federal register

FRIDAY, NOVEMBER 25, 1977

PART VI

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

■

SURF CLAM AND OCEAN QUAHOG INDUSTRIES

Fishery Management Plan

[3510-12]

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

SURF CLAM AND OCEAN QUAHOG FISHERIES

Fishery Management Plan

A fishery management plan for the Surf Clam and Ocean Quahog Fisheries has been reviewed and approved in accordance with Section 304 of the Fishery Conservation and Management Act of 1976, 16 U.S.C. 1801, as amended. The plan was prepared and submitted by the Mid-Atlantic Fishery Management Council. This action has been taken under a delegation of authority from the Secretary of Commerce to the Deputy Assistant Administrator for Fisheries, National Oceanic and Atmospheric Administration. The plan has been found to be consistent with the national standards in § 301 of the Act, the other provisions of the Act and other applicable law.

An emergency is found to exist and therefore emergency regulations will be published to implement the plan immediately for a period of 45 days, pursuant to § 305(e) of the Act. In the near future, regulations will be proposed in the FEDERAL REGISTER to implement the plan on a permanent basis. These proposed permanent regulations will be open for public comment for a period of 45 days from the date of publication.

We also wish to announce that the Plan contains a moratorium provision which prohibits additional vessels from entering the surf clam fishery for a one-year period from the date of this notice. For the moratorium not to apply to a particular vessel, that vessel must:

1. During the year immediately preceding this notice, have landed surf clams in the course of a directed fishery for surf clams;
2. Be under construction for, or in the process of being re-rigged for, the surf clam fishery on the date of this notice; or
3. Be a replacement for a vessel of substantially similar harvesting capacity which involuntarily leaves the surf clam fishery during the moratorium.

Persons who may deem themselves affected may contact: Mr. William G. Gordon, Regional Director, Northeast Region, National Marine Fisheries Service, 14 Elm Street, Gloucester, Massachusetts 01930. Telephone 617-281-3600.

This action was taken under a delegation of authority from the Secretary to the Deputy Assistant Administrator for Fisheries, National Oceanic and Atmospheric Administration.

Signed at Washington, D.C. this 17th day of November, 1977.

WINFRED H. MEIBOHM,
Associate Director for Fisheries.

FISHERY MANAGEMENT PLAN

FOR SURF CLAM AND OCEAN

QUAHOG FISHERIES

MID ATLANTIC FISHERY MANAGEMENT COUNCIL

in consultation with

NEW ENGLAND FISHERY MANAGEMENT COUNCIL
SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

October , 1977

Responsible Federal Agency:

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

ACKNOWLEDGEMENTS

The Mid-Atlantic Council greatly appreciates the assistance and cooperation of several individuals and groups that participated in the preparation of this plan. Major contributions included:

Biological Analysis - Dr. Brad Brown, Dr. Frederic Serchuk and Steve Mauraski of Northeast Fisheries Center, National Marine Fisheries Service, Woods Hole, Massachusetts.

Economic Analysis - Joe Mueller, Regional Economist National Marine Fisheries Service, Gloucester, Massachusetts.

Preparation of Regulations - Brooks Bowen, Attorney, NOAA Washington, D.C.

Initiation of Surf Clam/Ocean Quahog Management (starting in 1972) - Surf Clam Sub-Board composed of Directors of Marine Fisheries from Coastal States of Maine through Virginia Industry Representatives and the Regional Director, National Marine Fisheries Service, Northeast Region, Gloucester, Massachusetts.

Preparation of the First Draft - Ronald Rinaldo, Project Manager of the State-Federal Fisheries Management Program for Surf Clams and Ocean Quahogs, Annapolis, Maryland.

II. TABLE OF CONTENTS

3

4

III. INTRODUCTION

PLAN DEVELOPMENT

Plan development was begun approximately four years ago through the National Marine Fisheries Service State-Federal Program. State, federal, and industry representatives were involved in the program. The draft plan produced by this program and was accepted for the purposes of holding public meetings on March 10, 1977 by the Mid Atlantic Fishery Management Council.

The plan is a result of the comments received at the public meetings and hearing and the deliberations of the Council.

OBJECTIVES OF THE PLAN

The Mid Atlantic Regional Fishery Management Council, under whose purview this plan is being prepared, recognizes that the surf clam populations are declining and that a long-term stock rebuilding program must be instituted. Such a program will require significant cutbacks in the allowable harvest levels of surf clams. At the same time, however, the Council recognizes that there are compromises which must be made with respect to the rate of stock rebuilding and the short-term economic dislocation that can occur in the industry, associated with such required catch reductions. Further, the Council recognizes that as a rebuilding program is implemented in the surf clam fishery, significant fishing effort may be transferred to the ocean quahog resource, since recent technologic advances in the processing of quahogs renders them , for some segments of the industry, to be close substitutes for surf clams in the marketplace.

Therefore, the Council has decided that the surf clam and ocean quahog fisheries must be included in a joint management plan, and has adopted the following objectives for this plan:

1. Rebuild the declining surf clam populations to allow eventual harvesting approaching the 50 million pound level, which is the present best estimate of the maximum sustainable yield (MSY), based on the average yearly catch from 1960-1976.

2. Minimize the short-term economic dislocations to the extent possible consistent with objective 1 and promote economic efficiency.

3. Prevent the harvest of the ocean quahog from exceeding biologically sound sustainable yield levels, and direct the fishery toward maintaining optimum yield.

IV. DESCRIPTION OF THE STOCKS COMPRISING THE MANAGEMENT UNIT

IV-1. Species and Their Distribution

Surf Clam

The surf clam (Spisula solidissima(Dillwyn)) is found along the northwestern Atlantic coast from the Gulf of St. Lawrence to Cape Hatteras, North Carolina. Many common names are used for this species: bar clam in Canada, hen clam in Maine, sea clam in Massachusetts, and surf clam, beach clam or skimmer clam in the middle Atlantic states. In size, it is the largest species of Spisula, and is most abundant in the Middle Atlantic Bight (Chamberlin and Stearns, 1963; Merrill and Webster, 1964, Jacobson and Old, 1966; Yancey and Welch, 1968).

Surf clams occur on the continental shelf from the lower edge of the intertidal zone to a depth of about 140 feet (43 m), although they have been found at greater depths (Merrill and Ropes, 1969). They inhabit sand or gravel bottoms where shells, shell fragments, and fine sediments may be mixed with the basic bottom types. Coarse sand and fine gravel seem to be the preferred substrates.

In the Gulf of St. Lawrence, the Bay of Fundy, and the Gulf of Maine surf clams are found immediately below the low tide line. Farther south to the Virginia and Cape Hatteras area, they are distributed up to approximately 23 miles (37 km) offshore to depths of 120 feet (36.6 m). Clams have been found at depths of 250 feet off Digby Gut, Nova Scotia (Yancey and Welch, 1968). Off the coast of New York and New Jersey, surf clams inhabit the coastal areas within the three mile teritorial sea as well as deep offshore beds and are abundant primarily from southern New York to northern Virginia waters.

Surf clams require waters of near oceanic salinity. They are usually found on open beaches and open ocean bottom, but are also found in some estuaries such as Long Island Sound.

Surveys have been conducted by the National Marine Fisheries Service (NMFS) since 1965 to estimate the relative abundance of surf clams in the Middle Atlantic Bight. Data are available for the years 1965, 1966, 1967, 1969, 1970, 1974, 1976 and 1977. Detailed information on the areas surveyed through these years may be obtained through the Cruise Reports available through the Sandy Hook Marine Laboratory of the NMFS.

The primary inshore commercial area is along the coast of New Jersey, along the southwestern end of Long Island, New York, and Nantucket Sound beds off Rhode Island. However, some of this inshore resource is influenced

7

by pollution. Offshore populations are concentrated into three areas. They are: 1) 5 to 40 miles offshore mid-New Jersey area, 2) the Delmarva Peninsula area, and 3) the southern Virginia coast. Within each of these areas there are, however, so called "hot spots" where exceptional concentrations of clams exist. The offshore New Jersey concentration has been virtually eliminated. Over 50% of the bottom area where these clams were concentrated was exposed to anoxic conditions during the summer of 1976 and total loss to the population occurred over 2100 square miles of bottom. The surf clam commercial beds off the Delmarva Peninsula contain the remaining commercial beds off the Atlantic coast.

Ocean Quahog

The ocean quahog (Arctica islandica) is a boreal species occurring on both sides of the Atlantic Ocean, and is the only living species in the family Arcticidae. It occurs on the northwestern Atlantic continental shelf from Newfoundland to Cape Hatteras and along the European coast from the White and Barents Seas to the Bay of Cadiz and Shetland Islands, the British Isles, and Iceland (Nicol, 1951; Zatsepin and Filatova, 1961).

In the Gulf of Maine and near Cape Cod ocean quahogs are usually nearshore inhabitants. On Georges Bank they are found along the southern edge out to its eastern tip. Commercial concentrations are located offshore from New York through Virginia. Depth distribution in the Middle Atlantic Bight is from about 50 to 768 feet (15 - 234 m) with the largest concentrations occurring between 82 and 197 feet (25 - 60 m).

8

IV-2. Abundance and Present Condition

Reproductive Cycle

Surf clam

Sexual development in the surf clam begins at about one year of age. Full sexual maturity is reached at age two. Ropes (1968a, b) determined the annual frequency and duration of spawning in beds off New Jersey. The spawning season appears to be related to bottom temperature. In most years, major spawning occurs in mid-July to early August, with a second minor spawning occurring in mid-October to early November. This sequence is dependent upon the habitat environment and in one year, only a single spawning was observed between mid-September and mid-October.

Fertilized eggs quickly develop and the newly hatched larvae are free swimming. During the first 20 days of life the larvae gradually undergo changes in shape and form until they resemble an adult clam and settle to the bottom to live in the substrate. Enormous numbers of juvenile clams settle to the bottom but only a very small percentage survive to adult and/or commercial size. After settling, a clam can either leap or crawl using its muscular foot and maintains a very active existence moving within and about the substrate.

Examination of shell structure and results from tagging studies have provided information on the age, size and growth of young clams. They may survive for as long as 17 years (Ropes et al., 1969, from Westman and Bidwell, 1946). Studies are now being conducted to determine the age for any particular size. Growth rates vary between areas but an average estimate of growth appears to be 1/2 to 1-1/4 inches per year as measured along the long axis of the clam. Although clam growth may vary with age and location, Figure 1 shows a composite estimate of the growth rage for Virginia surf clams.

The growth of surf clams has been investigated by Belding (1910), Yancey and Welch (1968), and Ropes et al. (1967). Yancey and Welch (1968) summarized four different growth curves.

Clam data collected from commercial landings in 1974 and 1975 were analyzed for various growth, size and weight relationships. A summary of these relationships is given in Table 1.

Ocean quahog

Ocean quahog are dioecious (Silbajoris, 1975). Off Rhode Island, spawning starts in June-July, peaks in August, and usually is complete in October. Water temperatures in that area during spawning range from about 56° F (13.5° C) at its onset to about 59° F (15° C) during August (Loosanoff, 1953). Ocean quahog larvae are planktonic, but for an unknown period of time (Saila and Pratt, 1973).

Population dynamics

Research cruise surveys of surf clam populations in the Middle Atlantic Bight have been conducted by the NMFS since 1965. Although population assessment was not the primary objective of many of these surveys, useful analyses of population trends in relative abundance and recruitment can be performed nevertheless (Brown et al., 1977).

Relative abundance*

The relative abundance of surf clams in principal commercial fishing areas in the Middle Atlantic Bight was determined by deriving a catch per tow index from NMFS survey data for offshore northern New Jersey, offshore southern New Jersey, and offshore Delmarva (Table 2). Survey stations which consistently exhibited 0 clams per tow (beyond 45 m) off New Jersey and Delmarva were eliminated from the calculations. Since gear varied somewhat between cruises, results were standardized to a 48 inch dredge and 5 minute tow.

The survey indices indicate a drastic decline in recent years for offshore New Jersey surf clam populations. The relative abundance of the offshore Delmarva Peninsula populations, however, has remained relatively stable (Figures 2 and 5).

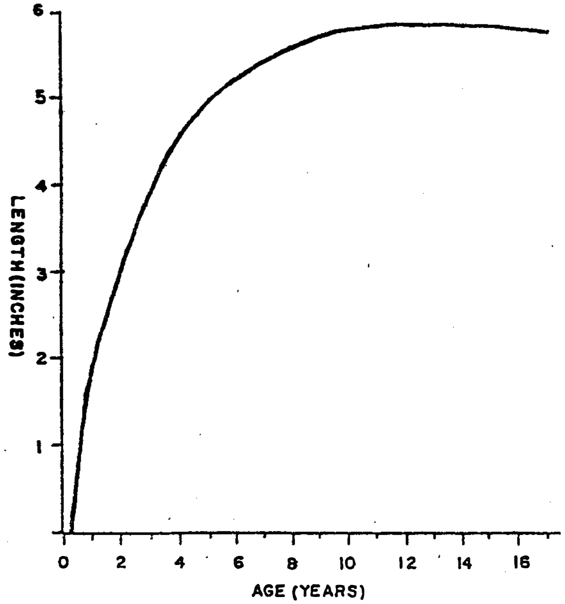
Recruitment rates*

Pre-recruit indices for surf clam populations were obtained by applying the percentage of sample length frequency distributions in the recruiting size classes from the research surveys to the total survey indices. Since commercial size surf clams are generally larger than 4.5 inches (115 mm) size groups from 90 - 120 mm were examined (Table 3). Figures 4 and 5 show the trends in relative abundance of recruiting surf clams (size group 110 - 120 mm) from 1965 - 1977. Recruitment indices have been low for the New Jersey populations during the last several years, while the Delmarva indices indicate a relatively stable recruitment level.

---

* from Brown et al. (1977).

Figure 1. The Length-Age Relationship of Virginia Surf Clams



Loesch, 1975, Manuscript Report to Technical Committee

11

TABLE 1. Summary of growth relationships for the Middle Atlantic Bight surf clam. In parenthesis, a test of isometric growth, i.e. slope = 3.0 and test statistics, T.

Relationship	Equation
Shell length and total weight	$\ln W_t = -10.3188 + 3.21034 \ln L$ (Ho : B_1 = 3.0, T = 1.21717, not significant)
Shell length and drained meat weight	$\ln W_t = -8.97583 + 2.766297 \ln L$ (Ho : B_1 = 3.0, T = 1.31958, not significant)
Shell length and dry shell weight	$\ln W_t = -8.25149 + 2.7168 \ln L$
Shell length and shell height	$H = 11.08362 + 0.36744 L$
Shell length and shell width	$W_d = 7.48196 + 0.36744 L$
Shell length and chondrophore length	$C_r = -4.96645 + 0.76096 L$
Shell length and shell cross-section	$CS = 0.04679 + 0.99711 L$
Chondrophore and shell cross-section	$CS = 33.45673 + 4.19146 C_r$
Age and shell length	$L = 174.8 [1 - e^{-0.19(t + 0.81)}]$
Age and total weight	$W_t = 762.7 [1 - e^{-0.11(t - 3.13)}]$
Age and drained meat weight	$W_t = 263.2 [1 - e^{-0.14(t - 2.05)}]$

12

Table 2. Relative abundance of surf clams from NMFS shellfish cruises, 1965-1977 (Number per tow). (From Brown et. al. 1977)

Cruise	AREA N NJ (off)	S NJ (off)	NJ (off)	DMV (off)
1965-Spring	36.7	29.2	34.1	25.0
1965-Autumn	34.5	38.6	35.6	25.5
1966-Spring	55.9	--	55.9	13.3
1966-Summer	29.7	40.2	34.0	29.2
1967-Spring	66.7	--	65.3	17.2
1969-Spring	31.3	40.7	34.4	24.6
1970-Summer	19.1	12.6	17.5	18.8
1974-Spring	18.7	43.7	28.1	33.5
1974-Summer	15.6	--	15.6	--
1976-Spring	7.8	8.5	8.0	26.3
1977-Winter	2.5	8.6	7.6	32.0

13

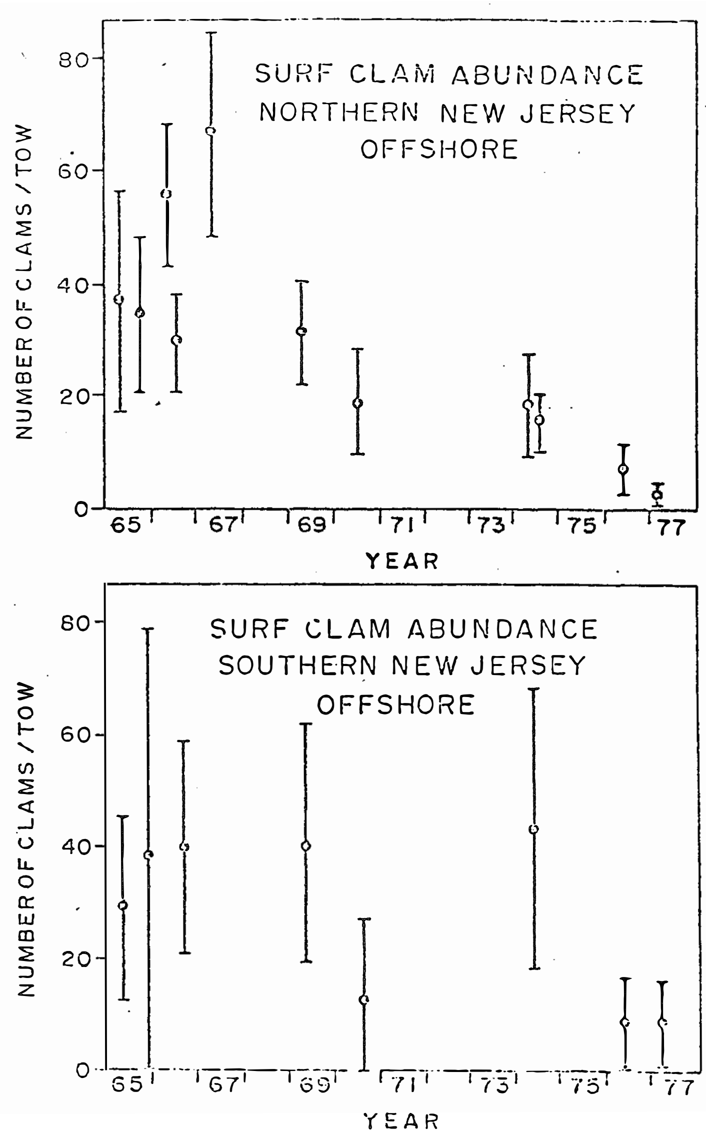
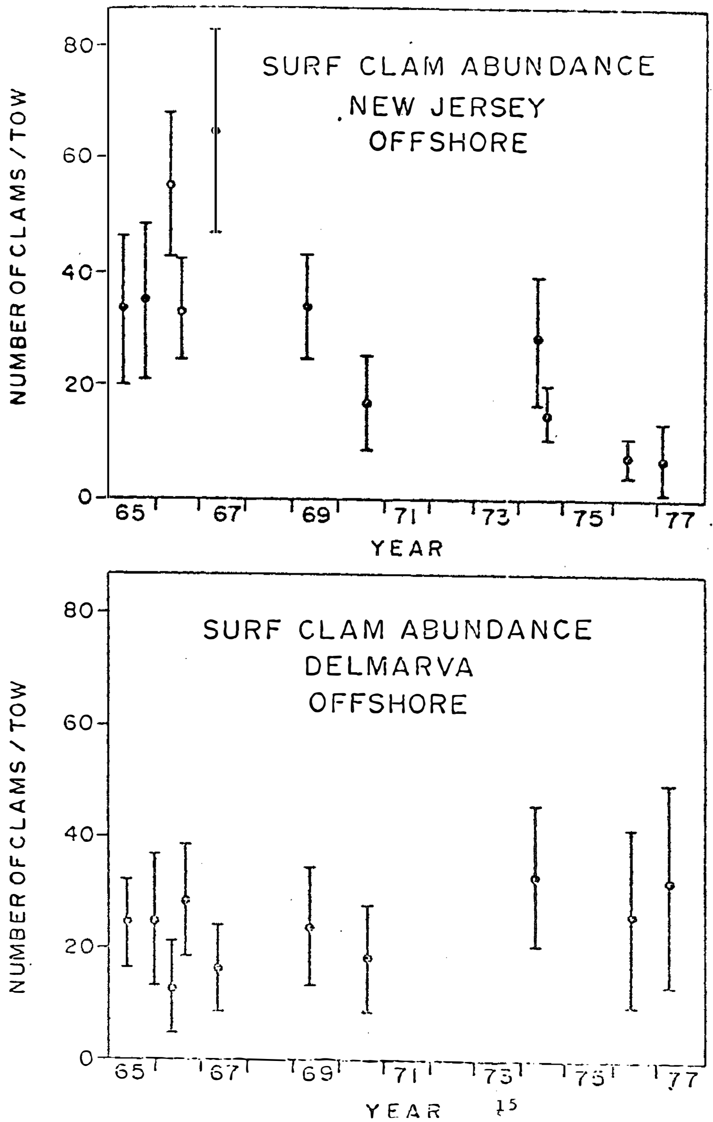


Figure 2. Relative abundance of surf clams from NMFS shellfish cruises, 1965-1977, Northern New Jersey (offshore), Southern New Jersey (offshore) (Mean No. per tow and 95% C.I.). (From Brown et. al. 1977).

14



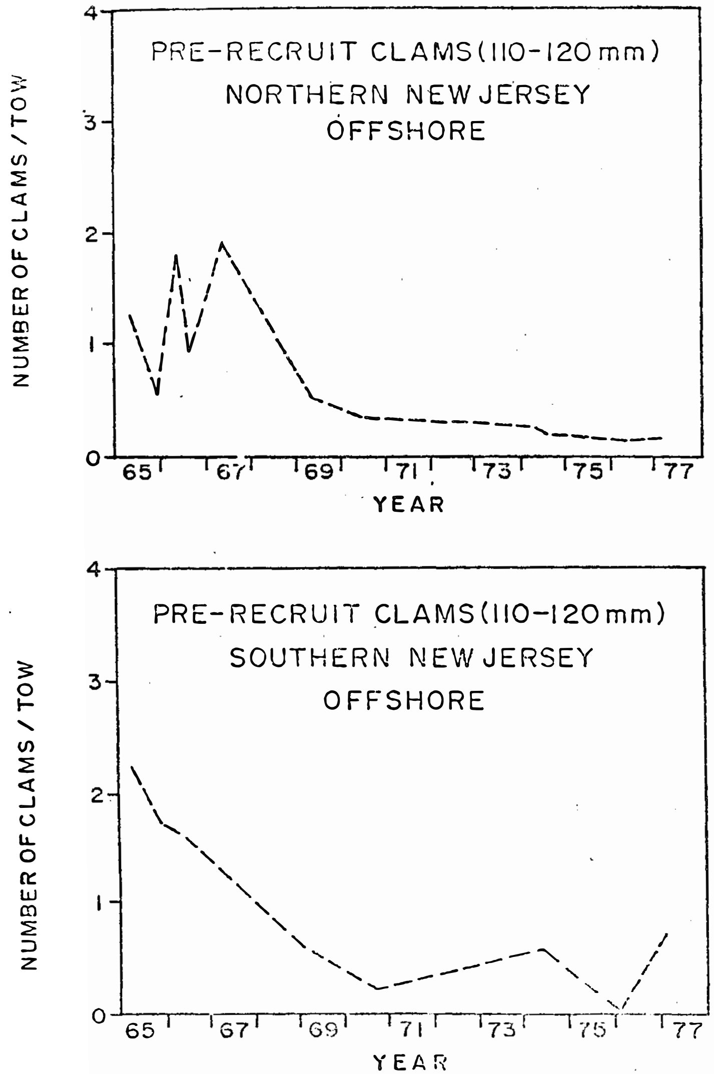
15

Figure 3. Relative abundance of surf clams from NMFS shellfish cruises, 1965-1977, New Jersey (offshore), Delmarva (offshore) (Mean No. per tow and 95% C.I.). (From Brown et. al. 1977).

Table 3. Relative abundance of recruiting surf clams, from NMFS shellfish cruises, 1965-1977 (number per tow). (From Brown, et. al., 1977).

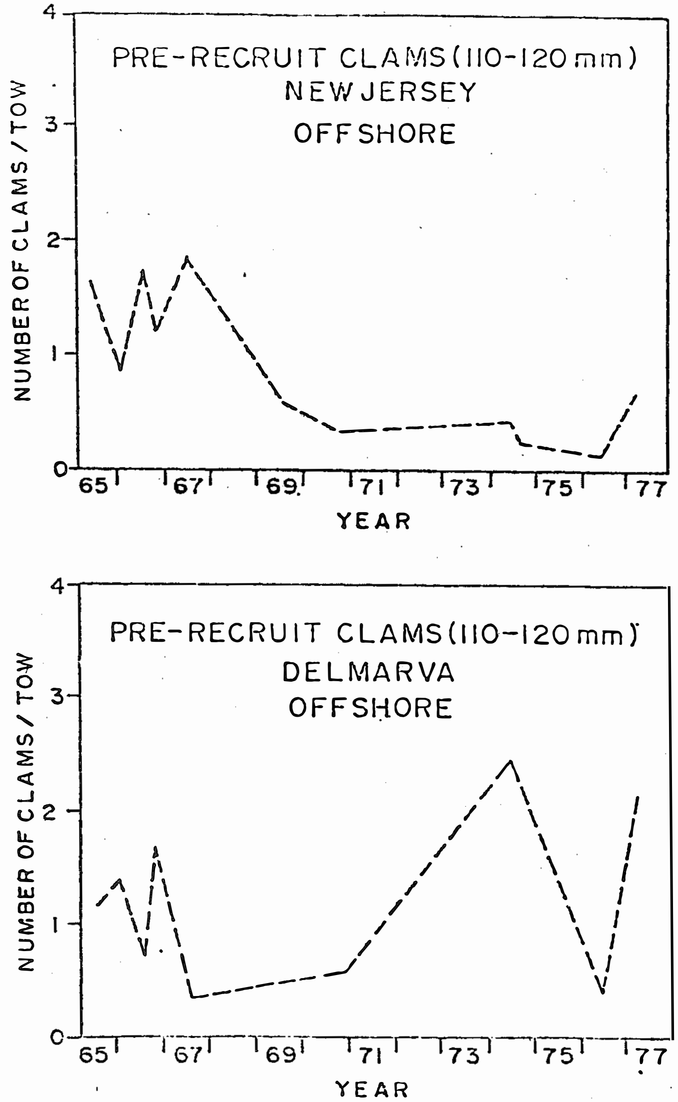
Cruise	Size class (mm)	N NJ (off)	S NJ (off)	NJ (off)	DMV (off)
1965 - Spring	90-100	0.70	2.98	1.56	1.88
	100-110	0.66	1.87	1.12	1.15
	110-120	1.29	2.22	1.64	1.20
1965 - Autumn	90-100	0.36	2.24	0.87	0.84
	100-110	0.66	4.36	1.66	1.33
	110-120	0.57	1.74	0.89	1.40
1966 - Spring	90-100	1.06	-	1.06	0.31
	100-110	1.57	-	1.57	0.77
	110-120	1.79	-	1.79	0.75
1966 - Summer	90-100	1.04	0.48	0.83	1.02
	100-110	0.83	0.36	0.65	1.69
	110-120	0.92	1.57	1.17	1.64
1967 - Spring	90-100	0.47	-	0.47	0.12
	100-110	1.13	-	1.13	0.28
	110-120	1.87	-	1.87	0.38
1969 - Spring	90-100	0.28	0.29	0.28	1.13
	100-110	0.38	0.77	0.51	0.59
	110-120	0.56	0.57	0.56	0.49
1970 - Summer	90-100	0.23	0.00	0.23	0.58
	100-110	0.40	0.28	0.38	0.55
	110-120	0.36	0.28	0.35	0.55
1974 - Spring	90-100	0.36	0.44	0.40	0.87
	100-110	0.26	0.44	0.33	3.45
	110-120	0.26	0.61	0.43	2.48
1974 - Summer	90-100	0.16	-	0.16	-
	100-110	0.22	-	0.22	-
	110-120	0.22	-	0.22	-
1976 - Spring	90-100	0.07	0.00	0.07	0.16
	100-110	0.21	0.00	0.21	0.53
	110-120	0.14	0.00	0.14	0.45
1977 - Winter	90-100	0.06	0.52	0.47	0.74
	100-110	0.25	0.69	0.64	1.63
	110-120	0.19	0.74	0.68	2.11

16



17

Figure 4. Relative abundance of recruiting surf clams from NMFS shellfish cruises, 1965-1977, Northern New Jersey (offshore), Southern New Jersey (offshore) (Mean No. per tow). (From Brown et. al, 1977).



18

Figure 5. Relative abundance of recruiting surf clams from NMFS shellfish cruises, 1965-1966, New Jersey (offshore), Delmarva (offshore) (Mean No. per tow). (From Brown et. al. 1977).

IV-3. Ecological Relationships

Introduction

The ecosystem can be divided into the following fundamental groups which are necessary for the system to continue indefinitely: abiotic (nonliving) substances; autotrophic organisms (primary producers) which are able to use abiotic material to store solar energy in the form of organic matter; and decomposers which break down organic matter, using its stored energy to create inorganic constituents. Most ecosystems also have consumers which convert organic material to another form, using some of the stored energy of the organic material for maintenance. The rate of transfer of material and energy between parts of the ecosystems is affected by the amount, type or condition of biotic and abiotic material (factors) in the system.

Annual Cycle of the Plankton Community

The annual cycle of the plankton community of the region is typical of the temperate zone. During the winter, phytoplankton and zooplankton abundances are low. Nutrients are available, but production is limited by low levels of solar radiation and temperature. As spring approaches and the level of solar radiation increases, an intense diatom bloom occurs. As the bloom progresses, concentrations of inorganic nutrients decrease.

As water temperatures increase during late spring and summer, zooplankton become increasingly abundant because of the more rapid development of early life stages, the spawning of fish and invertebrates and the abundant food supply. Zooplankton feed predominantly but not exclusively on phytoplankton. Fish larvae commonly feed on copepods (Sherman and Honey, 1971; Sherman and Perkins, 1971; Marak, 1960, Marak, 1974; all cited by Cohen, 1975). Some zooplankton, particularly Sagitta and ctenophores, prey upon fish larvae (Lillelund and Lasker, 1971; Theilacker and Lasker, 1974; Bigelow, 1926; all cited by Cohen, 1975).

During summer, zooplankton reaches maximum abundance while phytoplankton declines to a level near the winter minimum. Dinoflagellates and other forms apparently better suited than diatoms to warm, nutrient-poor waters become more abundant during summer. Bacteria in the sediment actively regenerate nutrients, but because of vertical temperature and salinity gradients, the water column is stable and nutrients are not returned to the euphotic zone (where solar radiation and nutrients are "fixed" into organic matter). On Georges Bank, nutrients regenerated by sedimentary bacteria are immediately available to phytoplankton because of mixing. Thus, diatoms dominate throughout the year on Georges Bank (Cohen, 1975).

During autumn, as water temperatures decrease, the water column becomes mixed and nutrients are renewed to the euphotic zone. This stimulates another phytoplankton bloom which is halted by low levels of solar radiation. Phytoplankton and zooplankton levels then decline to their winter minimum while nutrient levels increase to their winter maximum.

Anomalous conditions within the generalized annual cycles described before are probably common. The stability of the water column which affects nutrient availability may be disrupted by severe storms. Anomalies in temperature may disturb the timing between the annual cycles of interacting species.

Nekton

The nekton (swimming organisms as opposed to plankton, which are drifting organisms) is predominantly fish, although there are nektonic mammals (whales and porpoises) and molluscs (squids).

The feeding habits of nekton vary by species, the size of the individual, and probably with season and food availability. Small fish, including the young of some large species, often feed on plankton. There are also some large species (various whales, basking sharks, and ocean sunfish) which are plankton feeders throughout life. Other fish, squid, and small benthic invertebrates, are also common food of nektonic organisms. Maurer's (1975) work indicates that many commercially important species of the northwest Atlantic continental shelf of the United States can be classified as either fish or invertebrate feeders, but such a classification is not likely to be valid for younger individuals of the species.

Nektonic organisms are distinguished from other biotic components of the ecosystem by their ability to distribute themselves over the continental shelf independent of the circulation of the region although some species may use currents for transportation or orientation. This ability to migrate between locations or to maintain a desired location allows individuals of a species to obtain a desired breeding location with some consistency year after year. Such groups are called stocks, and although they may mix with other stocks some of the time they are generally isolated from other members of their species during the breeding season.

Benthos

Benthic organisms are those living on the bottom or within the bottom sediments. They are distinguished from demersal nekton by the latter's ability to move from one location to another by freely swimming in the water column.

Numerous factors determine the distributions and abundances of benthic species. Among the most important factors are the composition of the sediment and the stability of the physical environment associated with water depth.

Except in shallow water where autotrophic macroalgae are common, the primary source of food for benthos is sinking organic matter (phytoplankton, detritus). Among the deposit feeders are polychaetes and some amphipods. There are also benthic predators and scavengers including shrimps, crabs, lobsters, and snails. Ultimately, most of the energy and nutrients stored in organic matter are released by the bacteria of the sediments. There are marine bacteria in the water column also, but these are of lesser importance in the recycling process (Russell-Hunter, 1970).

While benthos is dependent on sinking organic matter for food, many benthic species interact with the plankton and nekton in the water column. These benthic species such as lobsters, sea scallops, and surf clams have planktonic larvae and, therefore, the abundance of their benthic stages depends upon the interaction of their larvae with planktonic and nektonic predators and prey, and upon the transport of their larvae by currents to a suitable benthic environment.

Animals commonly associated with dredge samples of surf clams taken between Long Island and Cape Hatteras are: crabs (Cancer irroratus, Ovalipes, ocellatus, and Libinia); moon snails (Polinices heros and Lunatia duplicata); razor clams (Ensis directus); southern quahog (Mercenaria campechiensis), and various echinoderms of the classes Holothuroidea, Asteroidea, Echinoidea and Ophiuroidea (Yancey and Welch, 1968).

21

IV-4. Estimate of Maximum Sustainable Yield (MSY)

Yield Per Recruit

Yield per recruit (the expected yield in weight from a single recruit) is a function of growth and natural mortality (M) and depends upon the age (size) at first selection and the instantaneous fishing mortality rate (F). For offshore surf clam populations in the Middle Atlantic Bight, Murawski (1977) determined yield per recruit values (grams) for various combinations of length at selection (l_c) and F (M=0.25). Age at recruitment to the exploitable population was assumed to be 2.5 years in these analyses. Three different sets of growth parameters were utilized in the Y/R evaluation due to growth rate differences between the Mid-Atlantic offshore clam population samples (Table 4).

Table 5 presents the yield per recruit results using the growth rate from NMFS samples taken off the Maryland coast. By increasing the length at selection from 3.5 inches to 4.0 inches or to 4.5 inches, the yield per recruit increases by 2 to 11% or 1 to 20%, respectively, as F increases from 0.2 to 0.9 The percent change in Y/R at F_{max} for these same values of l_c are 7 and 15%, respectively. Similar results were obtained in the other two Mid-Atlantic offshore yield per recruit analyses. These are tabulated in Murawski (1977).

Maximum Sustainable Yield*

Brown et al. (1977) documented trends in surf clam landings by area caught for the period 1965 - 1976. Clam landings were prorated to area caught using NMFS commercial surf clam vessel interview data. Areas were considered inshore or offshore for depths less than or greater than 15 meters, respectively. Total catch in each area was derived by multiplying the percent of bushels attributed to each area (from the interview) by the total landings from each port and then summing (Table 20). For certain areas and years, insufficient data were available; these are indicated by omitted values in Table 6. For 1974 - 1976, NMFS Statistical Division personnel prorated catches to inshore and offshore for area of landing. While these data are listed in Table 6. for New Jersey, they are overestimated to the extent that vessels landing in New Jersey fished to the south. Similar 1975-1976 estimates of inside and outside three miles in the Delmarva Peninsula area indicate only a small amount of surf clams was caught within three miles.

Surf clam yields off of Delmarva have averaged 20 million pounds in recent years (this does not include catches from this area landed in New Jersey) Considering that both the survey relative abundance and recruitment

---

* Much of this section is from Brown et al., 1977

22

Table 4. Growth Studies and Associated Population Parameters used in Yield-per-recruit analysis of surf clams.

Growth Curve	L_{∞}(mm) (Shell Length)	W_{∞}(g) (Meat Weight)	t_o(yr)	K	M	t_{λ}(yr)	t_r(yr)
	-------------------	Population Parameter	------------				
NMFS Maryland #2	177.94	223.10	0.4759	0.3726	0.25	14	0.25
NMFS Maryland #1	162.74	174.12	0.1679	0.3270	0.25	15	0.25
Loesch (1975)	147.34	132.13	0.0062	0.3840	0.25	16	0.25

Murawski 1977 Report to the Mid Atlantic Council on Surf Clams

Table 5. Yield-per-recruit (g) for various lengths at selection using the NMFS Maryland #2 Growth Curve.

F	2.0"	2.5"	3.0"	3.5"	4.0"	4.5"	5.0"
	----------	Length at selection	----------				
0.1	17.9	18.2	18.4	18.5	18.3	17.8	16.9
0.2	23.6	24.0	25.5	26.1	26.5	26.3	25.4
0.3	24.9*	26.5	28.0	29.3	30.2	30.6	30.0
0.4	24.5	26.6	28.7	30.5	32.0	32.8	32.6
0.5	23.5	25.9	28.5	30.8	32.8	34.0	34.2
0.6	22.2	25.0	27.9	30.6	33.0	34.7	35.3
0.7	21.0	24.1	27.3	30.3	33.1	35.1	35.9
0.8	19.9	23.1	28.6	29.9	32.9	35.3	36.4
0.9	18.8	22.2	25.9	29.4	32.7	35.3	36.7
1.0	17.9	21.4	25.2	28.9	32.5	35.3	36.9
1.1	17.0	20.6	24.6	28.5	32.2	35.3	37.0
1.2	16.2	20.0	24.0	28.1	32.0	35.2	37.1
1.3	15.5	19.3	23.5	27.7	31.7	35.1	37.2
1.4	14.9	18.8	23.0	27.3	31.5	35.0	37.2
1.5	14.4	18.2	22.6	26.9	31.3	34.9	37.3
1.6	13.8	17.8	22.2	26.6	31.0	34.8	37.3
1.7	13.4	17.3	21.8	26.3	30.8	34.7	37.3
1.8	13.0	16.9	21.5	26.0	30.6	34.6	37.3
1.9	12.6	16.6	21.1	25.8	30.4	34.5	37.2
2.0	12.2	16.2	20.8	25.5	30.3	34.4	37.2

*Underlined values indicate maximum yield per recruit for given size at entry.

Murawski 1977. Report to the Mid Atlantic Council on Surf Clams.

Table 6. Estimated Surf Clam Catch by Area, in Millions of Pounds

Year	Long Island	Northern New Jersey Inshore <15 m	Northern New Jersey Offshore > 15 m	Southern New Jersey Inshore <15 m	Southern New Jersey Offshore > 15 m	New Jersey Inshore < 15 m	New Jersey Offshore > 15 m	Delmarva Inshore <15 m	Delmarva Offshore > 15 m	Va./N. C.
1965	1.5	0.2	32.9	8.1	0.1	8.3	33.0	-	-	-
1966	1.8	0.2	32.4	10.1	-	10.3	32.4	-	-	-
1967	2.3	-	22.6	13.3	2.1	13.3	24.7	-	-	-
1968	3.0	0.1	13.4	7.0	6.6	7.1	20.0	-	-	-
1969	3.4	2.7	14.2	15.9	1.7	18.6	15.9	-	-	-
1970	4.4	-	6.0	25.2	4.0	25.2	10.0	14.4	4.1	-
1971	4.7	-	-	-	-	-	-	3.1	9.3	-
1972	2.7	-	-	-	-	-	-	3.2	11.4	15.2
1973	3.3	-	-	-	-	-	-	2.1	26.1	22.6
*1974	4.0	0.1	3.5	11.6	6.6	11.7	10.1	0.6	19.4	43.6
*1975	4.6	2.2	1.6	26.2	5.0	28.4	6.6	1.2	19.1	24.1
*1976	3.5	1.2	1.4	1.9	19.5	3.1	20.9	2.0	18.4	0.1

* New Jersey catches based on inside 3 miles-outside 3 miles. Values may be high to the extent that New Jersey landings were not caught off New Jersey.

indices have remained stable in this area, yields of about 20 million pounds for the area south of New Jersey could result in a stable fishery for the next few years. This permits a small catch off North Carolina - southern Virginia, which presently sustains a limited fishery. Based on the 1976 survey of the few resources off Long Island, the survey cruise index has also remained stable with surf clam catches of about 3 - 4 million pounds.

The drastic decline in New Jersey catches has parallelled the survey indices. From 1965 to 1967, cruise indices averaged 45 clams per tow with commercial catches of 30 million pounds (Tables 2 and 6). In 1969 to 1970, the catch per tow indices averaged 26 clams and the offshore New Jersey catch 13 million pounds. The survey indices for 1976-1977 averaged 7.8. Adjusting the mortality to be equivalent to the early periods results in catches between 3.9 and 5.2 million pounds. Recruitment indices have been low in recent years (Table 3, Figures 4 and 5), indicating that no recovery would be possible with these catches, but that the population would not decline further. The 1976 oxygen depletion, however, resulted in a significant clam kill in the northern New Jersey area; the relative abundance index declined from 7.8 to 2.5 (Table 2). The overall offshore New Jersey average did not change significantly since a greater number of survey samples were taken from southern New Jersey in an attempt to determine the southern boundary of the clam mortality area. If the northern New Jersey index were weighted equally with the southern one, the equivalent catches would be between 2.8 and 3.7 million pounds. If the survey indices were approximately weighted by area (i.e., twice as much weight given to northern New Jersey), the resulting catch levels would be between 2.3 - 3.0 million pounds. If a good probability of stock build-up is desired, values of catch lower than these would be required.

The New Jersey inshore populations were not thoroughly covered in the research cruise surveys. However, the limited number of inshore stations examined support the conclusion of lower populations and lower numbers of pre-recruits in recent years (Schneider et al., 1977).

In the absence of detailed information on catch per effort in the surf clam fishery and detailed data on growth of clam populations in the Middle Atlantic Bight, estimates of MSY based on stock production cannot be satisfactorily obtained. The average of the commercial surf clam catch from 1960 - 1976, i.e., about 50 million pounds, is a first-approximation estimate of MSY.

Ocean Quahog

Harvest of the ocean quahog populations can potentially alleviate some of the stress on the surf clam industry. Current utilization of ocean quahogs is low compared to the resource potential, but annual harvests will increase as this species gains greater market acceptance.

Results of the 1976 NMFS shellfish assessment cruise indicated a biomass of ocean quahogs of 5.4 billion pounds (meats) from Long Island south to Virginia (Resource Assessment Division, NMFS, 1977). Population abundance was estimated by the area swept method, stratified by quahog density, depth range, and geographical region. Commercial quantities of ocean quahogs exist north of Long Island, but biomass above Long Island including the Gulf of Maine is relatively unknown.

Medium and larger size ocean quahogs (3.5 inches and up) represent 40% of the total biomass south of Long Island, or 2.16 billion pounds. If annual natural mortality is assumed to be 10% (as has been estimated for other shellfish species based on clapper data), the formula given by Gulland (1971) can be used for estimating the sustainable yield for virgin stock exploitation.

$$C_{max} = XMB_o$$

where: C_{max} = annual maximum sustainable yield (MSY)

X = 0.5, based on the Schaefer (1954) yield model

M = instantaneous natural mortality

B_o = virgin biomass available to the gears.

C_{max} (MSY) = (0.5) (0.1) (2.16) = 0.108 billion pounds, or 108 million pounds of meats.

Reports of very old (100 years) ocean quahogs (Dr. Ida Thompson, Princeton University, pers. comm.) imply that natural mortality may be much lower than 10% annually. If the instantaneous rate of natural mortality is 0.014 (which it would be if 25% of the population survived to 100 years old), MSY estimated from Gulland's formula would equal 15 million pounds of meats (Resource Assessment Division, NMFS, 1977).

27

There are indications that there is an additional mortality due to dredging activities on exposed unharvested clams. This mortality is in addition to natural mortality. The presence of high numbers of broken clams in the quahog catch is evidence of a substantial mortality attributable to the dredge. Estimating a 40 - 60% loss from dredge mortality (personal observation)[1] to ensure that the total mortality from fishing is limited to 108 million pounds of ocean quahog meats, the allowable harvest level from the resource should be between 43.2 and 65.8 million pounds for the area south of Long Island.

The presence of very long-lived quahogs and reports that age at maturity is 7 - 8 years, indicate that the preliminary assessment should be treated with caution, since the effects of overfishing could be extremely long lasting. Based on the foregoing and the lack of better scientific information the Council recommends a precautionary level of 30 million pounds until such time as better analyses are available.

[1]Prof. Harold Haskin, Rutgers University

28

I V-5. Probable Future Condition*

Biological Impacts of No Action

No action to limit surf clam catches could result in a continued acceleration in the decline of population abundance for those surf clam populations already exhibiting low abundance and low recruitment (i.e., offshore New Jersey populations. Equally, harvests above the recommended level in those areas now showing stable abundance and recruitment (i.e., Delmarva surf clams) could precipitate future reduction in yield and seriously affect future recruitment.

Landings data for surf clams for the first four months of 1977 show that 16 million pounds of meats were landed from New York to North Carolina. Monthly landings have ranged from 2.5 - 6.7 million pounds and averaged about 4.8 million pounds per month, based on the monthly catch rates. If the average rate were to continue for the remainder of 1977, this would result in a yearly harvest of nearly 60 million pounds of surf clams. If the inshore-offshore distribution of the catch is similar to 1976, then about 82% or 49 million pounds of surf clams will be taken from the offshore beds. If the Delmarva Peninsula population were harvested such that 80% of the total yield came from this area (in 1976, New Jersey and Delmarva contributed about equally to the offshore yield; however, it is likely that more fishing pressure is now directed towards Delmarva populations because of the 1976 New Jersey clam kill), then approximately 39 million pounds of clams would be taken there. This is a 95% increase over the 20 million pound recommended harvest for Delmarva surf clams.

From 1965 - 1967, during the peak years of the New Jersey offshore fishery, research survey cruise indices averaged 45 clams/tow in New Jersey, and total catches taken equalled 90 million pounds (261 million pounds were taken 1958 - 1967 from this area). Currently, the Delmarva survey indices averaged about 30 clams/tow, or approximately two-thirds of the former New Jersey level (Brown et al., 1977). Assuming the Delmarva fishery beds to be roughly equal in area to those of offshore New Jersey, an expected total yield of 175 million pounds exists for the Delmarva surf clam fishery. This compares with the 164 million pounds taken from the Virginia beds from 1972 - 1975 prior to the collapse of that fishery.

* taken from Brown (pers. comm., July, 1977).

Total Landings of Surf Clam (millions of pounds of meat) expected if no management instituted.

YEAR	INSHORE	OFFSHORE	TOTAL
1977	10	49	59
1978	6	42	48
1979	6	42	48
1980	6	10	16
1981	6	5	11
1982	6	5	11

From Brown (pers. comm., July, 1977).

The Delmarva surf clam fishery has already yielded 135 million pounds 1970 - 1976 (108 million offshore and 27 million inshore). The recommended harvest of 20 million pounds would maintain the current stability in this fishery. If an additional projected 19 million pounds were removed in 1977 and continued in subsequent years, the duration of the fishery would probably last no more than 3 - 4 years. If recruitment in the last two years of that period (i.e., beyond the range of the present indices) is poor then the collapse could come as early as two years, whereas catches at the 20 million pound level would allow the fishery to continue for an additional period pending successful recruitment. The effects of this level of removal on subsequent recruitment cannot be precisely determined, but the fishery trends exhibited in the early New Jersey offshore fishery and the recent Virginia fishery suggest that recruitment could be seriously diminished and a fishery collapse imminent.

Any harvest of surf clams in offshore New Jersey beyond the recommended 1 - 2 million pounds during 1977 will further aggravate the precarious status of these populations. Present low recruitment levels imply that the projected 1977 harvest of offshore New Jersey surf clams could eliminate this fishery within a year.

Landings of ocean quahogs totalled 6.9 million pounds (meats) during January-April, 1977. If this intensity of catch continued during the rest of 1977, about 21 million pounds would be harvested. While this value is lower than the recommended harvest quota of 30 million pounds, the possibility of reducing local populations to low abundance levels cannot be discounted. Little is known about ocean quahog biology and productivity and, hence, from a biological perspective a conservative catch level should reduce ecological impact on this species.

External Factors

The occurrence of future biological phenomena unrelated to fishing activities (i.e., anoxic conditions causing mortality) has not been included in the present assessments. Thus, projections on the future yield and stability of both the surf clam and ocean quahog fisheries may need to be subsequently modified to incorporate the biological effects of any detrimental or beneficial external factors.

V DESCRIPTION OF THE HABITAT

Geophysical Setting

Climatic, physiographic, and hydrographic differences distinguish the region from the Gulf of Maine to Cape Hatteras into two areas with the dividing line at Nantucket Shoals off Cape Cod. At Cape Hatteras the continental shelf extends seaward only 20 miles, but widens to about 70 miles off New Jersey and 100 miles off Cape Cod. The Gulf of Maine is a coldwater bight with a deep central basin nearly sealed off from the open Atlantic by Georges and Browns Banks. The bank boundaries fall off sharply into the continental slope.

From Nantucket Shoals to Cape Hatteras the bottom out to about 200 m in depth is chiefly sand interspersed with large pockets of sand-gravel and sand-shell. From a depth of 200 to 2000 m the bottom is a mixture of silt, silty-sand, and clay. Beyond the 2000 m depth, clay predominates over silt as the chief substrate. Surface circulation is generally southwesterly during all seasons, interrupted by coastal indrafting and some reversal of flow at the northern and southern extremities of the area. Water temperatures range from less than 2° C to over 24° C depending upon season and depth. Salinities close to the coast are about 32 °/oo, increase to 34 - 35 °/oo near the edge of the shelf, and exceed 36.5 °/oo along the main flow lines of the Gulf Stream.

Bottom sediments in the northern portion of the region, Nantucket Shoals to the Gulf of Maine and its boundary banks vary from rock to silt. Sediments of the inner coast from Cape Ann to southwestern Nova Scotia are typically rock or rock-gravel. Most of the deeper central Gulf of Maine sediments are some form of silt, and those of Georges and Browns Banks are chiefly sand and sand-gravel, respectively. Circulation within the Gulf of Maine is generally counterclockwise. Chilled Nova Scotian waters enter through the Eastern Channel and move across Browns Bank and slope waters and through the Northeast (Fundian) Channel. Gulf of Maine waters spill out over Georges Bank and through the Great South Channel onto Nantucket Shoals. The anti-cyclonic eddy over Georges Bank that develops in the spring breaks down into westerly and southerly drift by autumn. Water temperatures in this area range from 2° C to 17° C at the surface and over the banks, and 4° C to 9° C at 200 m in the inner Gulf of Maine. Both the southern boundary of Georges Bank and the deep basins of the inner Gulf of Maine are influenced by intrusion of slope waters. Average salinities vary from about 32°/oo to 35 °/oo. The lower salinity values are close to shore, but they vary with depth depending upon the influence of slope water intrusion.

V -1 and V -2. Condition of the habitat and Habitat areas of particular concern

During the summer and early autumn of 1976, oxygen concentrations at bottom were severely depleted, and widespread mortalities of benthic organisms occurred in the section of New York Bight shown in Figure 6. This near-anoxic (and in places anoxic) region of O_2 levels less than 2ppm (parts per million) was located approximately 4 miles (6.5 km) off New Jersey and covered an area about 100 miles (160 km) long and 40 miles (64 km) wide during the most critical phases of the depletion (Sharp, 1976). Normal O_2 levels in this region are greater than 4 ppm.

Investigations to date indicate that this state was probably induced by a combination of meteorological and circulatory conditions in conjunction with a large-scale algal bloom (predominantly of *Ceratium tripos*). Lack of normal seasonal turbulence occasioned by relatively few storms (Hurricane Belle notwithstanding), unusual wind patterns, and above-average surface water temperatures probably all contributed to depletion of the oxygen content of waters beneath the permanent thermocline in this region (Sharp, 1976). It is not known to what degree the routine dumping of wastes (sewage sludge and dredge spoils) in the ocean contributed to the depletion. However, it is reasonable to assume that any effect would have been detrimental (Atkinson, 1976),

The species affected by the anoxia of most commercial importance were surf clam, red hake, lobster and crabs. Finfish were observed to be driven to inshore areas to escape the anoxia, or were trapped in water with concomitant high levels of hydrogen sulfide (Steimle, 1976).

Resultant stress on the region's surf clam population was first observed in early July, 1976. A survey in late July by the NMFS indicated surf clam mortalities ranging from 0 - 56%, compared to expected normal mortalities of about 2%. A later survey in September, 1976, "found that the average mortality had risen to 50% in a 2100 square mile section off New Jersey, generally covering the area from Manasquan Inlet to Avalon and between 3 and 40 miles offshore. It was estimated that this represented a loss of 59,000 metric tons of surf clam meats, thus representing about 25% of the offshore surf clam stocks of New Jersey. Because July is the normal spawning season for surf clams, the impact on future stocks may also be severe. Mortalities were also observed in New Jersey's ocean quahog population... In early August mortalities for this species were less than 1%. Mortalities increased in September to almost 8%, with a high of 40% at some individual stations" (Steimle, 1976).

Reduction in oxygen levels in New York Bight below normal levels has been observed several times in recent history (Atkinson, 1976), although not to levels as low as those observed in summer, 1976. The relative

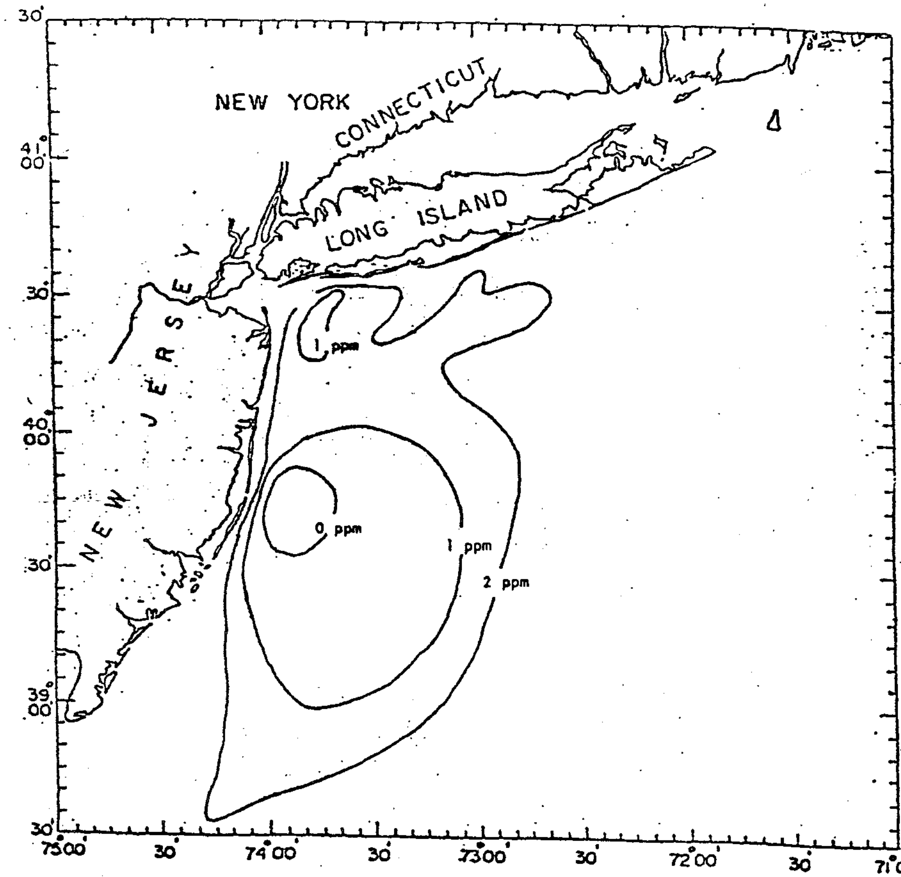


Figure 6. Oxygen concentrations (parts per million) in "fish kill" area of middle Atlantic Bight, summer, 1976 (from Sharp, 1976).

contribution of any of the above mentioned factors to the anoxia cannot yet and may never be fully assessed. However, it is important to note that each of these conditions, by itself, was not a unique, previously unobserved phenomenon.

It is as yet too early to predict the long-term effects of the anoxic condition on any of the affected resources or their habitats. Future surf clam/ocean quahog recruitment may or may not be significantly influenced by the event. However, the 1976 phenomenon points to the vulnerability of the surf clam/ocean quahog habitat. It is doubtful, however, that cessation of ocean dumping alone in the Middle Atlantic Bight will prevent such an event from reoccurring.

VI. FISHERY MANAGEMENT JURISDICTION, LAWS, AND POLICIES

VI-1. Management Institutions

Other than the Fishery Conservation and Management Act of 1976 (P. L. 94-265), no institutions have management authority over surf clams and ocean quahogs throughout their ranges.

VI-2. Treaties or International Agreements

No treaties or international agreements exist relative to surf clams or ocean quahogs.

VI-3. Federal Laws, Regulations, and Policies

The most important federal law relative to the surf clam and ocean quahog fisheries is the Fishery Conservation and Management Act of 1976. This plan was produced pursuant to that statute.

The Water Pollution Control Act, as amended, is important in maintaining the habitat of surf clams and quahogs.

Federal law provides for financial assistance for commercial fisheries. Part 251, Title 50, Code of Federal Regulations sets forth this program as operated by the National Marine Fisheries Service. On July 12, 1977, the National Marine Fisheries Service issued a final rulemaking establishing conditional fisheries status for the surf clam fishery. This means that financial assistance in that fishery will be limited to that which does not significantly increase harvesting capacity.

VI-4. State Laws, Regulations, and Policies

The States of New York and New Jersey have regulations which cover clams in general and, therefore, relate to sea clam in their inshore waters but these are principally concerned with the prohibition of taking clams from polluted waters and time and location limitations on fishing to help enforce these regulations. In 1975, New Jersey enacted regulations to specifically control the inshore harvest of surf clams. These regulations are now in effect and are designed to control the size and total number of clams harvested from their waters while protecting the economic viability of the individual vessels. These regulations were modified and updated in 1976.

VI-5. Local and Other Applicable Laws, Regulations, and Policies

No local or other applicable laws, regulations, and policies relating to the surf clam and ocean quahog fisheries relative to the Fishery Conservation Zone are known to exist. New Jersey levies a tax on surf clams landed at ports within that State.

VII . DESCRIPTION OF FISHING ACTIVITIES

VII -1. History of Exploitation

Overview of the Surf Clam Industry

As early as 1634 it is reported that American Indians roasted surf clams that washed ashore on Virginia beaches. Clams were also used as livestock feed and fertilizer by the early English settlers. The surf clam industry began around 1870 as a New England bait fishery which supplied the groundfish fleet.

Production between the 1870s and 1929 did not exceed 3,000 barrels of salted surf clams per year. In 1929 power boat dredging with scrape type dredges began, and from that date through 1942 landings did not exceed 2 million pounds per year.

Increased demand for food during World War II led to the use of surf clam meats for human consumption. An early constraint to increasing this market was the inability of processors to remove sand from surf clam meats. The development of an effective drum washer in 1943 solved this problem.

Harvesting efficiency was improved with the development of the hydraulic jet cage dredge in 1945. Apparently, most of the surf clam industry entered the field of food processing around 1946. Hand methods of processing surf clams continued until the development of automatic shucking machines in the early 1970s. The machines supplemented hand processing and streamlined the harvesting, processing, and marketing sectors of the industry.

Surf clam harvests in the 1940s began off New York and concentrated in this area from 1945 through 1954. Surf clam meat was much cheaper and more readily obtainable than hard- or soft-shelled clam meat, and surf clam had better consumer acceptance than ocean quahog meat. The major producers of prepared clam products began to utilize surf clam meat exclusively, and the major surf clam processing companies began to increase their own production of prepared clam products.

Of particular significance to the industry was the discovery of extensive and densely populated surf clam beds off the New Jersey coast around 1950. A few surf clams were also landed from beds off Delaware and Maryland during 1951 to 1960, but until 1966 the New Jersey beds provided the resource base for the industry. During this period, slight gear modifications and improvements increased harvesting efficiency and thus clam yield, to a point where daily vessel quotas were imposed by the processing plants whose capacities were limited.

---

*The historical overviews draw on a soon-to-be published (1977) study of the U.S. clam industries by T. Ritchie, University of Delaware.

Overview of the Ocean Quahog Industry

The ocean quahog resource is considered to be large but underutilized. The industry began in Rhode Island around 1943 when the war food program became interested in obtaining additional food and red meat substitutes. After the war, ocean quahog meats were used as inexpensive substitutes for the more expensive hard and soft shelled clam meats, but two major deterents to successful marketing were the darker color and the strong flavor of the meats. After the Rhode Island fishery landed 1.5 million pounds of ocean quahog meats in 1946, the entire industry declined to low levels due to greater production in the surf clam industry.

The industry associated with harvesting and processing the ocean quahog (Arctica islandia) currently has handled only about 1% of the total volume and only about .5% of the total exvessel value of the clams landed during the past ten years in the United States.

There were six vessels engaged in the 1975 fishery which landed 1.3 million pounds of ocean quahog meats valued at $250,000. Significant commercial landings have been made off Rhode Island, more recently off New Jersey in 1976 and 1977.

Recently, harvesting and processing of ocean quahogs has increased. The increase is directly related to the declining availability and increased cost of surf clam meats and to technologic advances that resolved the flavor - color problems. Rhode Island currently has six vessels engaged in fulltime harvesting, and three clam processing plants there utilize ocean quahog meats in prepared clam products. In New Jersey, nine relatively modern surf clam vessels are now engaged in harvesting ocean quahogs and six major clam processing plants there are processing ocean quahogs.

VII -2. Domestic Commercial Fishing Activities

Historical Catch Information - Surf Clam

Table 7 gives the total pounds of meats and the dollar value of surf clam landings by state. This represents the available data on landings since 1950 obtained through the National Marine Fisheries Service Statistical Services Branch, Gloucester, Massachusetts. In most cases these data were originally collected as bushels of clams landed and later converted to pounds using a conversion factor of 17 pounds/bushel.

Some trends are evident from the historical record: the growth of the fishery in the New York and New Jersey area, the shift in effort to the Virginia beds, and the consistent landings in the Delmarva area.

Table 7. SURF CLAM LANDINGS

lbs. of meat in thousands - $ in thousands

	NEW YORK		NEW JERSEY		DELAWARE		MARYLAND		VIRGINIA		NEW ENGLAND		TOTAL	
	#	$	#	$	#	$	#	$	#	$	#	$	#	$
1950	3286	331	4298	416			130	11			28	8	7742	766
1951	4046	422	6420	622			1532	138			22	6	12020	1188
1952	4138	431	7418	802			1089	174			3	1	12648	1408
1953	3345	418	6578	790			2454	204					12377	1412
1954	3360	420	6877	844			1346	168			232	26	11815	1458
1955	2026	253	8278	967			1695	141			23	4	12022	1365
1956	2368	306	11583	1277	2	(1)	1850	173			123	26	15926	1782
1957	1599	220	15224	1867	192	18	934	134			4	1	17953	2240
1958	429	69	12462	1317	780	93	792	93			1	(1)	14464	1572
1959	514	61	20164	1622	1705	170	850	70			2	1	23235	1924
1960	722	85	23448	1546	478	48	420	34			3	(1)	25071	1713
1961	722	65	26697	1693			71	6			12	2	27502	1766
1962	840	76	29830	1917	99	9	75	6			10	2	30854	2010
1963	974	91	37548	2580			64	5					38586	2676
1964	1218	109	36875	2504			38	3			13	3	38144	2619
1965	1505	127	42307	3048			275	22			1	(1)	44088	3197
1966	1840	148	43174	3714			64	6			35	8	45113	3876
1967	2305	190	41589	4051			1149	106			16	5	45059	4352
1968	3008	295	32181	3299			5328	536	17	2	18	5	40552	4137
1969	3431	390	36039	4278	2757	324	7127	894	208	24	13	3	49575	5913
1970	4182	490	39669	4685	8734	935	13681	1475	889	110	163	35	67318	7730
1971	3688	438	28721	3877	7694	1030	7752	981	4507	527	173	37	52535	6890
1972	2713	313	21332	2780	8551	1132	7330	1151	23384	2528	161	37	63471	7941
1973	3319	413	21588	2709	6630	780	7448	1167	43323	4777	17	4	82325	9850
1974	3951	719	22656	2948	5817	770	5426	939	58219	6836	9	2	90078	12214
1975	4580	260	35550	4721	2315	362	5351	1011	39084	5681	16	4	86894	12539
1976	3455	1089	24378	10830	0	0	7135	3829	14064	7545	21		49074	23314

Source: Fishery Statistics of the U.S.

The New Jersey catch peaked in 1966 at 43 million pounds of meats but has steadily declined from this level. As the New Jersey catch declined, the inshore Delmarva and Virginia populations were utilized more heavily. The development of mechanical shucking devices around 1970 eliminated the need for daily restrictions on the harvesting sector; landings rapidly increased as a result.

Surf clam harvesting vessels have usually concentrated their efforts in one productive area until the catch rate declines, and then move on to more productive surf clam grounds. The diminishing availability of the offshore New Jersey surf clam beds and discovery of beds off Virginia resulted in a shifting of effort to Virginia in the early 1970s. As a result, Virginia landings rose from 1.6 million pounds of surf clam meats in 1971 to 58.2 million pounds in 1974. Since 1974, however, Virginia landings have declined 14.1 million pounds of meats in 1976.

Landings of surf clam meats were down approximately 10% in 1975 (from 1974), and would have been considerably lower if approximately 18 million pounds of surf clam meats had not been harvested from inshore New Jersey waters. Surf clam landings in 1976 were about 49 million pounds (44% decrease from 1975). With the significant decrease in total surf clam landings, exvessel values for surf clams have increased from approximately $2.45 per bushel in 1975 to as high as $10-$11 per bushel by the end of 1976.

The basic structure of the industry varies as one goes along the coast from north to south. The New England fishery is a very small fishery. For instance, the output in Rhode Island is hardly enough to support one man. In New Jersey, Delaware, Maryland and Virginia, it is a full-time fishery sustaining large vessels with full-time crews and processing plants with full-time labor forces. As mentioned earlier, the industry tends to move around in search of unutilized concentrations, which is necessitated by overuse of the exploited concentrations which are unregulated. All of the catch is processed, and processors must be guaranteed a constant source of product. This led to formal agreements with harvesters and in some cases the actual purchase of harvest equipment.

At present, the industry is in a period of flux. Vessels moved from Virginia to New Jersey in early 1976. Expected productivity on the northern beds did not materialize, and many have returned to Virginia. Virginia and New Jersey surf clam beds have been under intense fishing pressure now for four years and the signs of overfishing are apparent.

Historical Catch Information - Ocean Quahog

The ocean quahog fishery has traditionally been a fishery operated from Rhode Island ports. The decline in the surf clam has caused some shift of the New Jersey fleet to ocean quahog. This is evident by the tremendous increase in New Jersey landings in 1976.

The surf clam industry has created a strong market demand for prepared clam products. The supply of surf clam meat is decreasing, and the cost of surf clam meat has increased significantly. Processors are increasingly utilizing ocean quahog meats to the extent technically possible in suitably prepared clam products, resulting in the expansion in the usage of ocean quahog resources. Ultimately, the development of this industry is largely a function of the further success of processors being able to substitute quahogs for surf clams in processed food products.

VII -3. Foreign Fishing Activities

The surf clam and ocean quahog fisheries are domestic fisheries only.

VII -4. Interactions between Domestic and Foreign Participants in the Fishery

There are no foreign participants in the fishery.

Table 8. Volume and Value of Ocean Quahog Landings by State in Thousands of Pounds and Thousands of Dollars.

	RHODE ISLAND		NEW JERSEY		TOTAL	
	#	$	#	$	#	$
1974	804	139	0	0	804	139
1975	1,255	239	0	0	1,255	239
1976	1,446	358	4,099	1,237	5,545	1,595

VIII. DESCRIPTION OF ECONOMIC CHARACTERISTICS OF THE FISHERY

VIII-1. Domestic Harvesting Sector

Relative importance of the Surf Clam Harvest in the Principal States

Table 9 presents a summary of the value of surf clam landings for three preincipal surf clam landing states: New Jersey, Maryland, and Virginia. Surf clams have constituted a very significant percentage of the total value of all the landings in these states.

In New Jersey during the late 1960's, the surf clam catches constituted up to 39% of the total value of the state's landing of fish and shellfish. In New Jersey the surf clam catch in 1976 constituted about 30% of the total value of the states landing, up from 24% in 1975. In Maryland and Virginia, the percentages while not as high as New Jersey, have been increasing during the 1970's and in 1976 constituted about 12% of the value of total catch in Maryland and 16% of the value of the catch in Virginia.

Relative Significance of Surf Clam to U.S. Industry

In terms of total volume of clam meats landed annually, the surf clam is the most significant commercial clam industry. The landing of surf clam meats has accounted for 69% of the volume of all clam meats in the U.S., and 25% of the exvessel value during the past 10 years.

Vessel Data

The number of vessels in the surf clam fishery gradually, increased from 68 in 1965 to 104 in 1970. The number of vessels then declined slightly from 1970 to 1975 but since 1975 it is estimated that the fleet increased by about 54 vessels to a present total of 154 vessels. It is believed that by the end of 1977 there will be about 162 vessels in the fishery.

The vessels in the surf clam fleet vary tremendously with respect to their physical characteristics. In 1975 the tonnage per vessel ranged from 9 to 386 tons, with an average of 74 tons. The vessels length ranged from 37 to 155 feet, with an average of 70 feet. The horsepower of the vessels ranged from 60 to 1530, with an average of 265. Crew size ranged from 2 to 5 men, with an average of 3 men. The size of the blade dredge ranged from 34 to 60 inches with an average length of 49 inches (it is known that some vessels now have blades as large as 200 inches). All of these data are summarized in Table 10 Table 11 contains data on the size distribution of these vessels.

43

Table 9.

Relative Value in $1,000 of Surf Clam Landings for the Principal States

Year	New Jersey Total Value	%	Maryland Total Value	%	Virginia Total Value	%
1965	12,000	25	13,000	(1)	27,000	-
1966	10,000	37	14,000	(1)	21,000	-
1967	11,000	37	17,000	(1)	18,000	-
1968	10,000	33	16,000	3	21,000	(1)
1969	11,000	39	18,000	5	18,000	(1)
1970	13,000	36	19,000	8	22,000	(1)
1971	12,000	33	20,000	5	22,000	2
1972	14,000	20	19,000	6	27,000	9
1973	18,000	15	21,000	6	41,000	12
1974	17,000	17	22,000	5	36,000	17
1975	20,000	24	23,000	4	33,000	17
1976	35,000	30	31,000	12	43,000	16

(1) = less than 1% or $1,000, whichever is relevant.

Source: Fisheries Statistics of the United States, 1965 - 1976.

44

Table 10.

Physical characteristics of surf clam vessels

	Length[1] (feet)	Gross Tonnage[1] (gross tons)	Horsepower[1] (hp)	Crew Size[1] (men)	Dredge Blade[1] (inches)	Dredge Blade[2] (inches)
Minimum	37	9	60	2	34	48
Maximum	155	386	1530	5	60	200
Average	70	74	265	3	49	84

1) 1975 Virginia Institute of Marine Sciences data.

2) 1977 Mid Atlantic Fishery Management Council data.

Table 11. Estimated Vessel Distribution by Tonnage Class in the Surf Clam Fishery, 1965- 1977.

YEAR	TOTAL VESSELS	NO. IN CLASS 1 (0-50 tons)	NO. IN CLASS 2 (51-100 tons)	NO. IN CLASS 3 (101+tons)
1965	68	33	33	2
1966	74	34	34	6
1967	91	40	40	11
1968	86	38	42	6
1969	92	32	56	4
1970	104	33	59	12
1971	92	28	46	18
1972	90	29	44	17
1973	93	32	44	17
1974	98	35	46	17
1975	99	35	46	18
1976	122	33	55	34
1977	162 *	38	65	59

* Expected to be actively in fishery by the end of 1977.

In a recent study of the factors affecting the productivity or relative fishery power of the vessels, Mueller (1976) found that the principal factors were the days absent from port and the ratio of the vessels horsepower to the size of the blade in the dredge. All of the vessels in the fishery (approximately 100) were surveyed in 1975 but only 27 responded. Based on results of this sample of 27 vessels, Mueller estimated the relative fishing power of the 1-50, 51-100, and 101+ tonnage class vessels to be 1.0, 1.31, and 3.56 respectively. Visgilio (1973) used similar tonnage class groupings and estimated the relative fishing powers to be 1, 1.63, and 5.8. Irrespective of the specific numbers, the important point is that larger vessels clearly add more effective effort for each additional vessel entering the fishery than the smaller ones. It is estimated that most of the vessels that entered the fishery in 1976 and 1977 would be in the two larger size classes.

The best scientific information available estimates MSY for this fishery at about 50 million pounds. The surf clam fleet harvested in excess of that amount in 1973, 1974, and 1975, before the entry of the additional vessels. Thus, there appears a considerable excess of capital and labor in this fishery.

Vessel Productivity

Table 12 contains data on the number of vessels, total landings, total value of the landings in current and deflated (1967) dollars and the catch per vessel in pounds, current dollars, and deflated dollars.*

A declining trend in the catch per vessel (in pounds) during the 1965 to 1968 period occurred as the New Jersey surf clam beds were being subjected to intensive fishing pressure, prior to the development of the Virginia fishery. As development took place during the early 1970's, the total catch increased even though the number of vessels remained fairly constant. Consequently, increase in the catch per vessel occurred during this period until 1976 when the catch declined by about 44% (compared to 1975) and the number of vessels increased by about 23%. The apparent reason for the decline in catch per vessel resulted from a combination of a decrease in abundance of surf clams on the Virginia beds, and closure of the New Jersey fishery in the summer and fall of 1976. This resulted in an increase in the price per bushel from $2.45 to a high of $10-11. This price increase is believed to be the principal cause for the increase in vessel numbers.

The value of the catch per vessel, both in current and 1967 dollars, generally increased from about 1968 to the present time. Indeed, the deflated value of the catch per vessel was the highest in 1976 (an increase of 42% compared to 1975) despite the fact

*These data are not weighted by the relative fishery powers of the vessel.

Table 12. Some Vessel Productivity Data

Year	No. of Vessels	LANDINGS Pounds (1000)	LANDINGS $Current (1000)	LANDINGS $1967* (1000)	CATCH PER VESSEL Pounds (1000)	CATCH PER VESSEL $Current (1000)	CATCH PER VESSEL $1967 (1000)
1965	68	44,088	3,197	3,383	648	47	50
1966	74	45,113	3,876	3,988	609	52	54
1967	91	45,100	4,246	4,246	495	47	47
1968	86	40,552	4,137	3,970	471	48	46
1969	92	49,575	5,913	5,385	539	64	58
1970	104	67,318	7,730	6,646	647	74	64
1971	92	52,535	6,840	5,680	571	75	62
1972	90	63,471	7,941	6,336	705	88	70
1973	93	82,308	9,850	7,400	885	106	80
1974	98	96,069	12,214	8,269	980	125	85
1975	99	86,894	12,539	7,775	877	127	79
1976	122**	49,074	23,314	13,714	402	191	112

*Deflated by the Consumer Price Index
**Estimated - the time phasing of the entrance of the vessels during 1976 and 1977 is not known with certainty.

Source: Fisheries Statistics of US and personal communications with surf clam industry representatives.

that the catch per vessel (pounds) was the lowest during the entire period (a decline of 54% compared to 1975). Again, the price increase from $2.45 to $11 per bushel accounts for this phenomenon.

Vessel Earnings

There are no published cost-earnings data available at this time for the vessels in the surf clam fishery. An attempt to secure the requisite financial statements was made during the preparation of this document and the review process. Income statements for a number of vessel years were obtained. However, the statements were not all for the same year, nor were they necessarily representative of the various tonnage classes in the fleet. Thus, the data did not lend itself to usual summarization procedures.

Nevertheless utilizing these data, other cost data reported in Visgilio (1973), the estimates of the relative fishing powers presented above by Mueller and Visgilio, and the aggregate landings of the fleet in 1976, it is possible to "construct" a very crude approximation of the average financial performance of the vessels in the fleet.

In the previous section it was indicated that there were about 154 vessels in the surf clam fishery currently. However, it is not known to what extent these new entrants participated in the fishery in 1976. For purposes of this analysis, it is estimated that there were 122 full time vessels in this fishery during 1976. It is further assumed:

1. that the 122 vessels were comprised of 33 vessels from the smallest tonnage class (less than or equal to 50 tons), 55 vessels from the medium tonnage class (51-100 tons), and 34 vessels from the largest tonnage class (101+), and,

2. that the average of Mueller's and Visgilio's estimates of the relative fishing power can be used to forecase the relative catches per vessel in the fleet. The average of the fishing power estimates are 1.0, 1.47, and 4.71.

Before the estimates of the gross earnings are presented utilizing the relative fishing powers, it would be useful perhaps to estimate the gross earnings per vessel if all were homogeneous. In such a case the average gross earnings per vessel would then be simply the total revenue at the vessel level divided by the total number of active vessels. In 1976 the reported total value of the catch was $23,314,000. The total number of assumed active vessels is 122. Therefore, the average gross revenue per vessel would be $191,098. Since this fugure is strictly an average, many boats would be expected to have less earnings and some boats would be expected to perform better than this average.

Since some of these vessels can exert more fishing effort or fishing power during a period of time, it is expected that some of the gross revenues would differ significantly and systematically from the overall fleet average. Above it was indicated that the relative fishing powers of 1.0, 1.47 and 4.71 are assumed for 1976 for the three tonnage classes. Therefore, the expected catch per vessel in each class can be computed by:

1. Sum the total fishing power units as follows:

CLASS	NUMBER OF VESSELS		TOTAL FISHING POWER/VESSEL		TOTAL POWER UNITS/CLASS
I	33	*	1.0	=	33
II	55	*	1.47	=	80.85
III	34	*	4.71	=	160.14

The total power units in the 1976 fleet are then 273.99.

2. Calculate the expected value of the catch per fishing power unit $23,314,000 ÷ 273.99 = $85,091.

3. Calculate the expected catch per vessel. Since the value of the catch per fishing power unit is $85,091 the expected catch per vessel in each class is then:

CLASS	FISHING POWER		CATCH/ POWER UNIT		EXPECTED CATCH/VESSEL
I	1.0	*	$85,091	=	$85,191
II	1.47	*	$85,091	=	$125,083
III	4.71	*	$85,091	=	$400,777

Again, we are aware that these are averages only and that some vessels in the classes earned three times as much as the group average.

However, we are also aware that some vessels fared poorer than these averages. This would be expected. Regrettably, we do not have data in the range for each class on gross revenues.

The value of the 1976 quahog catch must be added to these estimates. The value of the catch was about $1.63 million; assuming half of the Class II vessels and all of the Class III vessels could land quahogs, the additional revenues for Class II and III vessels would be $5,973 and $38,277, respectively.

Using these estimates for gross vessel receipts and the available cost data, it is possible to generate estimates of net income and the fishermen's earnings. These estimates are in Table 13. It is estimated that the vessels have net incomes before taxes of $7,847, 10,955 and 75,900 respectively for Classes I, II and III. The average crew share for the three tonnage classes would have been $11,345, 16,600, and 39,514 respectively. There is no data available to estimate the return on investment.

Harvesting Sector Employment

Assuming 3, 3 and 4 men per crew for size Classes I, II and III respectively, it is estimated that there were about 400 people employed on these vessels in 1976 (a total of 122 vessels assumed).

Table 13. Estimated cost and earnings for 1976 for vessels in the surf clam fishery.

	Class 1 (0-50 tons)	Class 2 (51-100 tons)	Class 3 (101+tons)
Gross Receipts	85,091	131,056	439,054
Less			
Variable Costs			
Wages	34,064	49,801	158,059
Fuel	7,901	14,816	147,471
Supplies	5,105	7,863	26,343
Misc. Taxes	1,702	2,621	8,781
Total Variable	48,744	75,101	240,654
Fixed Costs			
Repairs & Maintenance	6,000	12,000	40,000
Depreciation	7,500	12,500	40,000
Insurance	10,000	14,000	22,500
Interests	4,000	5,000	18,000
Misc.	1,000	1,500	2,000
Total Fixed	28,500	45,000	122,500
Total Cost	77,244	120,101	363,154
New Income Before Taxes	7,847	10,955	75,900
Estimated Crew Size	3	3	3

VIII-2. Domestic Processing Sector

Surf Clam

Overview

Surf clams are processed in the New England, Middle Atlantic, and Chesapeake Bay regions. The Mid-Atlantic region provided 60% of total output in 1973 and 48% in 1974. Production of surf clams in the other two regions is considerably less. In 1973, New England surpassed the Chesapeake's production of processed surf clams by 4% but in 1974 the reverse took place - that is, the Chesapeake surpassed New England's production by 4%.

The total value of production of processed surf clam products in 1973, 1974 and 1975 was 73, 92, and 93 million dollars respectively. These values should not be construed as value-added, for they are based on a great deal of double-counting as will be explained below.

Meat Weight Flow

Processing can be separated into two stages. The first stage consists of shucking and eviscerating the clam with only the muscle retained for final product use. They may then either be canned and shipped for further processing or processed on the spot. In the second stage, the muscle is cut into strips, breaded, cooked and frozen as fried clams or minced for chowders or minced-canned clams.

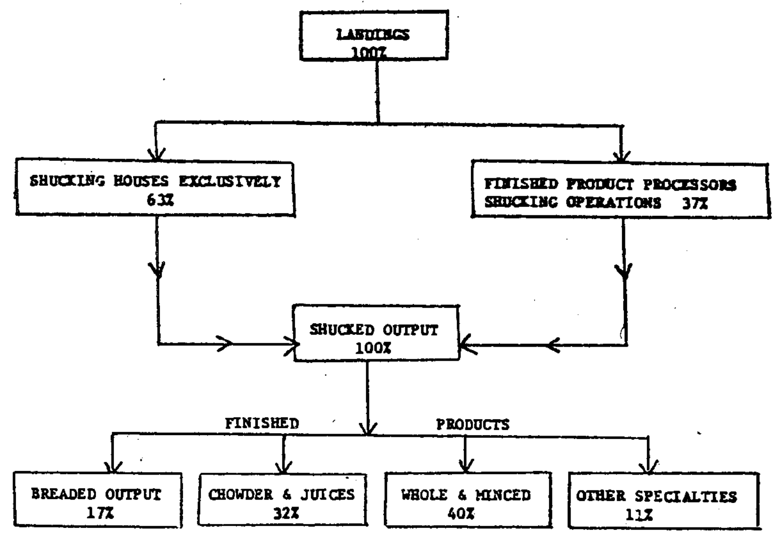
Figure 7 depicts the product flow based on plant production figures for 1975.

In 1975 about 63% of the landings were shucked by plants that produce no products other than shucked surf clam meats. The balance of the landings were shucked by processors who also perform other finishing operations. Some of the output shucked by finished product plants was sold to other plants that only produce finished products.

In terms of final product composition, it is estimated that 40% of the meat landings are in whole and minced canned products, 32% are in chowder and juices, 17% are in breaded products, and 11% of the landings go into other specialty clam items.

It is believed that the larger finished product plants ship their finished products to retail outlet warehouses, while smaller independent processors sell their products through wholesalers to institutional markets. At this time no breakdown is available in terms of final marker distribution.

Figure 7. Meat Weight Flow



Number of Plants and Employees

Table 14 presents data on the number of surf clam processing plants by state for the years 1971 to 1975.

In 1975, 13 of these plants were located in New Jersey, with Maryland and Virginia having 7 plants each. In 1973, 1974 and 1975 there was an average of 4183, 3777 and 4074 people employed in these plants. Since these plants process other products, not all of this employment can be attributable to surf clam production. In 1975, it is esimtated that about 2685 people were involved in the production of surf clam products in these plants. This estimate is based on the value of clam production in each plant compared to its total production.

Table 15 presents an estimate of the distribution of these employees by plant type in 1975. The 47 plants were divided into four categories depending on output:

1. Shucking output only
2. Canned output only
3. Breaded output only
4. Mixed output; i.e., canned, breaded, etc.

Forty percent of the total average employment at the processing level in 1975 was accounted for by the shucking house. This was followed by the mixed products plant (32%), canning plants (23%), and breading plants (5%).

Degree of Dependency on Surf Clam and Concentration of Production

Table 16 presents data describing the degree of specialization or dependency on these plants on surf clam production and the percentage of the total value of processed surf clam products accounted for by the firms in the various groupings. Several things are apparent by the data in Table 16. More than half of the plants are extremely dependent upon surf clam production as evidenced by the fact that 75% or more of their total production are surf clam products.

In short, these plants that account for the vast majority (83%) of the surf clam production were not diversified in 1975 as evidenced by the high percentage of their total production accounted for by surf clams. The implication of this is discussed later in this document with regard to the proposed management measures.

Table 14

Number of Plants by State

YEAR	ME	MA	RI	NY	NJ	PA	DE	MD	VA	TOTAL
1971	1	7	2	5	16	2	3	9	7	52
1972	1	5	1	4	14	2	3	8	8	46
1973	1	6	2	4	15	2	3	7	6	46
1974	1	6	3	4	15	2	3	7	7	48
1975	1	7	3	4	13	2	3	7	7	47

Table 15. Average Clam Employment Distribution by the Plant Type, 1975

	MIXED PRODUCTION PLANTS	CANNING PLANTS	BREADING PLANTS	SHUCKING PLANTS
NUMBER	886	611	124	1064
PERCENT	32%	23%	5%	40%

TOTAL ESTIMATED CLAM PRODUCTION = 2685

5 6

Table 16. Some Data on Plant Specialization and Production Concentration

THE VALUE OF SURF CLAM PRODUCTION IS:

	LESS THAN 25% OF TOTAL PRO-DUCTION	BETWEEN 26%-50% OF TOTAL PRODUCTION	BETWEEN 51%-75% OF TOTAL PRODUCTION	MORE THAN 75% OF TOTAL PRO-DUCTION
PERCENT OF TOTAL FIRMS	13%	17%	15%	55%
PERCENT OF TOTAL VALUE OF SURF CLAM PRODUCTION	6%	6%	5%	83%

5 7

Employment Functions

One area of considerable interest is the relationship between plant production and employment since management policy decisions regarding landings limits obviously impacts on finished product production which in turn has implications for changes in levels of employment.

To address this issue employment functions were estimated for the four different plant types above. Reasonable results were obtained for all plant types except the canning plants. In these plants there is apparently considerable variation in the level of capital stock available and regressions procedures did not yield statistically reliable relationships between production and employment. For the other plant types the results are summarized below.

PLANT TYPE	SHUCKED OUTPUT COEFFICIENT	BREADED OUTPUT COEFFICIENT	CANNED OUTPUT COEFFICIENT	R^2	D-W
Shucking House	.026671* (t=14.371)			.69	1.79
Breading Plants		.021947* (t=5.84)		.83	2.4
Mixed Plant	.04899* (t=5.68)	.01249 (t-1.75)	.0077** (t=1.36)	.77	2.31

*Significant at the 5% level
** Significant at the 10% level

One interprets these results as follows: For the shucking plants the regression coefficient for production is .026671, implying that, on the average, for every change of 37.5 thousand pounds of shucked production or .026671, it is expected that there would be a change in employment of one man.

Ex-Vessel and Wholesale Price Analysis

This section examines those factors that explain variation in the ex-vessel and wholesale prices of clams and clam products.

Table 17 presents the ex-vessel prices of surf clams, and the wholesale prices of hard shucked clams, whole and minced clams, chowders and juices, and breaded clams for the 1966-1976 period. The table also presents the Wholesale Price Index period and the landings of surf clams for the 1966 and 1976 period. While the wholesale prices presented are for all hard clams, in 1975 (which is believed to be typical of the period) surf clams accounted for 88% of the hard shucked volume, 99% of the breaded clam volume, 99% of the whole and minced volume and 67% of the chowders and juices.

58

Table 17. Surf Clam Price Data, 1966-1976

YEAR	EX-VESSEL PRICE ¢/lb	LANDINGS mill lb.	SHUCKED PRICE ¢/lb	WHOLE AND MINCED $/case	CHOWDER AND JUICES $/case	BREADED ¢/lb	WHOLESALE PRICE INDEX
1966	8.6	45.1	30.0	12.35	6.33	106	.99
1967	9.4	45.1	31.0	12.99	6.92	100	1.00
1968	10.2	40.6	30.0	13.23	7.59	81	1.03
1969	11.9	49.6	36.0	16.10	8.02	89	1.07
1970	11.5	67.3	40.0	17.66	8.15	97	1.10
1971	13.1	52.5	38.0	15.45	8.08	100	1.14
1972	12.5	63.5	41.0	13.17	8.32	97	1.19
1973	11.9	82.3	42.0	15.92	9.12	98	1.35
1974	12.7	96.1	42.0	19.10	10.46	104	1.6
1975	14.4	86.9	62.0	19.75	11.5	113	1.75
1976	47.4	49.1	140.0	23.78	13.5	177	1.92

59

An important aspect of any management plan is the determination of the impact that a particular management option would be expected to have on prices. To this end the data in Table 17 were analyzed by tracking prices changes through the system. First the relationship between the ex-vessel price, surf clam landings, and the Wholesale Price Index (used as a surrogate to account for factor cost increases) was estimated. Second, the relationship between this price and the price of shucked meats (the intermediate product) was estimated. Finally, the relationships between the shucked price and the other wholesale price were estimated. A time series of relevant retail prices was not available.

The results of these estimated relationships are outlined in Table 18. The R^2 for the equations indicate that most of the variation in the various prices were explained by variation in the specified independent variable.

The Cochrane-Orcutt (1949) Procedure was used when usage of Ordinary Least Squares resulted in serious autocorrelation problems. The equation for estimating the wholesale price of chowders and juices still suggests that there are autocorrelation problems.

60

Table 18.
SUMMARY OF PRICE ANALYSIS

		REGRESSION COEFFICIENTS FOR						
DEPENDENT VARIABLE	CONSTANT	LANDING	WHOLESALE PRICE INDEX	EX-VESSEL PRICE	SHUCKED PRICE	R^2 (CORRECTED)	D-W	EQUATION ESTIMATION PROCEDURE
Ex-Vessel ¢/lb	-7.63139	-.40749 (t=-4.99)	37.0233 (t=7.776)			.8554	1.0529	Ordinary Least Squares
Shucked Price ¢/lb			7.7864 (t=3.288)	2.61307 (t=15.1383)		.97	2.1342	Ordinary Least Squares
Wholesale Price of Breaded Products ¢/lb	60.3413 (3.344)		4.54073[1] (t=.24)		.771742 (t=8.17)	.93	2.4	Cochrane-Orcutt
Wholesale Price of Chowder & Juices ¢/case	227.33 (t=6.42)		469.1 (t=14.82)		1.37 (t=6.48)	.99	1.33	Cochrane-Orcutt
Wholesale Price of Whole & Minced Clams ¢/case	1.373.43				6.74	.73	1.34	Ordinary Least Squares

[1] It was decided to retain this variable based on an examination of the residuals during the last several years.

61

Ocean Quahog

Current status of the industry

Recently, harvesting and processing of ocean quahogs has increased. The increase is directly related to the declining availability and increased cost of surf clam meats and to technologic advances that have resolved the flavor-color problems. Rhode Island currently has six vessels engaged in fulltime harvesting, and three clam processing plants there utilize ocean quahog meats in prepared clam products. In New Jersey, nine relatively modern surf clam vessels are now engaged in harvesting ocean quahogs and six major clam processing plants there are processing ocean quahogs.

Expected future of the industry

The surf clam industry has created a strong market demand for prepared clam products. The supply of surf clam meats is decreasing, and the cost of surf clam meat has increased significantly. Processors are increasingly utilizing ocean quahog meats to the extent technically possible in suitably prepared clam products, resulting in the expansion in the usage of ocean quahog resources. Ultimately, the development of this industry will largely depend on the further success of processors to substitute quahogs for surf clams in processed food products.

Processing

Ocean quahogs are more difficult to open than surf clams. It is accomplished with pressurized steam in Rhode Island; processors use ovens for opening the shells and report that ocean quahogs require twice as much opening treatment as surf clams. Also, the meat yield (per clam) reported from ocean quahogs by industry representatives is only about half that obtained from surf clams.

Some clam meat processors have managed to eliminate or disguise the strong flavor and aroma associated with ocean quahog meats. The darker meat problem has been partially solved by its use in prepared clam products that do not require light or white meat.

Marketing

The meat of ocean quahog is marketed under the general category of clam meats, and is used as an alternative to the more expensive surf, soft, and hard clam meats which are sometimes marketed in a general way also. In many prepared products, e.g., stuffed clams, Manhattan clam chowders, etc., ocean quahog meat is an acceptable alternative for more expensive and unavailable clam meats. Ocean quahog meat has thus far been found not to be suitable for New England type chowders or fried clam strips due to both color and flavor, although extruded products are being developed. The greatest sales problem exists in developing the meat as a desirable product on its own.

62

VIII-3. International Trade

Data are not available to specifically identify the international trade in surf clams and ocean quahogs.

Table A60 of the Shellfish Market Review and Outlook published by the National Marine Fisheries Service in June, 1977 indicated total imports of all clam species during 1976 was 6.7 million pounds. Total domestic landings of all clam species was 76.9 million pounds, of which 48.4 were surf clams and 5.7 million pounds were ocean quahogs.

IX. DESCRIPTION OF BUSINESSES, MARKETS, AND ORGANIZATIONS ASSOCIATED WITH THE FISHERY

IX-1. Relationship Among Harvesting, Brokering, And Processing Sectors

The information for this analysis is not available.

IX-2. Fishery Cooperatives Or Associations

The information for this analysis is not available.

IX-3. Labor Organizations

The information for this analysis is not available.

IX-4. Foreign Investment

The information for this analysis is not available.

X DESCRIPTION OF SOCIAL AND CULTURAL FRAMEWORK OF DOMESTIC FISHERMEN AND THEIR COMMUNITIES

X-1. Ethnic Character, Family Structure, And Community Organization

This information is currently not available. Relevant information will be gathered for inclusion in updates of this plan.

X-2. Age And Education Profiles Of Fishermen

This information is currently not available. Relevant information will be gathered for inclusion in updates of this plan.

X-3. Employment Opportunities And Unemployment Rates

This information is currently not available. Relevant information will be gathered for inclusion in updates of this plan.

63

X -4. Recreational Fishing

There is no recreational fishery for surf clam or ocean quahog.

X -5. Economic Dependence On Commercial Or Marine Recreational Fishing And Related Activities

This information is currently not available. Relevant information will be gathered for inclusion in updates of this plan.

X -6. Distribution Of Income Within The Fishery Communities

This information is currently not available. Relevant information will be gathered for inclusion in updates of this plan.

XI DETERMINATION OF OPTIMUM YIELD

XI - 1. Specific Management Objectives

The specific short-term management objective of this plan is to maintain the status quo of the two fisheries to the greatest feasible extent until adequate information pertaining to the MSY for surf clams and the entire life cycle of ocean quahogs is obtained.

XI - 2. Description of Alternatives

Alternatives considered but rules out of this plan were: (1) no regulations on either species; (2) increases and decreases in allowable harvest levels; (3) size limits; (4) dredge size restrictions; (5) vessel quotas; and (6) stock certificate program.

Based on available biological information harvest in excess of 1.8 million bushels of surf clams would result in further population declines. If no action were taken and/or larger surf clam quotas established, the resource would become rapidly depleted by the existing 162 vessel fleet. If the average harvest of the past five years, approximately 4.4 million bushels per year, were to continue, the resource would be fished to economic extinction in a few years and existing vessels and processors would be forced out of business or diverted to an alternate fishery. With rapid expansion to the quahog fishery, future over exploitation is a possibility without management controls. (See pages 123-129.)

Establishment of smaller allowable harvest levels would provide better protection for the quahog resource and quicker recovery of the surf clam fishery but at a higher short-term economic cost to those presently in the surf clam and ocean quahog fisheries.

Establishemnt of a minimum size limit on clams was considered but ruled out in favor of a provision to close beds to fishing based on size of clams present. A size limit on clams harvested would have required additional regulations prohibiting sorting on board. Also, because of a reportedly high rate of dredging mortality, any undersized clams caught and discarded would probably die and constitute a waste of the resource. Restricting size of dredge used was considered but discarded since such a restriction would be curtailing efficiency. Assingment of quotas per vessel was evaluated but not imposed because only limited information on previous catch and earnings was available and any vessel allocation at this time would not be fair or equitable.

A stock certificate program, an approach to limited entry, was discussed. A stock certificate program is an approach useful for attempting to insure the efficient production of the allowable harvest in a particular year in a fishery by the allocation of marketable vessel quotas. In the interim the Council has decided to freeze the number of licenses to limit further overcapitalization. The Council has decided that information on which to base an equitable stock certificate program is lacking at present.

XI -3. Analysis Of Beneficial And Adverse Impacts Of Potential Managment Options

Alternative Strategies

There were four alternative strategies that were considered for managing the surf clam and ocean quahog fisheries. These were:

1. Take no action
2. Impose an annual quota on surf clams and ocean quahogs with the surf clam quota to be allocated on a quarterly basis. These quotas are on Table 19, under offshore alternative II, III, and IV for 1978 and beyond.
3. In addition to the provision in (2), impose a four-day fishing week for surf clams.
4. In addition to the provision in (2), impose vessel quotas of 300, 400, and 500 bushels per week for Class I, II, and III vessels, respectively.

Forecasted Total Catches

The difference in strategies (Alternatives II, III, and IV) deals with the resultant distribution of the catches among the vessel classes. Alternatives II, III and IV are variants of an overall strategy of the Regional Council to control the rate of removals from the surf clam and ocean quahog populations. Table 19 presents the forecasted catches of surf clams if no action were taken and if controls were imposed on the surf clam catches. (The same overall rate of removals applies for Alternatives II, III, and IV.). While the Plan only addresses the management of the areas outside of the states territorial waters, these catches are presented in the Table, for they are of obvious importance to the financial performance of the fleet. For 1977, it is assumed that the Plan would only be in effect for the last quarter. The Table presents the catches through 1982 to illustrate the impact of excessive removals during the 1977-79 period on the 1980-82 catches of no action. This is contrasted to the fairly even pattern of production that could prevail during the 1978 to 1982 period if controls were instituted.

The rate of removals of ocean quahogs will largely be a function of their market acceptability. It is assumed that the patterns below will prevail during the 1977 - 1982 period regardless of whether or not there is a plan.

TABLE 19

FORECASTED CATCHES OF SURF CLAMS

(mill lbs)

	ALTERNATIVE I			ALTERNATIVES II, III, and IV		
YEAR	INSHORE	OFFSHORE	TOTAL	INSHORE	OFFSHORE	TOTAL
1977	10	49	59	10	32.5	42.5
1978	6	42	48	6	30.6	36.6
1979	6	42	48	6	30	36
1980	6	10	16	6	28	34
1981	6	5	11	6	28	34
1982	6	5	11	6	28	34

ESTIMATED QUAHOG CATCHES

YEAR	CATCH (mill lb)
1977	18
1978	30
1979	30
1980	40
1981	40
1982	50

Forecasted Exvessel Prices

Surf clam

The exvessel price equation presented in Table 18 was used to forecast the average exvessel prices under these alternatives. It was assumed that the Wholesale Price Index (one of the independent variables) would increase by 10% in 1977 and 7% thereafter through 1982. These forecasts are below. It should be pointed out that some of the values for landings that are used for Alternative I are outside of the range of those landings values used to calculate the equation. Thus there is a possibility of considera le error in the forecasted prices for Alternative I. They would probably be higher.

Year	Alternative I (¢/lb)	Alternatives II, III, and IV (¢/lb)
1977	46.52	53.23
1978	56.12	60.75
1979	58.41	63.28
1980	81.74	74.40
1981	90.44	81.06
1982	97.46	88.09

Generally the prices are lower under Alternative I through 1979 due to the larger catches in the early years. The exvessel price under Alternative I exceeds the prices under the other alternatives for the balance of the period as the catches drop precipitously.

One effect that is not included in the forecasts is the impact of increased quahog landings on surf clam prices. Since the quahog fishery is underutilized, the calculation of cross price flexibilities is not possible at this time. Further forecasting the exvessel price of quahogs involves a great deal of conjecture for the same reason as stated above. It is assumed that the following price pattern will prevail for quahogs for the period, namely an increase of about 7% per year. This assumption was based on discussions with some industry spokesmen.

ESTIMATE QUAHOG EXVESSEL PRICE

YEAR	PRICE (¢/lb)
1977	30.00
1978	32.10
1979	34.34
1980	36.75
1981	39.32
1982	42.03

Estimated total revenues

The above estimated catches and prices imply the following total revenues at the vessel level. All values are in millions of dollars.

Year	Surf Clams Alt. I	Surf Clams Alt. II, III, IV	Quahogs
1977	27.45	22.62	5.40
1978	26.95	22.23	9.63
1979	28.03	22.78	10.30
1980	13.09	25.29	14.70
1981	9.95	27.56	15.73
1982	10.72	29.95	21.03

Again the total revenues for Alternative I are higher for the earlier years until the drastic reduction in catch transpires. The revenues for the 1980-82 period are probably too low for Alternative I due to the bias in the price forecasts stated above.

Estimated Impact On Harvesting Sector

Estimated net revenues

The purpose of this section is to present the estimates of the present value of the net income before taxes for the fleet under the four alternatives and to discuss the distribution of these revenues among the various tonnage classes. To estimate these present values involved the computation of 72 income statements (3 vessel classes * 6 years * four alternatives). The assumptions for the calculations were:

1. The number of vessels by tonnage class for the period are:

	Class I	Class II	Class III
1977	36	62	56
1978-1982	38	65	59

2. That the average of Mueller and Visgilio's relative fishing powers can be used to forecast the distribution of the surf clam catch under Alternatives I and II.
3. That these average relative fishing powers are reduced by 8% for Class II vessels and 30% for Class III vessels with the imposition of a four-day fishing week. The relative advantage of the larger vessels declines as the larger quarterly quotas are assigned to the better weather months. The assumed adjusted fishing powers are:

Class I	Class II	Class III
1.0	1.35	3.3

4. That only half of Class II vessels and all of Class III vessels are capable of harvesting quahogs.
5. That the cost of fuel per bushel is 80¢ in 1977 and increases by 12% per year through 1982.
6. That the cost of repairs and maintenance and insurance increases by 7% per year.
7. That the crew shares are 40%, 38% and 36% of gross revenues for Class I, II, and III, respectively.

Given these assumptions, the data in Table 13, and the forecasted catches and revenues, it is possible to present estimates of the net income before taxes by tonnage class by year for each alternative.

Table 20 presents the estimated net revenues per vessel for the four alternatives. Table 21 presents the estimated net revenues for all the vessels in each class and for the fleet each year. The important point to remember is not the preciseness of a particular

number, but the relative magnitude and direction of the impacts under the four alternatives. Table 22 presents the discounted net revenues for each alternative for each year and for the six year period as a whole.

Several points are important from these t bles:

1. Except for Alternative I, taking no action, all other alternatives evaluated show an increase in net income before taxes when projected through 1982. Alternative I, if pursued, would result in a net loss of $1.603 million dollars over the next six years. Even with an anticipated doubling in price per bushel by 1982 under Alternative I, the loss is expected to occur because of drastically reduced future landings.

2. Alternatives II, III, and IV show increases in net income before taxes of $8.974, $8.801, and $7,268 million dollars, respectively, when projected through 1982. Alternative II, an annual quota of surf clams and ocean quahogs allocated quarterly, yields the maximum amount of net income over the six years, but with the largest share of the income accrued by Class III vessels, those over 100 tons. Adoption of alternative IV, quarterly quotas for each species plus a four-day fishing week and a vessel class limitation of 300, 400, and 500 bushels per week for Class I, II, and III vessels, respectively, will over the six year period increase earnings of vessels in Class I and II but sharply curtail earnings of Class III vessels.

3. Alternative III, while reflecting less net income that Alternative II ($174,000 less by 1982) does provide the greatest degree of equity in distributing income to all classes of vessels.

Table 20. Net Revenues (Loss) Per Vessel Per Year for the Four Alternatives ($)

YEAR	Alternative I CLASS 1	Alternative I CLASS 2	Alternative I CLASS 3	Alternative II CLASS 1	Alternative II CLASS 2	Alternative II CLASS 3	Alternative III CLASS 1	Alternative III CLASS 2	Alternative III CLASS 3	Alternative IV CLASS 1	Alternative IV CLASS 2	Alternative IV CLASS 3
1977	(213)	1976	48,971	(4,643)	(4,896)	25,798	(3647)	(3928)	23,987	(1690)	1,298	19,556
1978	(2,935)	(173)	51,265	(7,423)	(7,096)	28,008	(761)	(647)	15,912	12,376	17,004	(13,636)
1979	(3,562)	(1,122)	50,582	(8,472)	(8,646)	24,608	(1,758)	(2210)	12,804	11,502	15,614	(17,077)
1980	(19,497)	(23,828)	(16,020)	(6,966)	(4,546)	48,404	562	2763	34,814	15,440	22,755	(1,342)
1981	(24,337)	(31,353)	(38,541)	(6,216)	(3,464)	54,822	1924	4405	39,756	18,038	26,065	3,484
1982	(25,174)	(30,892)	(27,120)	(5,509)	(605)	74,199	3296	7984	58,369	20,698	31,378	19,179

72

Table 21. Net Revenues (Loss) Per Vessel Class for the Four Alternatives ($1,000)

YEAR	Alternative I CLASS 1	Alternative I CLASS 2	Alternative I CLASS 3	Alternative I TOTAL	Alternative II CLASS 1	Alternative II CLASS 2	Alternative II CLASS 3	Alternative II TOTAL	Alternative III CLASS 1	Alternative III CLASS 2	Alternative III CLASS 3	Alternative III TOTAL	Alternative IV CLASS 1	Alternative IV CLASS 2	Alternative IV CLASS 3	Alternative IV TOTAL
1977	(77)	123	2742	2788	(167)	(304)	1443	972	(131)	(243)	1343	969	(61)	(80)	1096	955
1978	(112)	(11)	3025	2902	(282)	(461)	1652	909	(29)	(42)	939	868	471	1105	(805)	771
1979	(135)	(73)	2984	2776	(322)	(562)	1452	568	(67)	(144)	755	544	437	1015	(1008)	444
1980	(741)	(1549)	(985)	(3235)	(265)	(295)	2856	2296	21	180	2054	2255	587	1479	(79)	1987
1981	(925)	(2038)	(2273)	(5236)	(236)	(225)	3234	2773	73	286	2346	2705	685	1694	206	2585
1982	(957)	(2008)	(1600)	(4565)	(209)	(39)	4377	4129	125	519	3444	4088	786	2040	1132	3958

73

Table 22. Estimated Present Value of the Net Incomes Before Taxes of the Four Alternatives for the Fleet ($1,000)

PERIOD	YEAR	DISCOUNT FACTOR 8%	ALTERNATIVE I ACTUAL NET	ALTERNATIVE I DISCOUNTED NET	ALTERNATIVE II ACTUAL NET	ALTERNATIVE II DISCOUNTED NET	ALTERNATIVE III ACTUAL NET	ALTERNATIVE III DISCOUNTED NET	ALTERNATIVE IV ACTUAL NET	ALTERNATIVE IV DISCOUNTED NET
0	1977	1.0	2857	2857	972	972	969	969	955	955
1	1978	.926	2902	2687	909	842	868	804	771	714
2	1979	.857	2776	2379	568	487	544	466	444	381
3	1980	.794	(3235)	(2569)	2296	1823	2255	1790	1987	1578
4	1981	.735	(5236)	(3848)	2773	2038	2705	1988	2585	1900
5	1982	.681	(4565)	(3109)	4129	2812	4088	2783	3958	2695
TOTAL PRESENT VALUE OF NET INCOMES				($1603)		$8,974		$8,801		$7,268

74

Estimated Impacts On Processing Sector

There are no data available to estimate the financial impact of the Alternatives on the processing sector. The approach used here is to attempt to estimate the employment impact.

Using the employment functions developed for the plants and the product flows, it is possible to present some forecasts of the impact on employment (Appendix).

It is very difficult to estimate the employment impacts on the processing sector due to the reduced availability of surf clams for a variety of reasons that include:

1. the plants may increase their production of other non-clam products; although the plants that currently process 83% of the clams are very dependent on surf clams.
2. the increase in the utilization of quahogs by some plants.
3. the lack of a significant statistical relationship between employment and production in the canning plants.

Since the quahog catches are assumed to be the same irrespective of if the plan is implemented, the estimates below are related strictly to the changes in employment due to surf clam catches. Since the total surf clam catches are assumed to be the same under Alternatives II, III, and IV, the comparison in employment impacts relates to the imposition of the plan controlling the catches vis-a-vis taking no action.

The forecasts for product production are obviously understated due to the lack of incorporating the quahog catches. The point is, however, that this applies to both major courses of action.

Estimated Impacts

In 1975 the estimated landings were about 86 million pounds of meats. However, the estimated total meat content of all finished products was about 63.4 million pounds of meats or about 74% of landings. This corresponds very closely to the percentage difference between the conversion factor of 17 lbs of meats per bushel that is commonly used and the 13 lbs of meats per bushel that processors say they actually can use. The difference is accounted for by those parts of the clam, such as the gonads, that cannot be used by the processors and represent wastage. This 63.4 million pounds of meats supported the production of the following finished products.

Item	Production (Lbs)
Breaded Products	21,548,000
Chowders and Juices	61,688,000
Whole and Minced Clams	13,537,000
Sauces	4,630,000

Table 23 contains the forecasted catches, usable meats, and the year to year variations in these if no action were taken (Alternative I) and if Alternative II, III, or IV were implemented. Assuming that the meat weight flow in the future is the same in 1975, it is possible to estimate the production of shucked, breaded, and canned production. Table 24 contains estimates of these production forecasts, based only on surf clams, for the 1976 to 1982 period and the year to year changes (Δt-1) if no action Alternative I is taken. Table 25 contains similar estimates if Alternatives II, III, or IV were implemented.

Table 26 contains the estimated changes in employment by plant type by year if no action were taken (Alternative I) and if controls were imposed (Alternatives II, III, and IV). These estimates were obtained by multiplying the year to year changes in production implied by the differing time paths of catches times the relevant employment regression coefficients from page 64. For the specialized canning plants, this reduction was divided by the average output per worker in 1975, namely 96,800 pounds. If it is assumed that the workforce in these

75

plants would change one man for every one unit change in the average product, then the figures calculated above represent the expected total change in employment for each year. It is estimated that (disregarding the impact of quahog production) there would be a reduction in employment between 1977 and 1982 of 1150 persons if no plan were implemented versus a reduction in employment of 458 men if controls are established. This represents a net gain of 692 people employed if the controls are placed on surf clam removals or conversely more than twice as many people would be unemployed in the processing sector if no action is taken compared to controls. Again, all of these estimates ignore the positive impact that quahog landings will have on production. Such estimates are not possible at this time.

Table 21. Forecasted Landings, Usable Meats, and Interyear Variation, 1976-82

YEAR	LANDINGS (mill)	Δt-1	USABLE MEATS	Δt-1	LANDINGS (mill)	Δt-1	USABLE MEATS	Δt-1
1976	49*		36.26		49*		36.26	
1977	59	+10	43.66	+7.4	42.5	-6.5	31.45	-4.81
1978	48	-11	35.52	-8.14	36.6	-5.9	27.08	-4.37
1979	48	0	35.52	0	36	-.6	26.64	-.44
1980	16	-32	11.84	-23.68	34	-2.0	25.16	-1.48
1981	11	-5	8.14	-3.70	34	0	25.16	0
1982	11	0	8.14	0	34	0	25.16	0

*Actual

Table 24. Forecasted Processed Production by Plant Type and Year to Year Change if No Action (Alternative I) is Taken (mill lbs)

YEAR	SHUCKED USABLE MEATS	SPECIALIZED SHUCKING HOUSE PRODUCTION: PRODUCTION	Δt-1	TOT. BREADED PRODUCTION	SPECIALIZED BREADING PLANT PRODUCTION: PRODUCTION	Δt-1	MIXED PLANT PRODUCTION: SHUCKED OUTPUT	Δt-1	BREADED OUTPUT	Δt-1	CANNED OUTPUT	Δt-1	EXCLUSIVE CANNING PLANT PRODUCTION: OUTPUT	Δt-1
1976	36.26	22.84	--	12.33	3.329	--	5.076	—	9.00	--	11.87	—	33.80	—
1977	43.66	27.50	+4.66	14.84	4.006	+.677	6.11	+1.034	10.83	7.83	14.3	+2.43	40.71	+6.91
1978	35.52	22.38	-5.12	12.07	3.258	-.748	4.97	-1.14	8.81	-2.02	11.63	-2.67	33.11	-7.6
1979	35.52	22.38	--	12.07	3.258	—	4.97	—	8.81	--	11.63	--	33.11	--
1980	11.84	7.46	-14.92	4.03	1.088	-2.17	1.66	-3.31	2.94	-5.87	3.88	-7.75	11.03	-22.08
1981	8.14	5.13	-2.33	2.77	.748	-.340	1.14	-.52	2.022	-.92	2.67	-1.21	7.59	-3.44
1982	8.14	5.13	0	2.77	.748	--	1.14	--	2.022	—	2.67	--	7.59	—

79

Table 25. Forecasted Processed Production By Plant Type and Year to Year Changes if the Plan is Implemented (Alternatives II, III, or IV) (mill lbs)

YEAR	SHUCKED USABLE MEATS	SPECIALIZED SHUCKING HOUSE PRODUCTION: PRODUCTION	Δt-1	TOTAL BREADED PRODUCTION	SPECIALIZED BREADING PLANT PRODUCTION: PRODUCTION	Δt-1	MIXED PLANT PRODUCTION: SHUCKED OUTPUT	Δt-1	BREADED OUTPUT	Δt-1	CANNED OUTPUT	Δt-1	EXCLUSIVE CANNING PLANT PRODUCTION: OUTPUT	Δt-1
1976	36.26	22.84	--	12.33	3.329	--	5.076	--	9.00	--	11.87	—	33.80	--
1977	31.45	19.82	-3.02	10.69	2,886	-.443	4.403	-.673	7,804	-1.196	10.30	-1.57	29.32	-4.48
1978	27.08	17.06	-2.76	9.21	2.487	-.399	3.79	-.613	6.723	-1.44	8.86	-1.44	25.24	-4.08
1979	26.64	16.78	-.28	9.06	2.446	-.041	3.730	-.06	6.614	-1.09	8.72	-.14	24.83	-.41
1980	25.16	15.85	-.93	8.55	2.309	-.137	3.522	-.208	6.242	-.372	8.24	-.48	23.45	-1.38
1981	25.16	15.85	--	8.55	2.309	—	3.522	—	6.242	—	8.24	--	23.45	--
1982	25.16	15.85	--	8.55	2.309	—	3.522	—	6.242	—	8.24	--	23.45	--

80

Table 26. Forecasted Changes in Employment by Plant Type

YEAR	SPECIALIZED SHUCKING HOUSES: ALT I	ALT II, III, IV	SPECIALIZED BREADING PLANTS: ALT I	ALT II, III, IV	MIXED PLANTS: ALT I	ALT II, III, IV	SPECIALIZED CANNING PLANTS: ALT I	ALT II, III, IV
1977	+124	-81	+15	-10	+92	-60	+71	-46
1978	-137	-74	-16	-9	-101	-59	-79	-42
1979	0	-7	0	-1	0	-5	0	-4
1980	-398	-25	-48	-3	-294	-18	-228	-14
1981	-62	0	-7	0	-46	0	-36	0
1982	0	0	0	0	0	0	0	0
NET TOTAL	-473	-187	-56	-23	-349	-142	-272	-106

Total Forecasted Reduction if no action is taken = 1150
Total Forecasted Reduction if controls are imposed = 458
Net gain in employment with plan 692

81

Impact on Consumer

A time series of retail prices for the various clam based products are not available nor is a time series on per capita consumption of the various products. Therefore, it is not possible to present any forecasts of future retail prices or per capita consumption nor is it possible to compute the gains or loss occuring at the consumer level as measured by the change in consumer surplus. For example, the Greliches equation is normally used to measure the change in consumer surplus. This formula is:

$\Delta CS = K P_1 Q_1 (1 - \frac{1}{2} NK)$

where

ΔCS = the loss or gain accruing to consumers

P_1 = the (retail) price of the product

Q_1 = the quantity consumer

K = the percentage change in price

N = the absolute elasticity of demand for the product.

Since data is essentially unavailable on these items it is obviously not possible to compute a discounted ΔCS for the two major courses of action for the 1977-1982 period.

However, the equations that were presented in Table 18 can be used to forecast wholesale prices of the principal product group. The extimates of these wholesale prices appear in Tables 27 and 28 for the uncontrolled and controlled strategies. As would be expected, the

wholesale prices for the uncontrolled scenario are lower than under controls until 1980 when the catches drop dramatically and the price paths cross as fairly even production is maintained in the controlled scenario. As was stated under the ex-vessel price section, the forecasts have two sources of error in them:

(1) The forecasts for the uncontrolled scenario for the 1980-1982 are probably too low as the forecasted catches are well outside of the historical range used to compute the price equations, and

(2) Neither price series builds in the cross price effects of increases in the landings of quahogs.

Table 27 Forecasted Prices if no Action is Taken

Year	W&M Wholesale ($/case)	C&J Wholesale ($/case)	Breaded Wholesale ($/lbs)
1977	$23.04	$14.35	$1.76
1978	24.80	15.41	1.97
1979	25.29	16.32	2.03
1980	29.49	18.09	2.53
1981	31.12	19.32	2.72
1982	32.45	20.52	2.88

84

FORECASTED WHOLESALE AND RETAIL PRICES

WITH CONTROLS
(Alternatives II, III, & IV)

Year	Breaded Wholesale ($/case)	Chowder & Juices Wholesale ($/case)	W&M Wholesale Retail ($/case)
1977	$1.90	$14.62	$24.21
1978	2.07	15.59	25.61
1979	2.14	16.51	26.15
1980	2.38	17.80	28.20
1981	2.53	18.93	29.46
1982	2.69	20.13	30.80

Table 28

85

In summary, consumers could be "better off" price-wise for the 1977-1979 period if controls were not imposed, but the situation would reverse itself for the 1980 and beyond period. How much they would be better or worse off cannot be precisely quantified at this time.

XI -4. Tradeoffs Between Beneficial And Adverse Impacts Of The Preferred Management Option

From the previous analysis it is clear that for the 1977-1982 period:

1) Net income at the vessel level is considerabley larger if controls on the rate of removals of surf clams are imposed.

2) While the maximum discounted net income would probably be achieved under an annual and quarterly quota, the imposition of the four-day week in addition to these reduces the discounted net income slightly, but lessens the impact on two smaller vessel classes considerably. The reduction in earnings to the larger class is not severe.

3) The reduction in employment will be minimized in the processing sector if controls are imposed.

4) In the long run, consumer prices will be lower if controls are imposed.

Thus, the Council recommends that to maintain a viable industry and promote efficiency and equity that Alternative III be implemented.

XI -5. Specification Of Optimum Yield

P.L. 94-265 defines optimum yield as that yield "A) which will provide greatest overall benefit to the nation, with particular reference to food production and recreational opportunities; and B) which is prescribed on the basis of the maximum sustainable yield from such fishery as modified by any relevant economic social or ecological factor" (Section 3(18)). We must start with the best estimate on maximum sustainable yield from each fishery from the available data and then determine optimum yield by applying various social, economic and ecological factors in a somewhat subjective manner. The projected US capacity has been determined from historical catch data and knowledge of the conditions of the industry. Table 29 provides a summary of the results of this analysis, described in detail below. The process of determining optimum yield, and its application to fishery management under P.L. 94-265, is shown in Figure 8. As shown in Table 29, the Total Allowable Level of Foreign Fishing is 0 for both the surf clam and ocean quahog fisheries.

Surf Clam

As indicated in Status of the Fisheries, the surf clam population is declining. It is estimated that 50 million pounds could be harvested annually if the populations were allowed to rebuild to their maximum level. Under current conditions, stock levels could not sustain the 49 million pound harvest in 1976 without a further decrease in population size. Significant anoxic water conditions off New Jersey during the summer of 1976 resulted in a clam mortality of 59 thousand metric tons. This represents 25% of the total population offshore of New Jersey (Steimle, 1976). The Mid Atlantic Fishery Management Council has considered various quota levels to counteract excessive fishing mortality and adverse environmental conditions. The analysis presented above indicates that the total harvest for 1977 should be limited to as low a level as possible to permit stabilization of the populations as soon as possible. However, industry spokesmen have indicated that low harvest levels could inflict economic hardship on those individuals involved in the harvesting and processing sectors, unless there were alternative species available. The usage of the ocean quahog as an alternative species, while increasing, must be generally considered as a limited substitute for the surf clam and may not be physically accessible to the vessels less than 50 gross tons. Thus, drastic cutbacks in the surf clam harvest, while it may be in the best long-term interest of the populations and the industry, could result in substantially reduced earnings for some segments of the industry. Thus a quota of 30 million pounds of meats from the Conservation Zone is recommended for each of the two twelve month periods following adoption of the plan by the Secretary.

Ocean Quahog

Maximum sustainable yield is estimated to be 108 million pounds of meat or approximately 10.8 million bushels of clams. The area below Long Island, New York, has reportedly the greatest biomass of quahogs. The biomass above Long Island to the Gulf of Maine, including Georges Bank, is relatively unknown.

A precautionary optimum yield of 30 million pounds, or 3.0 million bushels, has been recommended because of the preliminary nature of biomass estimates, uncertainity of age to maturity, life cycle, and natural mortality rates, and on observations of substantial dredge mortality to uncaught clams.

Table 29. Summary of Commercial MSY, OY and U.S. Capacity[1]

Species	MSY	OY	U.S. Capacity	Total Allowable Level of Foreign Fishing
Surf Clams	23,000 M.T. 50 Mil. lbs. 2.9 Mil. bu.	14,000 M.T. 30 Mil. lbs. 1.8 Mil. bu.	67,000 M.T.	0 M.T.
Ocean Quahogs	49,000 M.T. 43 Mil. lbs. 19.8 Mil. bu.	14,000 M.T. 30 Mil. lbs. 3.0 Mil. bu.	54,000 M.T.	0 M.T.

[1]See pages 31-33.

The U. S. capacity for surf clams was derived from assuming that all 154 vessels presently in the fishery would be capable of harvesting the maximum catch per vessel recorded during the 1965-76 period, namely 980,000 pounds per vessel, if the resource were available and price-cost conditions for this level of harvest are favorable. Capacity estimates for ocean quahog were derived by assuming that 87 vessels (all of Class III and half of those in Class II) can and will harvest the resource at the same relative fishing powers but at a reduced level of effort (see pages 53 and 55).

The fishing capacity (assuming maximum product storage) of the surf clam/ocean quahog fleet is large and a real potential of further overharvesting of the resource is possible without immediate control. Harvest of surf clams through July, 1977 amounted to 1.9 million bushels of clams which exceeds the conservation limit established for a full year in the plan. The 154 vessels in the fisheries have the accumulative theoretical capability , assuming all vessels fished at the same time, of harvesting 117,000 bushels of clams per day. This calculation is based on fishing power of the fleet (page 76 of the plan) and assumes a Class I vessel, those under 50 tons, catch 300 bushels per day. This assumption is supported by the fact of known catches by Class III vessels of 1800 to 2100 bu./day. In support of the emergency regulations (including the moratorium) note that the fishing capacity of the existing fleet is such that the entire quota for the next year could be harvested in 15 days; the quarterly quota of 350,000 bushels recommended in the plan for October through December could be caught in 3 days.

There are other indications of surplus harvesting capacity in the surf clam fishery. There has been a rapid increase in the size of the fleet (see page 51), particularly in the largest vessel class. The economic impact of additional vessels is significant. For example, if only 5 additional Class III vessels are added to the fleet in 1978 the impacts are a decline in Class I per vessel net income from $-761 to $-2231, a decline in Class II per vessel net income from $-647 to $-3110, and a decline in Class III per vessel net income from $15912 to $7959. There analyses were developed using the methodology shown on pages 76 and 77. The 1978 incomes are shown under Alternative III on Table 20, page 78. An excessive number of vessels could create unemployment and related socioeconomic problems and could damage the surf clam beds. Data adequate to develop a limited entry system (or to objectively evaluate whether one is needed in light of the other provisions of this plan) are lacking. It is, therefore, proposed that a moratorium on new entrants into the surf clam fishery be imposed for one year to promote socioeconomic stability. This will provide an opportunity to evaluate the provisions of the plan and the data to be generated through logbooks and other reports. At the end of the year, the moratorium can be extended, be lifted, or be replaced with another means of limiting entry as warranted. Vessels desiring to harvest new beds of surf clams discovered north of the 41st parallel will not be covered by the moratorium. However, entry into that fishery cannot be used as the basis for requesting a waiver of the moratorium to enter the surf clam fishery south of that line.

It is further recommended that emergency regulations be promulgated to prevent new entrants at a greatly accelerated rate prior to the plan adoption and to prevent the possibility of excessive stockpiling of clams and clam products.

The FCMA and its implementing regulations contain several principles and criteria which must be taken into account when an FMP recommends a limited entry system such as a temporary moratorium. Section 301(a)(4) of the FCMA requires that:

88

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

A. The Council believes that the one-year moratorium is fair and equitable because present investment in the fishery is essentially protected against further capitalization and because a vessel belonging to a person who has not previously participated in the surf clam fishery may be exempted from the moratorium and allowed to enter the fishery, if the owner demonstrated that denial of entry into the fishery would cause substantial economic hardship to a person who was a participant in the fishery in the year immediately preceeding the date of approval of this FMP. The Council recognizes that the moratorium cannot permanently "close the door" on new entrants, and intends in the next year to re-assess the need for an alternate limited entry system, such as a stock certificate program, which affords more opportunity to enter the surf clam fishery to persons and/or vessels which have not previously participated.

There is a relationship between limited entry and conservation of fishery resources. Limiting entry will facilitate calculation of the quotas, since there will be less likelihood of the quota being exceeded (because of greater fishing power) before NMFS can close the season. If more vessels were fishing, the reporting system might be inadequate to give the resource managers timely information about whether the season should be closed. Possbily the barring of new entrants will protect the economic return of the present participants, so they would have less incentive to falsify catch reports or otherwise disobey the management regulations. Enforcement of the regulations will be simplified by not having to deal with numerous new entrants.

The moratorium also will help to stabilize the long term economic/resource aspects of this fishery, and will help to provide a greater range of resource management options in the future.

C. The moratorium proposed in this plan does not, in the Council's view, give any particular individual, corporation, or other entity an excessive share of fishing privileges.

The moratorium will help the smaller vessels remain competitive in the fishery (since future entrants can be expected to be larger vessels with significantly greater fishing power), and will tend to stabilize and protect the investments of the participants. The Council recognizes that various economic factors (e.g., reduced catches, idle days, outstanding bank notes) probably will cause some vessels in each class to leave the fishery. The remaining vessels will have a more secure economic future, but this effect probably would occur regardless of the moratorium.

Section 303(b)(6) provides that an FMP may:

"establish a system for limiting access to the fishery in order to achieve optimum yield if, in developing such system, the Council and the Secretary take into account —

89

(A) present participation in the fishery,
(B) historical fishing practices in, and dependence on, the fishery,
(C) the economics of the fishery,
(D) the capability of fishing vessels used in the fishery to engage in ther fisheries,
(E) the cultural and social framework relevant to the fishery, and
(F) any other relevant considerations;"

A. Present participation in the fishery is discussed at pp. 48-69.

B. Historical fishing practices in, and dependence on, the fishery are presented on pp. 42-46.

C. The present and projected economics of the fishery are presented at pp. 72-94.

D. Many of the larget (Classes II and III) vessels can readily convert to the ocean quahog fishery, because the gear required for harvesting surf calms and ocean quahogs is virtually identical. The low surf clam quota should provide an incentive to some surf clam vessels to more to the quahog fishery.

The one-year moratorium, unlike other types of limited entry, does not exclude any present participant from further surf clam fishing, so no vessel will be forced by the moratorium itself to convert to another fishery. However, vessels in this fishery could be converted to many other fisheries such as scallops and squid, although it may be necessary and expensive to rerig the vessel before it can do so.

E. The relevant cultural and social factors in the surf clam fishery stem from the facts that many of the vessels traditionally dependent on the fishery are samller, older, and owned and operated by individual fishermen. Many families of owners and crew are of course dependent as well. Processing plant employees and other clam-related on-shore jobs may number as many as seven for each job aboard the clam boats, according to testimony at the public hearings held by the Council. The moratorium is deemed necessary in order to prevent further over-capitalization and further over-fishing which could result in the virtual collapse of the resource and the entire industry. The moratorium attempts to preserve the present resource and economic status quo, and attempts to avert a forecasted failure of the stocks and associated economic chaos, unemployment, idle capital, and social disruption (particularly in certain ports, where income generated by the clam industry has direct and secondary economic effects that are not fullt quantified but are believed to be significant).

F. Other relevant considerations which influence the Council to recommend a one-year moratorium include the frustration of State-Federal-industry efforts to devise a rational, effective management system over the years; the inability of States to coordinate their efforts to control fishing effort; and the declaration by NMFS that the surf clam fishery is now a "conditional" fishery, so NMFS will no longer issue financial guarantees for new vessels adding capacity to the fishery.

The Council thus believes that the moratorium will be an important component of the regulatory package required to achieve the optimum yield in the surf clam and ocean quahog fisheries. One of the considerations in determining optimum yield in this Plan is the aviodance of serious economic dislocation in the fishery. The moratorium will ease the pressure on surf clammers, particularly those with the smallest vessels, to compete with additional, possibly more efficient, vessels in taking the quarterly quotas. A one-year moratorium protects existing financial investments and discourages additional capitalization by investors responding incorrectly to scarcity of surf clams and increased prices.

90

In addition to the legal criteria addressed above, 50 CFR Section 602.3 (b)(13)(vi) provides that:

"Any plan containing a limited entry system shall also discuss why other management techniques are inadequate for conservation and management of the fishery."

The Council has determined that the one-year moratorium provision is necessary for the conservation and management of the fishery in order to maintain the social-cultural-economic aspects of the fishery during a period of resource and economic crisis. The moratorium is necessary to manage this common-property resource where investors have responded, and may still respond if no moratorium is imposed, to increased surf clam prices (caused by a reduced supply) by overallocating capital to this fishery. See article by G. R. Munro in "Economic Impacts of Extended Fisheries Jurisdiction," Lee G. Anderson, editor (1977). This is exactly what happened in the surf clam fishery in the last several years. It may still be viewed as profitable for fishermen to begin surf clamming, despite the quotas and the four-day work week. Without a moratorium, economic pressure in the fishery might intensify, and resource and social problems would follow.

The moratorium will provide a "breathing space" to allow economic stabilization to proceed, thereby helping to assure a long-term food supply from this resource, helping to aviod a resource collapse in the next few years, and helping to maximize the number of resource management options which would be available in the future.

91

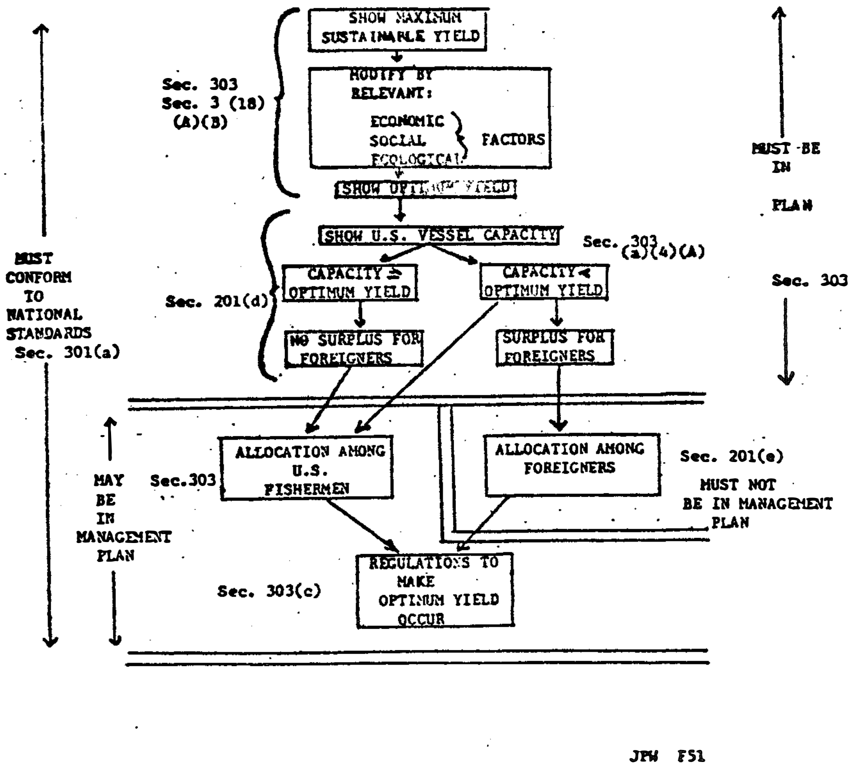


Figure 8. Anatomy of Management Under Public Law 94-265

DRAFT

XII MEASURES, REQUIREMENTS, CONDITIONS OR RESTRICTIONS SPECIFIED TO ATTAIN MANAGEMENT OBJECTIVES

THE PROPOSED REGULATIONS CITED BELOW ARE RECOMMENDED BY THE MID ATLANTIC COUNCIL FOR IMPLEMENTATION OF THIS PLAN BY SECRETARY OF COMMERCE UNDER SEC. 305 OF P.L. 94-265. THEY SHOULD BE REVIEWED AS PRELIMINARY AND SUBJECT TO POSSIBLE MODIFICATIONS BY THE SECRETARY.

Effective Date

The regulations in this section shall be effective at 12:01 A.M. on the day following publication of these regulations in the Federal Register.

Purpose

Regulations of this section shall apply to domestic fishermen who take surf clams (Spisula solidissima) or ocean quahogs (Artica islandica) in that portion of the Atlantic Ocean in which the United States exercises exclusive fishery management authority between the U.S./Canadian border on the north and the southern limit of the range of surf clams or ocean quahogs on the south except as otherwise may be specified.

Definitions

Act - means the Fishery Conservation and Management Act of 1976, Pub. L. 94-265 16 U.S.C. 1801-1882.

Authorized Official - means:

(a) Any commissioned, warrant or petty officer of the Coast Guard,
(b) Any enforcement agent of the National Marine Fisheries Service,
(c) Any officer designated by the head of any Federal or State agency which has entered into an agreement with the Secretary or the Commandant of the Coast Guard to enforce the provisions of the Act; or
(d) Any Coast Guard personnel accompanying and acting under the direction of any person described in subparagraph (a) of this paragraph.

Closed Season - means that time during which species shall not be taken and retained.

Directed Fishing - means the primary species fished for.

Director - means the Director, National Marine Fisheries Service or his designee.

Domestic Fisherman - means a person fishing from a vessel of the United States.

Fish - means finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals, birds and highly migratory species.

Fishery Conservation Zone (FCZ) - means the zone contiguous to the territorial sea of the United States, the inner boundary of which is a line coterminous with the seaward boundary of each of the coastal states and the outer boundary of which is a line drawn in such a manner that each point on it is 200 nautical miles from the baseline from which the territorial sea is measured.

Fishing - means

(a) The catching, taking or harvesting of fish;
(b) The attempted catching, taking or harvesting of fish;
(c) Any other activity which can reasonably be expected to result in the catching, taking or harvesting of fish or;
(d) Any operations at sea in support of, or in preparation for, any activity described in subparagraphs (a) through (c).

The term "fishing" does not include any scientific research activity which is conducted by a scientific research vessel.

Fishing Vessel - means any vessel, boat, ship, or other craft which is used for, equipped to be used for, or of a type which is normally used for:

(a) Fishing; or
(b) Aiding or assisting one or more vessels at sea in the performance of any activity relating to fishing, including, but not limited to, preparation, supply, storage, refrigeration, transportation, or processing.

Foreign Fishing - means fishing by a vessel other than a vessel of the United States.

Foreign Fishing Vessel - means any vessel other than a vessel of the United States.

Open Season - means that time during which species may lawfully be harvested taken and retained on board a fishing vessel.

Regional Director - means the Regional Director, Northeast Region, National Marine Fisheries Service, Federal Building, 14 Elm Street, Gloucester, Massachusetts 01930. Telephone: 617-281-3600.

Secretary - means the Secretary of Commerce or a designee.

Trip - means a departure from port, transit to the fishing grounds; fishing, including any by-catch fishing; and discharge of any part of the catch on board.

Vessel of the United States - means any vessel documented under the laws of the United States or registered under the laws of any State.

Foreign Fishing

Fishing by any vessel other than a vessel of the United States for surf clams or ocean quahogs is prohibited.

Restrictions

(a) No person shall take and retain on board any surf clam or ocean quahog.

(1) during closed seasons, or
(2) in closed areas as specified in these regulations;

or

(3) on days of the week in which fishing for surf clams is not permitted.

(b) No person shall possess, have custody of or control of, ship, transport, offer for sale, sell, purchase, import, export, or land, any surf clam, ocean quahog, or part thereof, which was taken in violation of the Act, these regulations, or any other regulations issued under the Act.

(c) No person shall:

(1) refuse to permit an authorized officer to board a fishing vessel subject to such person's control for purposes of conducting any search or inspection in connection with the enforcement of this Act, these regulations, or any other regulations issued under the Act.

(2) Forcibly assault, resist, oppose, impede, intimidate or interfere with any authorized officer in the conduct of any search or inspection described in sub paragraph (1) of this paragraph.

(3) Resist a lawful arrest for any act prohibited by these regulations; or

(4) Interfere with, delay, or prevent, by any means, the apprehension or arrest of another person knowing that such other person has committed any act prohibited by these regulations.

Penalties

Any person or vessel found to be in violation of these regulations may be subject to the civil and criminal penalty provisions and forfeiture provisions prescribed in the Act or other applicable Federal law.

In addition, the following unlawful acts shall result in an automatic revocation of any permits held by the violator or violating vessel:

(1) Falsification of reports and records.
(2) Failure to submit required reports and records.
(3) Fishing in a closed area.
(4) Fishing at times other than those authorized by the Secretary.

Emergency Regulations

The Secretary may issue emergency regulations, if and when needed, under Section 305 (e) of the Act, announced by publication of a notice in the Federal Register.-

Other Regulations

The Director may issue such regulations as may be necessary for conservation and management of the surf clam and ocean quahog fishery, if such regulations are consistent with the management objectives of the Fishery Management Plan and with the consent of the Mid Atlantic Fishery Management Council.

Catch Quotas

(a) Catch quotas for the period from October 1, 1977 to September 30, 1979, for licensed vessels of the United States fishing for surf clams are allocated by quarterly periods, as follows:

(1) Surf Clams

	Bushels
October 1, 1977 to December 30, 1977	350,000
January 1, 1978 to March 31, 1978	350,000
April 1, 1978 to June 30, 1978	550,000
July 1, 1978 to September 30, 1978	550,000
October 1, 1978 to December 30, 1978	350,000
January 1, 1979 to March 30, 1979	350,000
April 1, 1979 to June 30, 1979	550,000
July 1, 1979 to September 30, 1979	550,000

(2) Ocean Quahogs

Annual Quota: 3,000,000

(b) If the actual catch in any quarter falls more than 5,000 bushels short of the specified quarterly allocation for surf clams (or exceeds the specified quarterly allocation by more than 5,000 bushels) the amount of the shortfall (excess) shall be added to (subtracted from) the next succeeding quarterly allocation.

(c) The Director may under paragraph (b) above, adjust the quarterly allocation of surf clams by publication of a notice in the Federal Register. The Director may also establish quarterly allocations for ocean quahog if future need arises.

Effort Restrictions

(a) Surf Clams

(1) Fishing for surf clams shall be permitted only four days per week, from 12:01 A.M. Monday to 11:59 P.M. Thursday.

(2) When 50% or more of the quarterly allocation of surf clams has been caught, the Director shall determine whether the accumulative and estimated catch of surf clams during that quarter will exceed the quarterly allocation (as adjusted under section (a) (1) above). If the Director does determine that the quarterly allocation will be (will not be) exceeded, he may reduce (increase) the number of days per week during which fishing for surf clams is permitted, for the purpose of avoiding prolonged vessel tie-up times and fluctuations in the supply of surf clams which would result if the allocation were taken rapidly during the beginning of each quarter (facilitating the catch of the full quarterly allocation).

(3) Notice of the reduction (increase) in days per week during which fishing for surf clams is permitted shall be published by the Director in the Federal Register, and the reduction (increase) shall be effective immediately upon publication in the Federal Register. Notice shall also be sent by registered mail, return receipt requested, to each surf clam or ocean quahog processor subject to the plan.

(b) Ocean Quahogs

(1) Fishing for ocean quahogs shall be permitted seven days per week.

(2) When fifty percent (50%) or more of the allocation of ocean quahogs has been caught, the Director shall determine whether the accumulative and estimated catch of ocean quahogs during the year will exceed the annual allocation (as adjusted under section (a) (2) above). If the Director does determine that the annual allocation will (will not be) exceeded, he may reduce the number of days per week during which fishing for ocean quahogs is permitted, for the purpose of avoiding prolonged vessel tie-up times and fluctuations in supply of ocean quahogs which would result if the allocation were taken rapidly during the beginning of the year.

(3) Notice of the reduction in days per week during which fishing for ocean quahogs is permitted shall be published in the Federal Register by the Director and the reduction shall be effective immediately upon publication in the Federal Register. Notice shall also be sent by registered mail, return receipt requested, to each licensed surf clam or ocean quahog processor.

Closed Areas

(a) It shall be unlawful to conduct a directed fishery for surf clams in any designated closed area.

(b) Areas may be closed to surf clam fishing upon a determination by the Director (based on log book entries, processors' reports, survey cruises, or other information) that the area contains surf clams of which:

(1) 60% of more are smaller than 4½ inches in size; and

(2) not more than 15% are larger than 5½ inches in size.

Sizes shall be measured at the longest dimension on the surf clam.

(3) Notice of the closed area shall be published by the Director in the Federal Register.

Vessel Moratorium

Entry of additional vessels into the surf clam fishery is prohibited effective immediately upon adoption of the Fishery Management Plan for Surf Clam and Ocean Quahog Fisheries (FMP) by the Secretary. This provision would not exclude:

(a) Those vessels demonstrated to have been under construction at the time of the adoption of the FMP. Construction will be deemed to have commenced at the start of the laying of the keel.

(b) Replacement (with a vessel of a substantially similar capacity) of any vessel involuntarily leaving the fishery during the time when the moratorium is in force.

In situations where the Secretary finds that a denial of entry into the surf clam fishery will cause substantial economic hardship, the vessel involved shall be exempted from the provisions of this section.

The moratorium shall remain in effect for one year from the date of adoption of the FMP, unless the Secretary determines, after consultation with the Council and after a public hearing, that the moratorium should be terminated or extended.

Reports and Records

(a) Dealers

(1) All persons, individuals, firms or corporations, at any port or place within the United States, that buy from U. S. flag vessels or from a carrier licensed as a common carrier, engaged in either interstate or intrastate commerce, any surf clams or ocean quahogs taken by any fishing vessel, shall make and furnish to the Regional Director of the National Marine Fisheries

Service on a weekly basis the following information on forms supplied by the Regional Director, National Marine Fisheries Service:

(a) date of purchase,
(b) number of bushels purchased,
(c) permit number of the vessel clams were purchased from,
(d) price per bushel
(e) mailing address of plant.

Additional information may be required annually as part of the application documentation for a license.

(2) All persons purchasing or receiving any surf clams or ocean quahogs for transport to any port of the United States must maintain records identical to those required under paragraph (a) (1) above of this section.

(3) The possession by any person, firm or corporation of surf clams or ocean quahogs which such person, firm or corporation knows to have been taken by a vessel of the United States without a valid license, is prohibited.

(b) Owner or Operator

(1) In the case of a vessel licensed under this plan and conducting a directed fishery for any surf clams or ocean quahogs, the owner or operator of the vessel must maintain an accurate log of fishing operations showing date caught, permit number, time at sea, landing port, date sold, locality fished, duration of fishing time, crew size, crew share, price per bushel, buyer's name and the total amount in bushels of each species taken. Such logbooks shall be available for inspection by an authorized official. The logbook shall be presented for examination and subsequent return to the operator or owner of the vessel upon proper demand by an authorized official at any time during or at the completion of a fishing trip. Weekly logbook reports shall be submitted to the Regional Director, National Marine Fisheries Service, on forms supplied by the Regional Director. Such required documentation will be maintained by the owner or operator of the vessel for one year after the date of the last entry in the logbook.

Licensing Provisions

(a) Any vessel desiring to:

(1) Conduct a directed fishery for surf clams or ocean quahogs within the FCZ, or

(2) Transport, or deliver for sale, any surf clams or ocean quahogs taken within the FCZ must obtain a license for that purpose.

(b) The owner or operator of a vessel may obtain the appropriate license by furnishing on the registration form provided by the National Marine Fisheries Service information specifying the names and addresses of the vessel owner and operator, the name of the vessel, official number, directed fishery or fisheries, fish hold capacity (in "cages" or bushels), dredge size, bushels caught in past twelve months, number of fishing trips in past twelve months, engine and pump horsepower, the homeport of the vessel, and a cost-earnings statement. The registration form shall be submitted, in duplicate, to

the Regional Director, National Marine Fisheries Service, Gloucester, Massachusetts 01930, who shall issue the requested license, without fee.

New licenses will be issued to replace lost or mutilated licenses at twenty-five ($25.00) dollars per reissue. A license shall expire whenever vessel ownership changes, or when the owner of the operator of the vessel changes the directed fishery or fisheries of such vessel. Application for new license, because of a change in vessel ownership (which shall include the names and addresses of both the purchaser and seller and be submitted by the purchaser), a change in the directed fishery or fisheries of the vessel, or the removal of a vessel from the directed fisheries for surf clams or ocean quahogs must be filed with the Regional Director no later than ten (10) days following the change on a form provided by the Regional Director.

(c) The license issued by the National Marine Fisheries Service must be carried, at all times, on board the vessel for which it is issued and such license, the vessel, its gear and equipment and catch shall be subject to inspection, at reasonable times, by an authorized official. During the first thirty (30) calendar days after the effective date of this paragraph, the license need not be on board the vessel.

(d) Licenses must be maintained in a legible condition.

(e) Licenses issued under this part may be revoked by the Regional Director for violations of this part, pursuant to procedures in 50 CFR § 621.

Vessel Identification

(a) Each fishing vessel shall display its official number on the deckhouse or hull, and on an appropriate weather deck.

(b) The identifying markings shall be permanently affixed to the vessel in contrasting block Arabic numerals at least 3 feet (0.9144 meters) for vessels over 100 feet (30.48 meters) in length; 18 inches (45.72 CM) for vessels over 65 feet (19.812 meters) but less than 100 feet (30.48 meters) in length; and at least 10 inches (25.4CM) in height for all other vessels.

(c) The length of vessels shall be as determined by official Admeasurement as reflected by U. S. Coast Guard records. The official number is that number issued by the U. S. Coast Guard associated with the documentation of the fishing vessel or the official number issued by a state or the U. S. Coast Guard for undocumented vessels.

(d) The operator of each vessel shall:

(1) keep the identifying markings clearly legible and in good repair; and

(2) Insure that no part of the vessel, its rigging or its fishing gear obstructs the view of the markings from an enforcement vessel or aircraft.

Facilitation of Enforcement

(a) The operator of any vessel subject to the provisions of the Act shall immediately comply with instructions issued by authorized officers to facilitate boarding and inspection of the vessel for purposes of enforcing the Act and these regulations.

(b) Upon being approached by a Coast Guard cutter or aircraft or other vessel or aircraft authorized to enforce the Act, the vessel shall be alert for signals conveying enforcement instructions. The following signals extracted from the International Cod of Signals are among those which may be used:

1. "L" meaning "You should stop your vessel instantly;"
2. "SQ3" meaning "You should stop or heave to; I am going to board you, and
3. "AA AA AA etc." which is the call for an unknown station; to which the signalled vessel should respond by illuminating the vessel identification required by Section 651.11 of this Part.

(c) A vessel signalled to stop or heave to for boarding shall:

1. Stop immediately and lay to or maneuver in such a way as to permit the authorized officer and his party to come aboard;
2. Provide a ladder for the authorized officer and his party; and
3. When necessary to facilitate the boarding, provide a man rope, safety line and illumination for the ladder; and
4. Take such other actions as necessary to ensure the safety of the authorized officer and his party and to facilitate the boarding.

(c) Each licensed fishing vessel shall have available, by January, 1978, at all times a person who can converse in English and who can serve as an interpreter between an authorized officer and the operator.

Habitat Preservation, Protection and Restoration

Pollution

The Council is deeply concerned about the effects of marine pollution on fishery resources in the Mid-Atlantic Region. It is mindful of the mandate of Section 304(e) of the Fishery Conservation and Management Act which requires taking into account the impact of pollution on fish. The extremely substantial quantity of pollutants which are being introduced into the Atlantic Ocean poses a threat to the continued existence of a viable fishery. In the opinion of the Council, elimination of this threat at the earliest possible time is determined to be necessary and appropriate for the conservation and management of the fishery, and for the achievement of the other objectives of the Fishery Conservation and Management Act as well. The Council, therefore, urges and directs the Secretary to forthwith proceed to take all necessary measures, including but not limited to, the obtaining of judicial decrees in appropriate courts, to abate, without delay, marine pollution emanating from the following sources: 1) the ocean dumping of sewage sludge, dredge spoils and chemical wastes; 2) the discharge of raw sewage into the Hudson River, the New York Harbor and other areas in the Mid-Atlantic Region; 3) the discharge of pr treated sewage from ocean outfall lines; 4) overflows from combined se and storm sewer systems; and 5) discharge of harmful wastes of any dustrial or domestic, into the Hudson River or surrounding marin waters.

DRAFT

Development Of Fishery Resources

There is no surplus in either fishery. Primary product and market development are needed for ocean quahog.

XIII

SPECIFICATION AND SOURCE OF PERTINENT FISHERY DATA

General

Fishermen and processors are required to submit reports as specified below.

Domestic And Foreign Fishermen

Fishermen will submit, on a weekly basis, a catch record as set forth in Figure 9. Misrepresentation of information on these reports will constitute a violation of regulations implementing this plan and will be subject to the penalties, remedies, and procedures provided in 50 CFR part 621, which may include loss of a permit.

Processors

Processors and dealers will submit, on a weekly basis, reports as set forth in Figure 10.

AM PROCESSING PLANT WEEKLY REPORT Date__________to__________

Signature - Plant Manager

lant Name Plant Location (mailing address) Zip Code

ate of urchase	No. Bu. Purchased	Purchased From Vessel Permit No.	Size of Clams % Under $4\frac{1}{2}$"	$4\frac{1}{2}$-5"	5-$5\frac{1}{2}$"	Over $5\frac{1}{2}$"	Price Per Bu.	Yield Per Bu.	No. Plant Employees	No. Employees Processing Clams	Total Payroll of Clam Processing

Figure 10

103

CATCH RECORD

Surf Clam Permit No.__________
Ocean Quahog Permit No.______
Dredge Size__________________

Captain's Signature and Date______________________________

Date	Area Fished 10 min. interval	Time at Sea o.o hr.	Time Fishing Hour o.o hr.	Catch in Bushels	No. of Crew	Total Crew Share %	Landing Port	Buyer's Name	Date Sold
SURF CLAMS									
OCEAN QUAHOGS									

Notes:

Figure 9

102

Management Costs And Revenues

It is expected that initial governmental costs of implementing the management measures described in this plan will be limited to those costs incurred in issuing permits to vessels engaged in the surf clam/ocean quahog fisheries. Of this amount, an as yet undetermined amount may be recovered by the Secretary of Commerce, as specified by the FCMA of 1976, which authorizes the Secretary to recover costs of licensing and registration.

On-going and permanent (for the life of the plan) expenses will be limited to costs of processing and manipulation of data from vessel log books and processor records, as outlined in the plan. The preliminary estimate of this cost is approximately $35,000/twelve month period.

Other as yet undetermined costs of plan implementation may include costs incurred by the Coast Guard of enforcing closed fishing areas, should the need for such closures (see criteria for closure in plan) arise. It is impossible at present to predict the probabilities, durations, areas, or distribution of bed (s) closures.

104

IV XV RELATIONSHIP OF THE RECOMMENDED MEASURES TO EXISTING APPLICABLE LAWS AND POLICIES

Fishery Management Plans

This plan does not relate to other approved fishery management plans for other fisheries prepared by the Council or the Secretary of Commerce.

Treaties or International Agreements

No relationship exists between the recommendations of this plan and any known treaties or international agreements.

Federal Law and Policies

No known Federal laws or policies will constrain implementation of the recommendations in this plan.

State Local, and Other Applicable Laws and Policies

No known state, local or other applicable laws will constrain implementation of the recommendations of this plan.

105

XV.

COUNCIL REVIEW AND MONITORING OF THE PLAN

The Council staff will receive weekly summary reports of vessel logbook and processor data reports from the National Marine Fisheries Service. This information, along with recommendations from the Regional Director, will be provided to the Council monthly and be used as baseline information for determining the need for plan revisions. Research findings will also be utilized for this purpose.

Section 304(e) of the Fishery Conservation and Management Act of 1976 dictates that the Secretary of Commerce shall initiate and maintain a comprehensive program of fishery research to carry out and further the purposes, policies and provisions of the Act. The Council is responsible for reviewing and revising as appropriate specifications contained in management plans prepared by them for their geographical area of authority.

In order for the Council to monitor and predict biological and socioeconomic impacts of management decisions cited in this plan, certain basic data must be provided on a continuing basis. Some of this data will be obtained through the record-keeping provisions outlined previously in the plan. However, much of the biological as well as socioeconomic information needed by the Council to address and resolve equitably problems associated with quotas, limited entry, vessel moratorium, etc., will not be available from that input.

Therefore, the Mid Atlantic Council recommends to the Secretary the following areas of research as being of high priority, and requests that a comprehensive program of research on surf clam and ocean quahog including these topics be initiated or incorporated into ongoing research and survey efforts.

I Biological Research and Monitoring

a) Assessments of distribution, density, population structure and abundance of the resources throughout their geographic range in the United States Fishery Conservation Zone.
b) Estimation of year class strengths, recruitment successes.
c) Determination of reproduction potential relative to clam sizes and densities.
d) Study of biology of ocean quahog, especially age at maturation, natural mortality, yield per recruit and estimation of MSY.

Suggested form of study/results

On-going annual studies on (a), (c) and (d), with annual reports as appropriate.

II Fishery Research and Monitoring

a) Evaluation of incidental mortalities caused by fishing, relative to various gear, vessel and fishing technique characteristics.
b) Determination of catch/effort by vessel, vessel tonnage, area fished, and gear characteristics.

Suggested form of study/results

One-time study of (a). Quarterly compilation of (b) with annual report.

III Processing Sector Research and Monitoring

Continuous monitoring of: size frequencies of catch, costs and means of production, and wholesale/retail prices. Examination of species and product diversity in production by plant.

Suggested form of study/results

Quarterly compilations and reports.

IV Environmental Research and Monitoring

a) Assessment of hydrographic influences on reproductive and recruitment success, and transport and setting success.
b) Estimation of impacts of ocean dumping, dredging and other coastal activities on resources; prediction of probable impacts on resources from these operations in short and long-term.

Suggested form of study-results

One-time study and report on (a). On-going study and monitoring of (b), with annual reports. Especially important is capability for short-notice and intense assessments on emergency basis, to predict impacts of transient acute phenomena, e.g., anoxic conditions similar to those observed in summer, 1976.

V Socioeconomic Research and Monitoring

a) Compilation of vessel earnings and profits, employment (fishery/industry) profiles.
b) Analysis of demographic characteristics of affected communities and industries.
c) Analysis of degrees of interaction between clam and other fisheries with regards to shifts (and ability to shift) in employment, opportunity costs, shifts in effort as functions of earnings, etc.

Suggested form of study/results

(a): Quarterly compilation and yearly reports.
(b) and (c): One-time baseline studies and bi-annual (or as needed) updates.

VI Other

Assess potential of aquaculture to augment natural supply of clams.

Suggested form of study/results

One-time benefit/cost and feasibility study, review of state-of-the art.

XVI. LITERATURE CITED

Atkinson, L. P. 1976. Chemical oceanography. In: Sharp, J. H. (ed.), 1976. Anoxia on the middle Atlantic shelf during the summer of 1976. Report on a Workshop held in Washington, D. C., 15-16 October, 1976. NSF Contract No. OCE 7700465. Univ. Delaware: 81-84.

Bass, G. 1975. Economic profit of the surf clam industry. Office of Economic Research, National Marine Fisheries Service (unpublished).

Belding, D. L. 1910. The growth and habits of the sea clam (Mactra solidissima). Rep. Comm. Fish Game 1909, Commonwealth of Massachusetts. Public Document 25: 26-41.

Bigelow, H. B. 1926. Plankton of the offshore waters of the Gulf of Maine. Bull. U. S. Bur. Fish. 40(2): 1-509.

Brown, B. E., E. M. Henderson, S. A. Murawski, and F. M. Serchuck. 1977. Review of status of surf clam populations in the middle Atlantic. Northeast Fisheries Center, NMFS. Woods Hole Lab. Ref. No. 77-08: 16 p.

Chamberlin, J. L., and F. Stearns. 1963. A geographic study of the clam, Spisula polynyma (Stimpson). Amer. Geograph. Soc. N. Y., Ser. Atlas Mar. Environ. 3: 12 p.

Cochrane, D., and G. H. Orcutt. 1949. Application of least squares regression to relationship containing auto-correlated error term. J. Amer. Stat. Assoc. 44: 32-61.

Cohen, E. G. 1975. An overview of the plankton community of the Gulf of Maine. Ann. Meet. Int. Comm. Northw. Atl. Fish., Res. Doc. No. 106, Ser. No. 3599.

Davis, J., et al. 1975. Alternative management schemes for the surf clam fishery. Vir. Inst. Mar. Sci., Spec. Rept. in Applied Mar. Sci. and Ocean Eng. No. 713: 141 p.

Dower, R. C. 1976. Analysis of the impact on demand for clams of selected management alternatives. Unpublished M. S. thesis, Univ. Md.

Federal Register. February 10, 1977. 48(28).

Gulland, J. A. 1969. Manual of methods for fish stock assessment. Part I. Fish population analysis. Food Agr. Org. U. N. Man. Fish. Sci. 4: 1-154.

Haskin, H. H., and G. Starypan. 1976. Management studies of surf clam resources off New Jersey. Final Rept., NMFS Contract No. 03-043-356, Rutgers Univ.: 13 p + 16 figs.

Jacobson, M. K., and W. E. old, Jr. 1966. On the identity of Spisula similus (Say). Amer. Malacological U. Ann. Rept. 1966: 30-31.

Lillelund, K., and R. Lasker. 1971. Laboratory studies of predation of marine copepods on fish larvae. U. S. Fish. Bull. 69: 655-667.

Loesch, J. G. 1975. Inventory of surf clams in nearshore waters from Cape Henlopen to the False Cape area. Rept. (ms) NMFS Contract No. 03-4-043-357.

Loosanoff, V. L. 1953. Reproductive cycle in Cyprina islandica. Biol. Bull. 104: 146-155.

Marak, R. F. 1960. Food habits of larval cod, haddock and coalfish in the Gulf of Maine and Georges Bank area. J. Cons. Int. Exp. Mer 25: 147-157.

Maurer, R. 1975. A preliminary description of some important feeding relationships. Spec. Meet. Int. Comm. Northw. Atl. Fish., Res. Doc. No. 130, Ser. No. 3681.

Merrill, A. S., and J. W. Ropes. 1969. The general distribution of the surf clam and ocean quahog. Proc. Nat. Shellf. Assoc. 59: 40-45.

Merrill, A. S., and J. R. Webster. 1964. Progress in surf clam biological research. Bur. Comm. Fish., Biol. Lab., Oxford, Md., U. S. Fish Wildl. Serv. Circ. 200: 38-47.

Mueller, J. J. 1976. Usage of cross sectional production functions in fisheries management. Paper presented at Fish and Wildlife Conference, Hershey, Pennsylvania.

Murawski, S. A. 1977. Yield-per-recruit analysis of surf clams in the Middle Atlantic Bight. NEFC, Woods Hole Lab. Ref. No. 77-12: 10 p.

National Marine Fisheries Service. 1977. Shellfish market review and outlook. Current Economic Analysis S-38. Industry and Consumer Services Division, Market Outlook Group. NOAA SSOLB 38: 51 p.

110

Nicol, D. 1951. Recent species of the Veneroid pelecypod Arctica. J. Wash. Acad. Sci. 41(3): 102-106.

Parker, P. S., and E. D. McRae, Jr. 1970. The ocean quahog, Arctica islandica, resource of the northwestern Atlantic. Fish. Indus. Res. 6(4): 185-195.

Resource Assessment Division, Northeast Fisheries Center, NMFS. 1977. Summary of stock assessments June - 1977. Woods Hole Lab. Ref. No. 77-11: 46 p.

Ritchie, T. P. 1977. A comprehensive review of the commercial clam industries of the U. S. Unpub. ms, Univ. Delaware.

Ropes, J. W. 1968a. Reproductive cycle of the surf clam, Spisula solidssima, in offshore New Jersey. Biol. Bull. 135: 349-365.

Ropes, J. W. 1968b. The reproductive cycle of surf clams from the New Jersey coast. Proc. Nat. Shellf. Assoc. 58: 8-9.

Ropes, J. W., R. M. Yancey and A. S. Merrill. 1967. The growth of juvenile surf clams at Chincoteague Inlet, Virginia. Proc. Nat. Shellf. Assoc. 57: 5 (abstract).

Ropes, J. W., J. L. Chamberlin, and A. S. Merrill. 1969. Surf clam fishery. In: Firth, F. E. (ed.), The Encyclopedia Of Marine Resources. Van Nostrand Reinhard Co., N. Y.: 119-125.

Russell-Hunter, W. D. 1970. Aquatic Productivity. MacMillan Co., London: 305 p.

Saila, S. B., and S. D. Pratt. 1973. Coastal and offshore environmental inventory - Cape Hatteras to Nantucket Shoals. Chap. 6. Univ. R. I., Occ. Paper 5, Mar. Pub. Serv. 2: 125 p.

Schneider, R., M. Tarnowski, and H. H. Haskin. 1977. Management studies of surf clam resources off New Jersey. Rept. No. 7, NMFS Contract No. 03-4-043-346: 37 p.

Schaefer, M. B. 1954. Some aspects of the dynamics of populations important to the management of the commercial marine fisheries. Bull. Inter-Amer. Trop. Tuna Comm. 1(2): 27-56.

111

Sharp, J. H. (ed.). 1976. Anoxia on the middle Atlantic shelf during the summer of 1976. Report on a workshop held in Washington, D. C., 15-16 October, 1976. NSF Contract No. OCE 7700465. Univ. Delaware: 122 p.

Sherman, K., and K. A. Honey. 1971. Seasonal variations in the food of larval herring in coastal waters of central Maine. Rapp. et Proces-Verbaus des Reunions 160: 121-124.

Sherman, K., and H. C. Perkins. 1971. Seasonal variations in the food of juvenile herring in coastal waters of Maine. Trans. Amer. Fish. Soc. 100: 121-124.

Silbajoris, R. A. 1975. Underutilized marine fishery resources of New York State. Unpub. M. S. thesis, S. U. N. Y. at Stony Brook: 161 p.

Steimle, F. 1976. A summary of the fish kill-anoxia phenomenon off New Jersey and its impact on resource species. In: Sharp, J. H. (ed.), Anoxia on the middle Atlantic shelf during the summer of 1976. Rept. on a workshop held in Washington, D. C., 15-16 October, 1976. NSF Contract No. OCE 7700465. Univ. Delaware: 5-11.

Theilacker, G., and R. Lasker. 1974. Laboratory studies of predation of euphausiid shrimps on fish larvae. In: Blaxter, J. H. S. (ed.), The Early Life History Of Fish. Springer-Verlag, N. Y.: 765 p.

Visgilio, G. R. 1973. An economic evaluation of fishery management alternatives - an analysis of the surf clam industry. Unpub. Ph.D. diss., Univ. R. I.

Westman, J. R., and Bidwell. 1946. The surf clam, economics and biology of a New York marine resource. N. Y. Dept. Conserv. Mar. Fish. (unpub.).

Yancey, R. M., and W. R. Welch. 1968. The Atlantic coast surf clam - with a partial bibliography. U. S. Fish Wildl. Serv. Circ. 288: 14 p.

Zatsepin, V. I., and Z. A. Filatova. 1961. The bivalve mollusc Cyprina islandica (L.), its geographic distribution and role in the communities of benthic fauna. Trans. Inst. Ocean., Acad. Sci. USSR 46: 201-216 (Translation 74732, Dept. North. Aff. Nat. Res., Ottawa, Canada).

XVII.

APPENDIX I

Sources of Data and Methodology

Data in the plan was supplied by the National Marine Fisheries Service.

Biological and economic methodologies were developed by the National Marine Fisheries Service.