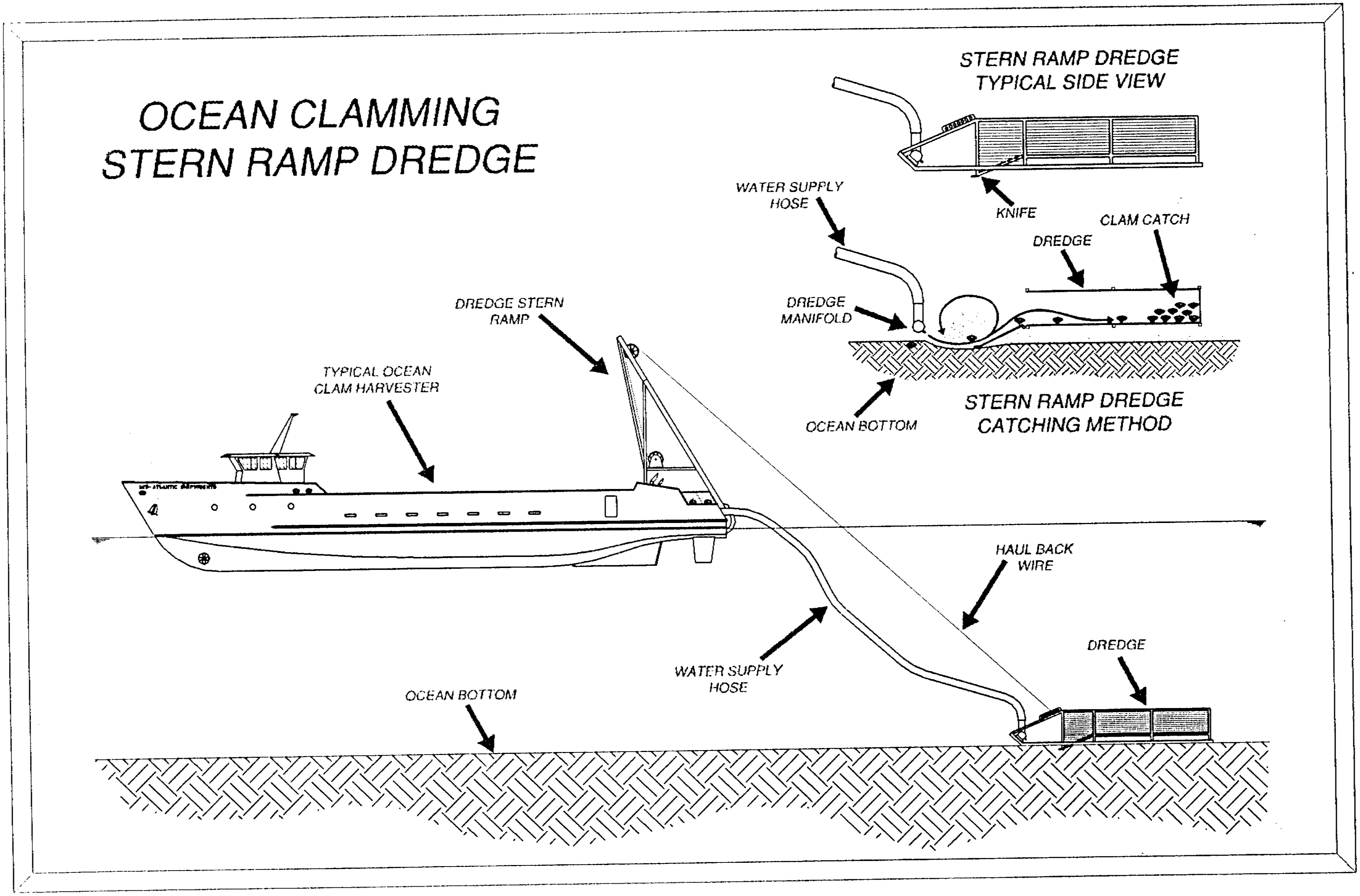


Figure 4. Operation of hydraulic clam dredge.

Source: Wallace pers. comm.

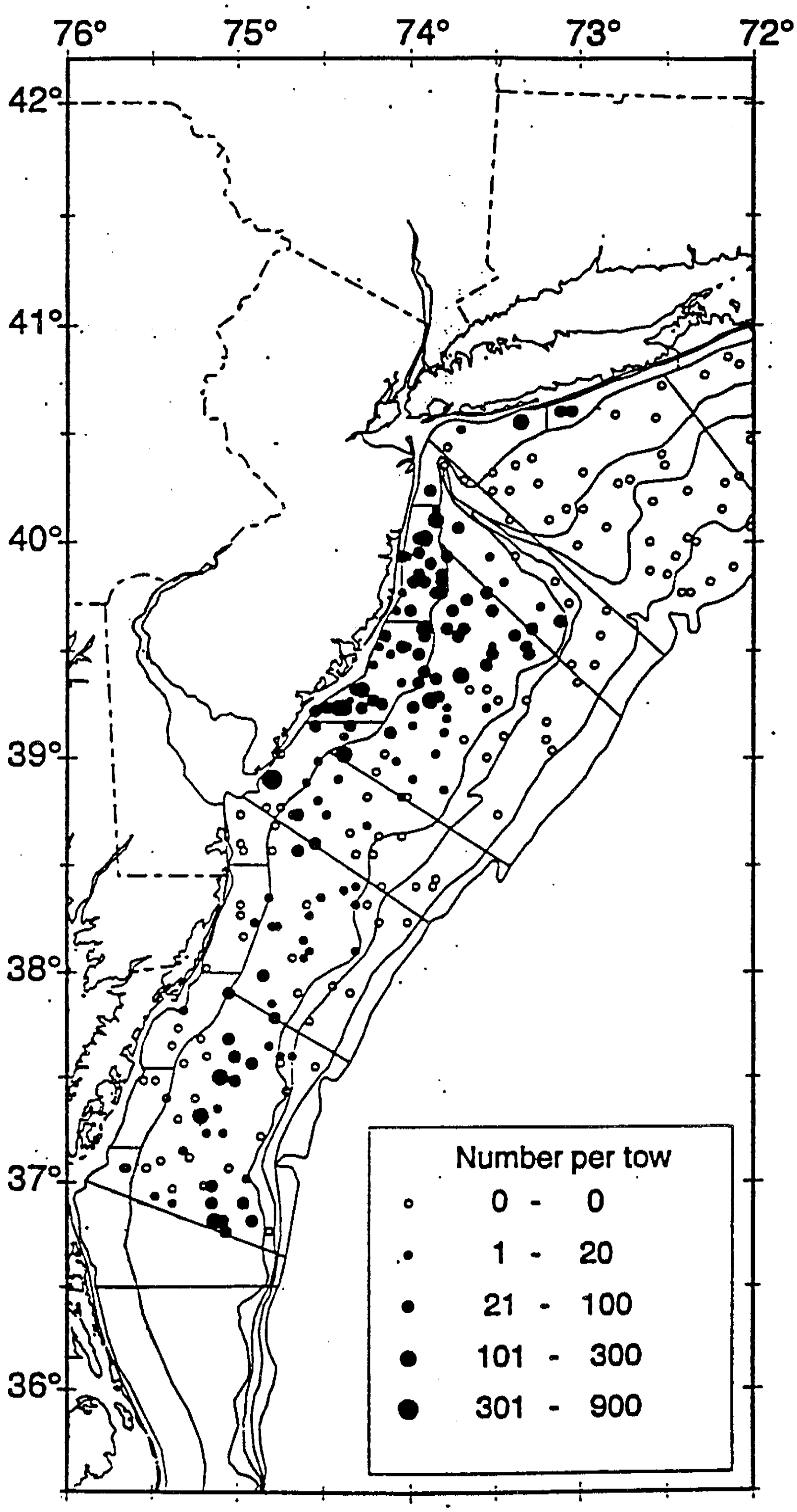


Figure 5. Distribution of 1999 survey surfclam abundance per tow (>=120mm) adjusted to 0.15 n. mi. tow distance with sensor data. Blade depth = 4 inches.

Source: USDC 2000a.

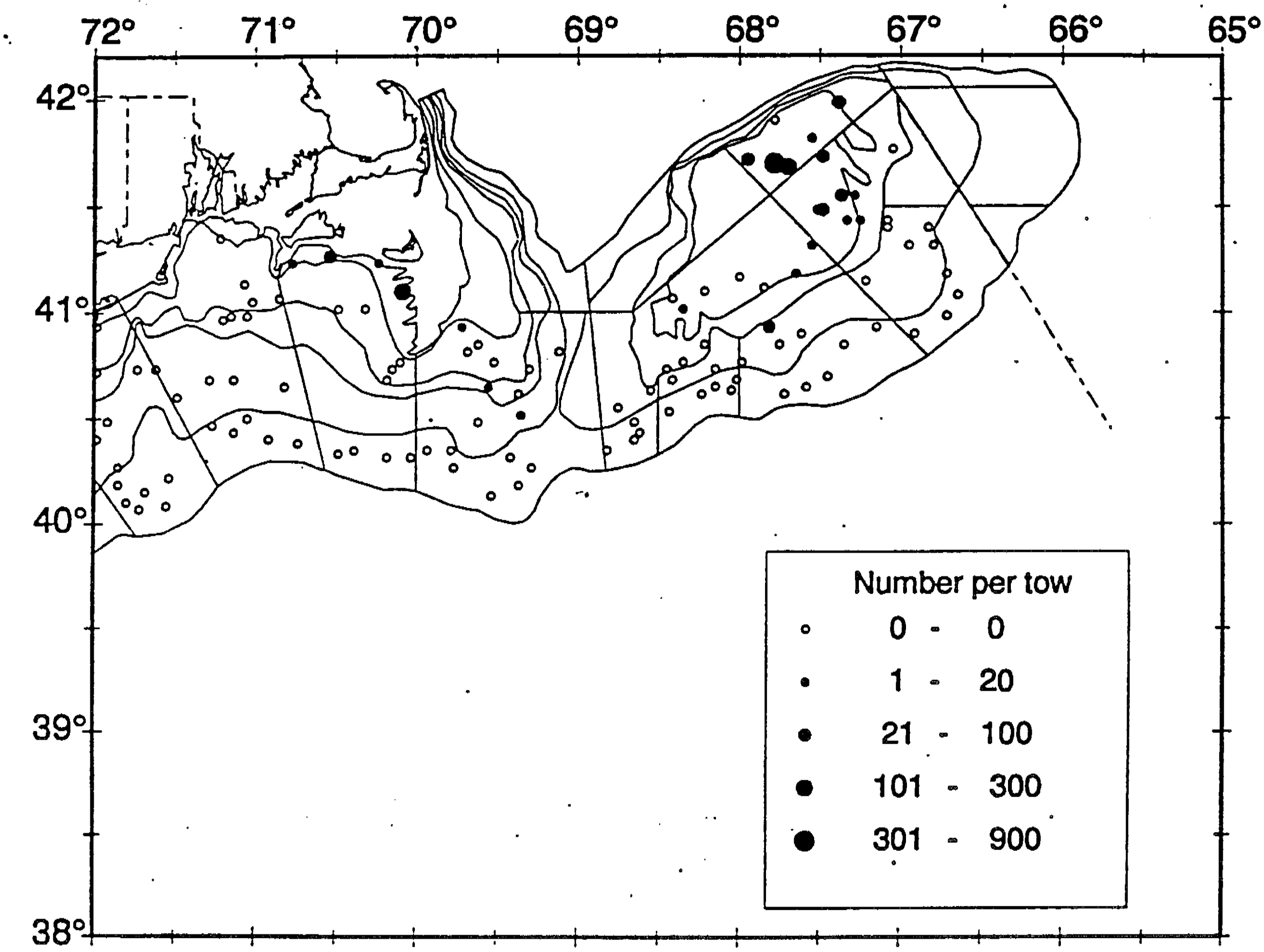


Figure 6. Distribution of 1999 survey surfclam abundance per tow (>=120 mm) adjusted to 0.15 n. mi. tow distance with sensor data. Blade depth = 4 inches.

Source: USDC 2000a.

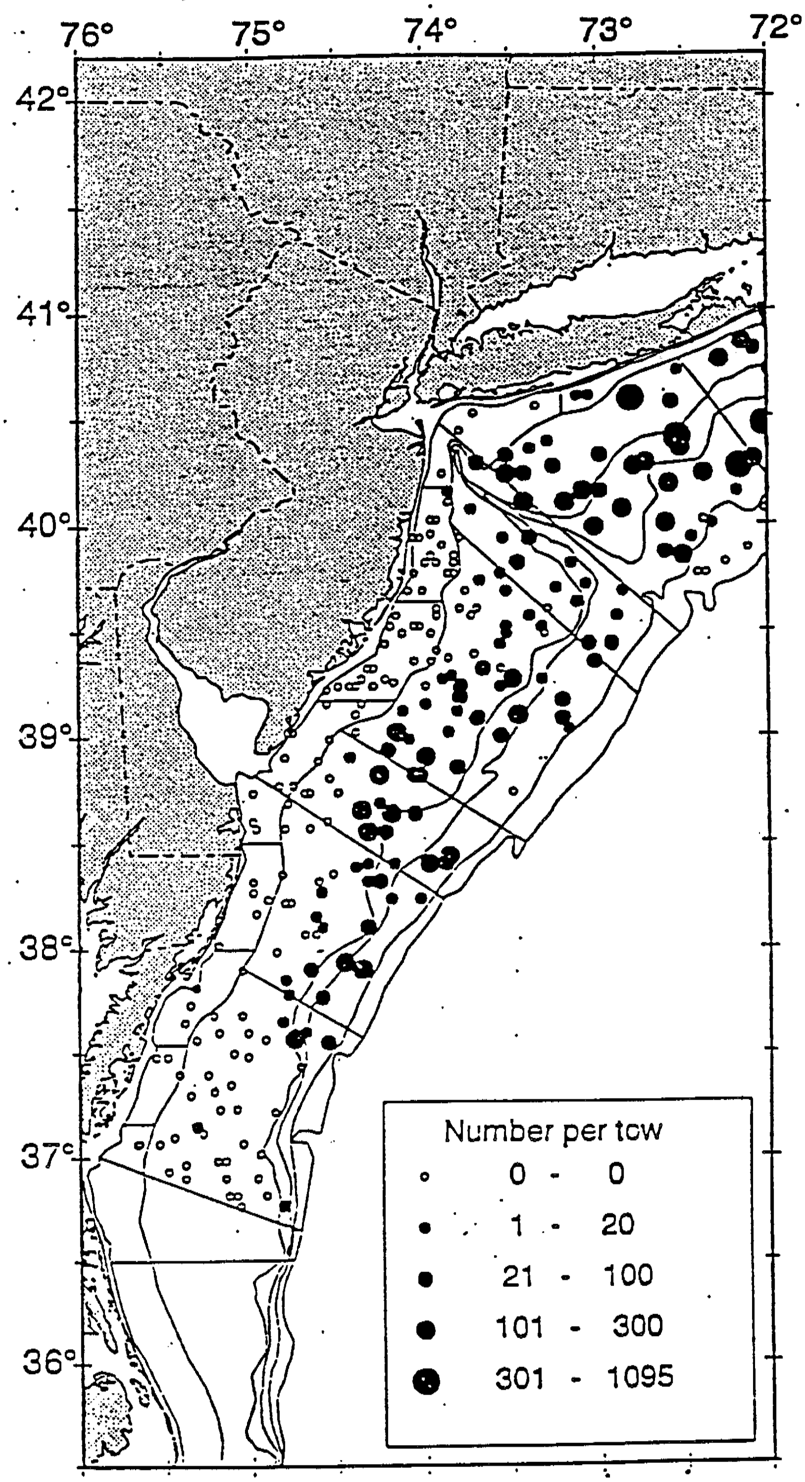


Figure 7. Distribution of ocean quahog abundance per tow (>=70 mm), during the 1999 NEFSC survey, adjusted to 0.15 n. mi. tow distance with sensor data. Blade depth = 4 inches. NEFSC clam strata boundaries are 10-30 m, 31-50 m, 51-60 m, 61-80 m, and 81-120 m. The 200 m bathymetric line is also shown.

Source: USDC 2000b.

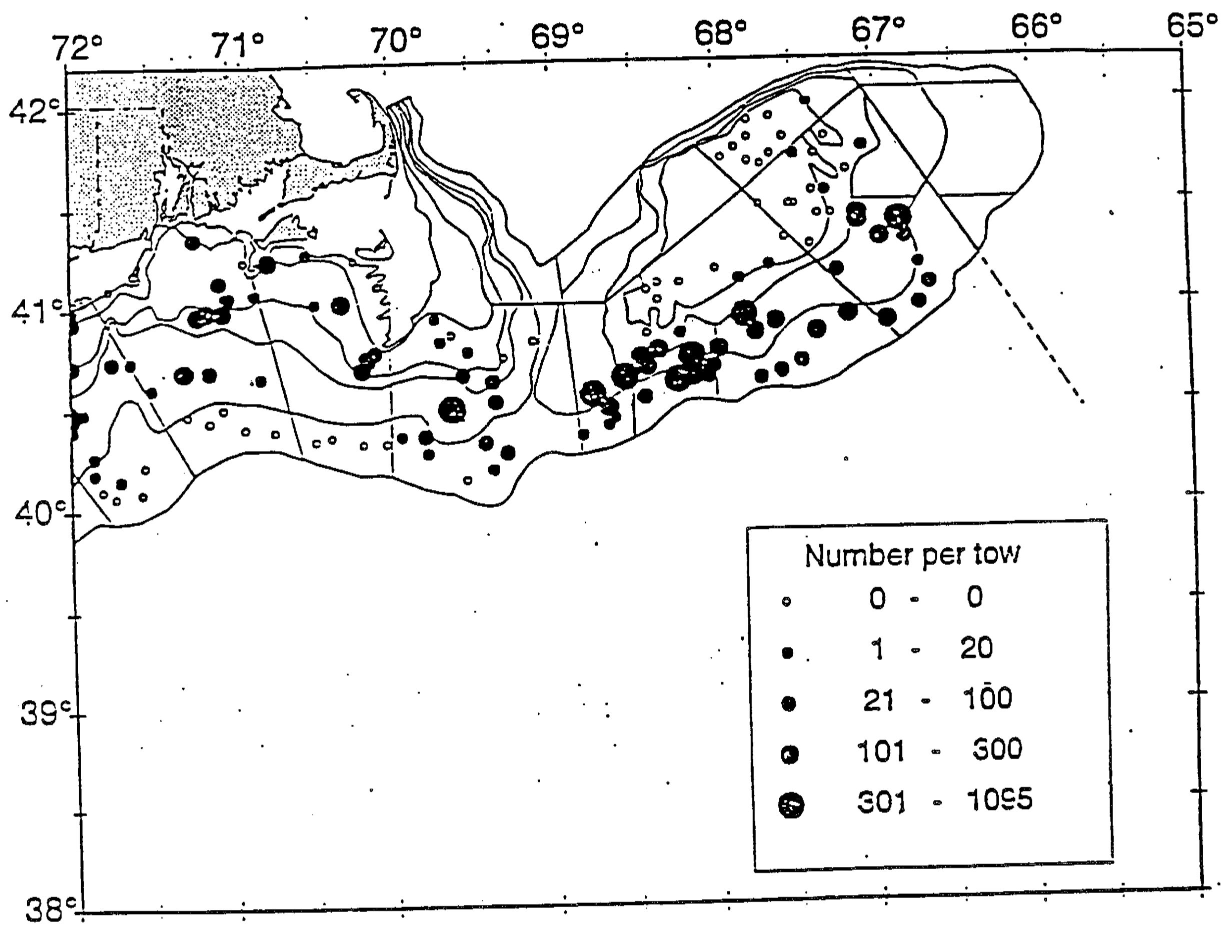


Figure 8. Distribution of ocean quahog abundance per tow (>=70 mm), during the 1999 NEFSC survey, adjusted to 0.15 n. mi. tow distance with sensor data. Blade depth = 4 inches. NEFSC clam strata boundaries are 10-30 m, 31-50 m, 51-60 m, 61-80 m, and 81-120 m. The 200 m bathymetric line is also shown.

Source: USDC 2000b.

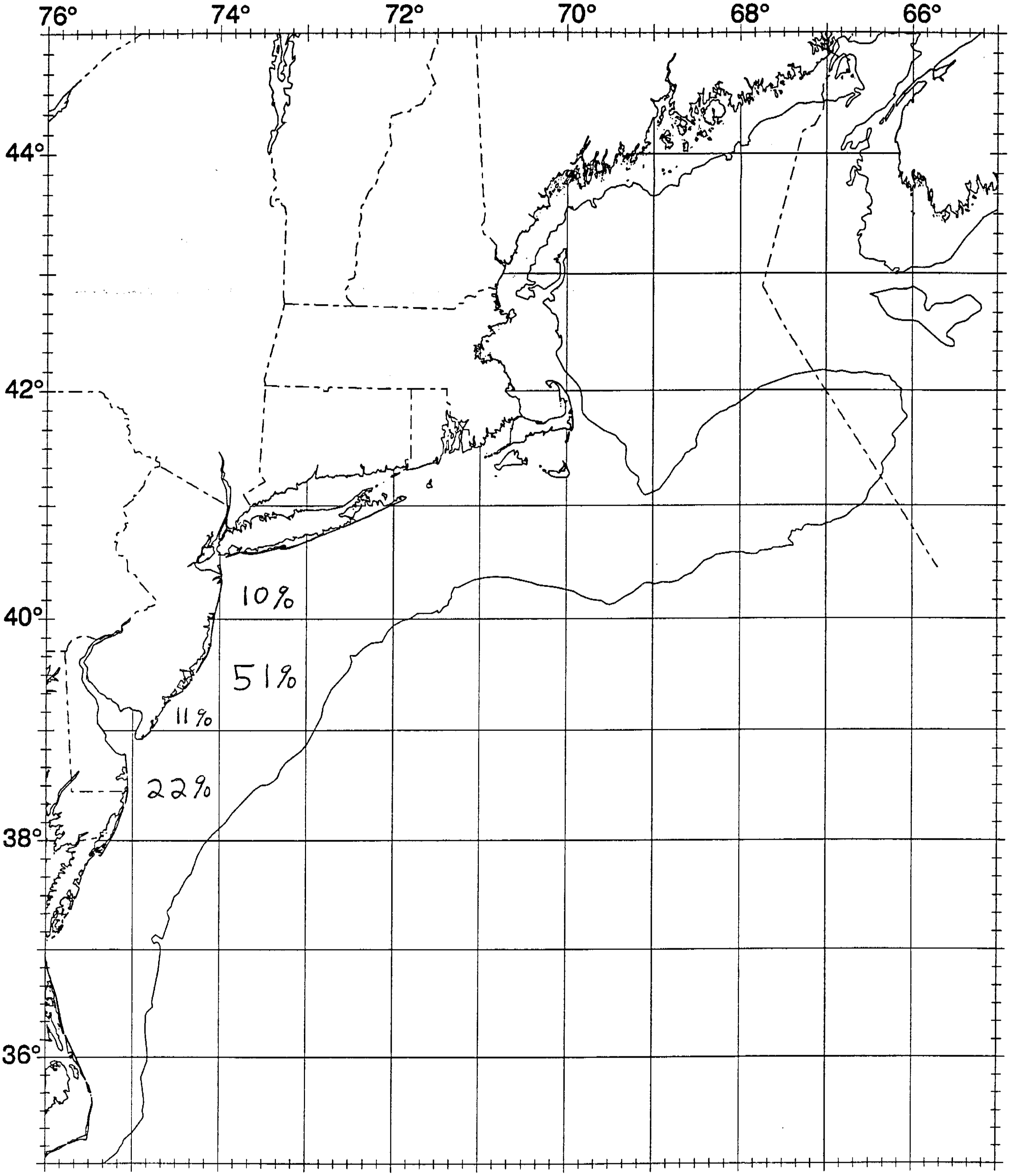


Figure 9. 2000 Federal surfclam harvests. Top 4 degree squares.

Source: NMFS clam vessel logbook files.

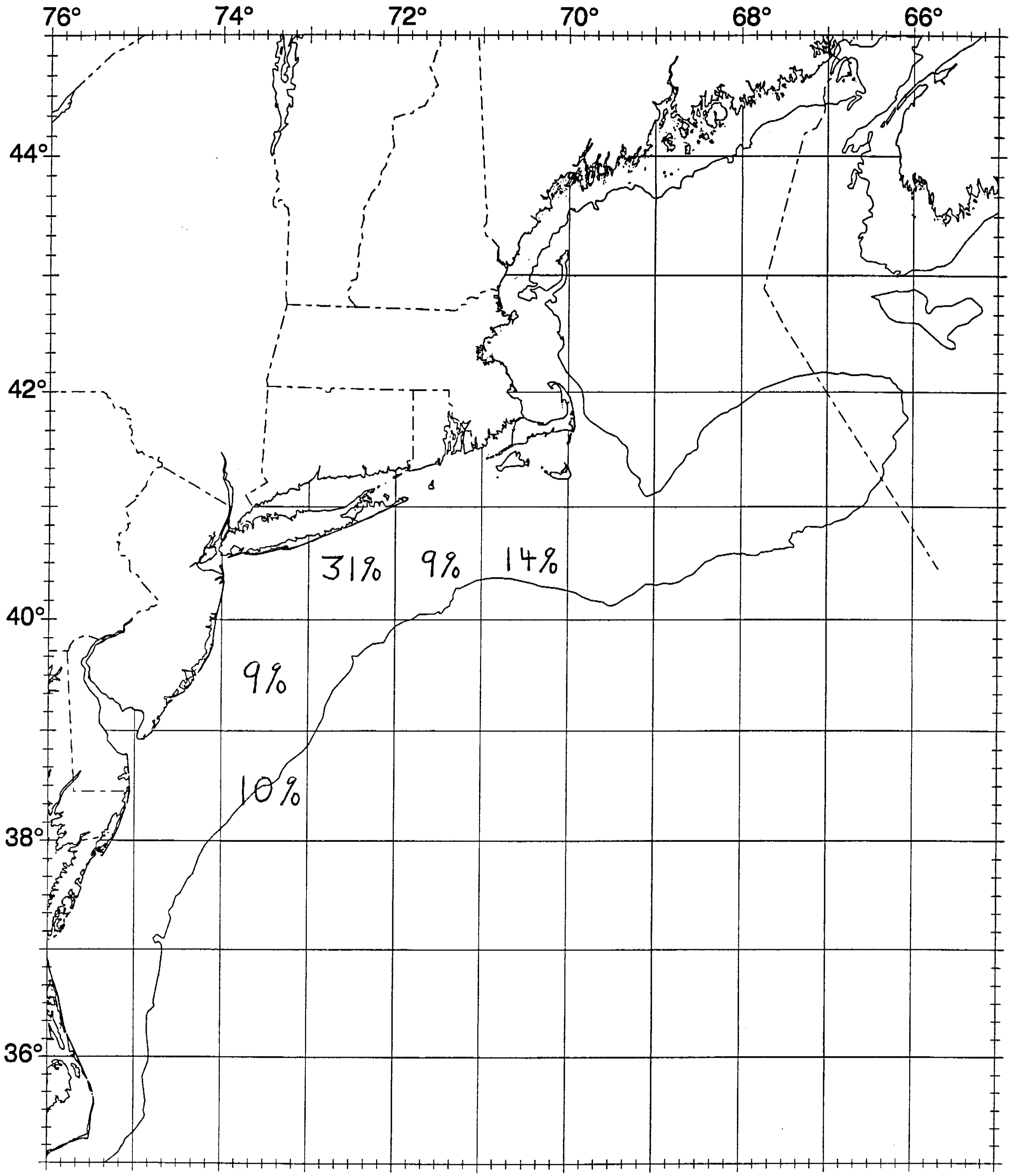


Figure 10. 2000 Federal ocean quahog harvests. Top 5 degree squares.

Source: NMFS clam vessel logbook files.

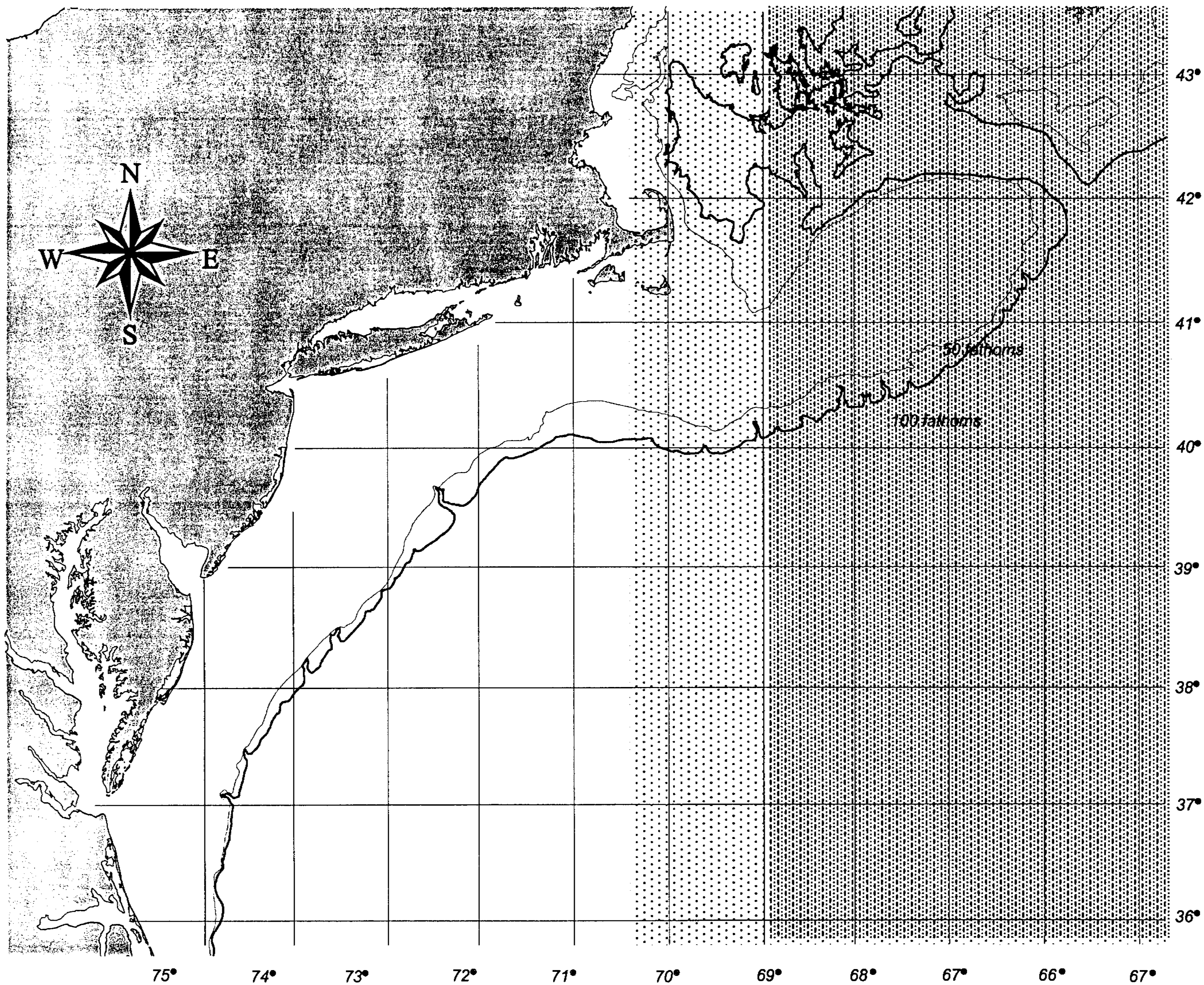


Figure 11. Two potential closed areas - - Options 2 (east of 69°) and 3 (east of 70°20').

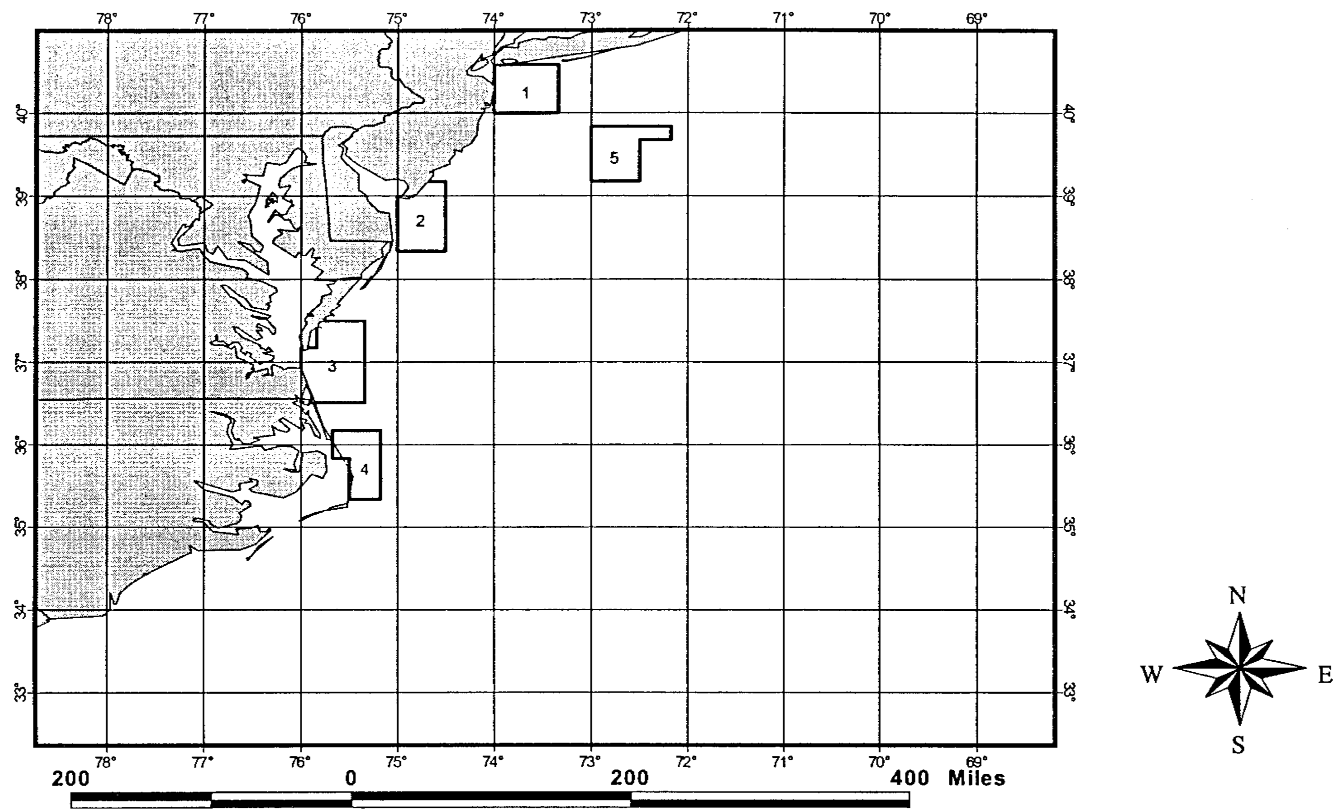


Figure 12. Closed area options 4 and 5 which are identical to those for summer flounder, scup, and black sea bass EFH.

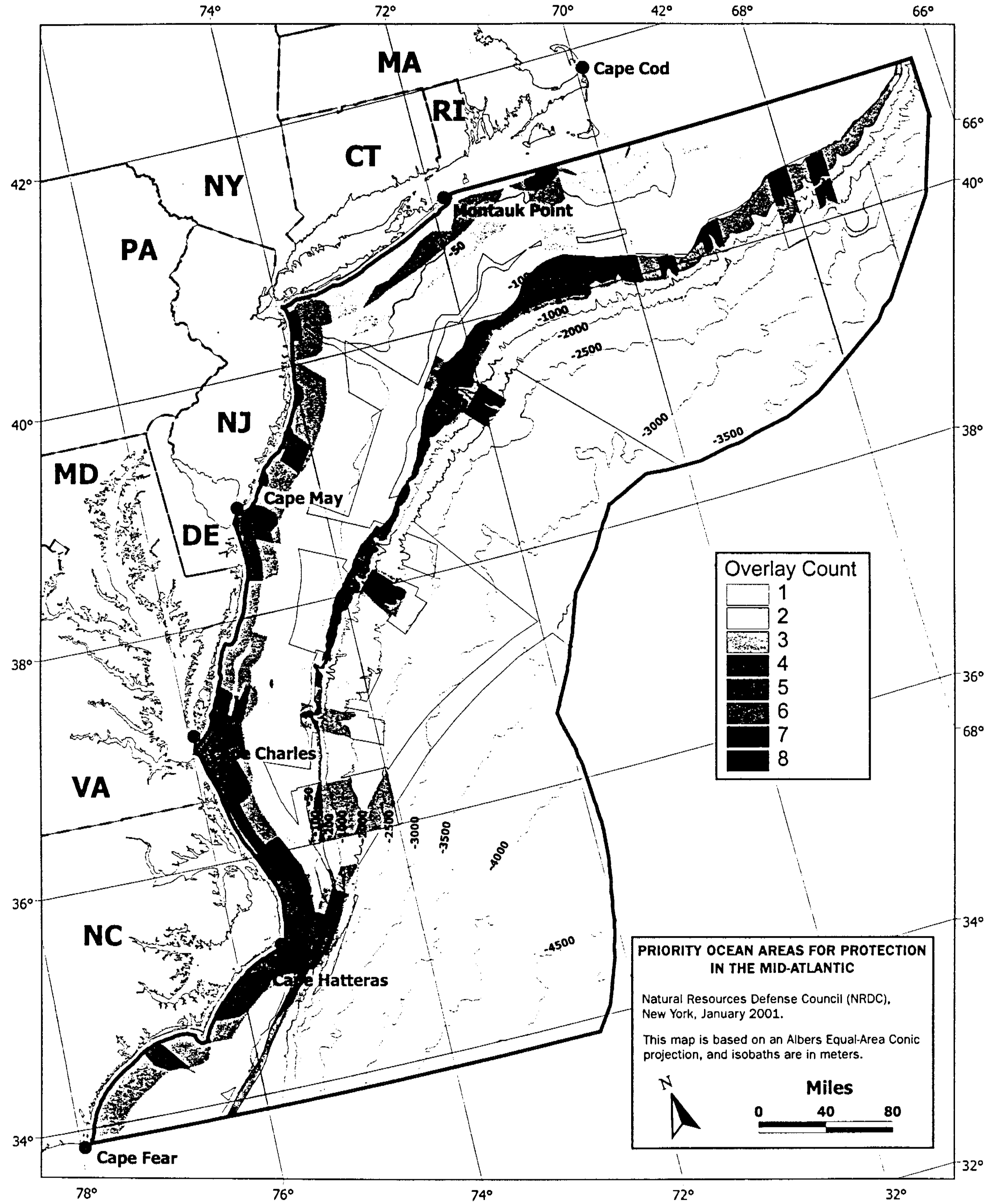


Figure 13. This map shows the areas of greatest convergence - where several workshop participants recommended the same or overlapping areas.

Source: NRDC 2001.

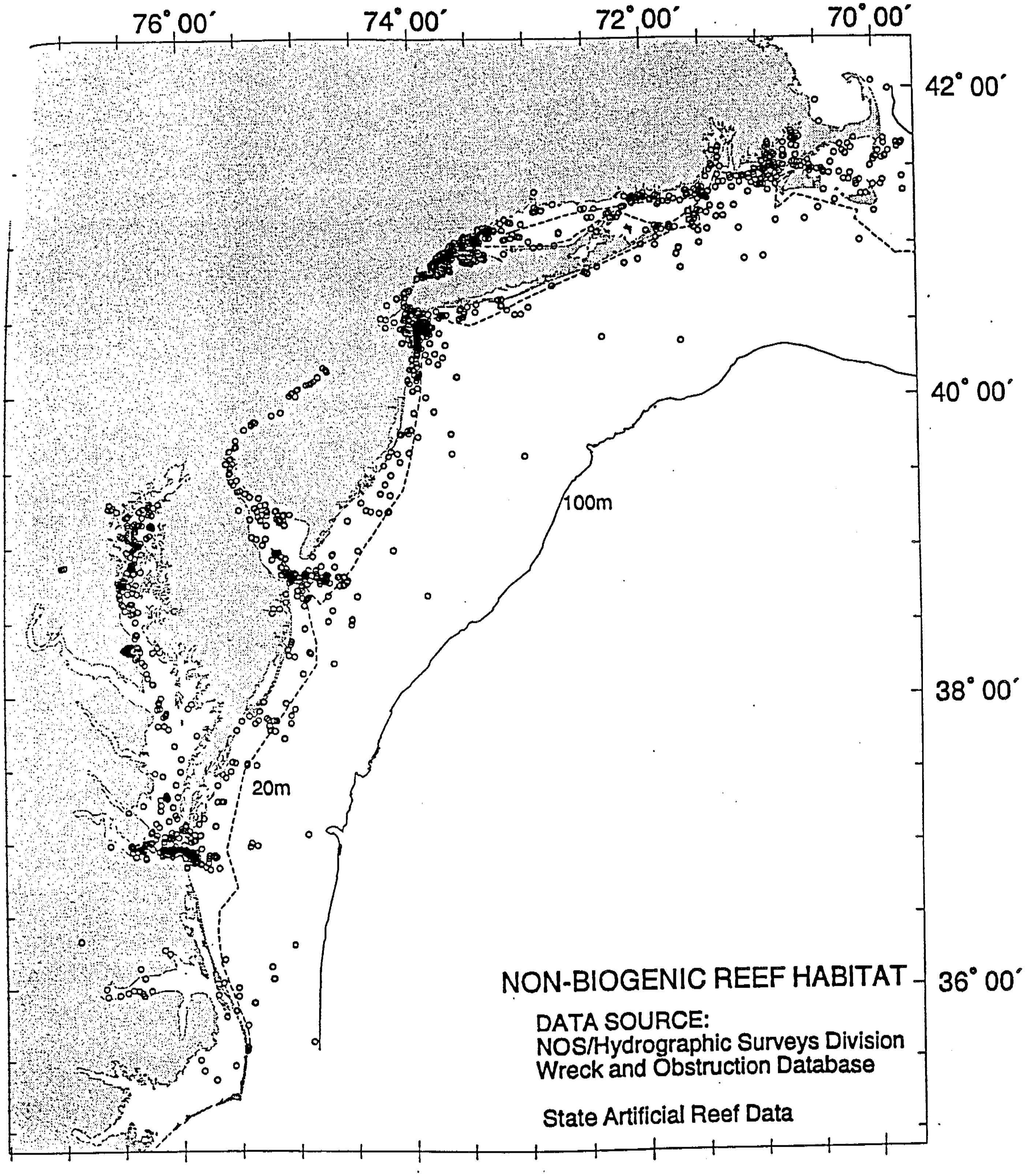


Figure 14. Location of non-biogenic reef habitat.

Source: Steimle and Zetlin 2000.

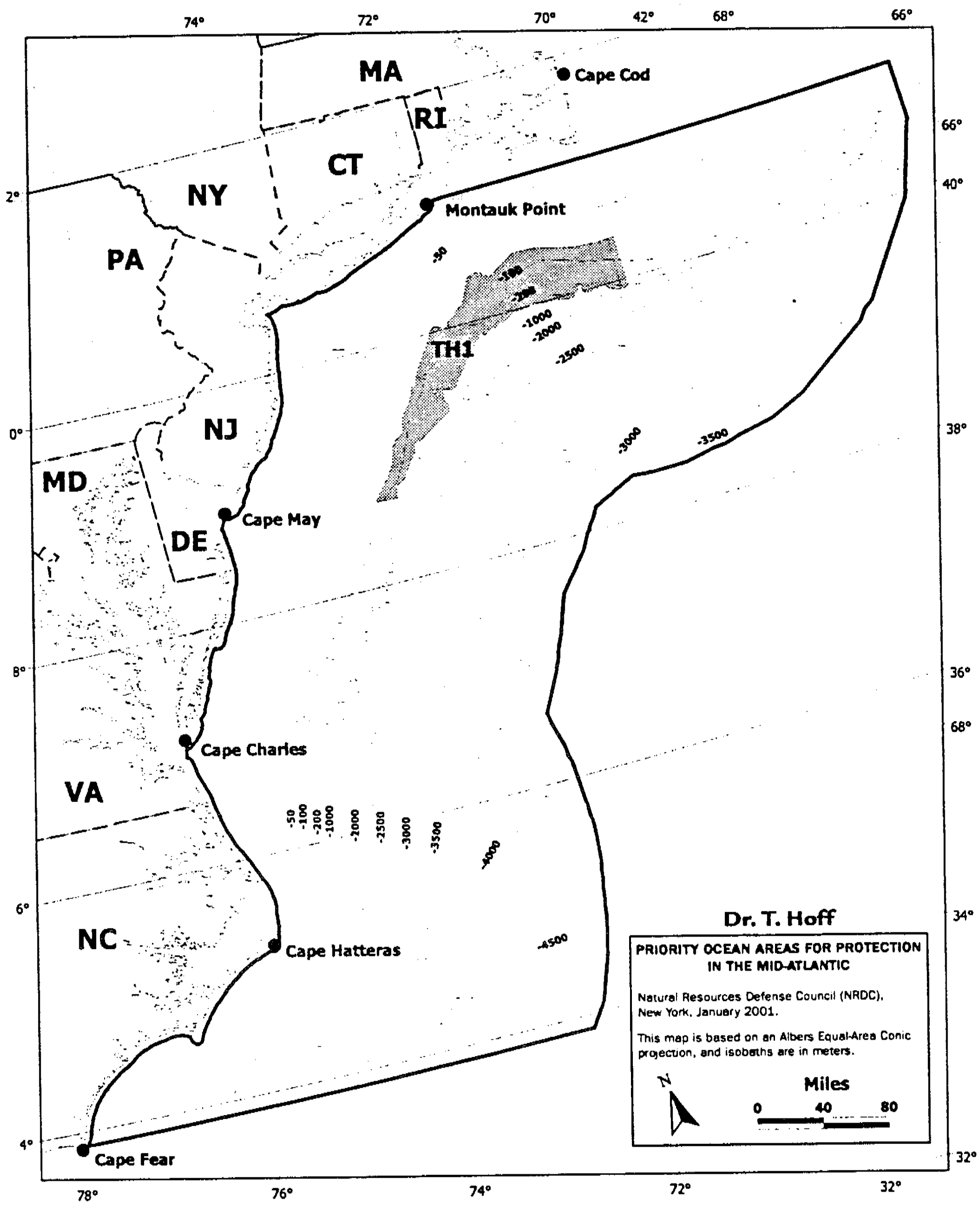


Figure 15. Tilefish HAPC, 250 to 1200 feet depths.

Source: NRDC 2001.

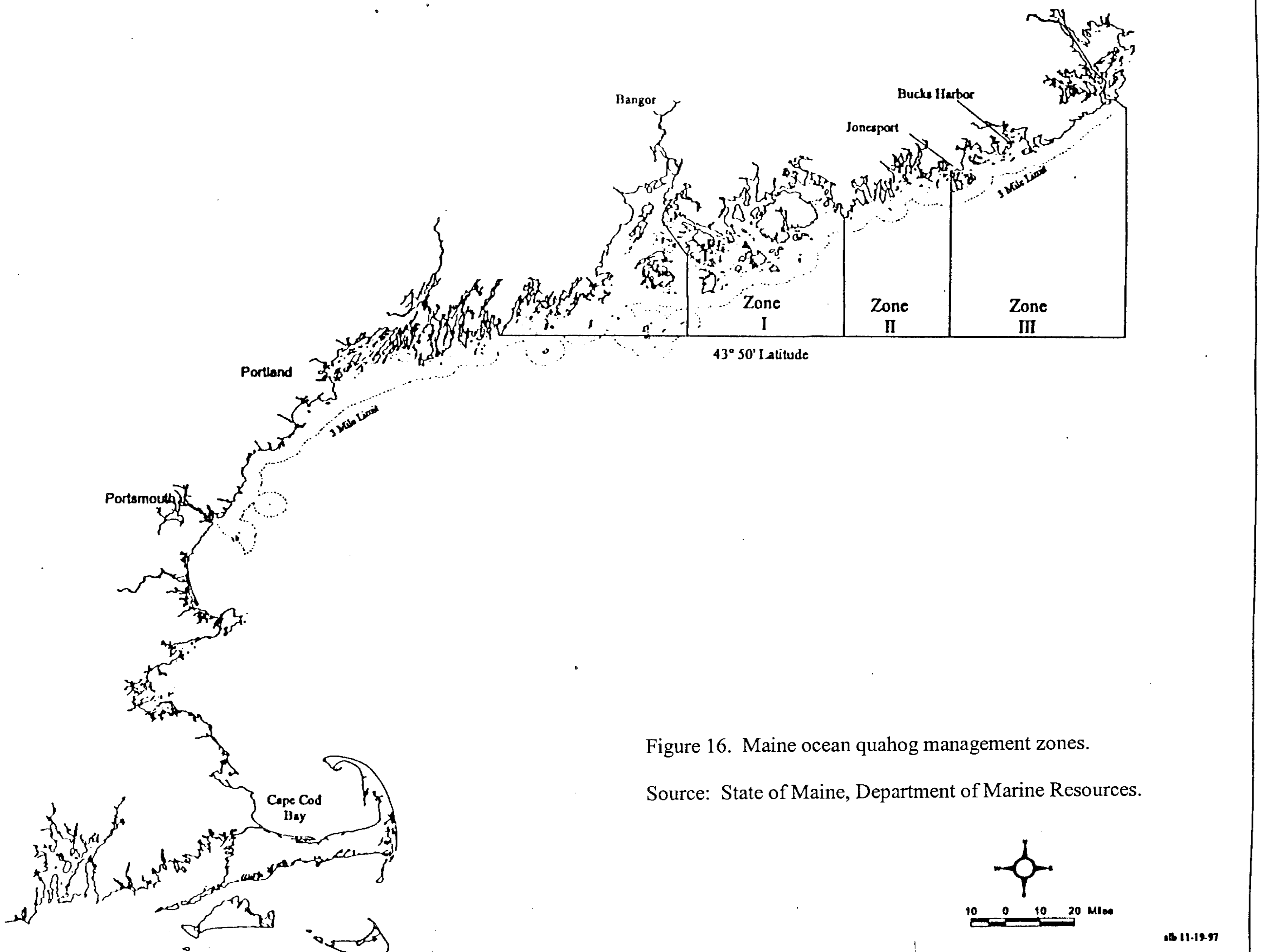


Figure 16. Maine ocean quahog management zones.

Source: State of Maine, Department of Marine Resources.

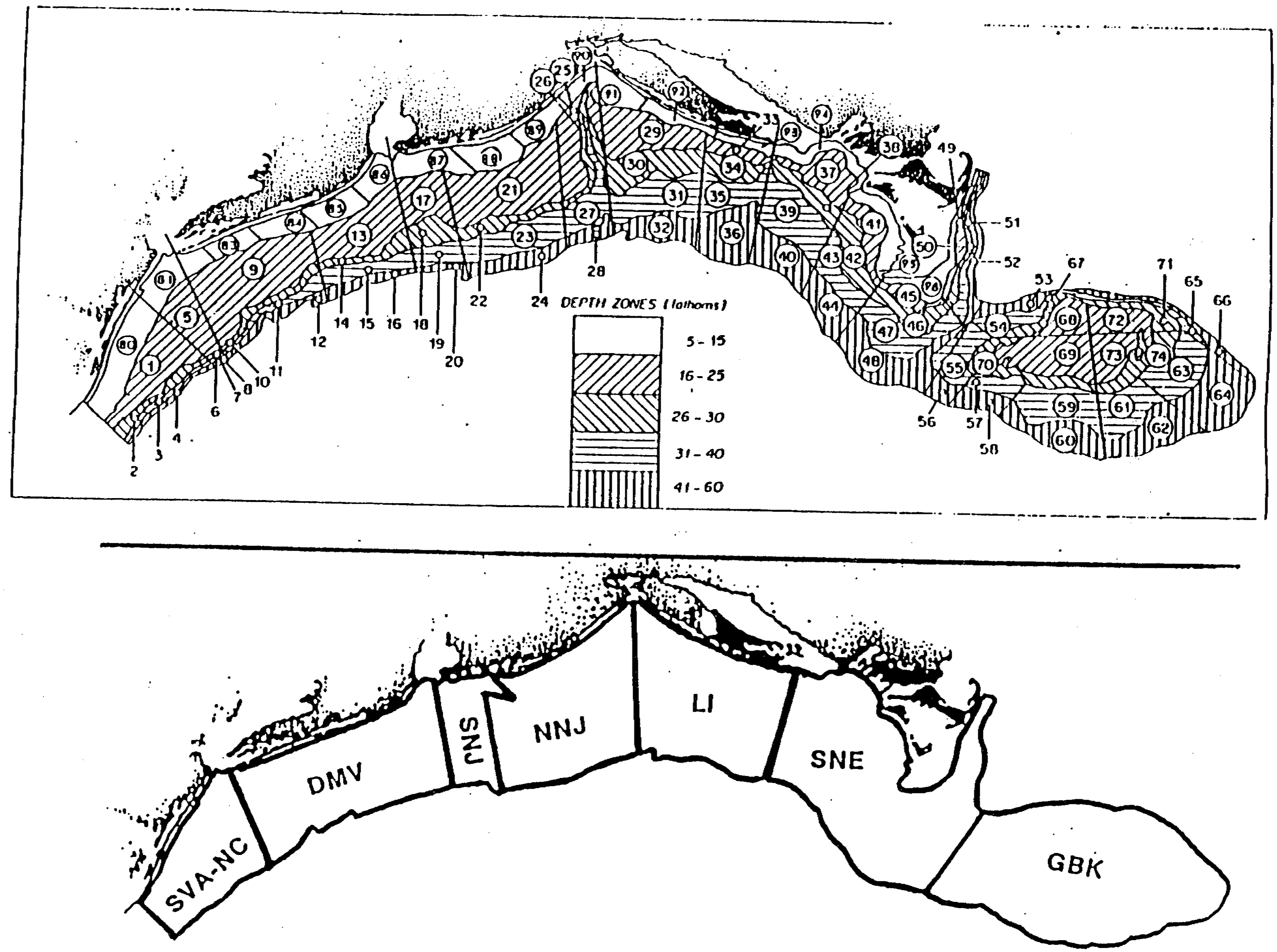


Figure 17. Survey Strata (sampling areas), National Marine Fisheries Service, Northeast Fisheries Science Center, Surfclam - Ocean Quahog Survey.

Source: USDC 2000a.

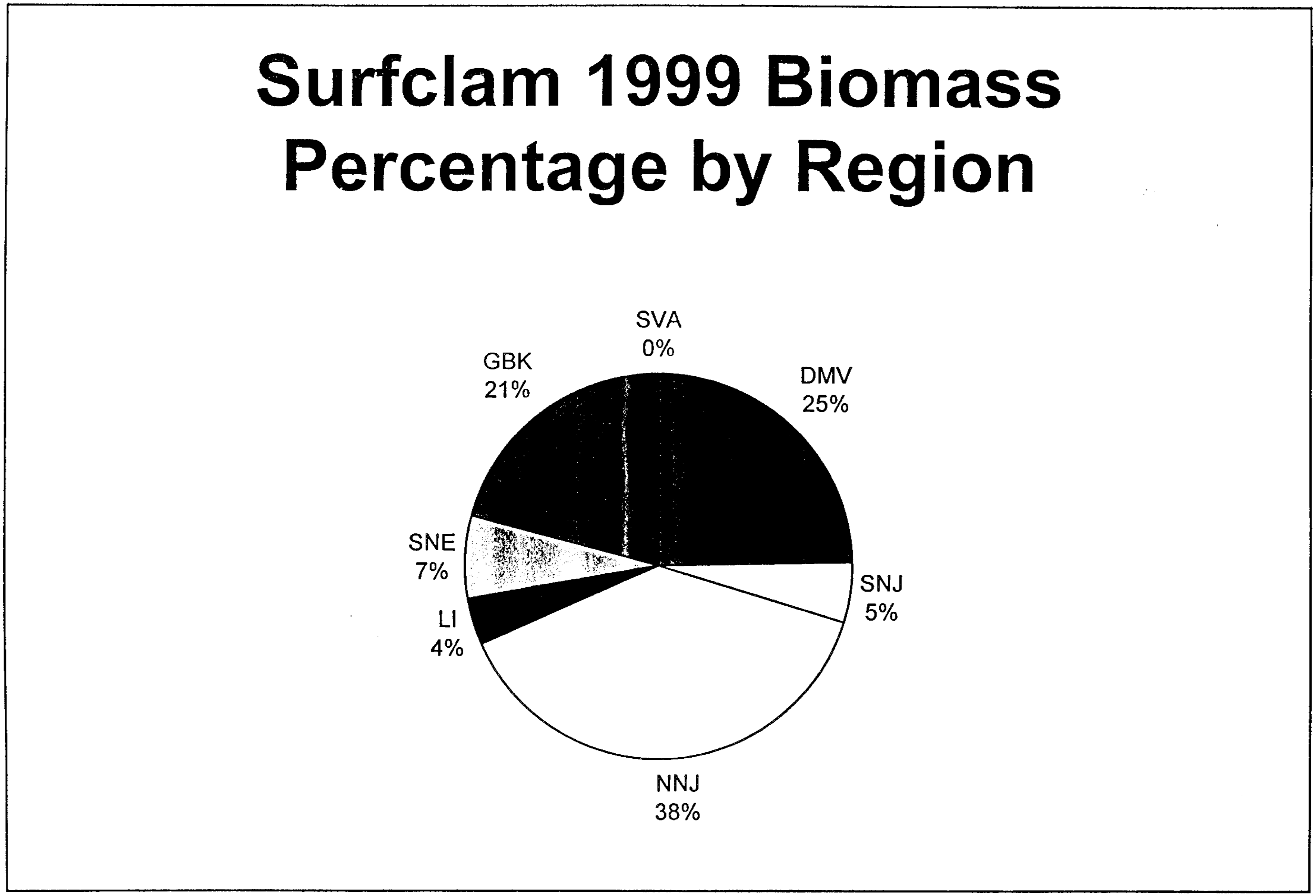


Figure 18. Regional surfclam biomass based on 1999 survey.

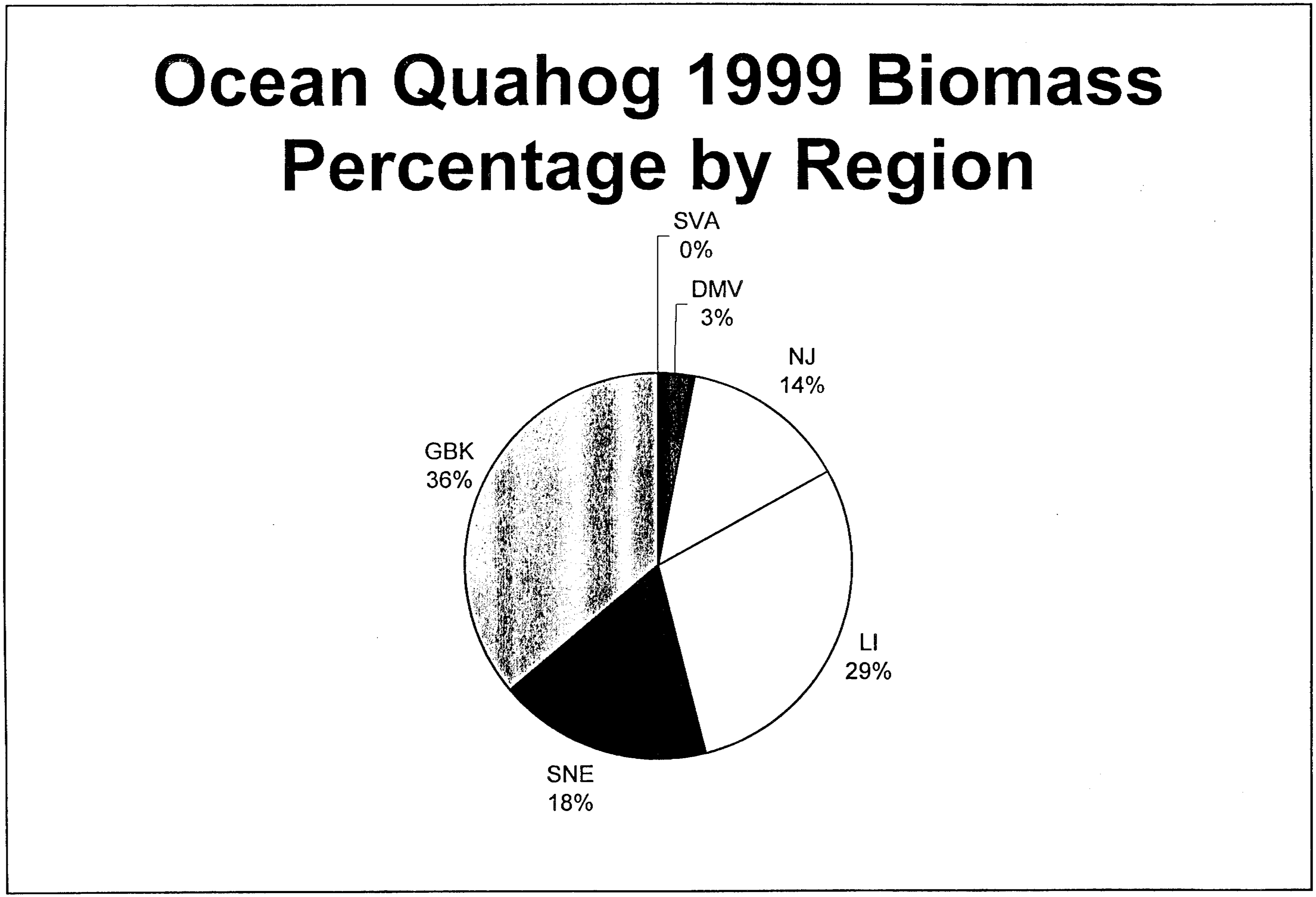


Figure 19. Regional ocean quahog biomass based on 1999 survey.

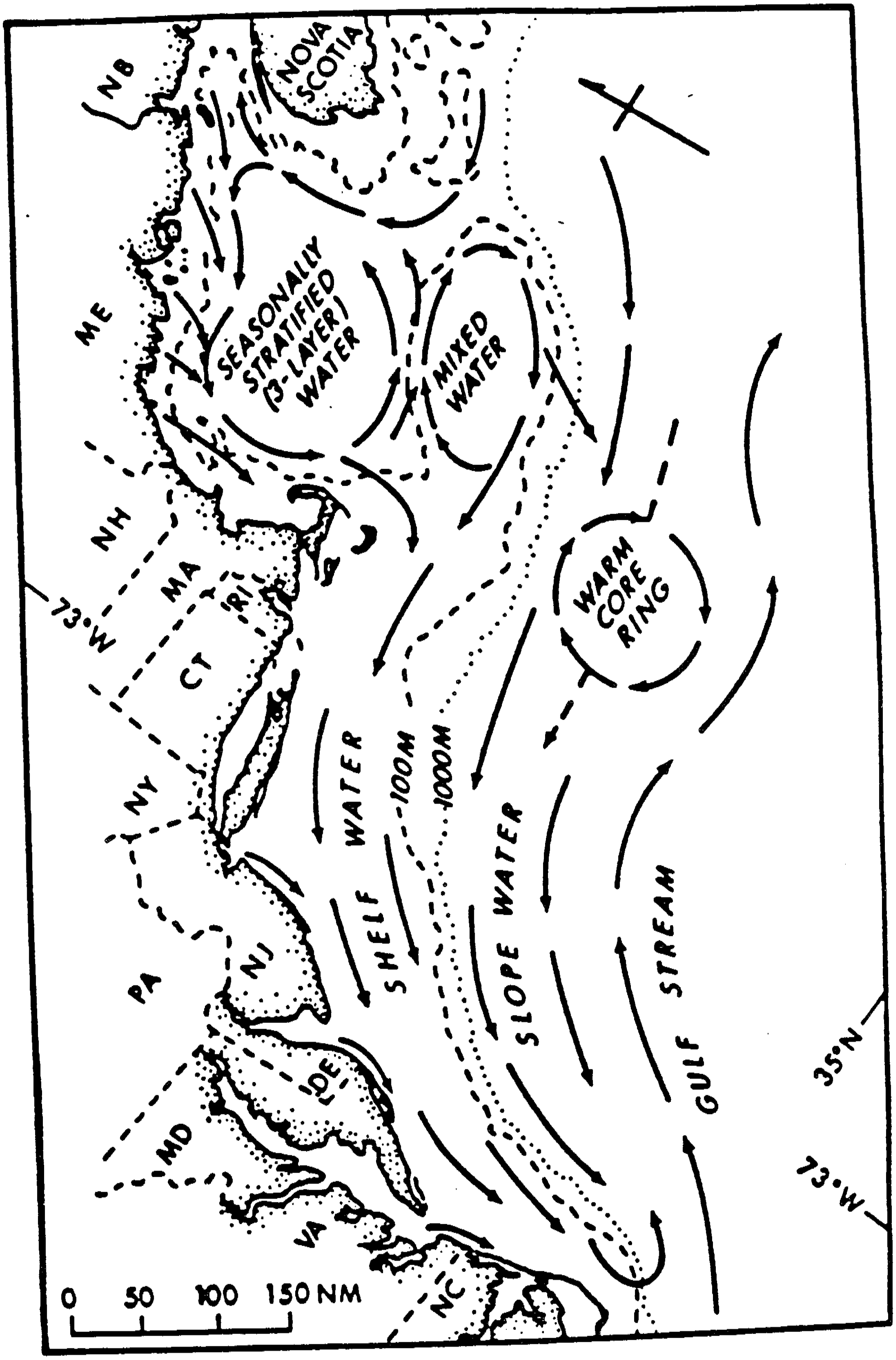
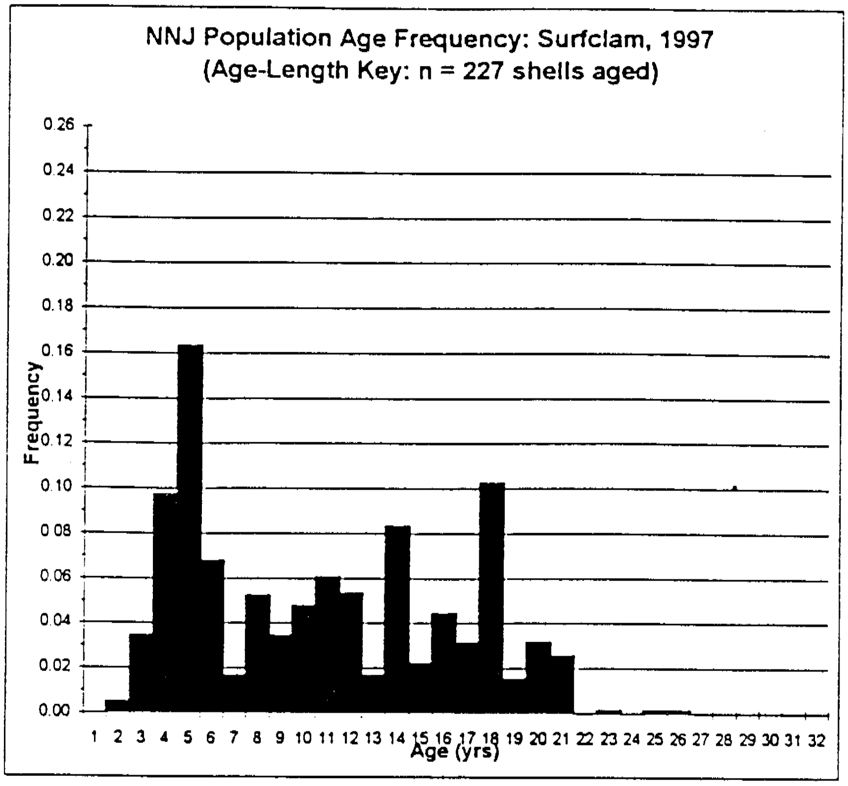


Figure 20. General surface layer circulation of northwestern Atlantic coastal and offshore waters.

Source: Smolowitz, 1988.



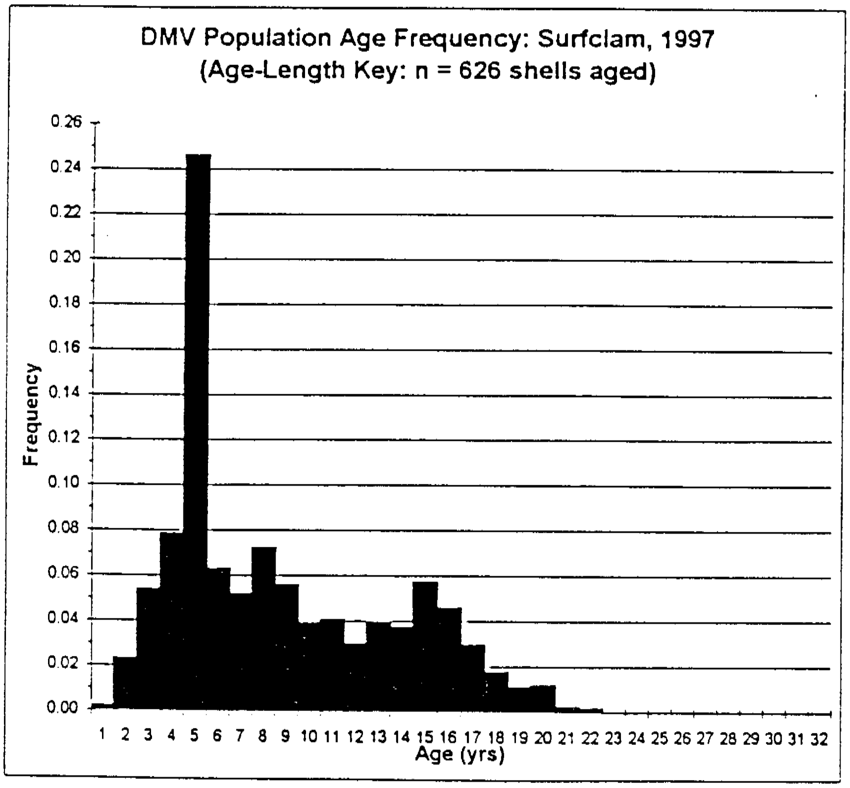


Figure 21. Age frequency distribution in 1997 for surfclams of N. New Jersey and Delmarva. Age/length keys were applied to the size frequency distributions for each region.

Source: USDC 1998a.

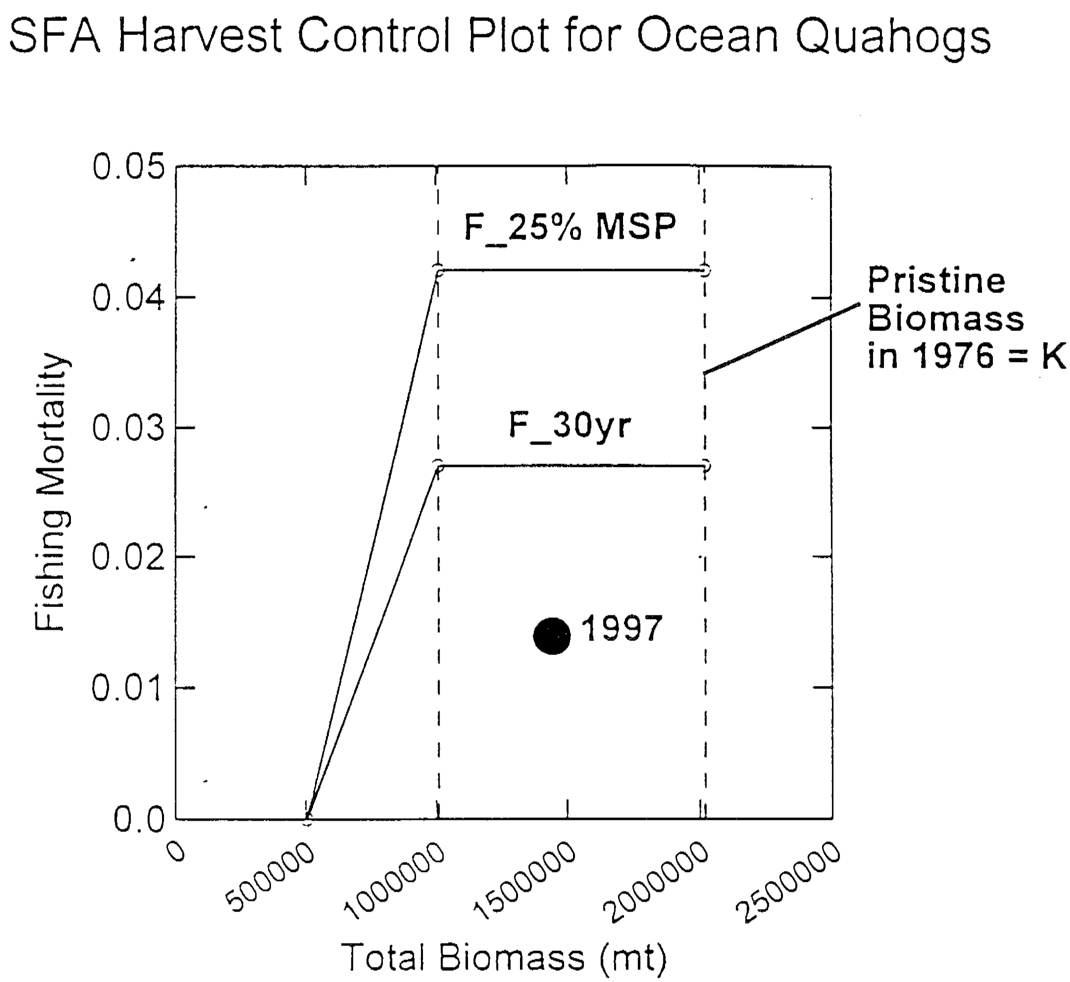


Figure 22. Estimated fishing mortality rate and total biomass of ocean quahogs in 1997 (filled circle) in relation to fishing mortality biomass thresholds and targets. Pristine biomass (K) in 1976 (right dashed line) is estimated via back-circulation method using 1997 population estimate and cumulative harvests. B_{msy} (left dashed line) is estimated as 1/2K. Horizontal lines represent two population biomass levels between 1/4K and 1/2K.

Note: 1 metric ton = 2205 pounds.

Source: USDC 1998b.

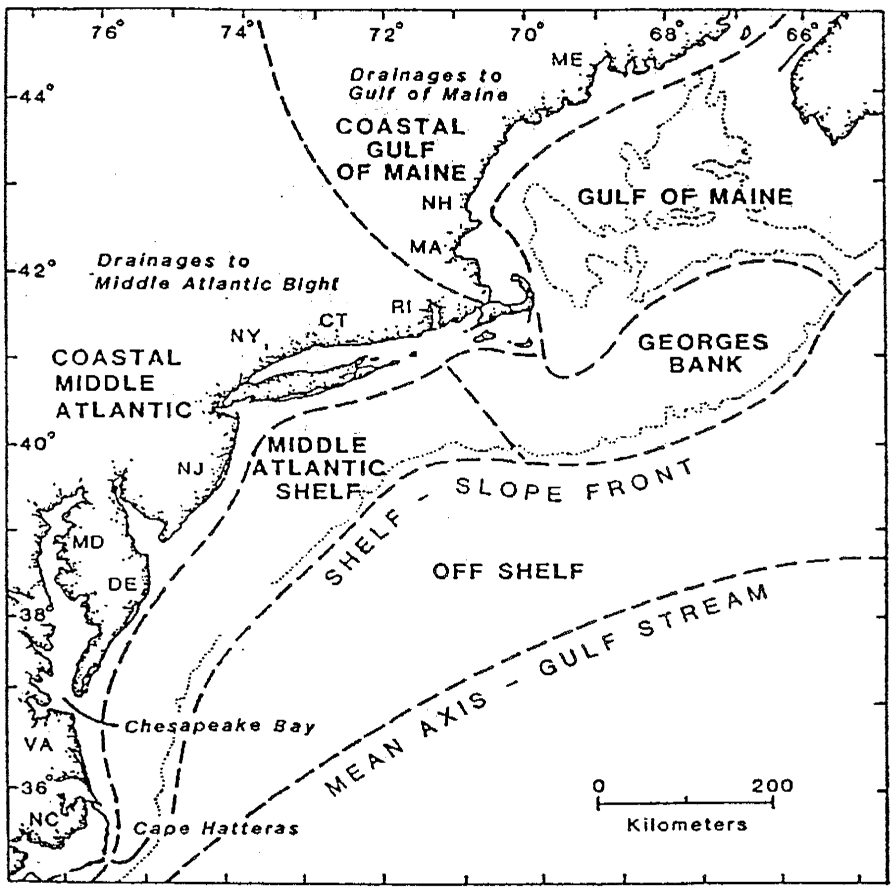


Figure 23. Northeast shelf ecosystem, including mean axis of Gulf Stream (from Pacheco 1988).

General Circulation During Stratified Season

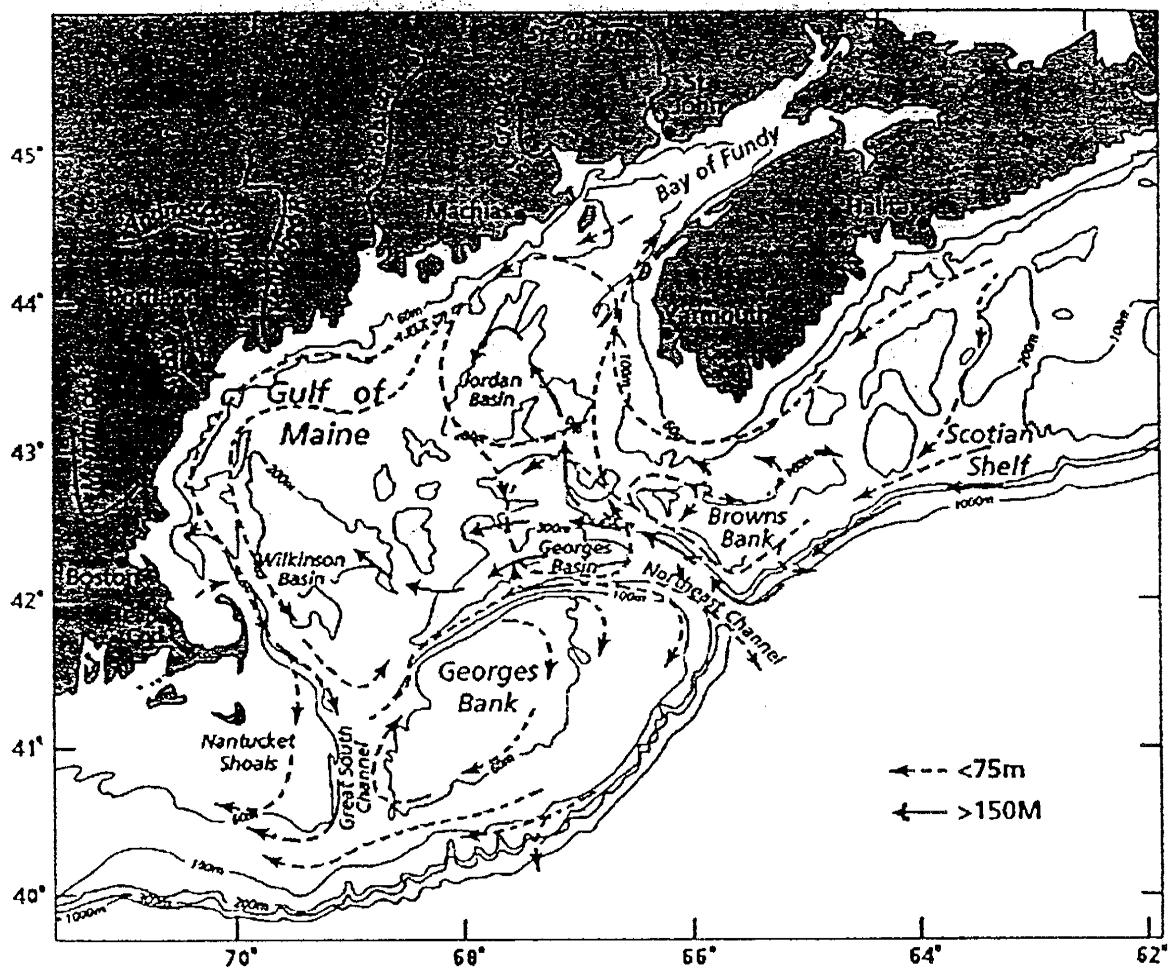


Figure 24. Circulation in the Gulf of Maine and Georges Bank.

Source: USDC 2001.

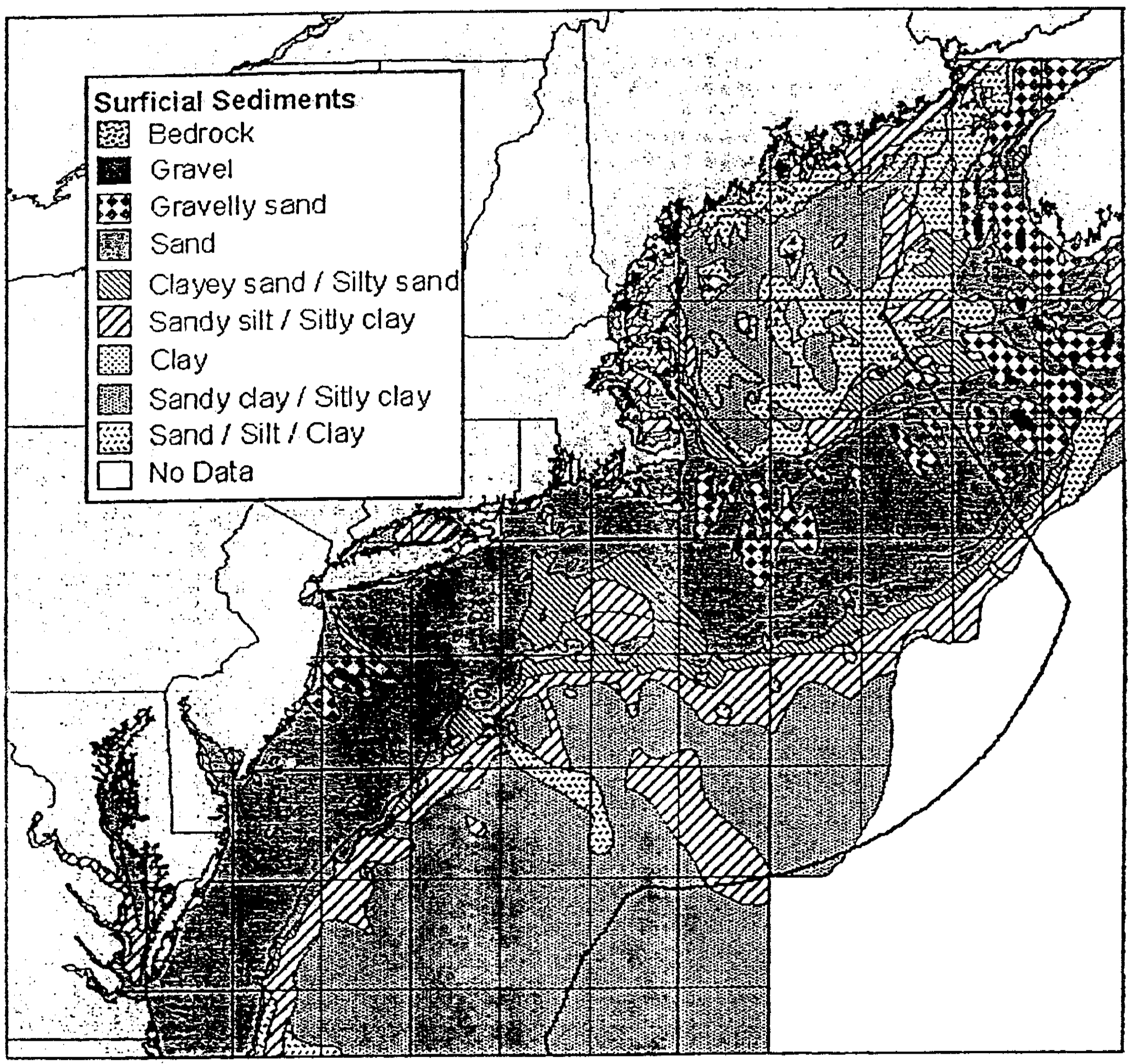


Figure 25. Distribution of surficial sediments in the Northeast shelf ecosystem (Poppe *et al.* 1986).

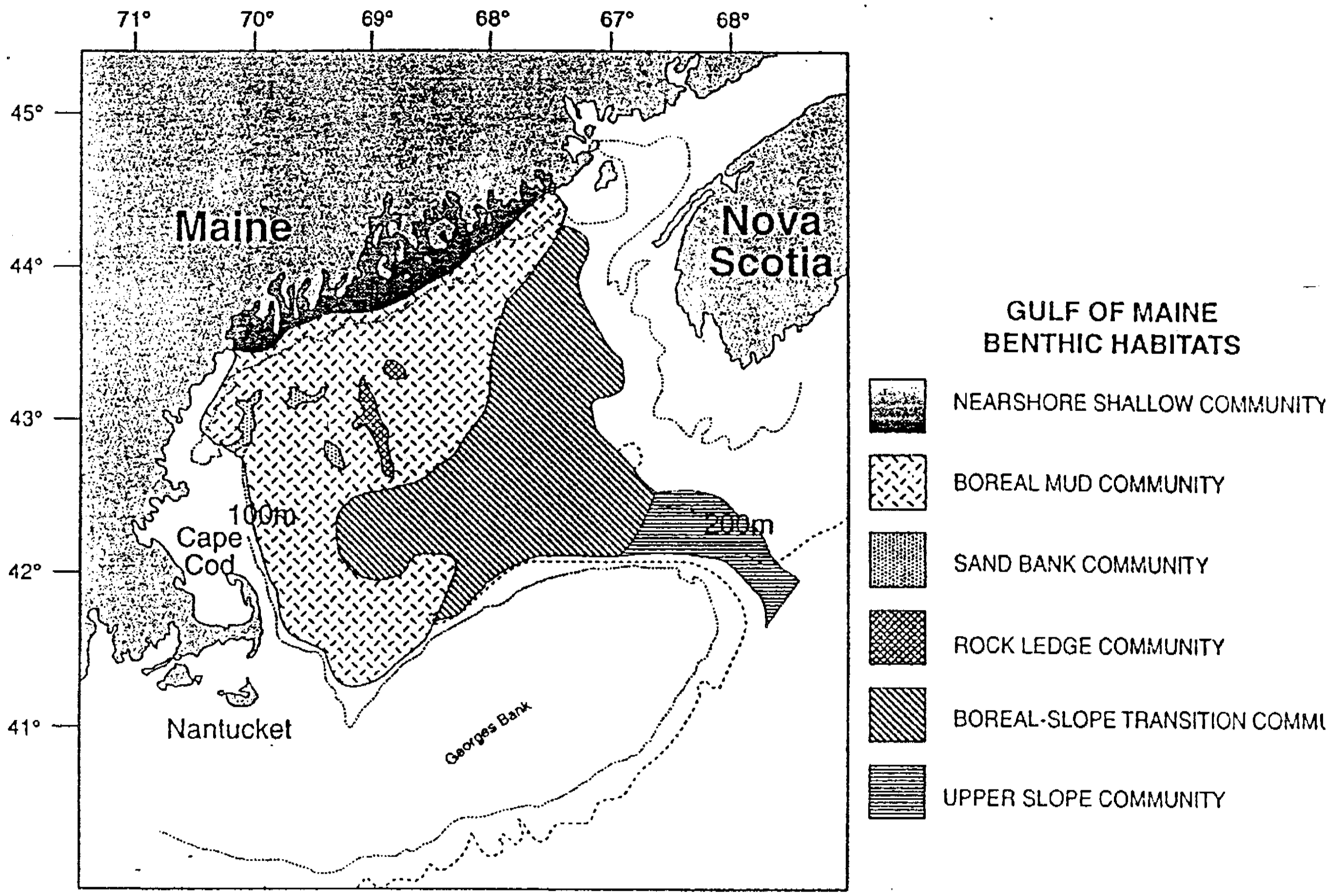


Figure 26. Location of Gulf of Maine benthic communities after Watling *et al.* 1988.

Source: USDC 2001.

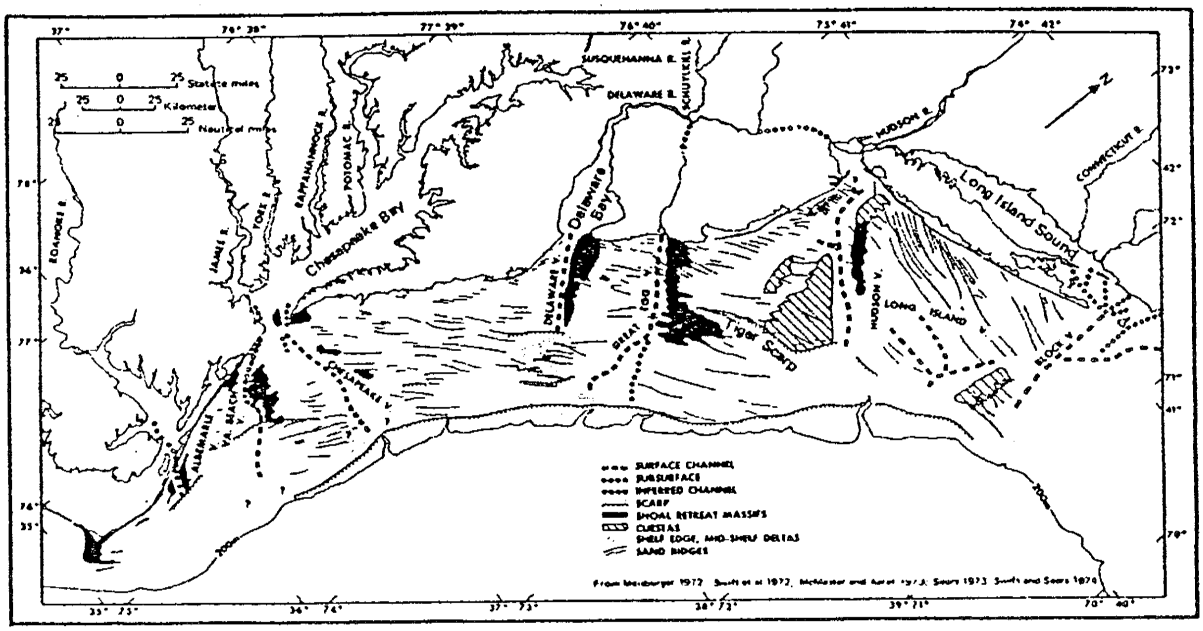


Figure 27. Middle Atlantic Bight morphology, including subsurface channels, scarps, massifs, shelf deltas and sand ridges (from Freeland and Swift, 1978).

Source: USDC 2001.

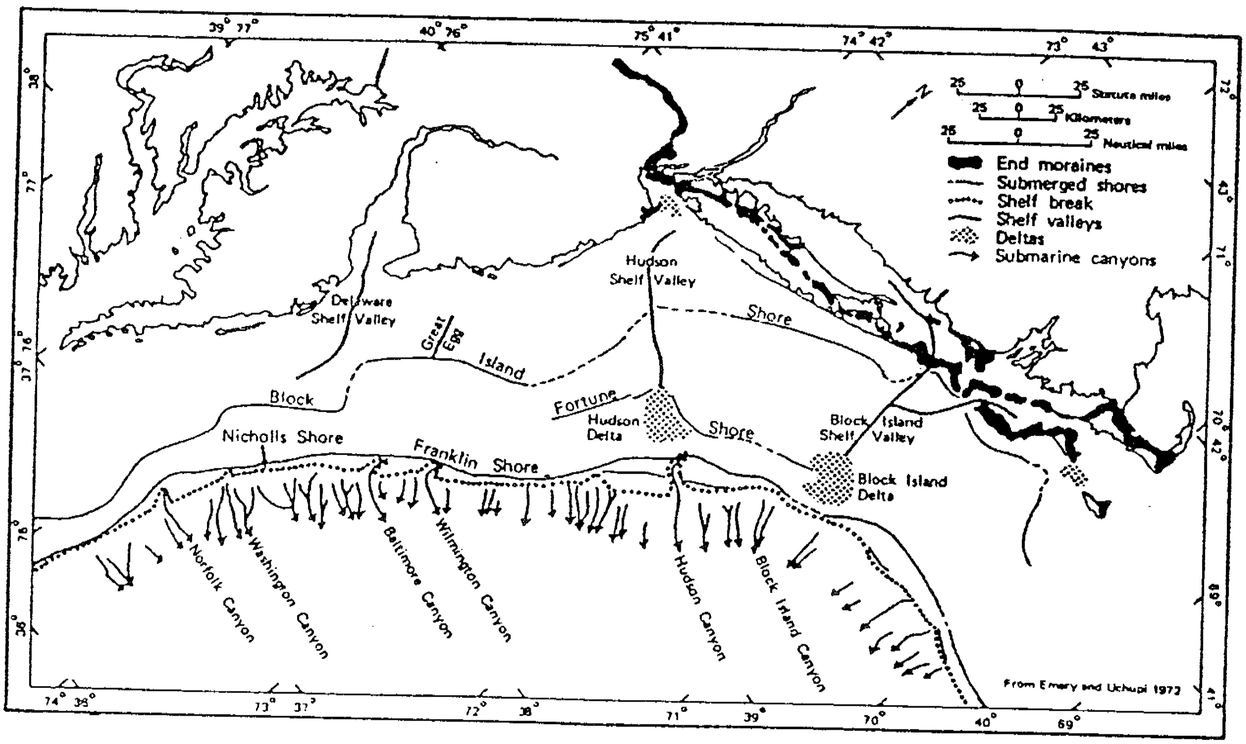


Figure 28. Major geologic features of the Middle Atlantic Bight region, including submarine canyons, submerged shores, shelf valleys deltas, and end moraines (from Freeland and Swift, 1978).

Source: USDC 2001.

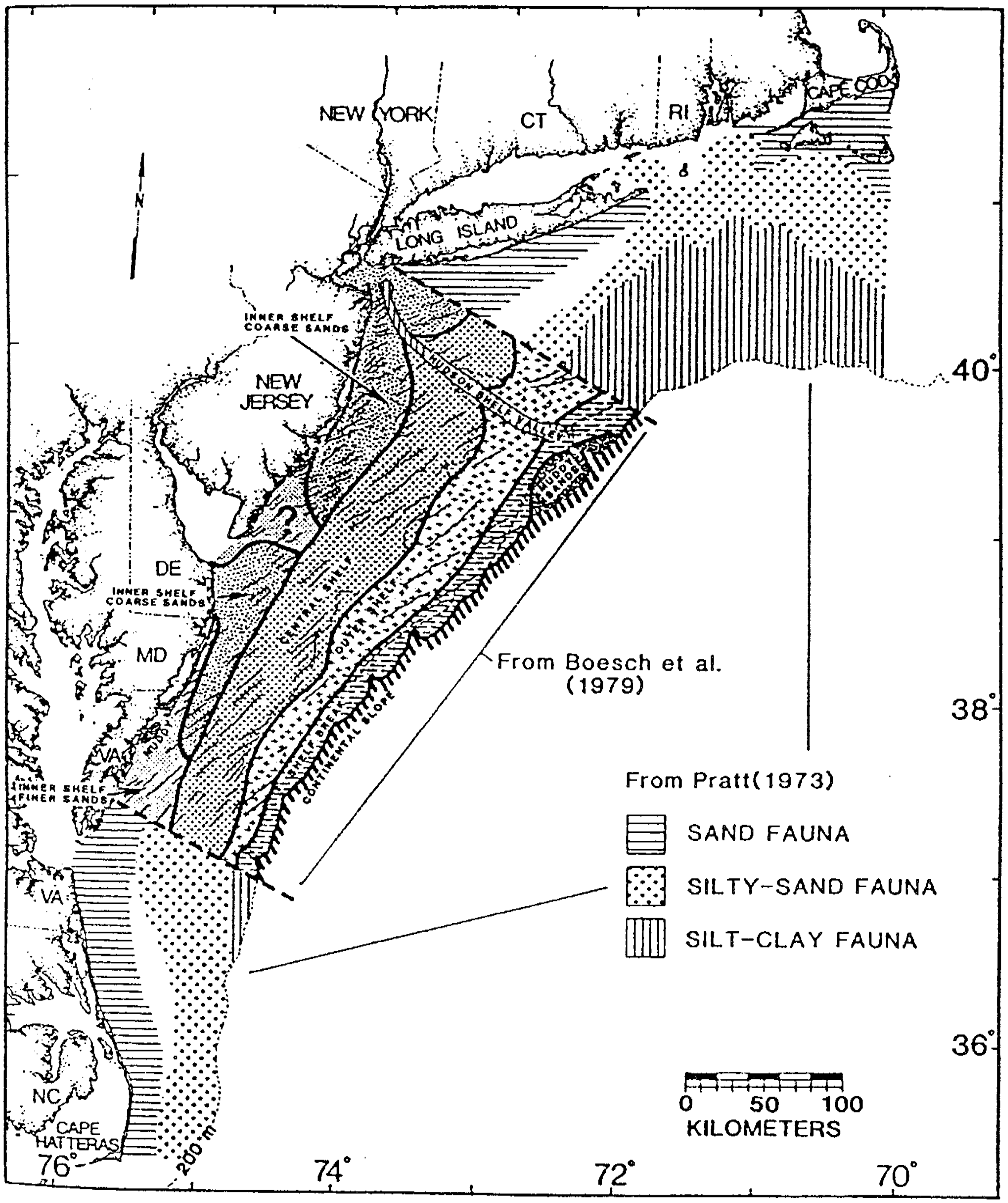


Figure 29. Comparison of Mid-Atlantic faunal zones identified by Pratt (1973) and Boesch (1979).

Source: USDC 2001.

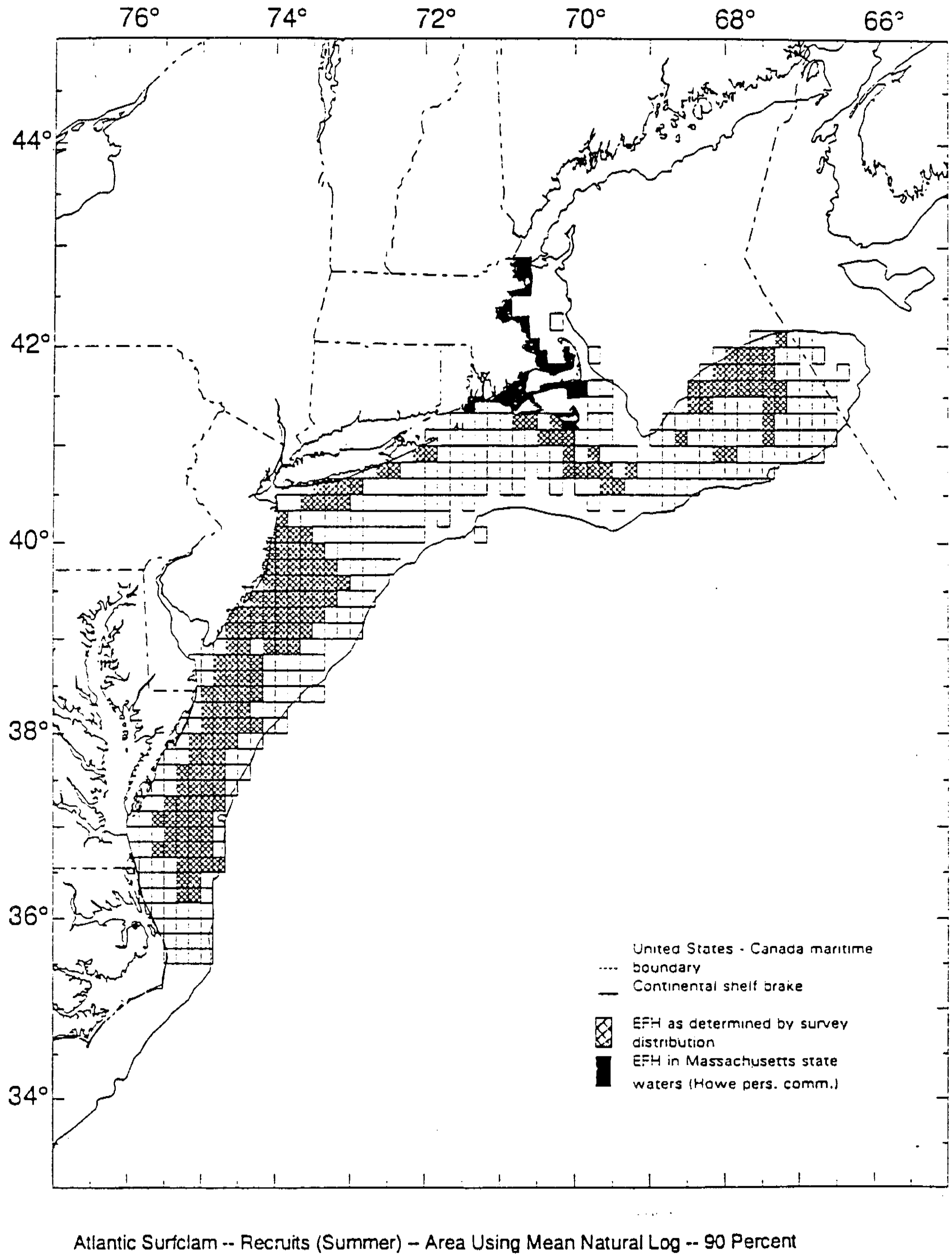


Figure 30. EFH for adult surfclams, areas which encompass the top 90% of the areas where surfclams were collected in the NEFSC dredge survey.

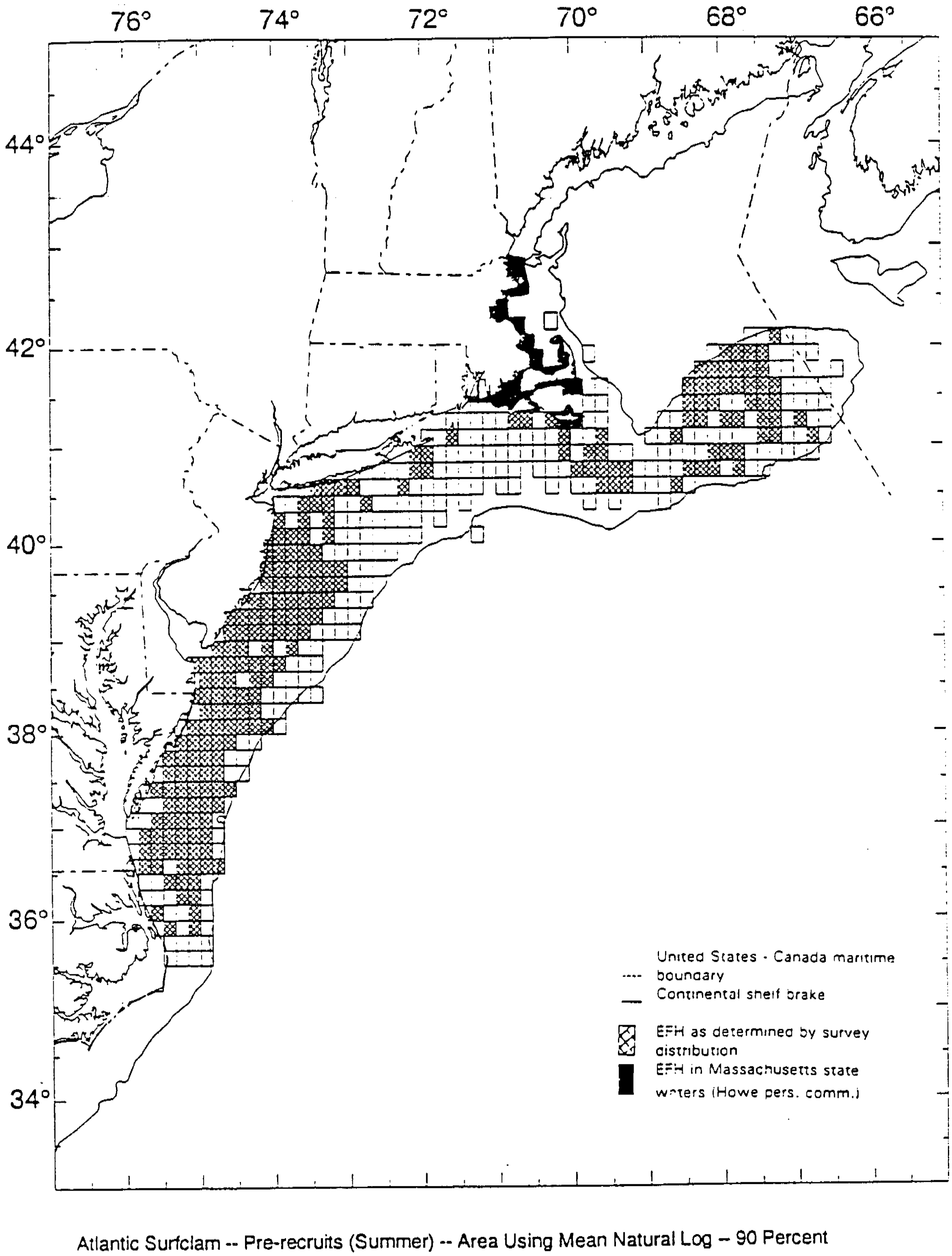


Figure 31. EFH for adult surfclams, areas which encompass the top 90% of the areas where surfclams were collected in the NEFSC dredge survey.

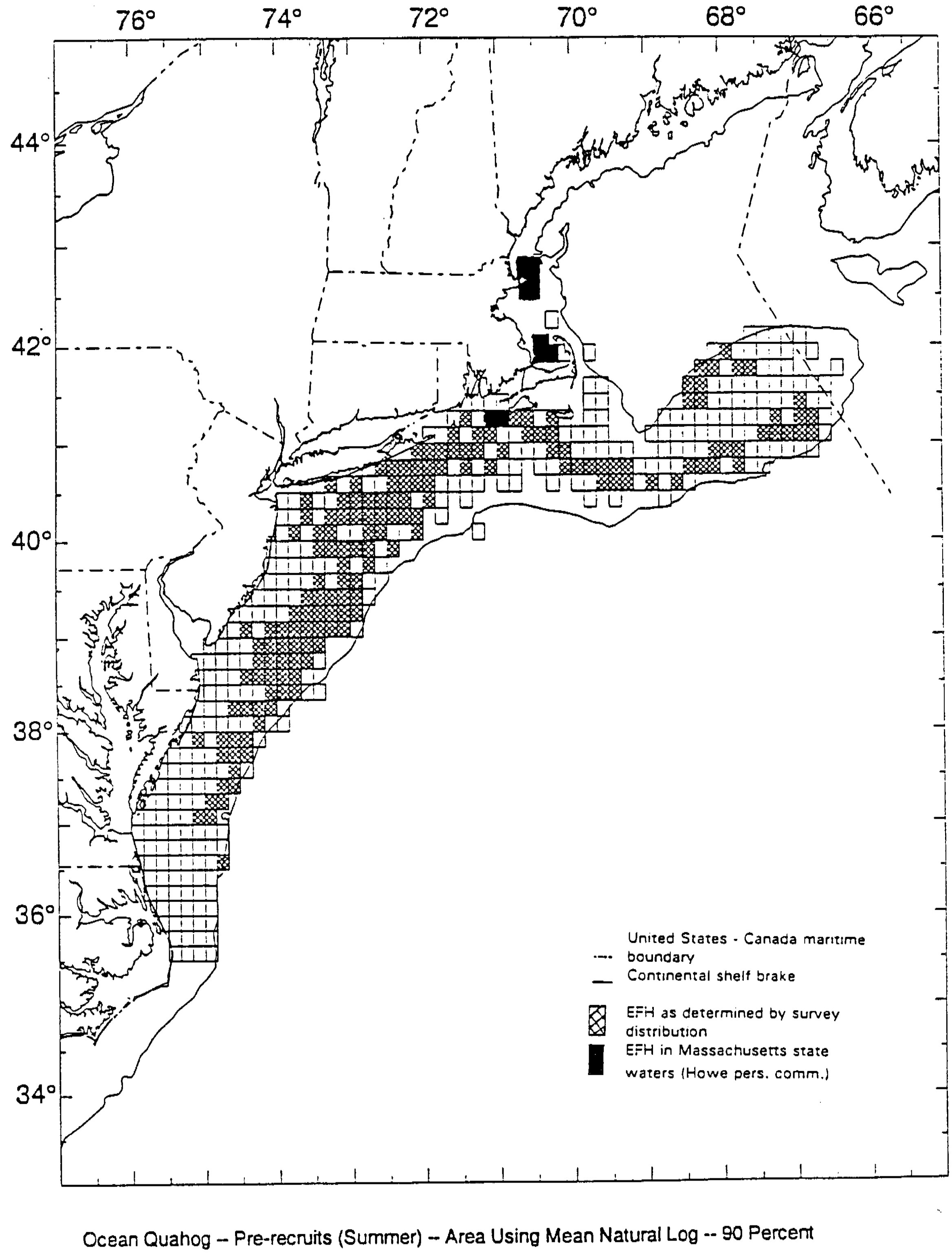
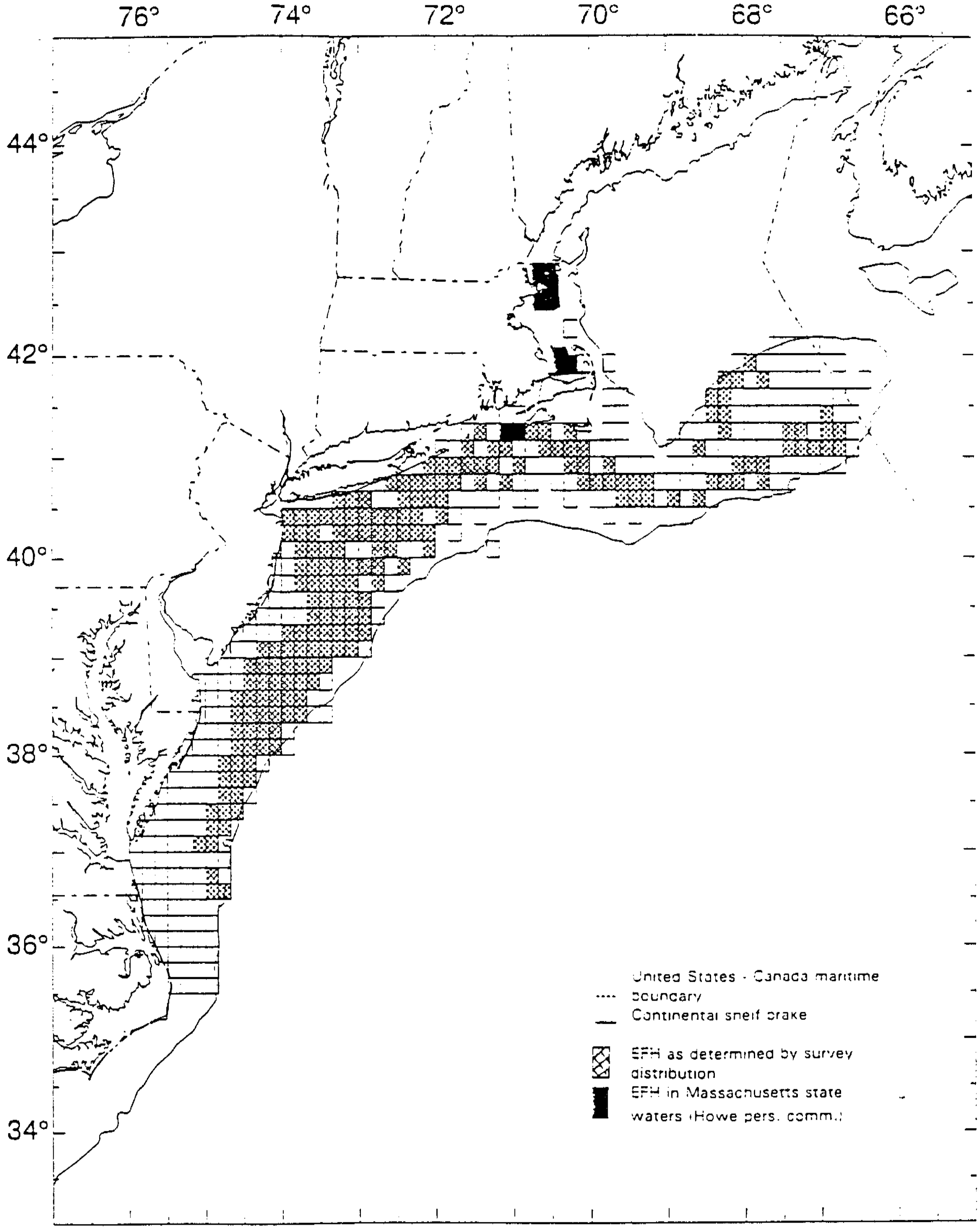


Figure 32. EFH for adult ocean quahogs, areas which encompass the top 90% of the areas where ocean quahogs were collected in the NEFSC dredge survey.



Ocean Quahog -- Recruits (Summer) -- Area Using Mean Natural Log -- 90 Percent

Figure 33. EFH for adult ocean quahogs, areas which encompass the top 90% of the areas where ocean quahogs were collected in the NEFSC dredge survey.

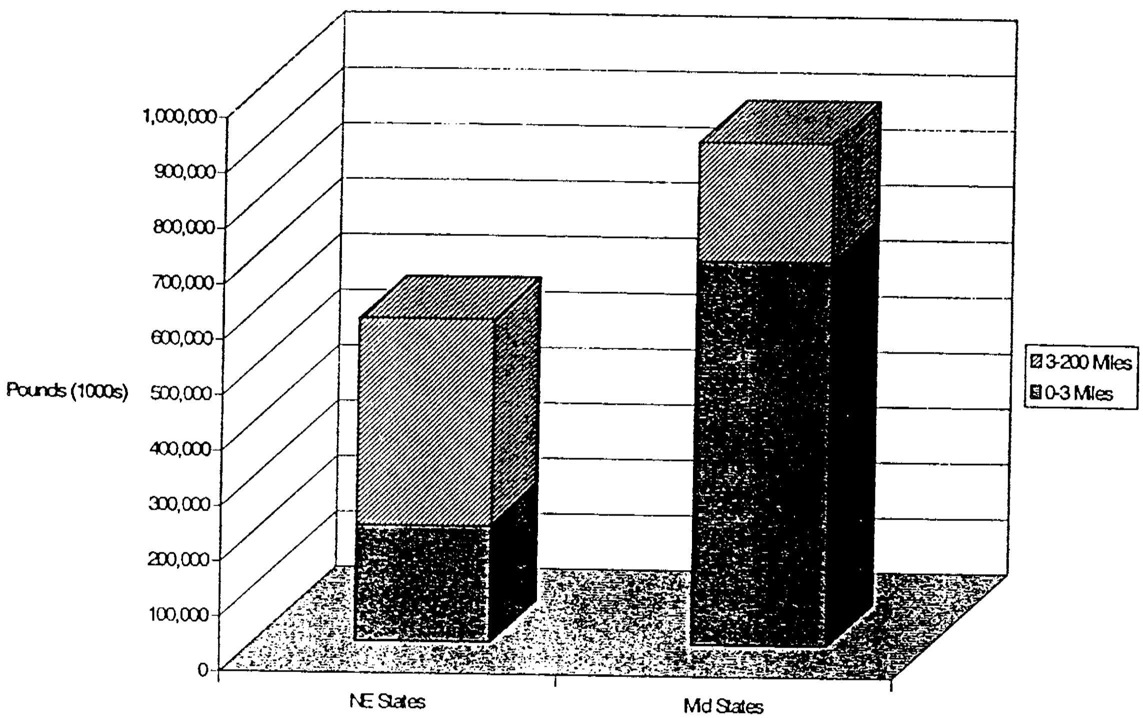


Figure 34. Inshore vs. offshore landings by area, 1999.

Source: USDC 2001.

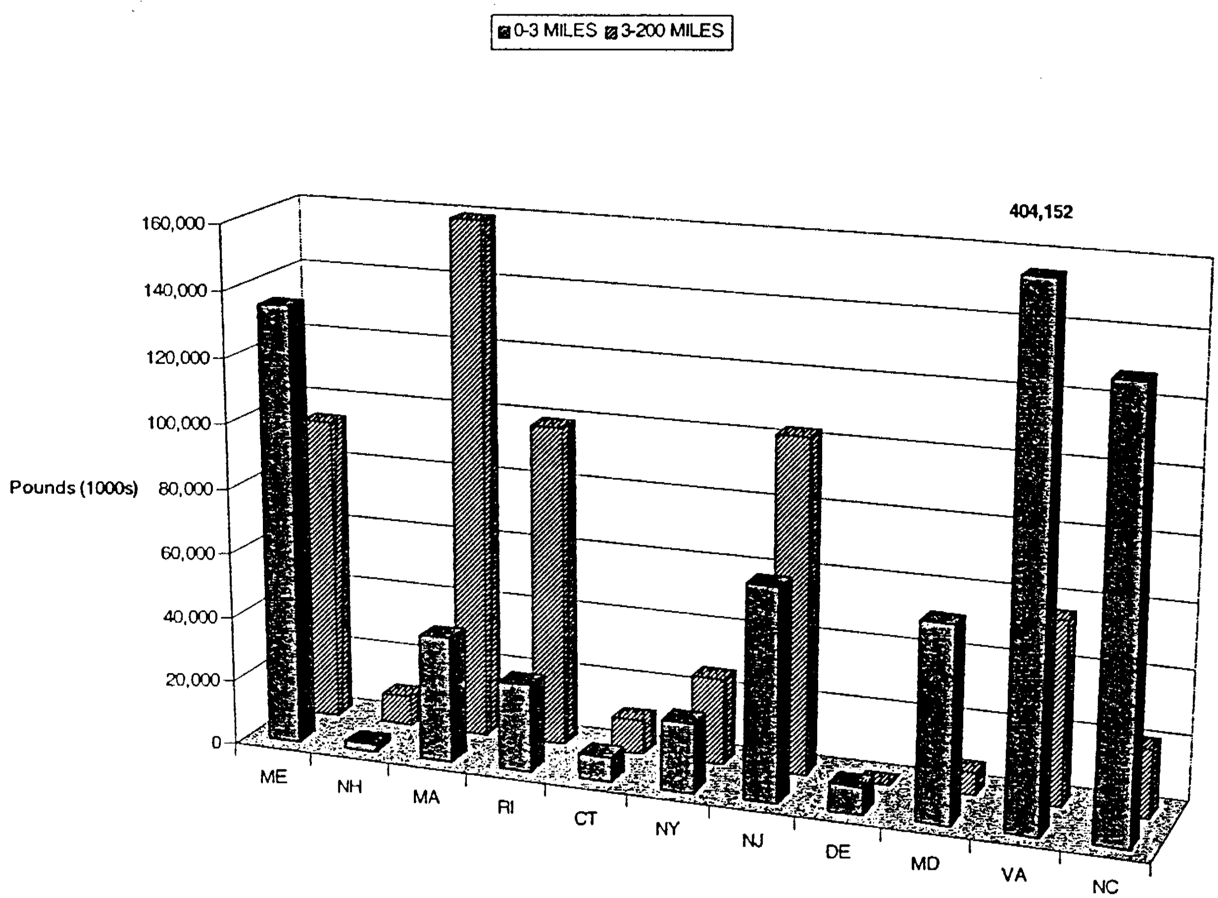


Figure 35. Inshore vs. offshore landings by state, 1999.

Source: USDC 2001.

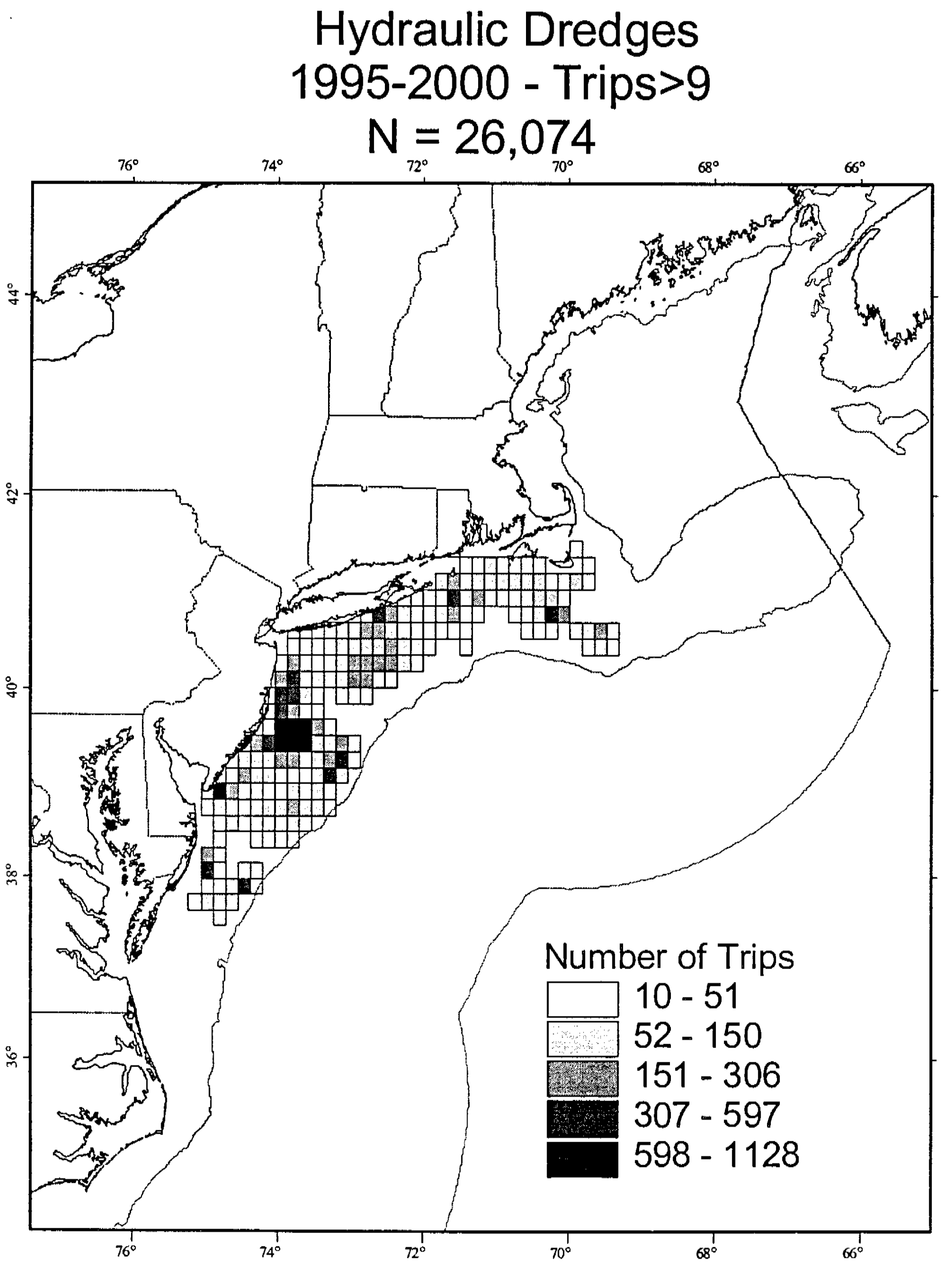


Figure 36. Hydraulic clam dredge effort during 1995 through 2000. Effort for both surfclams and ocean quahogs.

Source: Stevenson pers. comm.

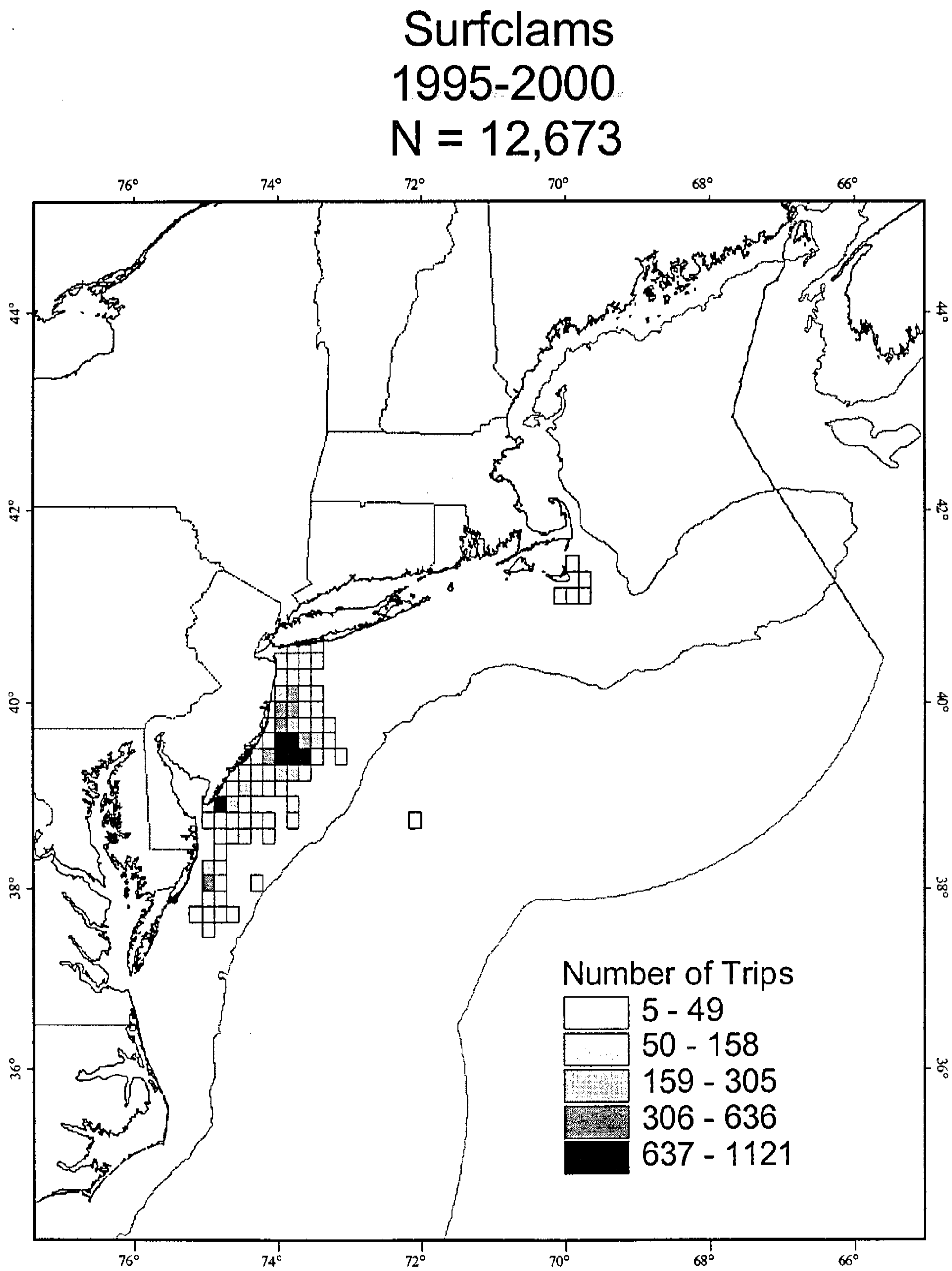


Figure 37. Hydraulic clam dredge effort for surfclams during 1995 through 2000.

Source: Stevenson pers. comm.

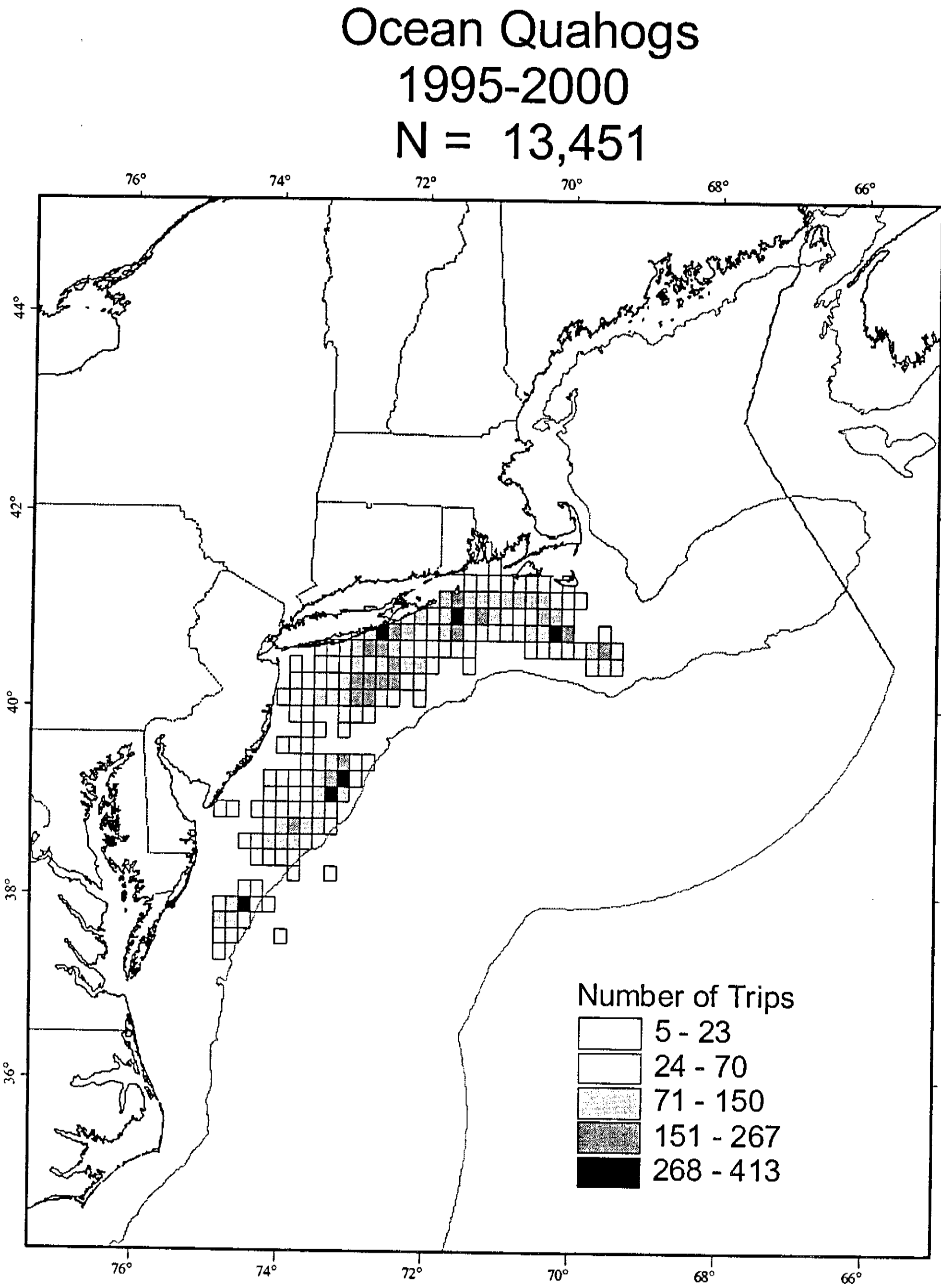


Figure 38. Hydraulic clam dredge effort for ocean quahogs during 1995 through 2000.

Source: Stevenson pers. comm.

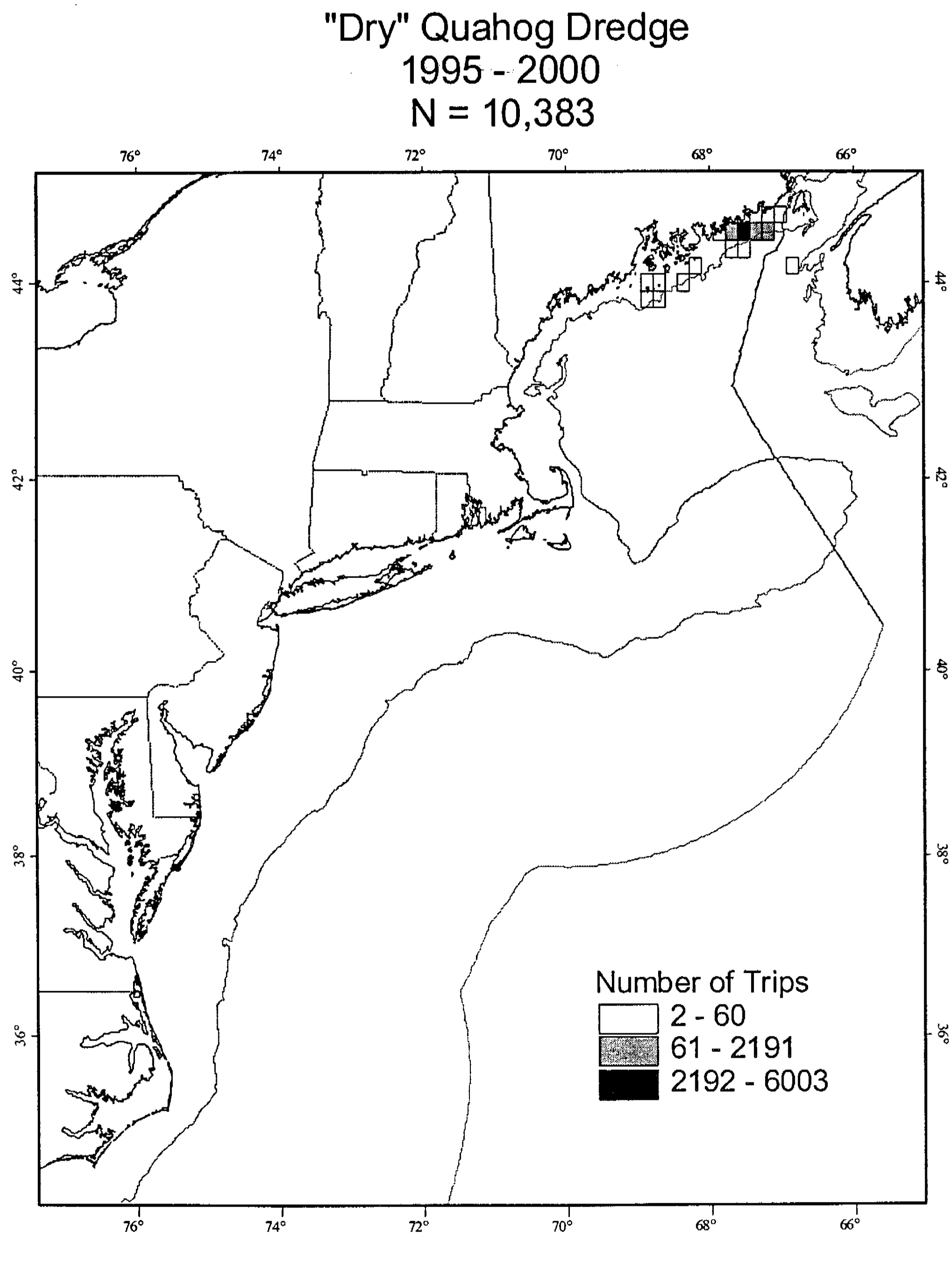


Figure 39. Non-hydraulic clam dredge effort for Maine "mahogany" ocean quahogs during 1995 through 2000.

Source: Stevenson pers. comm.

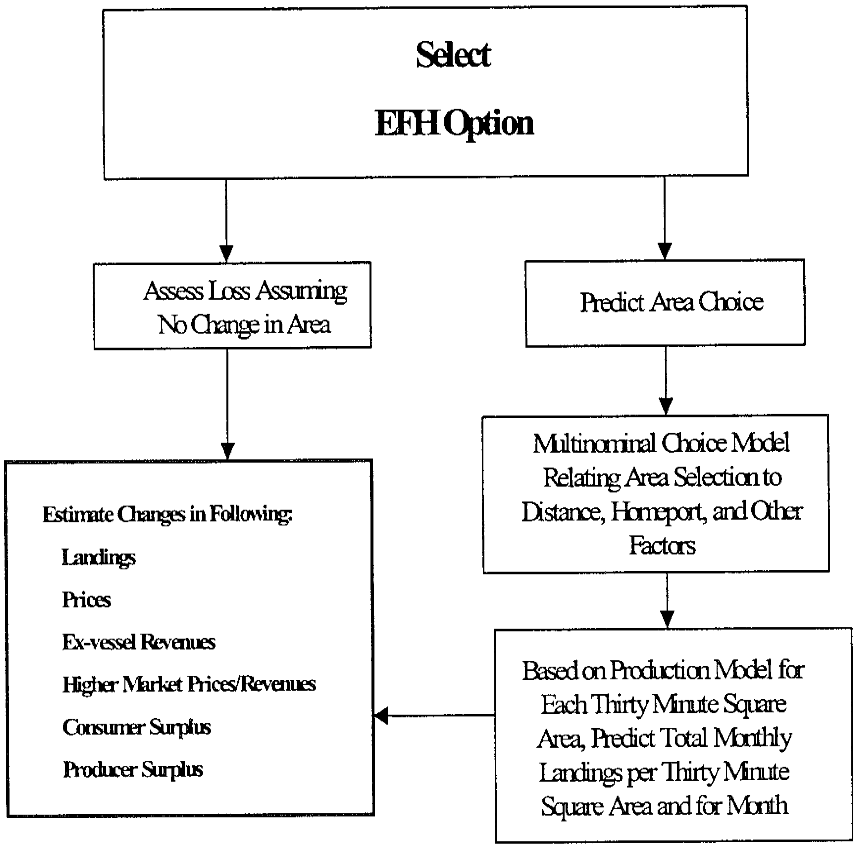


Figure 40. Analytical framework for assessing economic impacts and net benefits of essential fish habitat (EFH).

Source: Kirkley *et al.* 2002.

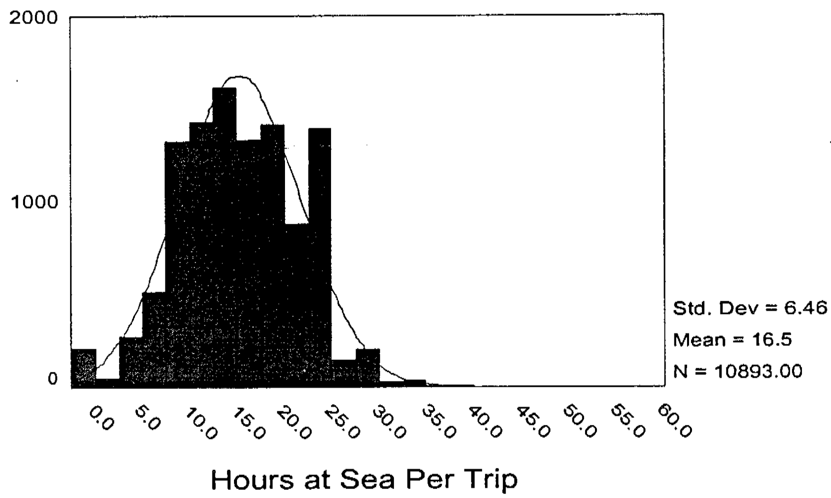


Figure 41. Frequency of hours at sea per surfclam trip, 1996-2000.

Source: Kirkley *et al.* 2002.

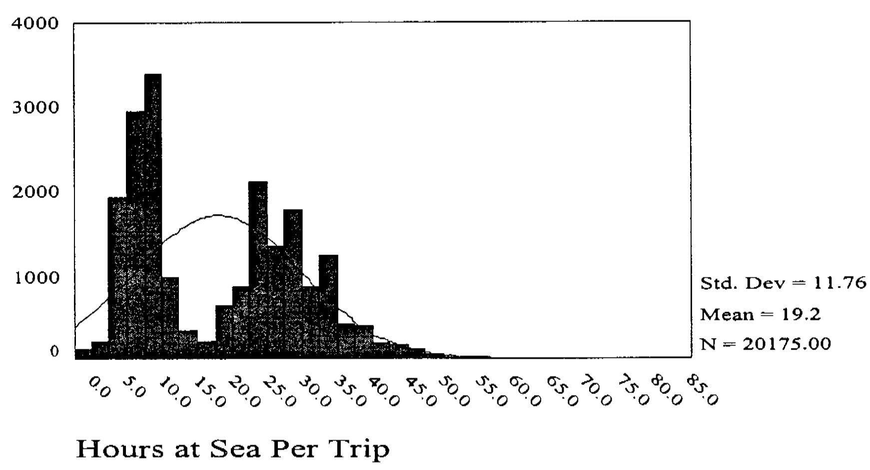


Figure 42. Frequency of hours at sea per ocean quahog trip, 1996-2000.

Source: Kirkley *et al.* 2002.

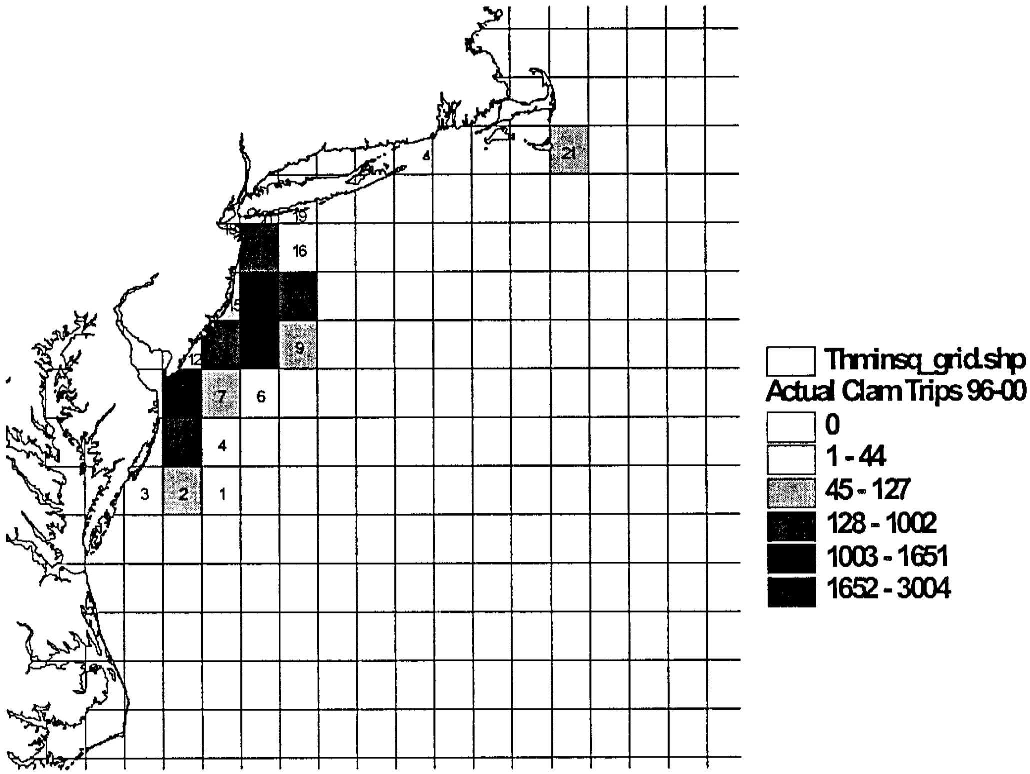


Figure 43. Clam actual trips (1996-2000) and definition of choice set.

Source: Kirkley *et al.* 2002.

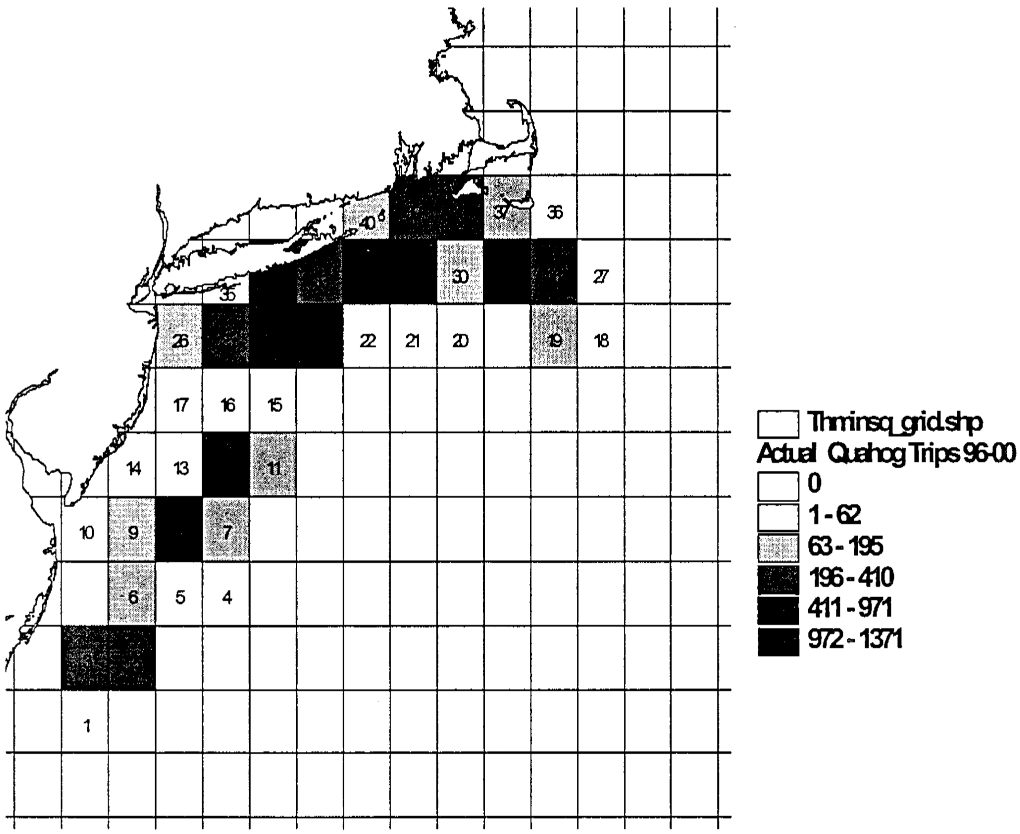


Figure 44. Quahog actual trips (1996-2000) and definition of choice set.

Source: Kirkley *et al.* 2002.

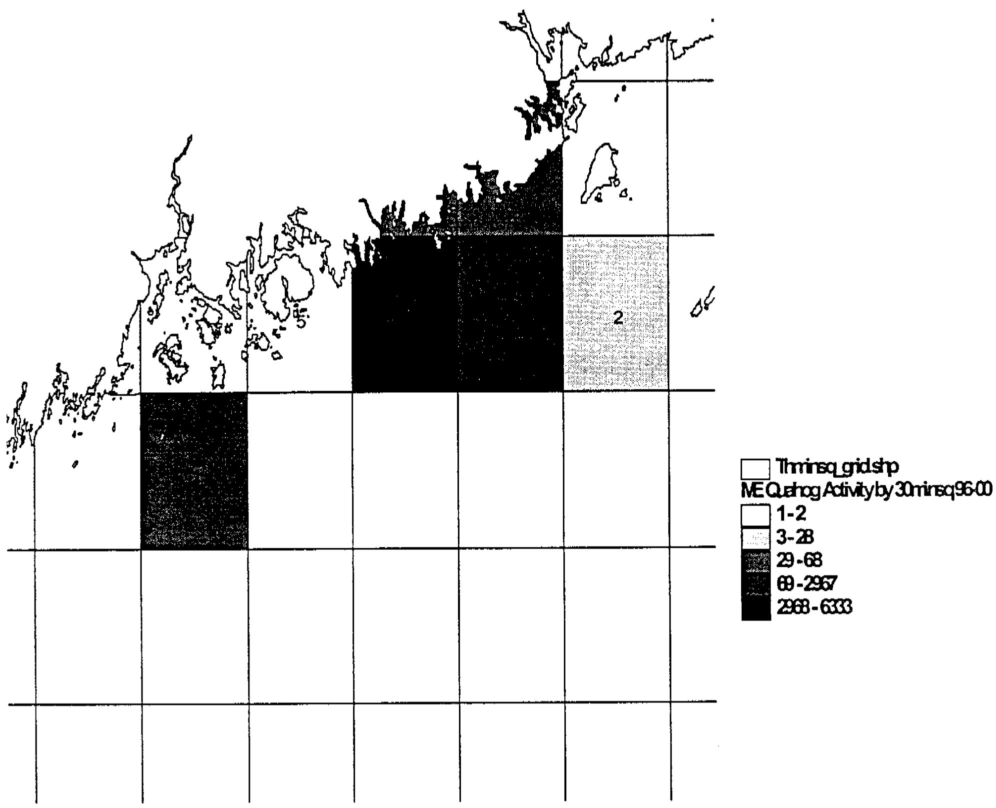


Figure 45. Maine ocean quahog actual trips (1996-2000) and definition of choice set.

Source: Kirkley *et al.* 2002.

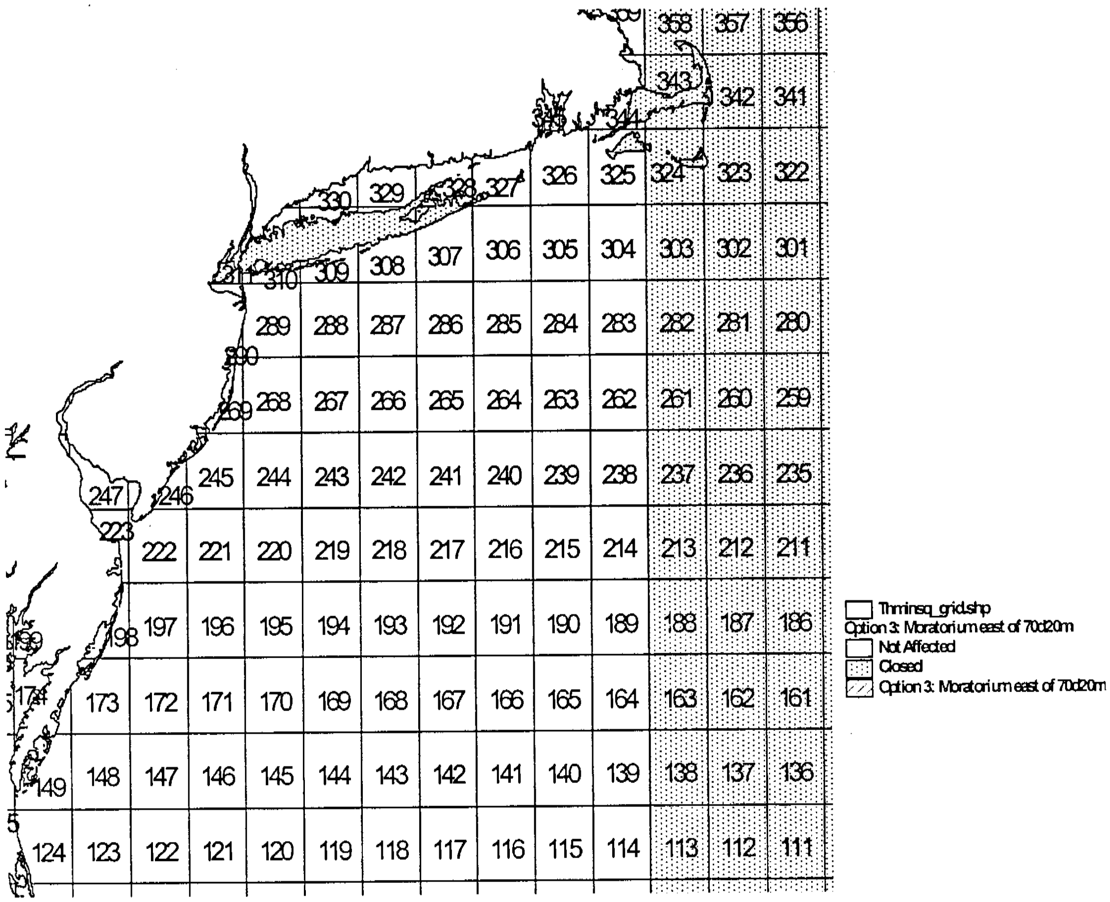


Figure 46. Option 3 closure: closed 30 minute squares.

Source: Kirkley *et al.* 2002.

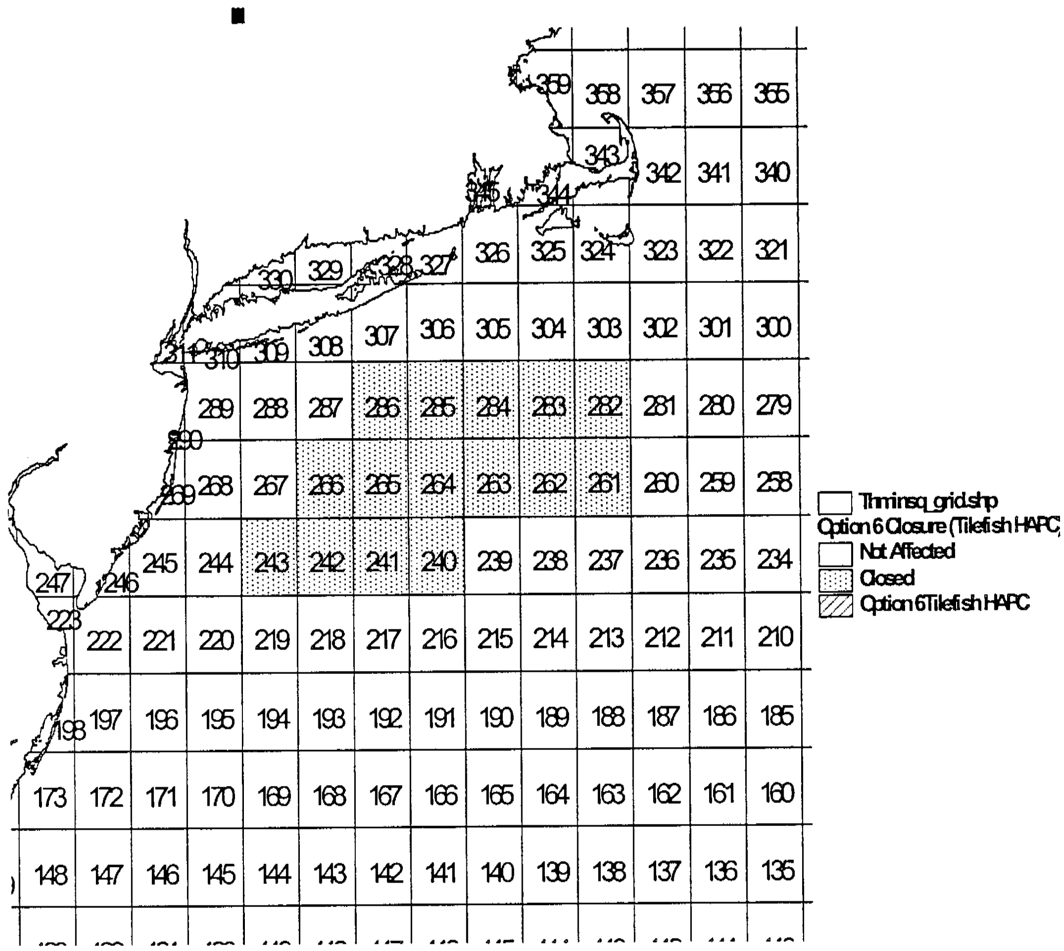


Figure 47. Option 6 closure: closed 30 minute squares.

Source: Kirkley *et al.* 2002.

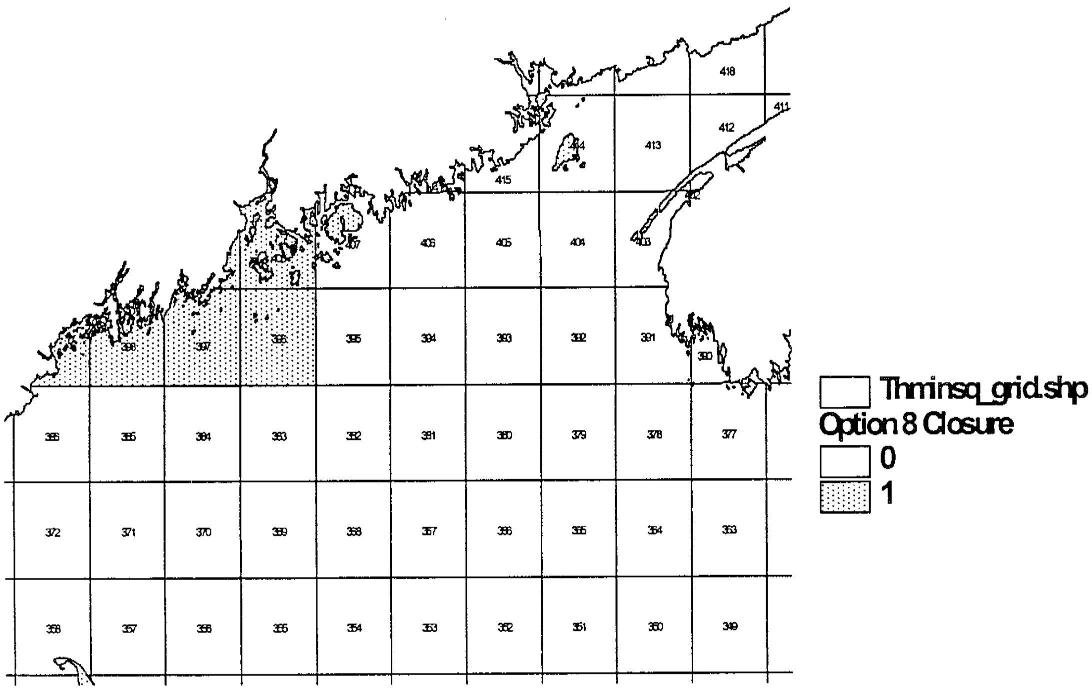


Figure 48. Option 8 closure: closed 30 minute squares.

Source: Kirkley *et al.* 2002.

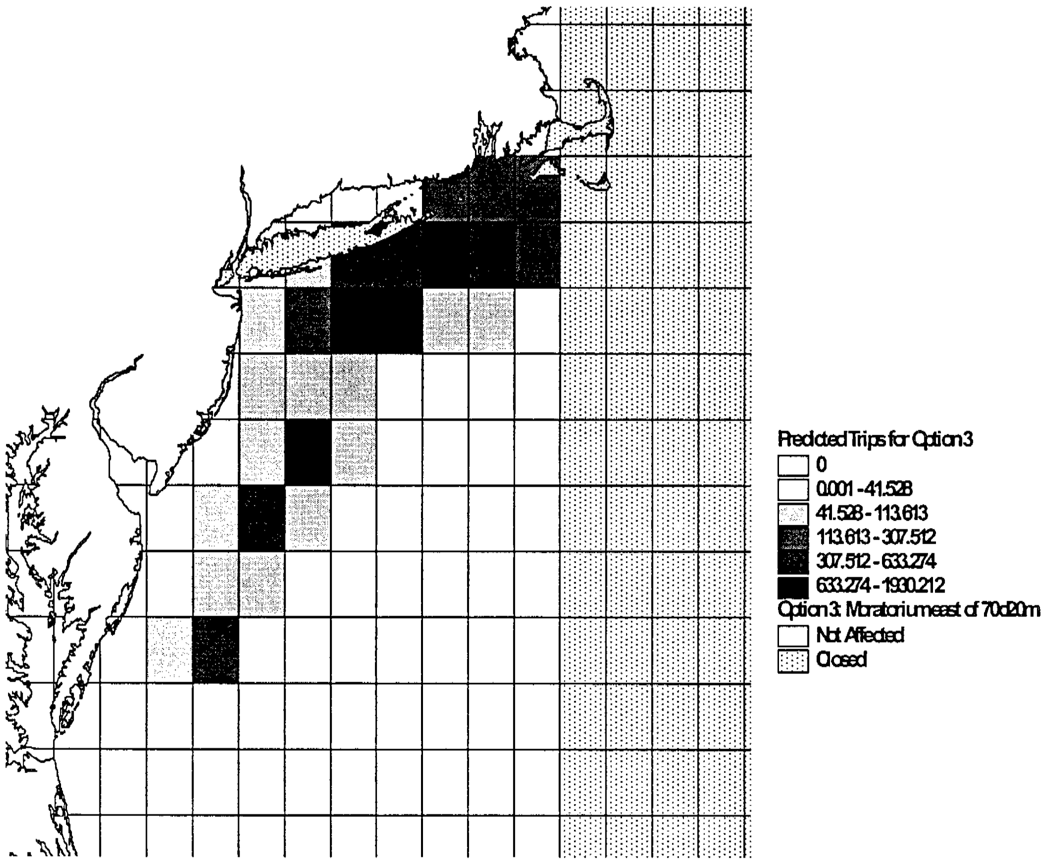


Figure 49. Option 3: ocean quahog predicted responses.

Source: Kirkley *et al.* 2002.

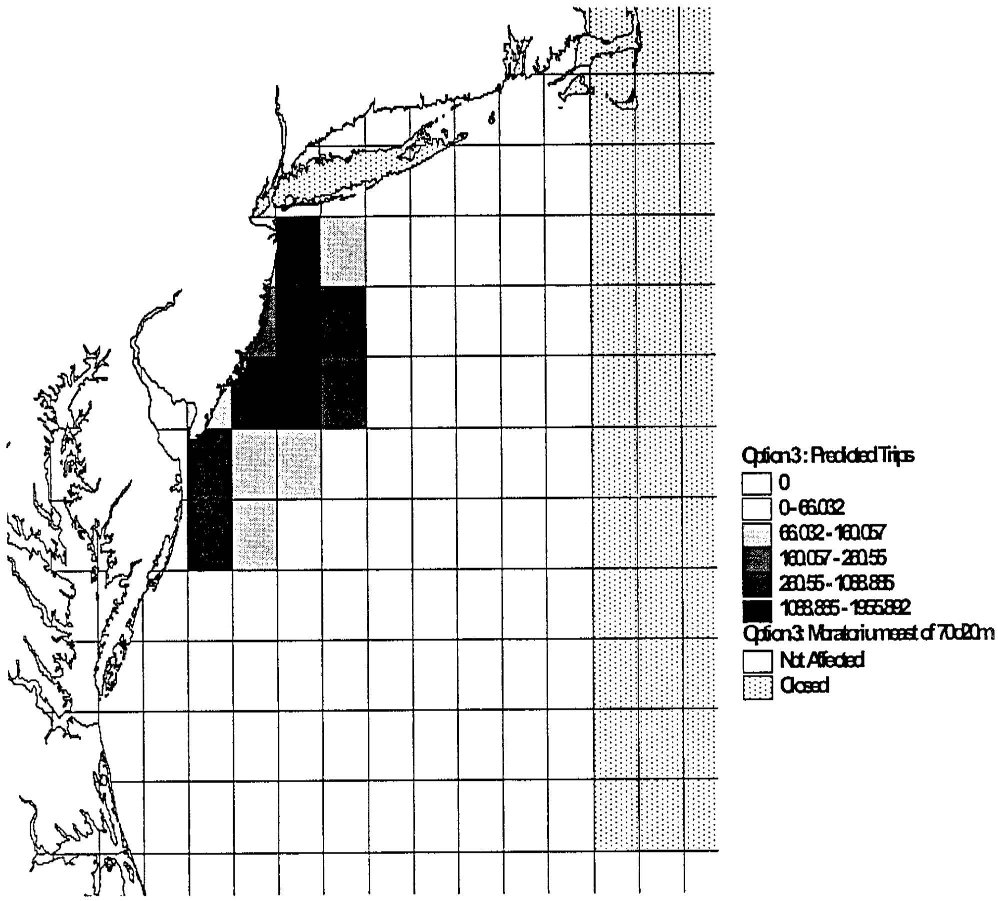


Figure 50. Option 3: surfclam predicted responses.

Source: Kirkley *et al.* 2002.

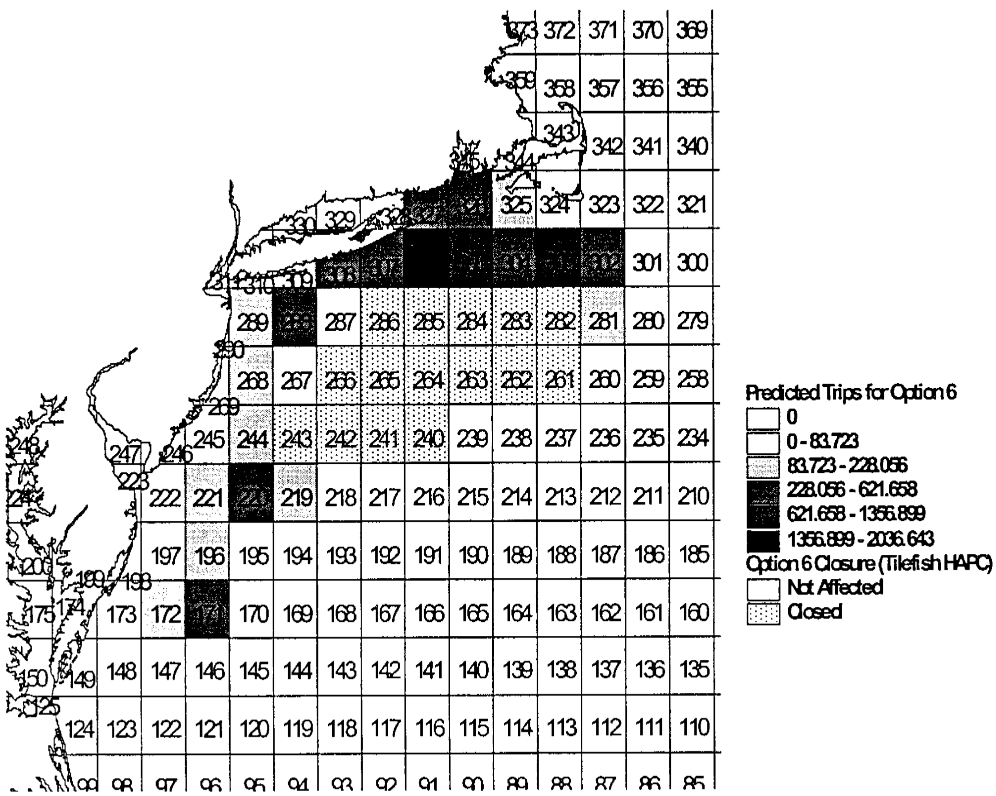


Figure 51. Option 6: ocean quahog predicted responses.

Source: Kirkley *et al.* 2002.

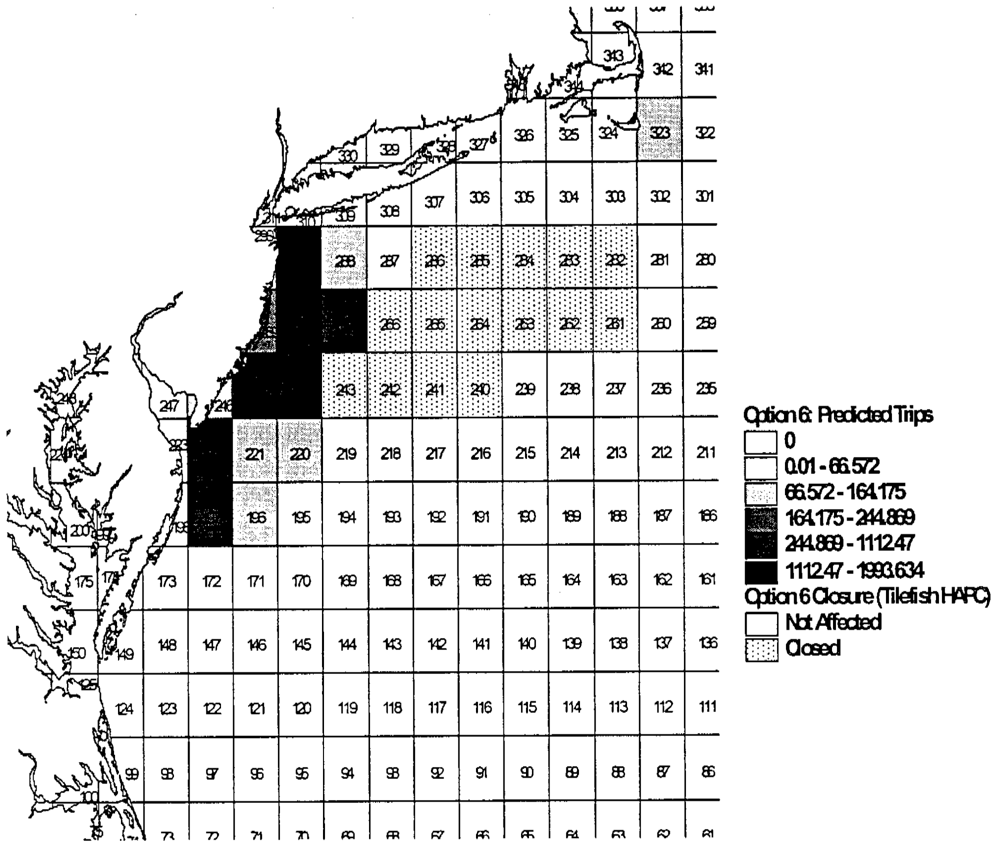


Figure 52. Option 6: clam predicted responses.

Source: Kirkley *et al.* 2002.

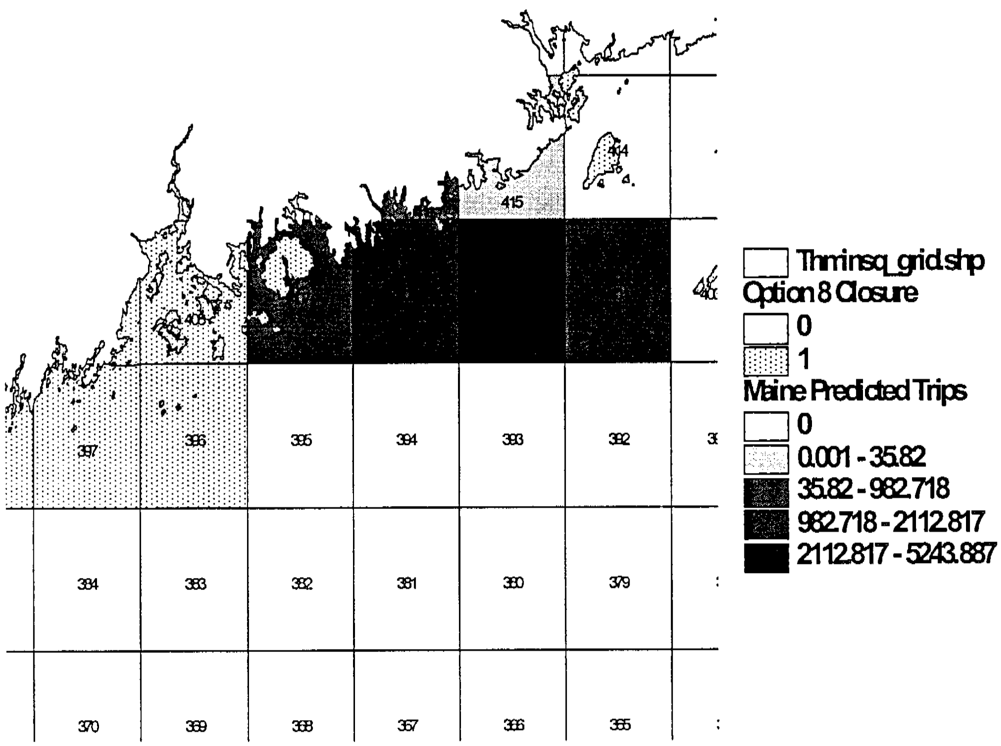


Figure 53. Option 8: Maine quahog predicted responses.

Source: Kirkley *et al.* 2002.

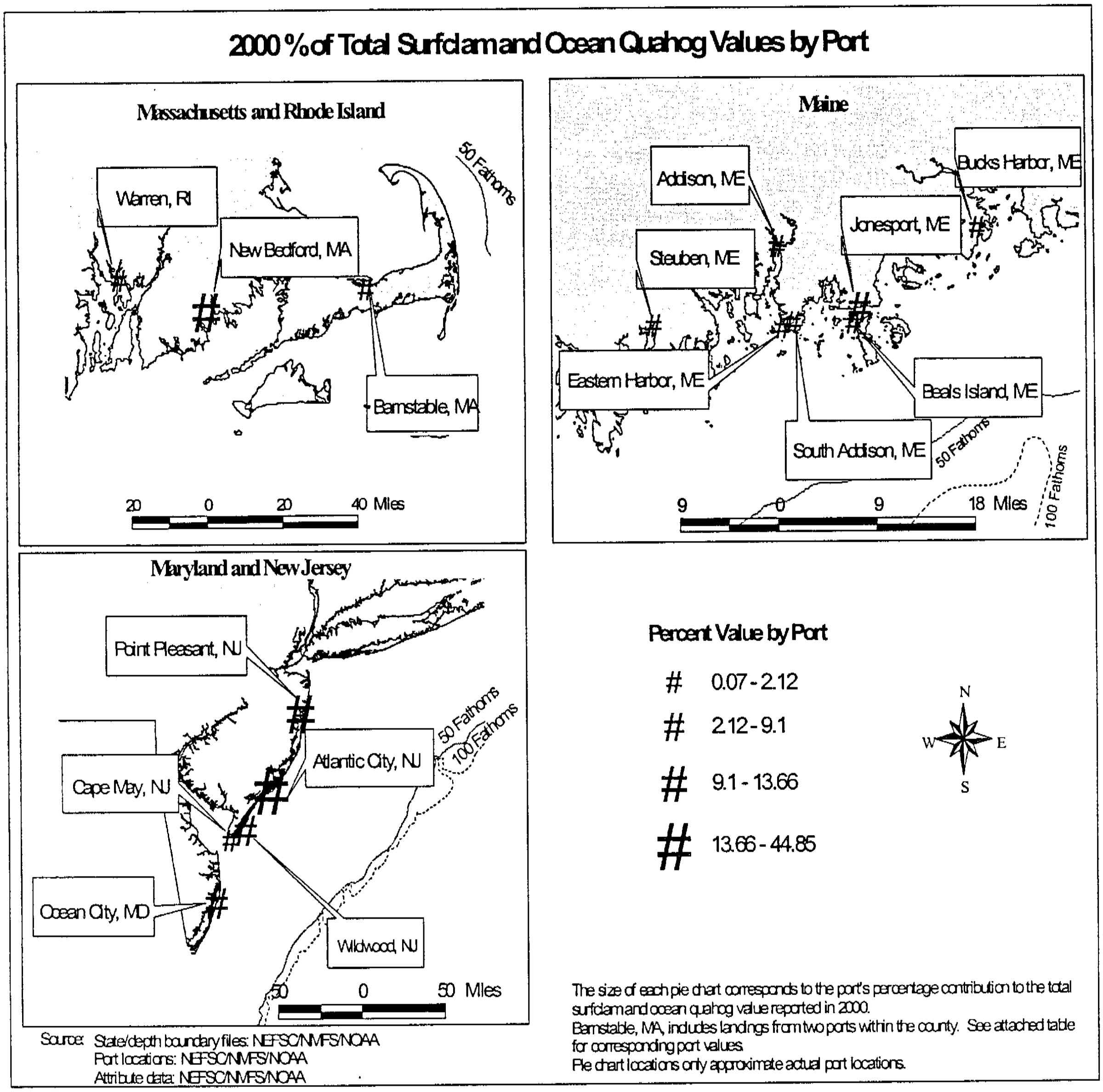


Figure 54. 2000 percent of total surfclam and ocean quahog values by port.

Source: McCay *et al.* 2002.

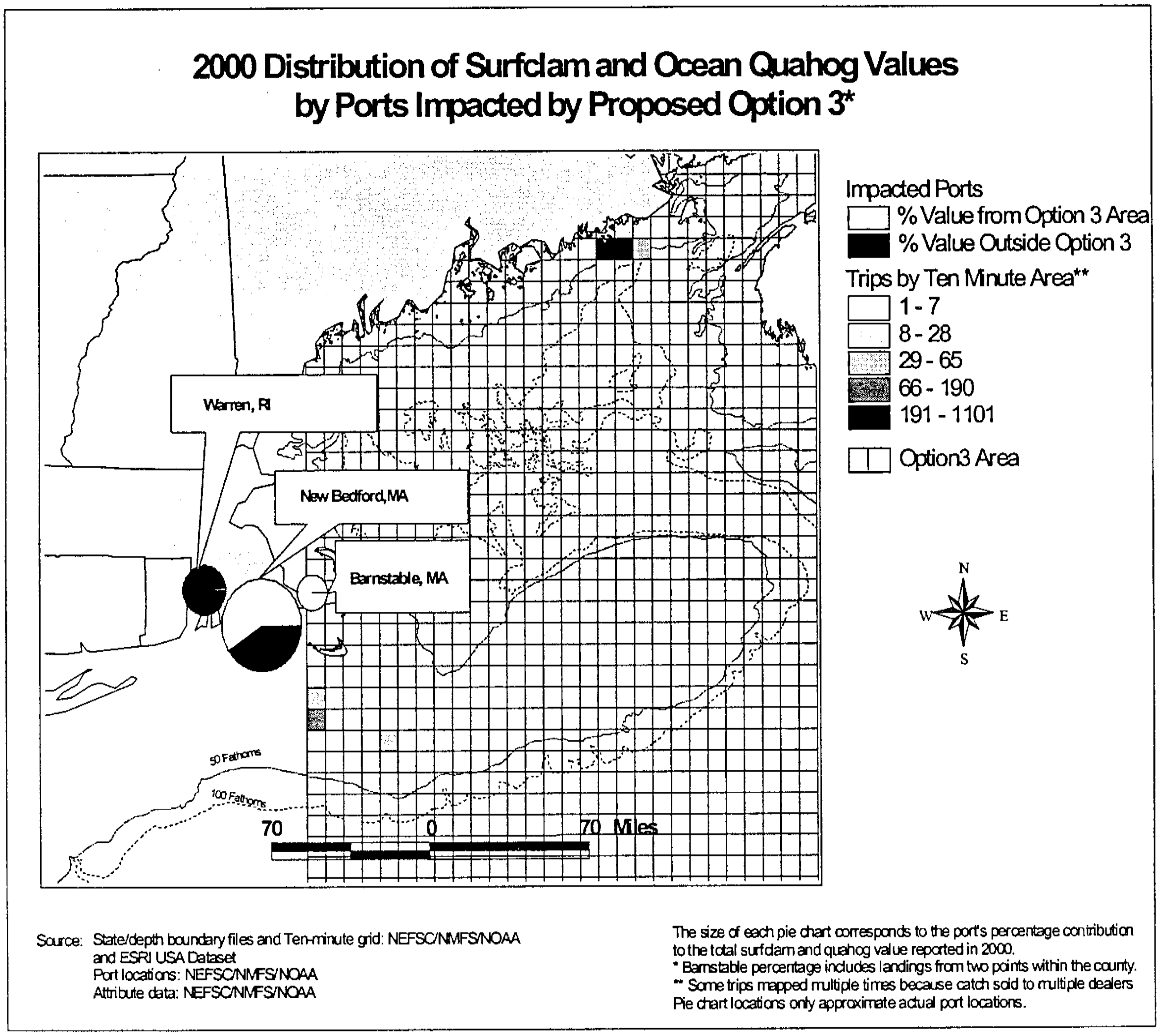


Figure 55. 2000 distribution of surfclam and ocean quahog values by ports impacted by proposed Option 3*.

Source: McCay *et al.* 2002.

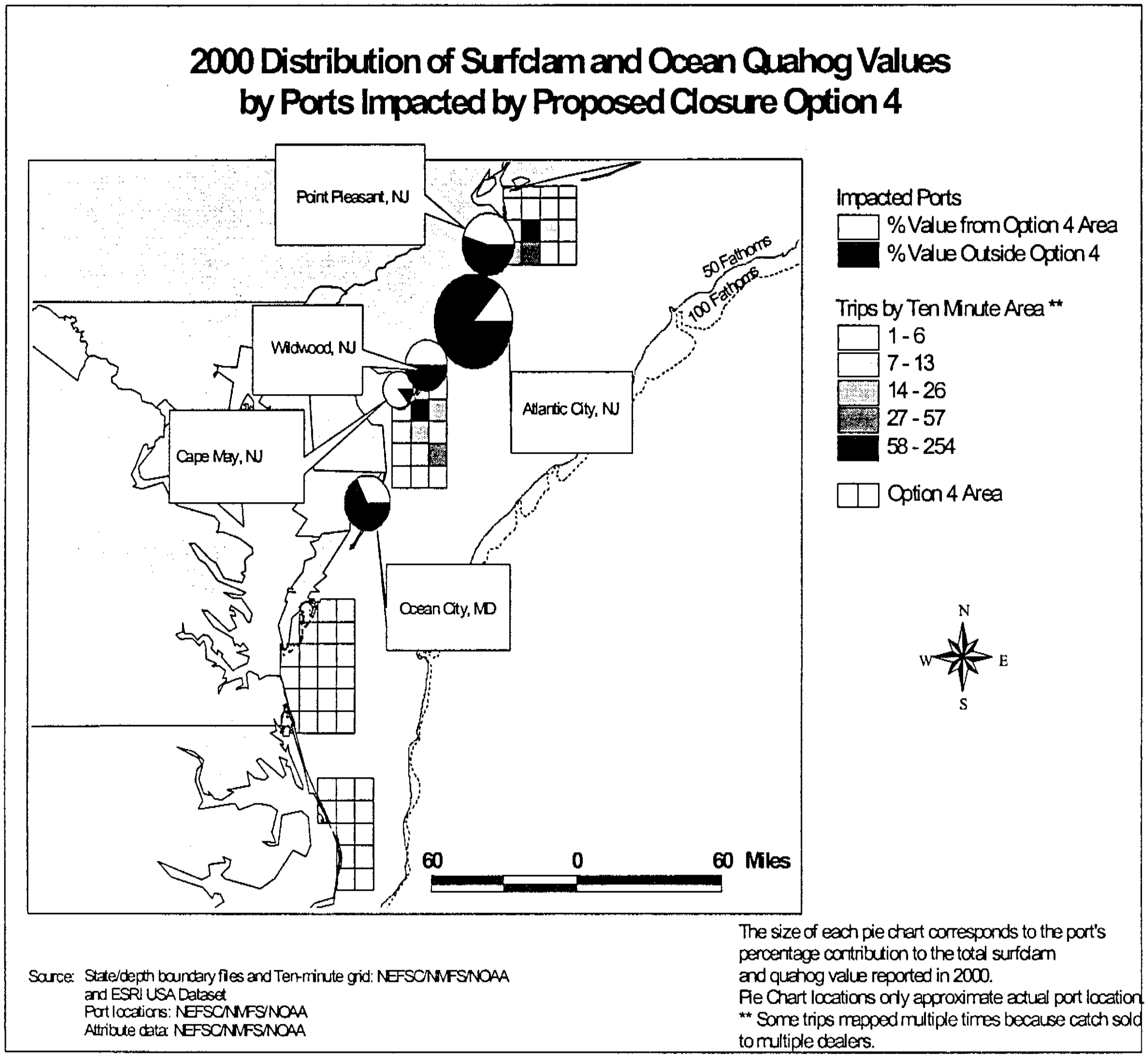


Figure 56. 2000 distribution of surfclam and ocean quahog values by ports impacted by proposed closure Option 4.

Source: McCay *et al.* 2002.

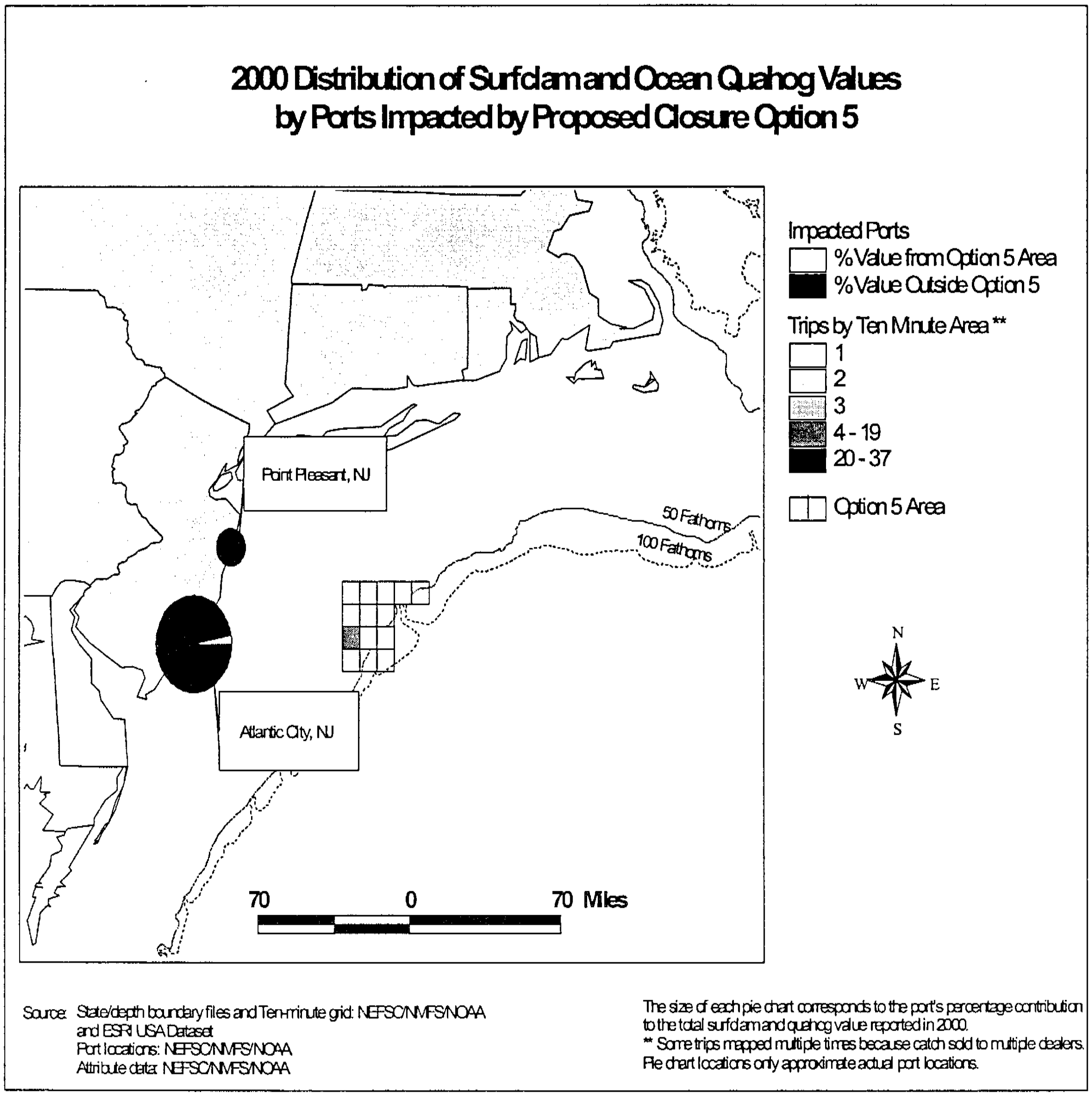


Figure 57. 2000 distribution of surfclam and ocean quahog values by ports impacted by proposed closure Option 5.

Source: McCay *et al.* 2002.

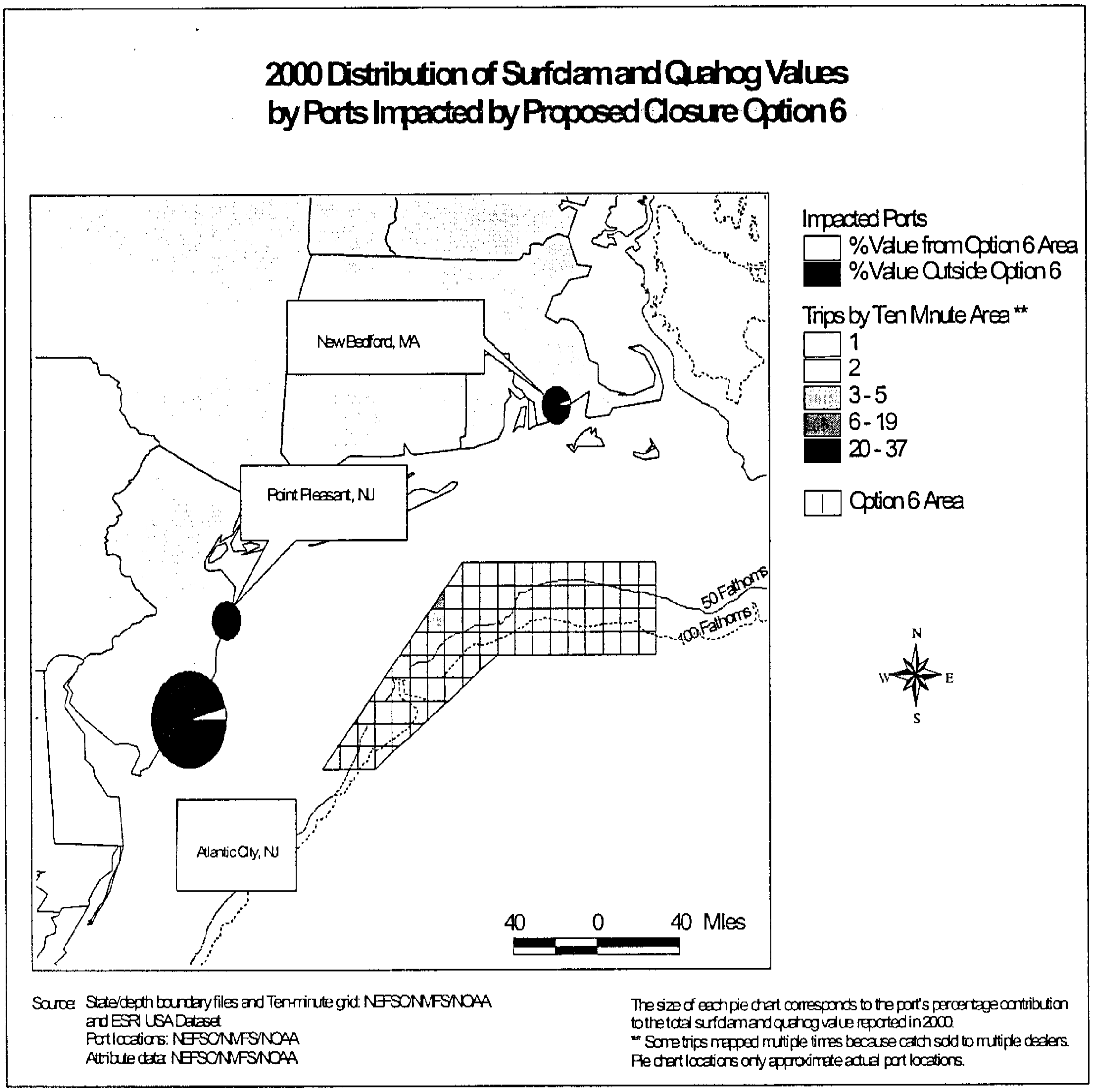


Figure 58. 2000 distribution of surfclam and ocean quahog values by ports impacted by proposed closure Option 6.

Source: McCay *et al.* 2002.

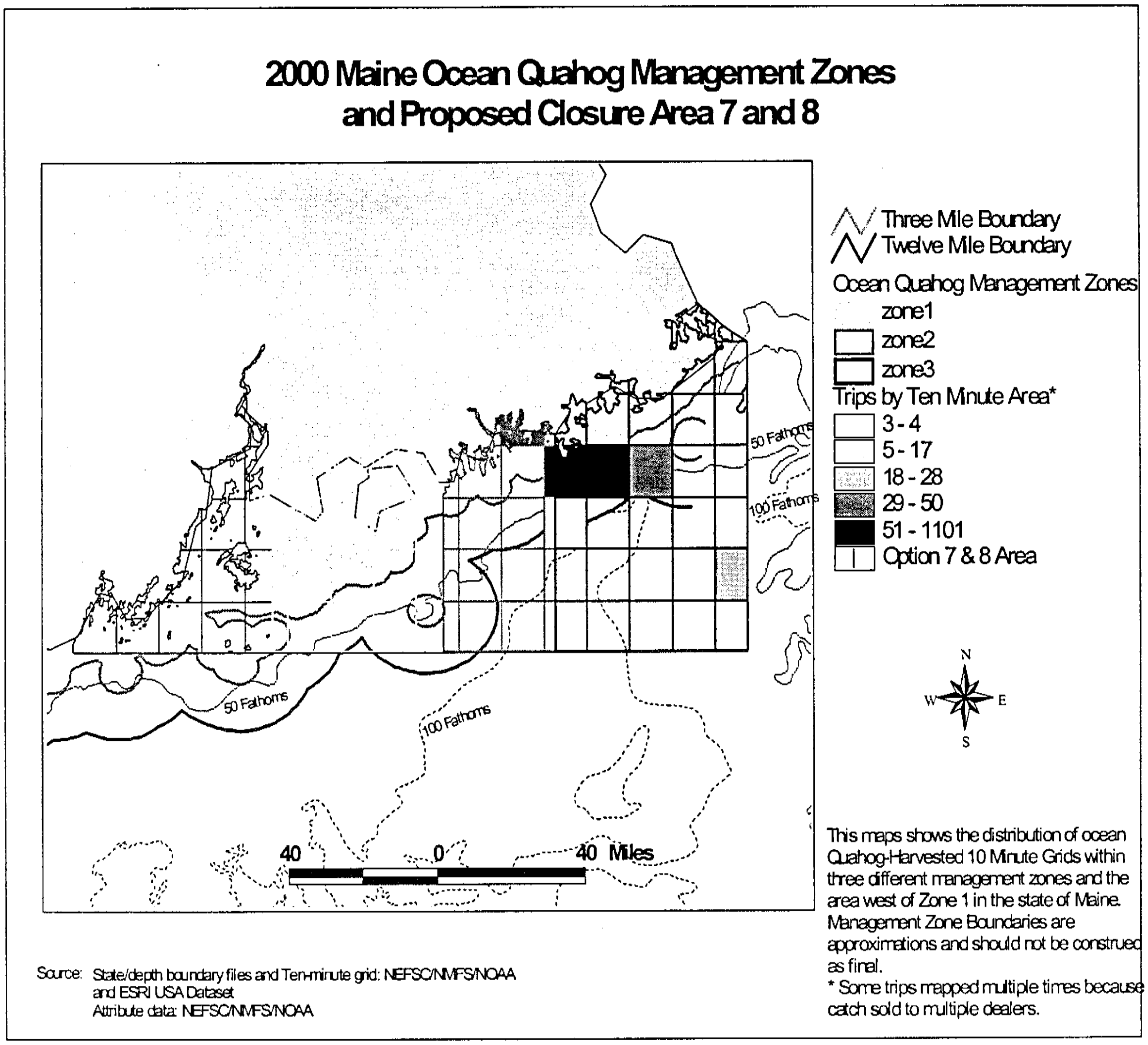


Figure 59. 2000 Maine ocean quahog management zones and proposed closure area 7 and 8.

Source: McCay *et al.* 2002.

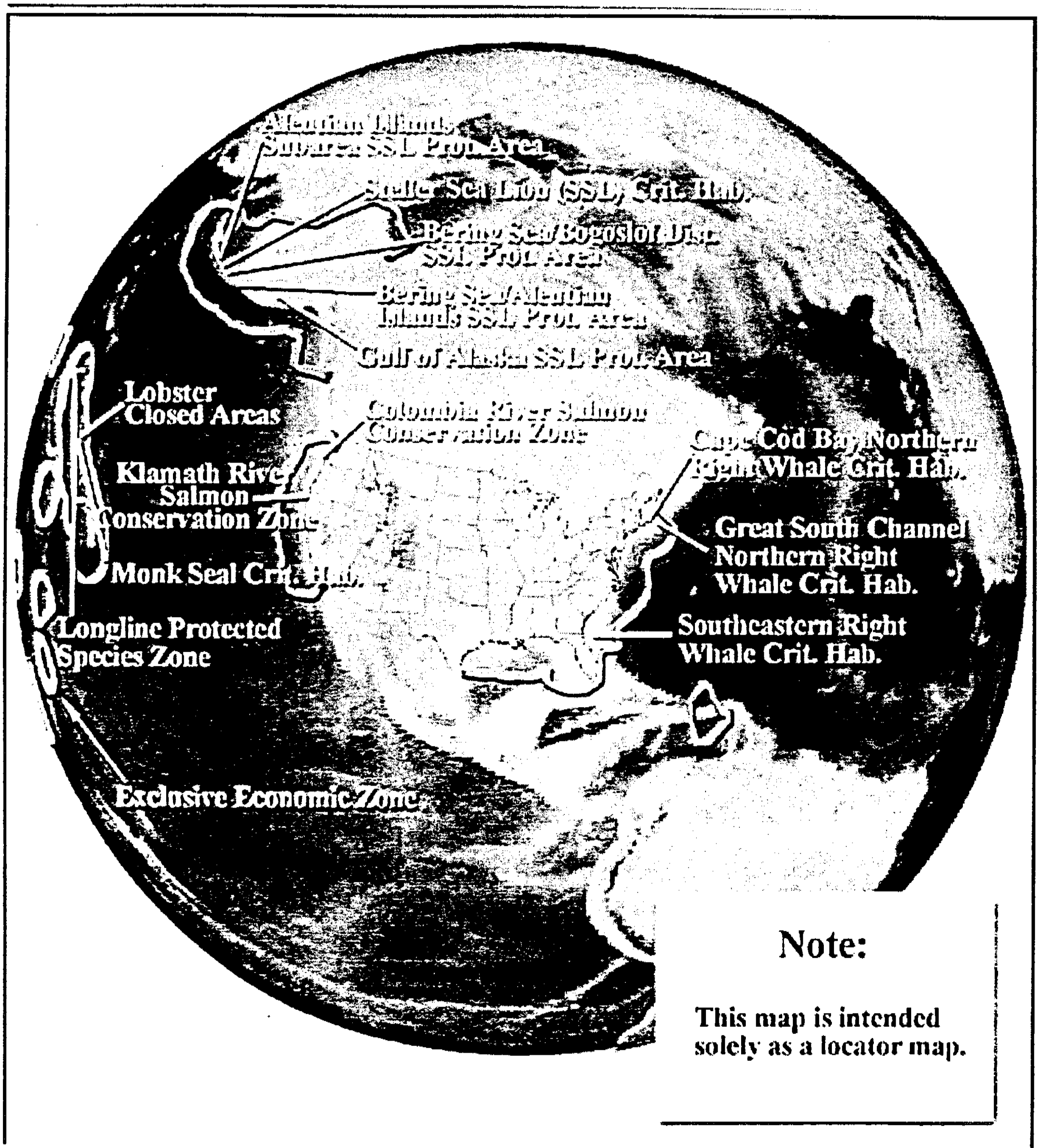


Figure 60. Federal Threatened/Endangered Critical Habitat and Species Protected Area Sites.

This map shows 13 Federal Threatened/Endangered Critical Habitat and Species Protected Area sites. NOTE: The protective zones for Stellar sea lions will be updated in 2001 as part of an Endangered Species Act review of the effects of the groundfish fishery in the Gulf of Alaska and Bering Sea.

Source of location data: NOAA/National Marine Fisheries Service.

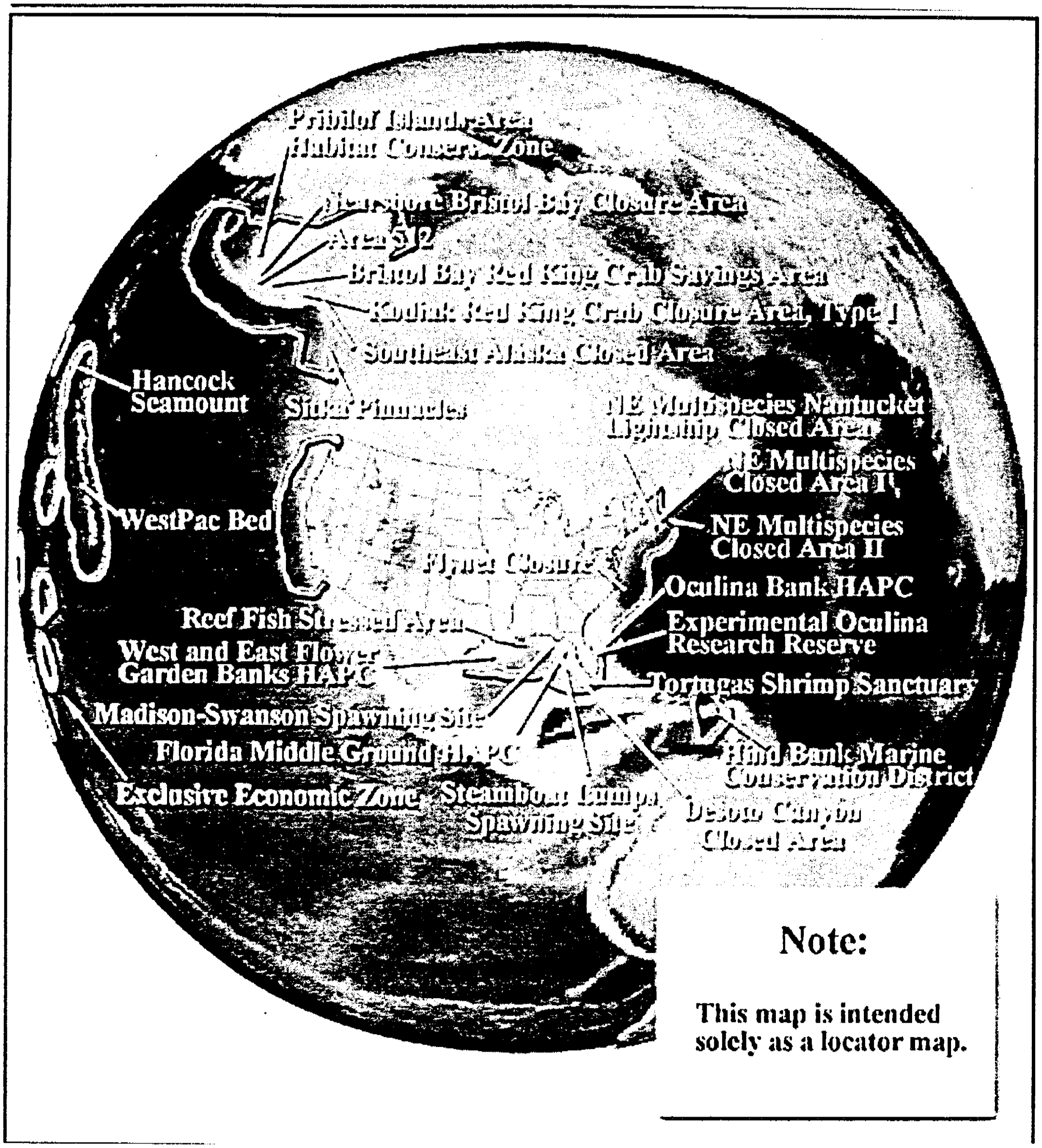


Figure 61. Federal Fisheries Management Zone Sites.

This map shows 23 Federal Fisheries Management Zone sites.

Source of location data: NOAA/National Marine Fisheries Service.

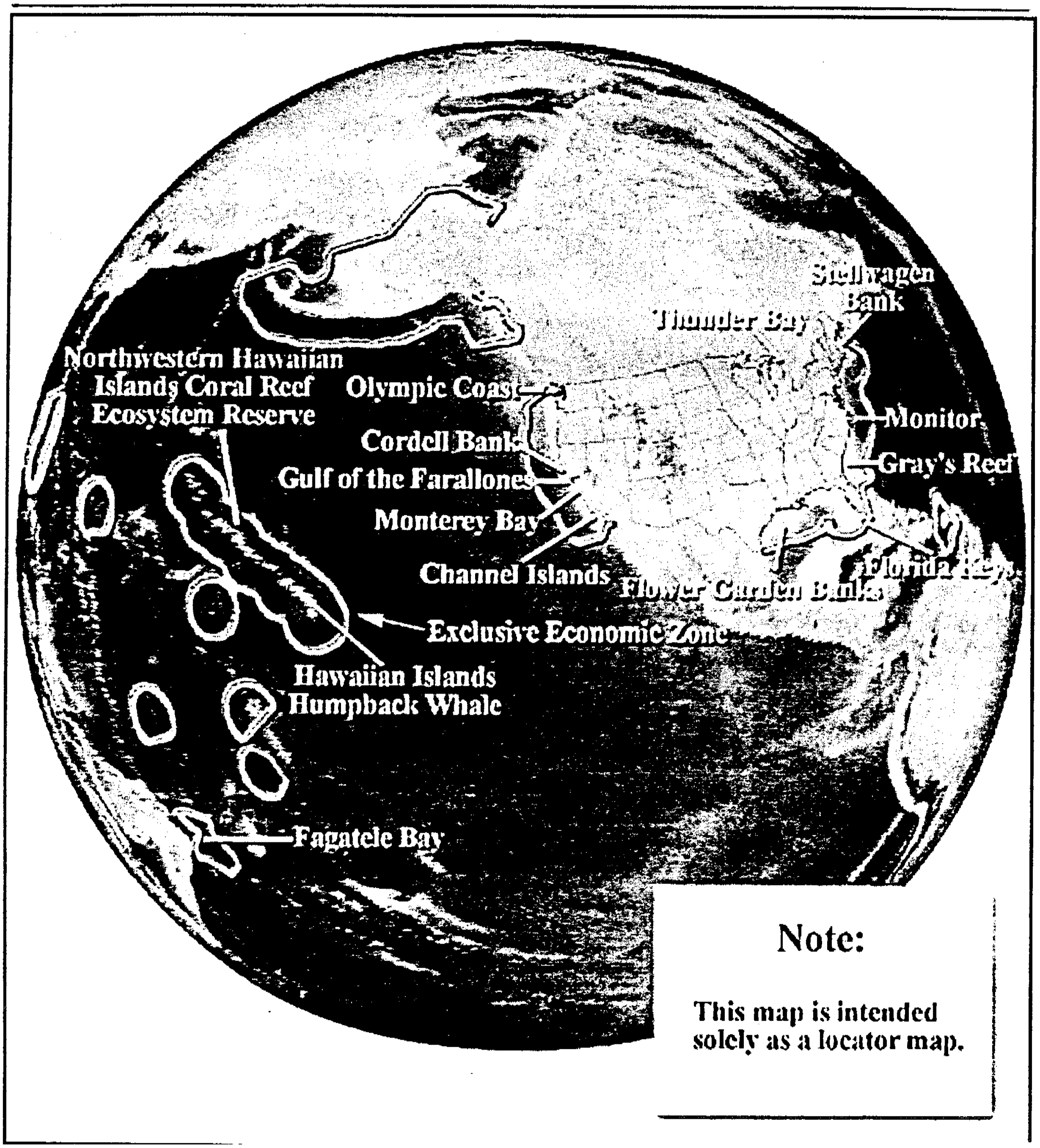


Figure 62. National Marine Sanctuary Program Sites.

This map shows the 14 National Marine Sanctuary Program (13 national marine sanctuaries and one ecosystem reserve) sites.

Source of location data: NOAA/National Ocean Service.