EFFECTS ON COMMERCIAL FISHING OF PETROLEUM DEVELOPMENT OFF THE NORTHEASTERN UNITED STATES

A REPORT FROM
THE MARINE POLICY AND
OCEAN MANAGEMENT PROGRAM

EFFECTS ON COMMERCIAL FISHING OF PETROLEUM DEVELOPMENT OFF THE NORTHEASTERN UNITED STATES

A Study Conducted within the
Marine Policy and Ocean Management Program
of the
Woods Hole Oceanographic Institution

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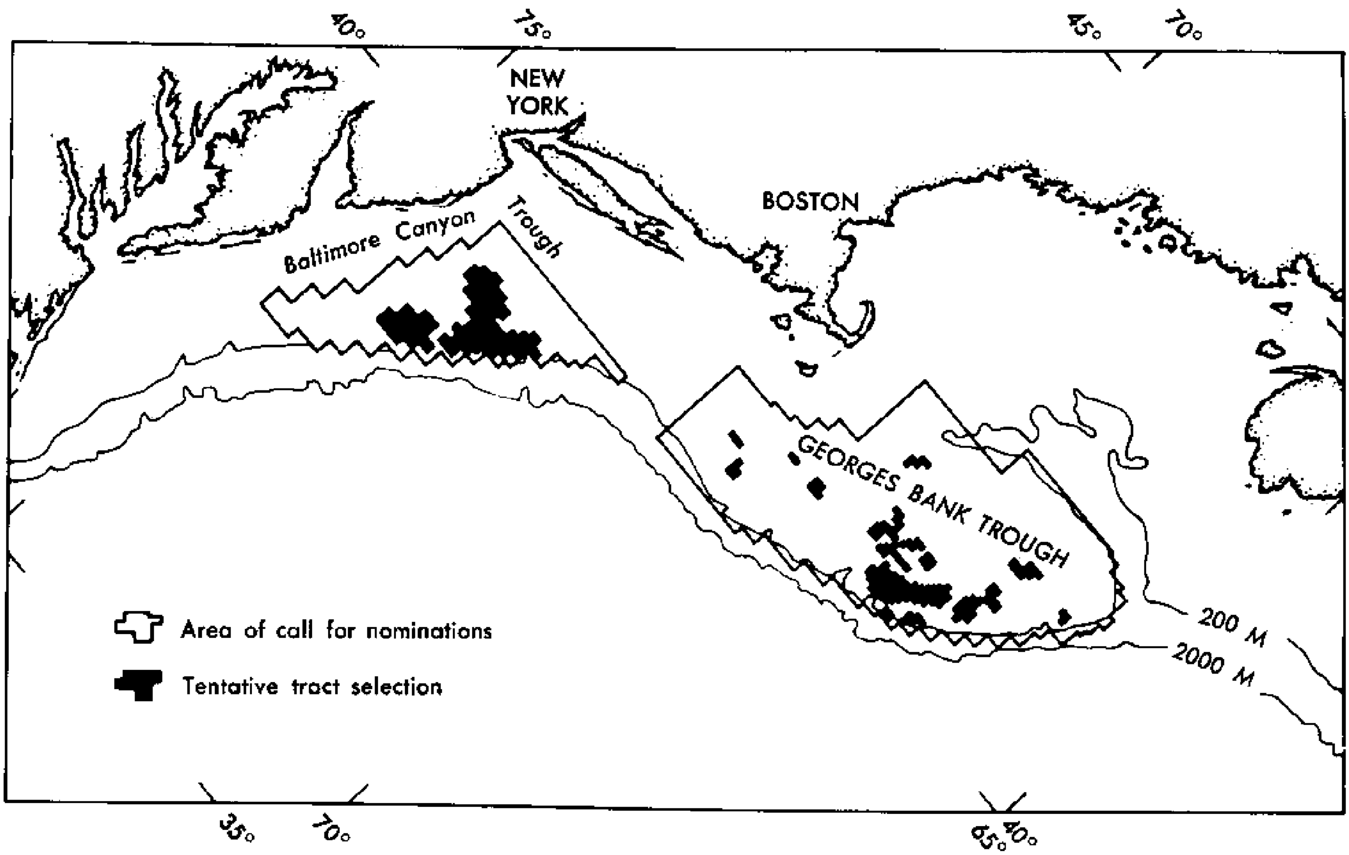
ABSTRACT

This report is the result of a study of the possible effects of future offshore petroleum development on the commercial fishing industry of the New England and Mid-Atlantic states. The study, made by an interdisciplinary group, was based on a variety of sources: two workshops involving fishermen, government officials and oil industry representatives; visits to the Gulf of Mexico and the North Sea; interviews with state coastal zone planning officials and with federal officials responsible for offshore development; interviews with and questionnaires from working fishermen; and finally, the analysis of existing fisheries data and the review of previous studies. The report considers the effects on fisheries in three general categories: offshore interactions, onshore interactions and pollution effects. Estimates are made of the probable magnitude of these effects on commercial fishermen. Recommendations are made as to steps which should be taken by the industries and by government to minimize undesired consequences.

The report also contains general descriptions of the following: the physical environment on the continental shelf of the area; the commercial fishing industry of the Mid-Atlantic and New England regions including the ports, the fishing frounds, the fishing gear and techniques used and the results of a poll of fishermen's attitudes toward petroleum development; the technology of the petroleum industry and the likely scale and pace of exploration and development in the area; the legal and regulatory framework governing the industries on the continental shelf.



PREFACE

The Marine Policy and Ocean Management Program was initiated in 1970 at the Woods Hole Oceanographic Institution in recognition of the increasing importance of bringing the science of the ocean together with the political, economic and international problems of the ocean. The program has provided fellowships at the Institution for research and study for young professionals (generally not scientists) who wished to direct their careers toward problems involving the uses of the ocean. As an experiment it was decided in the fall of 1974 to focus the interests of several members of the Program on a single problem. This report is a result of that study. The study members were an interdisciplinary group. Following the order of names listed on the title page, the professions represented are a marine geologist, a practicing fisherman, a geographer, two attorneys, a physicist, an anthropologist and an economist.

As the study proceeded we received very useful advice from an advisory committee of individuals from the Woods Hole community. These included: Richard H. Backus, Dean F. Bumpus, Robertson P. Dinsmore, Kenneth O. Emery, Bostwick H. Ketchum, Frederick E. Mangelsdorf, David A. Ross and Allyn C. Vine of the Woods Hole Oceanographic Institution; also William G. Gordon, National Marine Fisheries Service, Northeast Region; Richard C. Hennemuth, National Marine Fisheries Service, Woods Hole; and John S. Schlee, United States Geological Survey, Woods Hole. A. Lawrence Peirson III, Assistant Dean, provided both useful advice and administrative support. Lamin Sarr was research assistant for the group.

Mr. O. J. Shirley, Manager, Safety and Environmental Conservation, Shell Oil Company, Southern Region, was especially helpful in many ways. He provided considerable technical information concerning the petroleum industry and was invaluable in arranging visits of study team members to the Gulf Coast and the North Sea, and with petroleum industry members. Keith G. Hay of the American Petroleum Institute was most helpful with the workshops and in other ways.

The assistance of all the above mentioned people is greatly appreciated by the members of the study.

The study was funded by two sources: private funds of the Woods Hole Oceanographic Institution which were given to support the Marine Policy and Ocean Management Program, and a grant from the American Petroleum Institute. The latter grant made it possible for us to bring Richard B. Allen into the study as a consultant on the fishing industry and also provided funds for travel and for the two workshops. The Marine Policy and Ocean Management Program is part of the Institution's coherent Sea Grant Program, which is sponsored by the Office of Sea Grant, Department of Commerce, under Grant No. 04-6-158-44016.

The findings of this report are the exclusive responsibility of the members of the study; they should not be taken as either official positions of the Woods Hole Oceanographic Institution or as opinions necessarily shared by other members of the Institution's staff.

R. W. Morse
Study Director

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*The report is organized so that Chapter I is essentially self-contained with the Study Findings appearing at the end of Chapter I. Chapters II through V are essential background to Chapter I and are intended to provide information of general usefulness.

CHAPTER I

Statement of the Problem, Analysis and Summary of Findings

INTRODUCTION

The rapid acquisition of new oil and gas supplies within the United States is of high national priority. Since the unexplored continental shelves are believed to contain significant petroleum and gas resources, they have been targeted for an accelerated program of leasing. During 1976 oil and gas leases off the Mid-Atlantic and New England states are to be offered to private industry for exploration and development.

The prospect of such offshore activity has provoked much debate at both national and local levels. Since the development involves the intrusion of a new and aggressive industry into a region which values its traditional ways, it is not surprising that exaggeration and emotion often cloud the debate. At one extreme the picture is painted of oil on the beaches, refineries in old New England villages or the crippling of traditional fisheries. At the other extreme the prospect is given of lower fuel prices, or of significant new jobs and new tax revenues for an economically sick region.

These exaggerations are symptomatic of a larger political issue underlying the debate about offshore petroleum development. The incentives for development are national, the process is largely under Federal control and the lease revenues produced go to the Federal Treasury. The immediate negative impacts, however, are perceived to be local and regional. Thus to a first approximation, the benefits are national whereas the costs appear to be regional. The offshore development process as a consequence puts unusual strains on our governmental arrangements, all the way from the coastal towns to Washington. The town and state response to offshore development often has been defensive, not just because of uncertainty about the impacts of the development but also from a sense of impotence from being left out of the political process.

One consequence of the offshore development debate has been a proliferation of studies on the subject. Thus any new study, such as this, has a special burden of justification. It is not clear that anything new can be said on the subject. Moreover, the issues primarily are political and not technical. The fact is that the introduction of an offshore petroleum industry off the coast of the most industrialized section of the country is not a step into some unknown and forbidding world. The offshore petroleum industry is not a new invention. We know its practices and its technologies. We have the Gulf Coast, California and the North Sea for models of experience. The onshore areas adjacent to the prospective drilling sites are heavily populated and contain industrial activity already involved with the petroleum industry. While the public fear of pollution from offshore production is understandable, the coastal regions of the Atlantic already must face environmental problems of similar magnitude whether or not there is offshore development.

A special concern for the Mid-Atlantic and New England areas is the fishing industry, the focus of this study. Even in this case, the reader should be forewarned that the problems which can be anticipated are not radically new in nature nor are they ones which require esoteric analysis for their understanding. Many of the problems one can anticipate between the petroleum and the fishing industries are practical and operational; others are ones that arise whenever a new industry enters a region. The quality of the solutions will depend primarily on the quality of the planning process and the degree of mutual communication and accommodation occurring between the industries, particularly during the early stages.

This study addresses the interactions to be anticipated between a possible offshore petroleum industry and the domestic offshore commercial fishing industry off the East Coast. In particular we have addressed these questions:

—What will be the nature and character of the interaction?

—What specific areas of conflict and cooperation can be identified?

—What recommendations can be made to minimize conflicts and maximize cooperation?

Our purpose is also descriptive and informative. In the hope that it can be generally useful, we describe in some detail the character and technology of both the offshore fishing and petroleum industries, the physical environment of the coastal area, and the legal and regulatory framework within which planning is made and conflicts resolved.

This study emphasizes the interactions between the industries that are operational in nature. We are interested most in the interaction between *fishermen* and *oilmen*. This approach also reflects the reality that the domestic fishing industry is not an industry in the same sense that the oil industry is. For all practical purposes the fishing "industry" is a diffuse collection of individual operators; thus impacts are felt and adjustments made at very local and personal levels. In contrast, the oil industry is composed of large, sophisticated corporations with worldwide operations as well as a variety of companies of every scale.

This study does not deal directly with the interaction between oil and fish. While we felt it necessary to consider the effects of possible oil spills on the fishing industry, we have depended on existing studies in forming such judgments. Thus this is not a new study on the environmental effects of oil.

As with all studies which address immediate policy questions, this one is also limited by the assumptions on which it is based. For example, we implicitly take the current fishing industry as desirable and appropriate, and describe the possible effects on that activity by the petroleum industry. Judgments are made on the basis of whether the petroleum industry interferes with or enhances the fishing industry. Also, we examine the environmental effects of the petroleum industry but do not question the environmental effects of fishing. The reason our perspective is implicitly biased toward the traditional activities is not because we feel that fishermen wear the "white hats", but because we recognize that the burden of proof is placed on the newcomer. We also do not question the existing balance between private industry and government in offshore development.

Our definition of the problem is short-range in time. While this again may be realistic in a political sense, it forecloses exploration of national alternatives for *total* resource development of the nation's two hundred mile economic zone, an area which will either be a legacy of future Law of the Sea agreements or claimed by unilateral action. In short, we have taken present national policies for both fisheries and energy resources management as given. Both are certainly inadequate for the future.

Our study approach is pragmatic and judgmental rather than analytic. We did not view our primary task as one of generating new data, but rather of using existing data and studies as needed, filling in gaps with interviews of oilmen, fishermen and governmental officials, as well as first-hand observations of industry operations. Team members made field trips to both the Gulf of Mexico and the North Sea. A contributor to the study was a working member of the fishing industry. Some new information was developed by workshops and interviews. Two workshops were held at Woods Hole involving practicing fishermen as well as oil company representatives. The purpose of these workshops primarily was to identify problems anticipated by working fishermen and to identify possible solutions. Extensive interviews were conducted with many individuals in the Federal agencies which are involved in the development process. State governments in the Mid-Atlantic and New England areas were visited in order to see how the states were planning to deal with offshore development. A questionnaire was sent to fishermen and many others were interviewed. As varied as these study activities were, they consistently identified the same rather limited number of problems which can be anticipated as potential sources of conflict between the two industries. They are summarized later in this chapter.

The issue of offshore development should be viewed in the context of two larger debates about resource management which are now going on and will continue for the rest of this decade. On the international scene, radical changes are taking place in the law of the sea. On the domestic scene, there are basic differences between the states and the Federal government about resource development which are still being resolved.

The traditional law of the sea has been based on the concept of freedom of the seas. According to this, national sovereignty is limited to a territorial sea of usually three to twelve miles, beyond which the waters are international. Fish, outside the territorial sea, are common property owned only after they are caught. In recent times the high seas fisheries have been regulated by international treaty with national catch allocations made by mutual agreement of the nations which share the resources of a given fishery. Although behavior on the high seas long has been subject to international law, claims of national ownership of resources outside the territorial sea were not made until the Truman Proclamation of 1945. That Proclamation asserted U.S. ownership of resources on and in the contiguous continental shelves. Since then, the 1958 Geneva Convention recognizes such ownership rights by all coastal nations.

Stimulated by offshore petroleum discoveries, the desire to protect fisheries against over exploitation and the prospects for deep sea mining, many nations have pressed for a new and comprehensive law of the sea which would regulate all of the ocean and define the distribution of its benefits. For the past several years efforts have been underway within the United Nations to develop such a comprehensive international treaty. While agreement has not yet been reached it is clear that there will emerge, either by international treaty or by unilateral declarations*, a two hundred mile "economic zone". Within this zone the coastal nation will have exclusive control over the mineral and living resources. While this change need not affect the status of the offshore petroleum industry, it could have a profound effect on the fishing indus-

*The U.S. Congress has passed and the President has signed legislation to extend U.S. fishing jurisdiction to 200 miles. It will go into effect in March 1977.

try. With a two hundred mile economic zone, for example, the U.S. will have management responsibility over the substantial East Coast fishery from which at present the U.S. takes only twenty-four percent in tonnage of the harvest. Whether or not it is advantageous to increase domestic participation in the fishery, the fisheries alternatives available to the U.S. in the future must be viewed quite differently than in the past. As a minimum, we will shortly be in a position to exert increased control over the foreign fishing fleets off our coasts.

On the domestic scene, accelerated resource development has created tensions between the Federal government and the states. The Supreme Court has held that states have jurisdiction only to a distance of three miles off their coasts. Thus the Atlantic coastal states find themselves bordered by an extended "Federal Sea". What happens well within sight of shore is determined by Federal decision and yet what happens has direct consequences to the coastal states. Moreover, the coastal states do not share directly in the resources. (An analagous situation holds with respect to resource development on Federal land in the western states.) One of the purposes of the Coastal Zone Management Act of 1972 was to provide a planning framework which could bring Federally regulated offshore activities into harmony with the desires and plans of the states. This Act is not yet fully implemented. Thus state and local governments generally do not feel that they are properly involved in the offshore development process which is now underway. Unfortunately, unnecessary delays in the development of urgently needed resources will continue to occur if there are not more effective ways for the state and Federal governments to work together.

BACKGROUND TO THE PROBLEM

There are two offshore areas of concern in this study: The Baltimore Canyon Trough, which lies to the east of New Jersey and Maryland, and to the south of Long Island; and Georges Bank Trough, which lies to the south and east of Cape Cod (see Frontispiece). Areas of potential oil interest are from thirty to one hundred twenty miles from shore.

A key event in the Outer Continental Shelf (OCS) development process is the *lease sale,* which is accomplished in several steps. The larger areas outlined in the Frontispiece were designated by the Department of Interior in their Call for Nominations. Against a grid of numbered "tracts", each of 5,760 acres, the oil companies were asked to nominate tracts of most interest within these areas. Invitations were also made at the same time for "negative" nominations, i.e., tracts which for some reason should not be put up for lease. Negative nominations could be made by any interested party on the basis of possible conflicts of petroleum development with other activities or interests. On the basis of these nominations tract selection is made by the Bureau of Land Management (BLM) in consultation with the United States Geological Survey (USGS). BLM issues "site specific" environmental impact statements for each lease sale, invites comments and holds hearings. There is then a lease sale on the tracts selected. BLM need not accept the high bid on a tract if the bid does not meet its expectations. Once a bid is accepted the successful bidder may proceed with exploratory drilling and eventually to develop the tract if commercial finds are made. At this writing, the initial lease sale for the Baltimore Canyon Trough area was scheduled for May 1976 and that for Georges Bank Trough for August 1976.* (See Chapter V for a detailed discussion of the regulatory framework governing the development process.)

There are certain general characteristics of the physical environment in the areas of interest which are relevant to possible offshore petroleum activity:

—Both areas of interest are reasonably far offshore. This distance, combined with estimates of the effects of water movement and winds make it unlikely than an oil spill at the production sites would come ashore. If it did, under normal circumstances, the time to reach shore would be thirty to sixty days by which time the oil would have substantially weathered.

—The character of the ocean bottom is generally suitable for petroleum development. The slopes are gentle and most of the bottom is compact and stable.

—It is a geologically stable area. Thus there is little chance of a Santa Barbara event — i.e., the escape of oil along a fracture zone.

— Pipeline construction is possible in much of the area. Engineering problems would arise in the shoals near Nantucket Island and on Georges Bank and in the Gulf of Maine, and possibly where there are sand waves close to the shores of Long Island, New Jersey and Delaware.

Highest average wind speeds in the area occur in March, lowest in August. Gales, winds of force 8 or higher (above 40 mph), are reported in almost 10 percent of ships observations in winter. This contrasts with a frequency of greater than 30 percent in the North Sea. Summer gales are rare but may be encountered during tropical cyclones or local thunderstorms. Hurricane frequency is about the same as the Gulf of Mexico. A special hazard is the frequency of fog on Georges Bank, especially in the summer when fishing activity is greatest.

*These lease sales have been delayed three to four months.

The areas present no new engineering problems with respect to platform construction. The long distance to shore and the fact that wave heights exceed five feet 20 percent of the time in summer and 30 to 40 percent of the time in winter indicates that present containment methods for oil spills often will be inadequate.

The major problems for the petroleum operations would seem to be the logistical and operating problems created by the long distance from shore combined with the frequency of poor weather and fog. (See Chapter II for a detailed discussion of the environmental factors.)

One of the most significant features of the continental shelf off the East Coast is that *it is one of the most productive fisheries areas of the world.* The offshore area is fished by more than seventeen nations and produces nearly one million metric tons of fin fish and squid annually, about 1 1/2 percent of the world's total catch. The United States takes about 24 percent of the offshore catch. In 1974 the New England and Mid-Atlantic fisheries (both offshore and inshore) were valued at $165 million, about 18.5 percent of the U.S. total. About 26 thousand full-time fishermen are employed and there are about one thousand boats of over five tons. The coastal area of the Northeast includes nine of the twenty-five highest volume ports in the country. In addition, fish processing and wholesaling in the New England and Mid-Atlantic region was valued at $412 million and employed nearly 18,000 people in 1971.

Commercial fishing takes place throughout the offshore areas in which petroleum development might take place. These activities are diverse with respect to both the species caught and the fishing gear employed. Purse seines, otter trawls, pair trawls, dredges, long lines and traps are all used. Most of these activities involve the setting and/or towing of operationally complex gear. Often the operations involve the coordination of more than one vessel. Large foreign fishing fleets regularly operate in the areas of concern. These use larger gear than the U.S. fishermen and often involve the concentrated and coordinated operation of many vessels in the same area. (See Chapter III for a detailed discussion of the fisheries, the fishing ports and the gear employed.)

Although future activities of the petroleum industry off the East Coast can be generally characterized on the basis of experience elsewhere, the exact scale, location and timing of operations is now uncertain. Indeed, at this early stage even the presence of any oil or gas in commercial quantities remains a matter of speculation.

The evolution of an oil producing area proceeds in three distinct, though overlapping phases: exploration, development and production. The exploration stage, which commences after the lease sale, involves detailed seismic exploration (by which the geological formations are mapped acoustically) and exploratory drilling. This stage is carried out by mobile platforms. If a find is made the extent and character of the field must be determined to establish that it has commercial possibilities. Only then is a development plan made and permanent platforms put in place. The drilling of the production wells takes place from such platforms and some platforms eventually could have as many as sixty wells. An oil field, which taps the oil trapped in a single geological feature, could eventually contain several such platforms, spaced about two miles apart. The production phase, which overlaps the development phase, requires the establishment at sea of facilities for separation of water and gas from the oil, as well as for storage. Transportation of the product may be by barge, ship or pipeline.

What might the scale and timing of the activities be? We are really sure only about the exploratory phase since this will take place whether or not there are commercial finds. A reasonable guess is that by 1980 there could be as many as eight to ten mobile drilling rigs operating in each area if encouraging deposits are found. These rigs each carry about one hundred fifteen men and require at least two service boats to carry supplies from shore. If commercial quantities of petroleum are found the first permanent platform would appear no earlier than 1980.

While predictions of what might happen in the future are uncertain, we have made educated guesses about the possible scale of future offshore operations. According to these there could be as many as five to eight permanent platforms established per year, and at full production there could be as many as thirty platforms in each area. These would be clustered in fields of perhaps ten platforms each. (See Chapter IV for detailed discussion of petroleum industry activities.)

In the remainder of this chapter we discuss the ways in which these activities of the petroleum industry can interact with those of the fishing industry, both at sea and in port. Our considerations are limited to *direct* effects; for example, we consider competition for dock space, but we do not consider generalized impacts such as those on schools or housing. The interactions which our study has identified are considered in the following headings:

	At Sea	On Shore	Pollution
Interactions	Loss of fishing space Obstructions and debris Navigation hazards and benefits	Harbor space Shore space Marine services Labor market Capital Social effects	Coastal effects Physical interference from a major spill Possible effects on fish stocks of: • large spills • chronic pollution

Loss of Fishing Space: The most obvious interaction between the two industries will take place in a competition for space at sea. Having been granted a lease on a given tract, a developer naturally has acquired only limited rights within that "sea space". The developer is allowed to engage in those activities which are reasonably required for the development, such as the building of a platform and the establishment of a safety zone to protect it (generally a radius of one-quarter nautical mile). Except for this, the area is still the high seas and other users can exercise the traditional rights of navigation and fishing. Nevertheless, it is obvious that the developer's activities will reduce the space available for fishing, and may in other ways interfere with the conduct of fishing.

A basic question is the degree to which the areas of possible petroleum activities coincide with fishing areas. Chapter III describes the East Coast offshore fishing industry with respect to fishing areas, as well as fishing ports and the gear used by fishermen. On the basis of the material presented there as well as data regularly compiled by the National Marine Fisheries Service it is possible to draw conclusions about the nature of the fishing activity in the two areas where petroleum leasing is proposed.

The most general conclusion is that there is practically no part of the continental shelf off New England and the Mid-Atlantic shelf where commercial fishing does not take place. Certain species, such as sea scallops, are fished at all seasons over wide areas of the Atlantic shelf. Many other commonly fished species migrate seasonally so that during the course of a year they are caught over wide regions. Moreover, since the Atlantic shelf is heavily fished by many different nations, a variety of species are sought.

Although fishing activity is widespread, there are well defined patterns where fishing is concentrated. These often show seasonal variations. Lobsters, for example, are caught all along the shelf break especially in the submarine canyons. Other species tend to concentrate along the Mid-Atlantic shelf break in the winter months. Thus there are quite distinct patterns, both by species and by seasons, in the geographical distribution of fishing effort. The total picture, however, must be thought of as a pattern of various shades of darker grey superimposed on a generally grey background. This general character of the distribution of offshore fishing is suggested in Fig. I-1 which shows the distribution of sightings of fishing vessels of all nations from surveillance flights made during the course of 1974. Since Fig. I-1 is a sampling of the locations of fishing vessels it is a crude approximation to the density distribution of fishing activity.

Figure I-1 rightly suggests that the Georges Bank area is more complicated with respect to fishing than the Baltimore Canyon Trough area. Not only is the Georges Bank region one of the most heavily fished parts of the world, but the structure of the fisheries is quite complex. Therefore, we shall deal separately with each of the two offshore regions.

The area of the Baltimore Canyon Trough included in the original Call for Nominations (Frontispiece) contains several domestic fisheries. Farthest

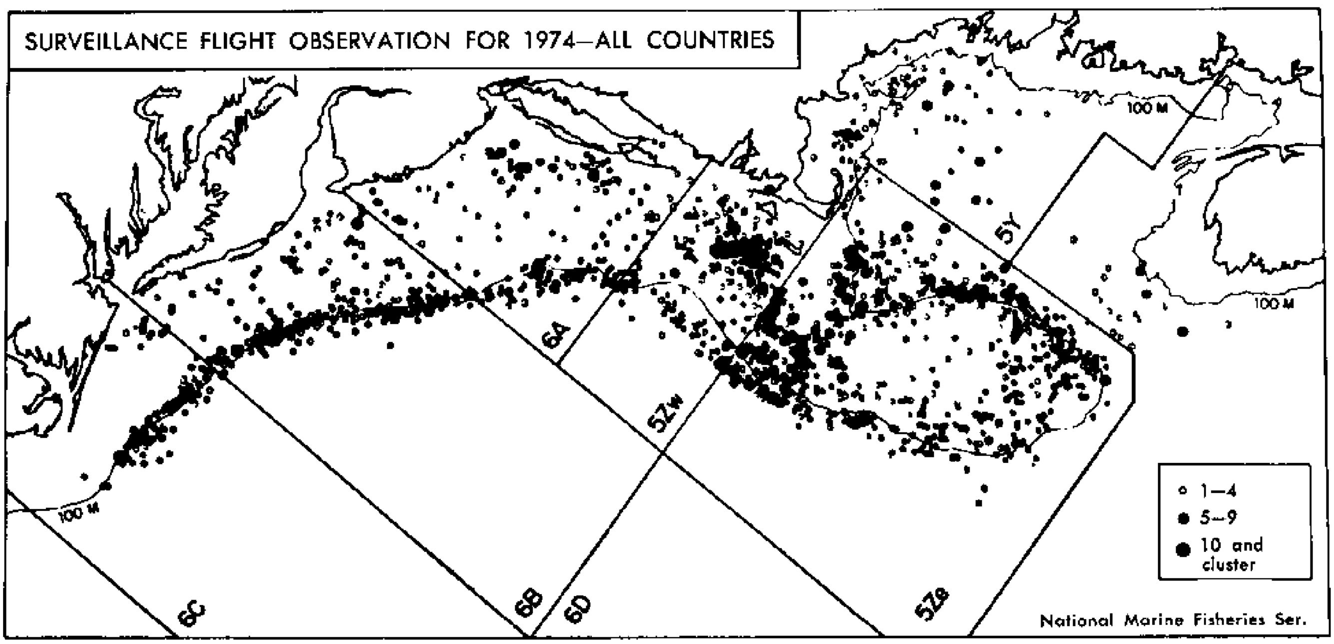

FIG. I-1 FISHING ACTIVITY Includes both U.S. and foreign fishing boats offshore is a lobster fishery along the continental shelf break. This operates in depths from 40 to 180 fathoms with the lobsters being taken in pots in the shallower areas and by otter trawling in waters deeper than 100 fathoms. The submarine canyons are the most productive lobster areas. There is an important sea scallop fishery distributed through the entire region in depths between 20 and 100 fathoms. These are taken with heavy rakes dragged along the sea floor.

Fluke and scup are taken in the offshore area in all the seasons except summer. Butterfish are taken in the winter between 50 and 100 fathoms, and in the summer are found inside the 30 fathom contour. Silver hake (whiting) and sea bass are also found offshore in the winter. All of these species are taken with otter trawls along the sea floor. Sea bass are also taken with pots or traps.

Nearer shore than the lease areas there are very important menhaden and sea clam fisheries. While these would not conflict with offshore drilling operations they could be affected by any pipelines coming to shore from production platforms and by supply and crew boat traffic.

Substantial foreign fishing also occurs in the Baltimore Canyon Trough area. Squid, mackerel, herring, and silver hake are fished there by the foreign fishing fleets. These are principally fall, winter and spring fisheries and occur along the coast between the 20 and 100 fathom contours. Trawling is done along the bottom and at mid-depth.

Following the Call for Nominations on the Baltimore Canyon Trough area, negative nominations were submitted on behalf of domestic fishing interests.* These called particular attention to the submarine canyon locations and certain fluke and scup grounds. More general fin fish and sea scallop grounds were also indicated as having importance. In Baltimore Canyon Trough the tracts selected by BLM for the first lease role (see Frontispiece) do not include areas of negative nominations.

The area of the Call for Nominations on Georges Bank Trough encloses one of the most productive fishing grounds in the world. As many as 500 fishing vessels may operate here at one time. Fishing effort takes place over all of Georges Bank except for areas shallower than 20 fathoms and in spawning areas closed by international agreement. In addition, fishing effort is very heavily concentrated in more limited areas on the bank because of seasonal concentrations of fish.

The traditional New England groundfish fisheries is found in a 20 to 100 fathom band from Hudson Canyon around and across Georges Bank. The fishery is made up of yellowtail flounder, codfish, haddock, pollock, lemonsole, dabs, greysole, hake, cusk and others. Yellowtail flounder are found on the bank within a depth range of 20 to 40 fathoms. The primary otter trawl fishery for codfish and haddock encompasses the Great South Channel between Nantucket Shoals and Georges Bank and the northern edge of Georges as well as the area to the east of the shoal parts of the Bank.

The groundfish longline fishery operating out of Cape Cod extends from the northern edge of Georges, to the Great South Channel and across to Cape Cod. Some of this also takes place in deep water to the west of Veatch canyon. On Georges Bank in 25 to 40 fathoms and throughout the Great South Channel there is an important sea scallop fishery; Canadian scallop fishing is particularly active on the eastern end of Georges. Further offshore a valuable lobster fishery is found on the southern and outer portion of the Bank. It is concentrated near the submarine canyons and goes from 60 to 300 fathoms in depth.

Very significant foreign fishing takes place in the Georges Bank area in depths from 30 to 120 fathoms; it is especially concentrated on the northern, western and southwestern portions of the Bank. Foreign fishing activity peaks in the summer and the ships move farther south in the winter. Fish taken are quite a different mix of species than those harvested by the domestic fishermen; the foreign fleets, for example, take large quantities of herring and mackerel.

The National Marine Fisheries Service has for many years kept statistics on the commercial domestic fish catch. These are reported after fish are

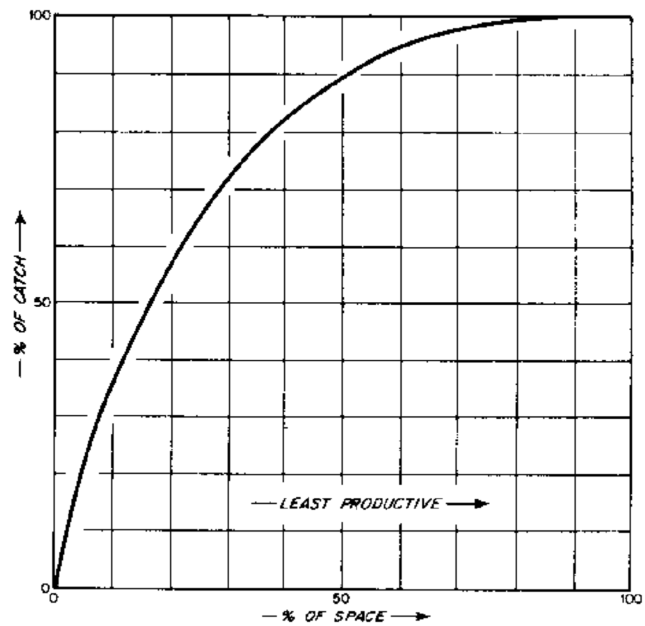

FIG. I-2 HISTORICAL CATCH DISTRIBUTION ON GEORGES BANK. Note that the 10% most productive area accounts for 37% of the catch. 50% of the area accounts for 90% of the catch.

*By Richard B. Allen of the Atlantic Offshore Fish and Lobster Association.

landed and the location at which the catch was made is recorded to the nearest reference latitude and longitude. Since these reference locations are 10 minutes of latitude and/or longitude apart, catch statistics are available for every 10 minute block (10 n. miles of latitude by 8.3 n. miles of longitude). These data have recently been published for the New England fisheries and include the lease area on Georges Bank (NMFS, 1975). Such statistics do not exist for the Baltimore Canyon Trough area.

At the outset it is of considerable interest to know the range of variability in fish catch over Georges Bank. This is displayed in Fig. I-2 for the area of Call for Nominations (see Frontispiece). The curve was constructed by ordering the enclosed 244 reporting areas (10 minute squares) according to fish catch (averaged from 1965-74, by weight) and then adding the catches cumulatively starting with the most productive areas first. According to Fig. 1-2, the most productive 10 percent of the space produces 37 percent of the catch, and only 10 percent of the catch comes from the least productive half of the area. It turns out also that the most productive reporting block is ten times as productive as the median (the median catch being defined as the catch which half the blocks exceed). Thus, for the domestic fishery there is significant spatial variation in the historical catch over Georges Bank; some areas are distinctly more productive than the average, others distinctly less productive.

Figure I-3 shows the location of the most productive fishing areas within the proposed lease area on Georges Bank. These are based on NMFS ten-year averages, by weight, of the total domestic catch of fish caught by bottom gear. The shaded areas are the most productive 10 percent of the area proposed for lease. As already noted, this 10 percent of area accounts for 37 percent of the catch. Also shown are the next most heavily fished areas that would have to be added to the shaded areas in order to account for 50 percent of the reported catch. These squares take up another 6 per-

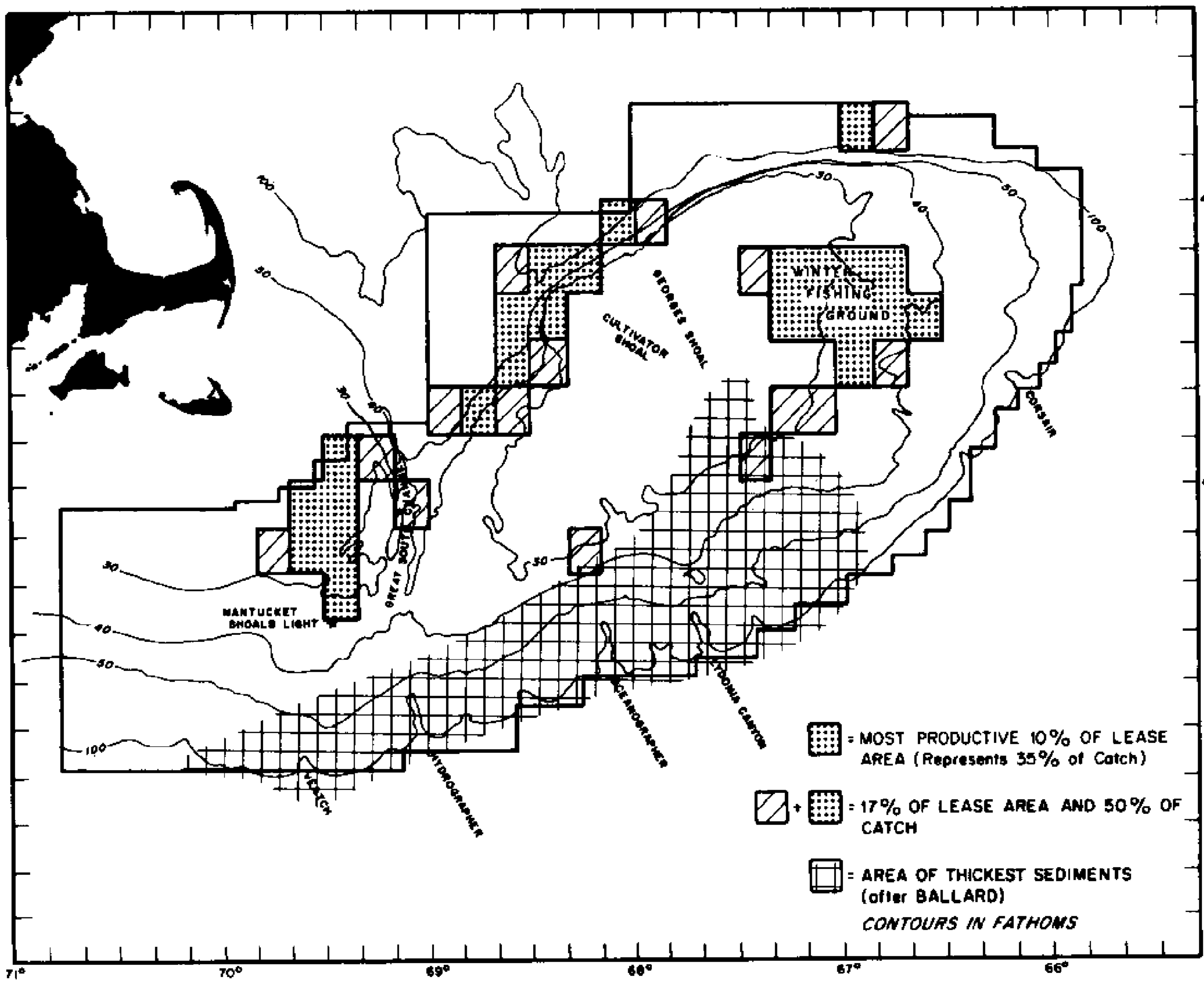

FIG. I-3 LOCATION OF THE MOST PRODUCTIVE FISHING AREAS AND AREAS OF THE THICKEST SEDIMENTS

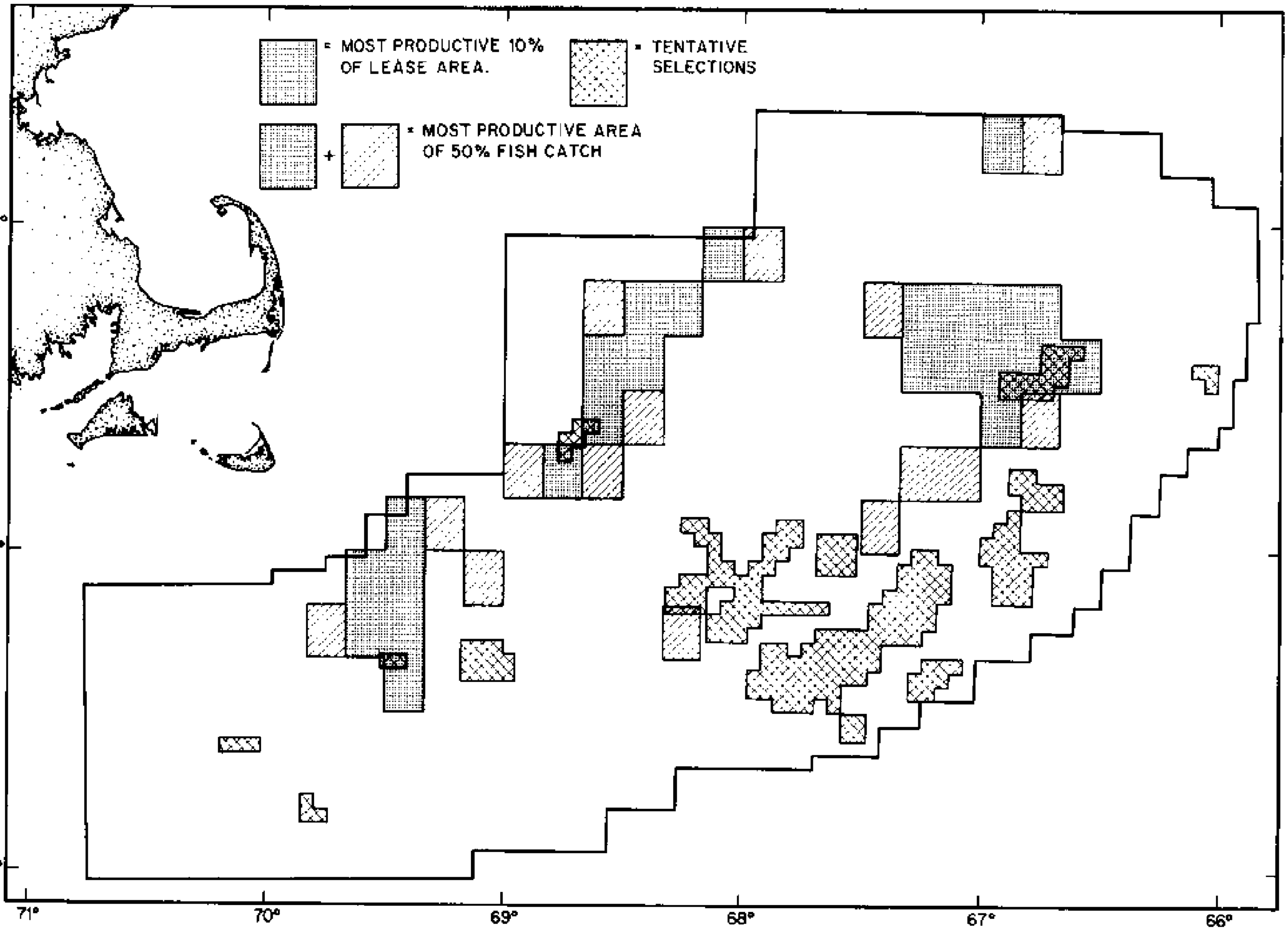

FIG. I-4 COMPARISON OF MOST HEAVILY FISHED AREAS WITH TRACT SELECTIONS

cent of the area and so *50 percent of the domestic fish catch comes from 16 percent of the proposed area.* *

The historically most productive areas are seen in Fig. I-3 to be in three general areas: on Nantucket Shoals just west of the Great South Channel, on the northwestern side of the Bank just west and northwest of the shoal areas of the Bank, and an area east of the shoal parts of the Bank. The latter area is identified on most charts as the "Winter Fishing Grounds", although the historical statistics show little seasonal variation there.

While it is not possible to say at present precisely where petroleum may be under Georges Bank, knowledge about the geological structure can be used to give an indication of the general areas where it is likely to be found. Figure I-3 also shows the area of thickest sediments (after Ballard and Uchupi 1975). The indicated area is where the thickness of sediments is greater than 3 seconds of roundtrip acoustic travel time. While many other factors determine the precise location of hydrocarbons, the region of thickest sediments gives a general indication where petroleum is likely to be found.

From the comparisons shown in Fig. I-3 it appears that the most productive areas of the historical, domestic fishing grounds generally lie to the north of the areas where petroleum is likely to be found.

It should be emphasized that Fig. I-3 does not account for the important lobster fishery nor consideration of foreign fishing. The lobster fishery, in fact, heavily overlaps the area of thickest sediment since so much of that fishery occurs on the shelf edge and in the canyons.

In early 1976 the Bureau of Land Management announced the tentative tract selections for the Georges Bank Area. These are indicated in Fig. I-4 and compared with the most heavily fished areas previously discussed. With a few exceptions, most of these tracts are within the area of the thickest sediments shown in Fig. I-3. However, each of the three most heavily fished areas have a few tracts which have been tentatively selected.

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*The chart published by NMFS showing the spatial distribution of total catch over Georges Bank does not clearly emphasize the locations of the most heavily fished areas (NMFS, 1975). Their first Figure of Volume I, which shows how the "total hail" varies by reporting area, divides catch into three levels. Unfortunately the threshold chosen for the highest of the three levels is taken so low that nearly 90 percent of the total catch is within the upper level.

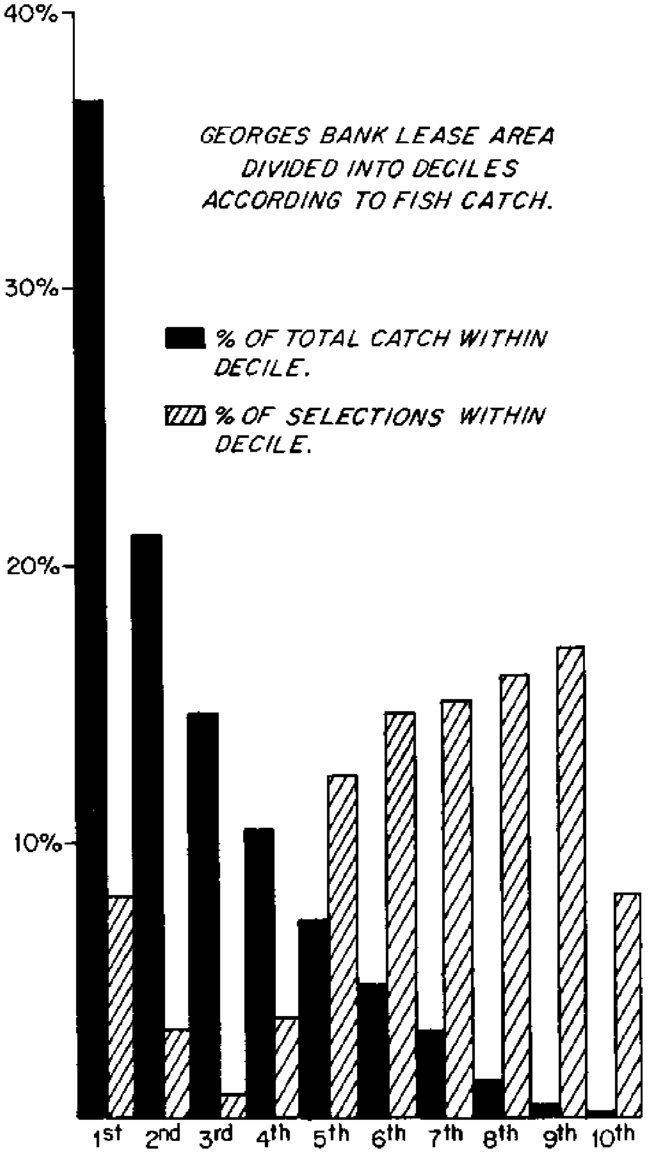

FIG. 1-5 COMPARISON OF THE DISTRIBUTION OF SELECTIONS TO THE DISTRIBUTION OF FISH CATCH

It is possible to compare the distribution of selected tracts with the distribution of historical fish catch. The area within the original Call for Nominations includes 244 NMFS reporting squares for which catch statistics exist. If these reporting areas are divided into deciles according to fish catch, then one can compare how the nominated tracts are distributed among them. Figure 1-5 shows the distribution of fish catch by deciles compared with the distribution of tract selections. If there were no correlation between the distribution of tract selections and fish catch, there would be 10 percent of the tracts in each decile. Instead, we see that there is a distinct tendency for the tracts to be distributed toward the least productive fishing areas. In fact, 84 percent of the selected tracts are in the least productive 60 percent of the area; this 60 percent of the area in turn is responsible for only 18 percent of the historical fish catch. Eight percent of the selected tracts are in the highest fishing decile which is responsible for 37 percent of the historical catch. Thus, there is a significant degree of separation between the location of the tract selections and the historical locations of fishing activity.

Before trying to quantify the effects of space competition, it is useful to characterize and contrast the ways in which the two industries use space at sea. Except for seismic work, the petroleum industry employs space statically. A location is "occupied" for a few months by an exploratory drilling rig, or for twenty or thirty years by a production platform. Fishermen, for the most part, use space dynamically and not statically. Most fishing deploys complicated gear from a moving vessel in pursuit of a moving objective. This means that a simple calculation of the static space occupied by platforms or pipelines will underestimate the space effectively removed from a dynamic fishing operation. The magnitude of this effect depends on the spatial distribution of the excluded spaces, local factors such as weather and currents, and will be a function of the type of fishing gear employed. Because of the great variability in possible circumstances it does not seem worthwhile to try to develop a mathematical formulation of this effect. However, it is probably reasonable to assume that on the average the effective space removed from fishing is at least a factor of two more than the static space taken up by a set of obstacles.

For both industries the value of space is an important function of geographic location. With fisheries we have seen that even though most areas have interest some areas are distinctly more productive than others. From the petroleum industry's perspective, most of the space has zero value and certain specific locations have very high value. Leaving aside any comparison of values *between* the industries, the distribution of equivalent "real estate" values for an area like Georges Bank is distinctly different *within* each industry. In one case it is like agricultural land, in the other it is like possible sites for office buildings.

It is possible to develop a schematic representation within which one can consider the overall spatial interaction between the two industries. This is particularly instructive if the approach of negative nominations were to be used as a policy instrument in reducing conflict between the two industries. That is, if the "best" fishing areas were to be withheld from leasing. Figure 1-6 shows schematically how the two recoverable resources (in total) depend upon the percentage of space made available for petroleum recovery. It is assumed that the

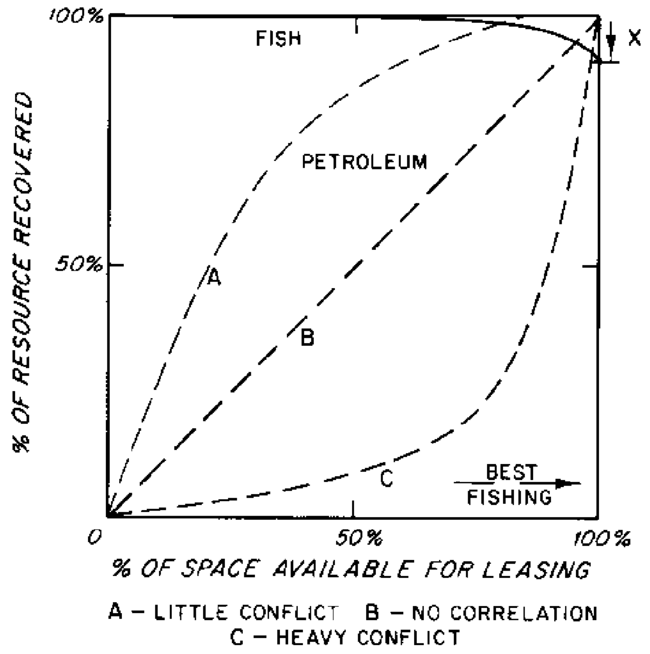

FIG. I-6 SCHEMATIC TRADE-OFF BETWEEN FISH AND PETROLEUM

space is distributed such that the most valuable *fishing* space is to the right (opposite to the way shown in Figure I-2). At one extreme (the left axis of Fig. I-6) no space is made available; clearly no petroleum can be recovered and there is no effect on the fish recovered. At the other extreme (the right axis of Fig. I-6) no space is withheld from leasing; all the petroleum available is recoverable and it is assumed that the total fish recovered is reduced by some percentage X. Figure I-6 shows schematically three possible situations with respect to the coincidence of areas of value to each industry: where there is little overlap between areas of high value to the two industries (A), where there is no correlation (B), and where there is a large degree of overlap (C). Clearly, the value of X is greatest in case C and smallest in case A.

The relative effects on the two industries of withholding the most valuable fishing areas from leasing can be seen in Fig. I-6. If, for example, the ten percent most valuable fishing areas were withheld from leasing, the negative impact on fisheries would be reduced by some fraction of X. In case A this would have little effect on the petroleum eventually recovered. However, X was small since there was little conflict in the first place, and so withholding the best fishing areas from leasing solved a non-problem. However, in case C, where there is heavy conflict, a policy of withholding the best 10 percent of the fishing areas would have a percentage effect on the petroleum resource eventually recovered of greater than 10%. The "tradeoff" between the two resources, however, depends upon X. Thus it is worth knowing, whether X is likely to be 0.1 percent, 1 percent or 10 percent.

The simplest starting point to estimate the spatial effect of platforms on fishing is to calculate the area which could be occupied by oil industry platforms. If we assume that a safety zone of 1/4 nautical mile is maintained around each platform or rig and that the latter have linear dimensions of about three hundred feet, the area displaced by each rig or platform is about two hundred seventy acres (0.32 square nautical miles). If at full production (not likely before 1985) there is a maximum of thirty platforms in each of the two areas under consideration, and if pipeline problems are ignored, the total area excluded by the platforms would be 8,100 acreas, or about 9.5 square nautical miles in each region. The dynamics of fishing increases the effective size of the area.

When oil fields are developed gathering lines would connect the platforms within a given field. If these pipelines were not buried the area between platforms could also be excluded for many types of fishing. Assuming that the centers of platforms are 2 nautical miles apart, the following table compares the total space excluded for a field of up to 10 platforms when the space between platforms is available for fishing and when it is not. The platform configurations, for the sake of calculation, are assumed to be closely spaced in squares or triangles on a simple square grid.

Number of Platforms in the Cluster	Area excluded in $(n. mi)^2$ if: inner space is available	inner space is not available
1	0.3	0.3
2	0.6	1.6
3	1.0	3.0
4	1.3	5.3
5	1.6	7.6
6	1.9	10.0
7	2.2	12.2
8	2.5	14.5
9	2.8	18.5
10	3.2	20.9

Three separate fields, each with 10 platforms, would exclude only about 9.6 $(n. mi)^2$ if the spaces between platforms are available for fishing. However, at least 62 $(n. mi)^2$ would be excluded if gathering lines prevented fishing between the platforms. This comparison demonstrates the potentially large difference between buried and unburied gathering lines.

While an area of only 9.6 n. square miles is negligible compared to the total area of a region like Georges Bank (about 20,000 n. square mi.), a simple area ratio overlooks at least two important factors: the significant spatial variations in fishing activity and the operational complexities of specific fishing operations.

In order to obtain an estimate of the possible effect on the fishing industry due to fixed installations, the most straightforward assumption would be that the catch is reduced in proportion to the area excluded. Geographical variations in fishing could be taken into account by using catch data. The fractional reduction in an area like Georges Bank could be estimated by calculating $A \cdot (c/C)$ where A is the excluded area, c is the average catch per unit area at that location and C is the total catch from the general region.

The ten year annual average of fish caught by bottom gear within the lease area on Georges Bank is approximately 1,400 million lbs. The ten year annual average catch per reporting area (which contains 83 square nautical miles) within the top decile of reporting areas is 20 million lbs. If the assumption is made that the total catch is reduced in proportion to the excluded area and that three clusters of ten platforms *are all in the most productive fishing decile*, then the hypothetical percentage reduction in catch X would be: 0.33 percent if inner space between platforms is available for fishing and a factor of two is used to account for dynamic effects. When space between platforms is not available X is increased to 1.1 percent.

These estimates for X, however, are not realistic because they assume that all platforms are in the most heavily fished areas. Referring to Fig. I-5 we see that this is not a plausible outcome since the tract selections are heavily distributed among the least fished areas. The actual distribution of tract selections can be taken into account by assuming that all selected tracts have the same probability for eventual petroleum production (i.e., that the locations of platforms eventually will be distributed in the same way that the tract selections now are). In that case X is proportional to $\Sigma A_i c_i$ where A_i is the area of lease selection in the i *th* fishing decile, c_i is the catch within the i *th* decile, and the sum is taken over all the ten deciles.* If this calculation is made for the distribution shown in Fig. I-5, then $X = 0.18 X_1$ where X_1 is the fractional reduction which occurs when all the platforms are in the most heavily fished decile (which is what was previously calculated). That is to say, the expected interference is 18 percent of what it would be if all platforms were in the most heavily fished areas. (It is interesting to note that the equivalent number would be 27 percent if the lease tracts were equally distributed among all fishing deciles; i.e., the predicted interference is two-thirds of what would be expected if the lease areas were randomly distributed.)

Our general conclusion is this; If on Georges Bank the eventual spatial distribution of production platforms is similar to the distribution of tract selections, the hypothetical percentage reduction in catch (X) would be: 0.06 percent if inner space between platforms is available for fishing; if space between platforms is not available for fishing, then the effect is increased to 0.2 percent.

The lobster fishery needs special comment because it is not dealt with satisfactorily by the previous arguments. In fact, the lobster fishery does overlap with areas of high petroleum potential. Since the catch data used are based on weight and not dollar value, this fishery is not appropriately represented in Figures I-3 and I-4. As noted earlier, lobsters are heavily fished along the shelf break and particularly in the submarine canyons. Because these areas present problems to the petroleum industry they are not likely to be given high priority by that industry until more is known about the commercial promise of the regions.

In later lease sales if the submarine canyon areas become important, they probably will have to be dealt with in a site-specific way. That is to say, the specific location of platforms would have to be considered because of the importance of local topography to the lobster fishermen.

Subsurface Obstructions and Debris: In our workshops and in many interviews, fishermen both here and in the North Sea commonly expressed concern that the petroleum industry could put obstacles or debris on the bottom which could damage nets and trawls.

A problem which seems to provoke much controversy is one which at first glance appears to be fairly mundane. Namely, bottom debris dumped by accident, by jettisoning in bad weather or by careless practice. While existing regulations forbid deliberate dumping, the ancient sea-faring practice of giving things the "deep six" still largely prevails at sea. Enforcement is inherently difficult. The problem is best addressed by direct communication between the operators in the industries so that the oil men can be made aware of the problems such practices create for fishermen. In addition, oil companies may wish to strengthen contractual requirements with their subcontractors which would insure good practices. The requirement to minimize the problem needs to be emphasized because, if not dealt with, dumping debris can be a source of much hostility and resentment directed toward the petroleum industry by the fishermen. It is taken as symbolic of the attitudes of the petroleum industry to the fishermen. (The liability issue is discussed in Chapter V.)

*One can show that $X/X_1 = (\Sigma A_i c_i)/c_1 A_t$ where X_1 is the interference when all platforms are in the most heavily fished decile, c_1 is the catch within the top decile and A_t is the total area of lease nominations.

Needless to say, the sea bottom is not in a pristine state when the petroleum industry arrives. Wherever ships operate the bottom is scattered with objects ranging from beer cans to shipwrecks.* It may be to a developer's advantage at the outset to survey the bottom areas near their drilling operations to establish a public inventory of bottom obstacles. Although individual fishermen keep "black books" of loran bearings of obstacles hazardous to their gear no compilation of this information exists. Such a compilation may not be easy to obtain because such information is viewed as proprietary by fishermen on the East Coast.

The production phases of petroleum operations require certain subsurface installations which can present the fishing industry with problems. The most important are *pipelines*. The earliest appearance of these would be as gathering lines which would run from each producing platform of a field to a gathering-processing platform. If the economics would justify it, at a later stage of development one or more pipelines could also lead from the fields to shore. At present, however, it is not possible to say with certainty when pipelines to shore would be installed. (See Chapter IV).

Whether pipelines are laid on the surface, trenched, or buried is important in assessing effects on fishermen. Indeed, the problem should be of key concern to both industries since collision of a 5 ton trawl door (such as used by Soviet or Japanese fishermen) with a surface laid pipeline is an encounter as likely to be won by the trawl door as by the pipeline. Unfortunately, the information which this study has developed is ambiguous on what can be predicted about pipeline practices. We have found, for example, that pipelines are often called "buried" when they have only been trenched. A trenched pipeline may be as much of a hazard to a fisherman as a surface laid one. Perhaps the only advantage is that the pipeline would be less likely to be moved if snagged by a trawl. We have also encountered differences of opinion on the practicality of burying gathering lines between platforms.

Past OCS practice has required the burial of pipelines to a depth of three feet in areas nearshore which are shallower than two hundred feet. Such a depth of burial would be adequate as a protection against fishing gear if the trench were properly backfilled. However, in the OCS areas off the East Coast a surface laid pipeline will not bury itself as can happen in the Gulf, nor will a trenched pipeline eventually be covered by natural sediment transport.

A pipeline may have valves which protrude into the water. These valves are relatively infrequent, but still may present a hazard. The petroleum industry has discussed developing protective domes for such valves so as to prevent damage to the valves or hang up of fishing gear.

Another potential hazard on the bottom are suspended wells. A suspended well head normally projects about fifteen feet above the bottom and is marked with a buoy. Suspended wells are not unusual in the Gulf of Mexico. However, we have no way of estimating how many there might be in the Atlantic OCS; presumably there would be many fewer than in the Gulf.

Subsea Production Systems are now being developed by the petroleum industry for use in water depths where conventional surface platforms are very costly. They are not likely to be used in water depths less than 800 feet. These systems are self-contained production facilities which sit on the bottom and are connected by gathering lines to a gathering-processing surface structure. The size and complexity of a subsea completion system would clearly require that bottom trawling and dredging should be kept clear – for the sake of both industries. The general impact of such a subsea facility on fishing would be comparable to a medium-sized shipwreck.

Navigational and Operational Interactions: During all phases of offshore petroleum operations, there will be numerous daily interactions at sea with fishing operations. In the early stages the most common encounters with fishermen will involve seismic ships and the supply boats which will be supporting drilling rigs. In later stages of development there will be ships or barges transporting oil to shore* and possibly the operations of pipelaying ships. Seismic ships tow very long streamers and need to follow a predetermined path. An encounter with a fishing boat which is also streaming its gear can be awkward and irritating for both, particularly if each does not appreciate what the other is trying to do. There is no magical solution for avoiding such conflicts. The irritations certainly can be minimized by good communication between industries and by trying to give advanced notice of seismic operations when they are planned for an extended time in a given area.

The movements of supply boats do not create qualitatively new problems. The petroleum operations add a modest amount of ship traffic to already busy areas. However, supply boat operators must recognize that a small wooden hulled fishing boat is not much of a radar target. Traffic control measures, such as lanes, could be introduced in the future if warranted. Also a much wider use of radar reflectors or transponders may eventually be in order.

*German submarines in the Spring of 1942 sank sixty ships along the stretch of coast we are considering here. The hulks remain.

*Oil industry representatives have indicated that barges would not be used in the areas under consideration because of weather conditions.

Fixed platforms and rigs must be properly lighted by law. Fixed platforms would be marked on charts and the location of drilling rigs would be given in Notices to Mariners. Their presence should create no qualitatively new navigational hazard. A fixed platform which is identified on the chart is less of a hazard for collision than a moving ship whose presence is unexpected, and certainly no boat should be regularly operating in such offshore areas without operable radar, radio and loran.

Fixed platforms, in fact, can provide navigational advantages to fishing boats. They are large radar targets and so are useful as navigational references. Since they are usually occupied, platforms are always a potential source of current information about the weather at sea. Finally, they could provide emergency assistance to a disabled vessel or an injured crewman.

ONSHORE INTERACTIONS BETWEEN THE INDUSTRIES

The opinion was expressed by several participants in our workshops that the onshore effects of offshore petroleum development will prove to be more troublesome for fishermen than offshore ones. It is not possible either to contradict or support this opinion at the present time. Without knowing the locations of onshore activities we can only make broad generalizations. We can conclude from these that there could be considerable conflict between the industries if petroleum offshore operations are based in the smaller, overcrowded fishing ports. Unfortunately some of these are closest to the areas of operations. On the other hand, there are potential benefits for fishermen if offshore operations would be based in the larger ports where port improvements would be welcomed.

Harbor Space:

An increase in the number of boats in harbors may crowd fishing vessels out of space now used or make dockage more expensive. It has been estimated that a minimum of two supply/crew boats are needed for each exploratory rig. This could result in as many as fifty new vessels operating from East Coast harbors. Maintaining production platforms involves one or two boats per platform. Increases in harbor traffic from oil supply boats, crew boats, tugs, and other vehicles could lead to increased numbers of accidents or cause delays in landing fish if the ports selected for petroleum operations are already crowded fishing harbors such as Chatham, Gloucester or Provincetown. On the other hand, a large underutilized port such as Boston or New Bedford or Fall River would be minimally affected if new facilities were built or existing facilities were expanded. Indeed, for ports which have the capacity for expanded use of their harbors the introduction of petroleum related activities could lead to desirable changes for fishermen if the changes were integrated with local plans.

Shore Space:

The demand for shore space will probably be greatest during development while the impact on wharfage is likely to be greatest during the exploration and early development phases before docks can be expanded. The impact on fishing ports could be minimized if consideration were given to those ports where land is readily available. Although small resort towns may be closest to oil fields and therefore convenient supply bases, the cost of going a few miles further to use an underused city port would be worthwhile in terms of problems avoided. Coordination with the coastal state's planning agencies could give companies associated with oil development information about alternative ports and shore space.

Marine Services:

Repair facilities and other services traditionally used by the fishing industry need to be considered if competition from the various supply and crew boats led to more expense or longer waiting lines. Owners of local repair facilities give preferential treatment to customers who pay cash rather than to those who expect long-term credit. Thus oil-related companies might well supplant fishermen who have traditionally enjoyed this advantage. Fishermen are not likely to welcome this change and the higher fees which could ensue. A possible longer run benefit to the fishermen is that oil boats might encourage improvement in repair facilities or dockage.

Labor Market:

The labor market for fishermen could be affected by a demand for crew members to work on supply or crew boats during all phases of petroleum development. The additional demand for seagoing labor is likely to have an impact on the fishermen by causing upward pressure on wage rates, or shortages of crew or captains for fishing vessels. If oil boat crew members received training which improved their skills or brought new members into the labor force, the fishing industry might beneft. Informal discussions between oil-related labor recruiters and local union and industry leaders could help to minimize this problem.

Capital:

Competition for capital between the oil and the fishing industries would be at most a limited problem. The major oil companies and their national and international suppliers will obtain funds internally or in national and international markets. However, funds sought by local suppliers to increase repair facilities or dockage might be drawn from the same local banks that finance fishing boats. The fishing industry could suffer from increased cost of capital or shortage of funds from local banks; limited local funds might be allocated to oil-related uses instead of traditional boat financing. The problem, if it arose, would be best handled at the state and local level.

Social Effects:

The impact of offshore oil on the community extends beyond the fishing industry, but the fishing communities may be affected more than others. The influx of temporary and permanent oil-connected personnel may change the local social system and might require expansion of schools, housing and other community supplied benefits. This expansion would be borne by local taxpayers before any substantial flow of money enters the community. The development phase is likely to involve the greatest number of temporary workers. If these workers locate in a city, rather than a small fishing community, their impact is not likely to be severe. A small village is less able to tolerate increased demands for housing and social services. Further, an influx of transient workers into such a community is likely to clash with established traditions and social norms. Such observations, though obvious, do reflect the experiences of the North Sea developments.

POTENTIAL IMPACTS OF POLLUTION

If oil is discovered in the new offshore areas and brought to production, some of it will be spilled or discharged into the ocean. What impacts could this have on the fishing industry?

Before attempting to examine this question it is essential that the approach taken in this study be clearly understood. This is especially so since the members of the study group are part of a scientific institution and the reader might expect that this study would provide authoritative scientific judgments about oil pollution. It is not the purpose of this report, however, to make an evaluation of the state of scientific knowledge.

The questions we examine are policy related, not scientific. They are specific and limited in scope. We are interested in two questions. First, on the basis of present knowledge, what special consequences can be foreseen for fishermen from the pollution effects of offshore petroleum development? Second, are these consequences likely to be significant for fishermen? Although scientific information is important in addressing such questions, the key words "consequences" and "significant" are not used as scientific terms. In the present context these words are to be measured strictly in terms relevant to the fishing industry. Thus the question is not how an oil spill affects marine life, but whether the net results of a spill could be great enough to affect the fishing industry in a way comparable to other factors which affect fishermen.

The question of the possible effects of oil pollution on fisheries can be approached in two ways: by examining the direct field evidence from past experience, and by estimating the magnitudes of the expected effects from what is known about the phenomena involved. Two general situations need to be distinguished: the effect of a single large spill, and the effects of chronic pollution at a given location resulting from both small spills and the discharge of oil-contaminated brines from production operations.

Most field studies of accidental oil spills deal with nearshore areas where the spill has been confined by local geography and where oil has come ashore. In such coastal situations damage to local marine life may be catastrophic immediately following the spill. Effects from a spill (at least of fuel oil) can be observable under certain circumstances for as long as several years, particularly if petroleum has become heavily incorporated in the sediments. In such coastal situations a large spill can lead to the closing of an area to fishing, particularly mollusk fishing, for an extended period.

There have been no definitive field studies on the effects on fisheries from large oil spills on the open ocean in situations similar to the OCS off the East Coast. Not only are such spills rare but studies in the open ocean present much more difficult logistical problems than ones in coastal areas.

The effects of chronic oil pollution on fisheries in areas where petroleum-related activities coexist with fisheries is not well documented. In the North Sea possible effects of oil pollution on fish catch cannot be separated from the effects of other pollutants, or from changes in fishing effort. In the Gulf Coast, where offshore petroleum development has existed for many years, commercial fishing activities have continued at high levels although the composition of catch and distribution of effort have changed over the years. A recent National Academy of Sciences' study (NAS, 1975) observes that:

> "One of the most extensive areas of coastal petroleum development and also an area of tremendous fisheries productivity is in Louisiana, with some oil fields that have been in production for more than forty years, and

many that have existed for at least twenty years. The chronic addition of oil through co-product brines is probably about twice the addition caused by accidental spills. Annual additions of petroleum at the estimated rates over the past thirty years would mean that Louisiana coastal waters have received 1.1. million barrels of oil. However, commercial fishing catches continue high in Louisiana water.

Although evidence of mortality in chronically polluted areas is rare, tainting of oysters is frequently reported . . . Tainted oysters must be removed to unpolluted areas for several months to make them marketable."

The N.A.S. study then points out that other historical activities of the petroleum industry in Louisiana have had far more serious consequences for the fisheries than oil pollution. Dredging for canals and pipelines in the coastal areas has caused erosion of marshes and salinity intrusion into the estuaries which have altered the nursery grounds. Thus, although the total fisheries yield in Louisiana has continued at a similarly high level for many years, the character of that catch has changed significantly. The N.A.S. study feels, however, that these changes are primarily attributable to *physical* changes in the coastal areas.

The paucity of direct evidence on the chronic effects of oil pollution on fisheries must be interpreted with caution. The evidence available is not adequate to demonstrate that there are no effects. The basic problem is that over a period of ten or twenty years several factors influencing the fish catch change simultaneously. The influence of any one of these factors can seldom be separately identified on the basis of the historical data. The evidence does suggest, however, that the effects due to chronic pollution are not dramatic except in a very localized situation where the level of contamination is unusually high.

The problem of the effects of oil pollution on fishing can also be approached by trying to estimate the magnitude of the effects in terms of what we know about the basic phenomena. The principal situations which appear to be important are the following: (a) the effects on fisheries within the *coastal* region resulting from the transportation to shore of oil from the offshore region, (b) the direct interference to fishing caused by the presence of an oil spill in the open ocean, (c) the effects on the offshore fisheries from decreased fish stocks resulting from large oil spills, and (d) the effects on the offshore fisheries from decreased fish stocks due to the effects of chronic pollution resulting from small spills and the discharge of oily brine at production sites. We consider each of these in turn.

(a) Pollution effects in the coastal areas due to offshore production depend upon the net changes in petroleum processing and transportation which result from offshore production. If the offshore crude oil is shipped ashore and then trans-shipped out of the region for refining there would be a net increase of pollution for the region. If, however, the crude oil came ashore by pipeline and were processed and distributed within the region there could be a net decrease in oil pollution for the coastal areas because the new oil would replace oil previously shipped in by more hazardous means. Therefore the *increment* to coastal pollution due to offshore production may not necessarily be large, and conceivably could even be negative. However, it does not seem possible to forecast now all the changes which will occur within the petroleum industry along the northeast coast if petroleum is found and developed offshore. Such a problem, in any case, is outside the scope of this study. It is unfortunate, however, that more cannot be said about this problem because the coastal pollution impacts could well be more serious than the offshore ones.

(b) The presence of a sizable oil spill in a fishing ground is clearly an impediment to a fisherman for a period of time after the spill. In the early stages of a spill patches of thicker oil would be surrounded by large areas of slick. The total area would be eliminated from fishing. In the later stages of its evolution the oil spill would be fragmented and dispersed over a large region and would consist largely of emulsified or tarry lumps. If the density of these fragmented residues were high they could foul fishing gear and the catch itself. The magnitude of the direct problems to fishermen depends upon the type of oil discovered, the frequency and the size of spills, the time taken for possible cleanup operations, and the length of time required for sufficient dispersal and weathering of that part of the spill not cleaned up. The effects can be estimated from the M.I.T. studies (M.I.T. 1973, 1974). They estimate that from one to seven major spills (over 1,000 barrels) could be expected in each of the offshore areas in the case of a major oil find over the lifetime of the field, some twenty or thirty years. A spill of 1,000 barrels would in its initial stages (in *calm* water) eventually cover about two square miles and take about two days to reach that size. A very large spill of 70,000 barrels theoretically would cover about twenty-five square miles and take nearly ten days to complete its spreading. The dispersion of a real spill, however, would be much more complex because of the high probability of severe weather in such a period. The surface remnants of such spills, though dispersed, would spread over much larger areas and could remain over the fishing grounds for many days after such a spill.

Presumably, however, a very large spill would lead to substantial and complicated cleanup operations. Since dispersing or sinking agents should not be used in a fishing ground, physical recovery of the spilled oil from the surface would be required. Because of the high frequency of bad weather in the area such recovery operations would be both incomplete and time-consuming. It is probable that the affected area would be closed to all traffic during the cleanup operation.

We conclude that although the net effect of interference with fisheries due to large oil spills is small when measured over the lifetime of the field (due to their infrequent occurrence), the effects on fishing operations when such a spill occurred could be substantial for times as long as several weeks after the spill. (The question of compensation for fishermen due to an oil spill is discussed in Chapter V.)

(c) The possible effects on fish stocks of a large spill at sea is a matter on which only very general speculation can be made. No significant field data exist and there is uncertainty in extrapolating the experiences of coastal situations to species found in the offshore environment. Moreover, the effects would vary significantly with the season and with the weather conditions in the days immediately following such a spill (which would influence evaporation and the mixing of fresh oil into the water), and they would depend upon the type of oil found in the areas. Adult fauna probably would not suffer heavy mortality; the principal concern would be for the effects on the larval and juvenile stages.

A quantitative attempt has been made (M.I.T. 1973, Vol. II) to estimate the possible magnitude of the mortality that might be suffered by fish larvae (which spend time in the surface layers) on Georges Bank due to a very large, 24,000 barrel spill. This was done by calculating the surface area swept out by such a spill and by assuming that all fish larvae moving into the slick (which moves through an area of roughly four hundred square miles) in the first four days were killed. From existing information about spawning areas and spawning seasons, the report estimates that the number of larvae killed would be about one percent (of a year's total) for those species which have spawning periods and grounds which are the most restricted in time and space. They note, too, that the effect of a one percent larvae kill would be significantly less than that on the succeeding adult population.

Such calculations, although they are probably the best that can be done at present, must be taken with caution because they require so many simplifying assumptions. For example, it is probably easier to estimate the spatial distribution of the affected area than it is the time span over which the effects are felt. Mixing processes could bring emulsified oil to the bottom in the shallower parts of the regions. If fresh oil is introduced to the bottom, exposure times are going to be much longer than four days.

The best we can conclude is that evidence does not now exist that a single large spill would be a major threat to the fisheries. Certainly evidence does not exist which would indicate that offshore drilling should not take place for that reason. However, efforts should be made to gain a better understanding of the problem as the development process proceeds. Recommendations will be made at the end of this chapter on that question.

(d) Possible effects on fish stocks from chronic pollution could result from the cumulative effects of small accidental spills and brine discharges associated with the production platforms. Present regulations require that the oil content of the discharged water after separation not exceed fifty parts per million. At such a concentration the oil introduced from the brine discharges probably exceeds the average of that due to small accidental spills.

Chronic pollution would not appear to be a serious concern in an open ocean area except in the immediate vicinity of a production platform. The M.I.T. Georges Bank Study (M.I.T., 1973) estimates that the biologically affected area would not extend for more than forty feet from the production platform.

Such estimates are uncertain because they require simplifying assumptions about the diffusion and distribution of the discharges and there are uncertainties about long-term, low-level biological effects. In contrast to the large spill, however, this is a situation which can be monitored as production develops and remedial steps taken if such estimates prove radically wrong. Thus we conclude that offshore chronic pollution is not likely to be a significant concern for the fisheries if adequate monitoring is conducted.

Other materials than oil are introduced into the water column or the bottom during the drilling of wells. For example, about 920 tons of inert spoils are discarded onto the bottom by the drilling of a single deep well. These materials will make modifications to the bottom, though only in the very immediate vicinity of a platform.

FINDINGS

General Findings:

The high level of fishing activity and its widespread nature along the East Coast makes some degree of conflict inevitable between the offshore petroleum and fishing industries. Our study indicates that a possible OCS petroleum development need not have a significant effect on the offshore fishing industry *as a whole*. Total fish catch, for example, is not likely to be appreciably affected. However, many quite specific and localized problems will arise between the petroleum and fisheries industries. These will involve operational conflicts at sea and competitions for space and services in ports which may be shared by both industries. The degree to which these conflicts cumulatively could become major problems is dependent on two factors: (a) how well such conflicts are anticipated in the planning processes of the oil industry, the Federal agencies, and the state and local governments, and (b) the extent to which good communication can be established between the oil industry and the fishing industry.

Some positive benefits to the offshore fishing industry could result from offshore petroleum activities. The presence of fixed platforms would provide some assistance to fishermen with respect to navigation and emergency help. Improvements to harbor facilities and services, made necessary by the petroleum industry, would be of benefit to fishermen if located and planned properly.

It should be emphasized that the domestic fishing industry is not an integrated or well organized industry but consists of a large number of very small or individual operations. *An effect, therefore, which is small in terms of the total industry is significant for the fishermen directly involved.* Adjustments and compensations for these effects are made by individual operators and not by many small adjustments distributed across the industry. Communication with the industry is difficult because of its localized character and because the industry is not highly organized on a regional or national basis.

Specific Findings:

1. *Loss of Space.* The space at sea permanently occupied by offshore production platforms will not significantly reduce the total fish catch.

Assuming that there will be as many as thirty production and associated platforms in each of the two prospective regions, and making the simplifying assumption that fish now caught in the space occupied by platforms could no longer be caught, the reduction in total catch is estimated to be 0.33 percent if all the platforms were in the most heavily fished areas. However, a comparison of the spatial distribution of historical fish catch on Georges Bank with the distribution of tract selections shows that most of the selections are not in the most productive fishing areas. A more realistic estimate for the hypothetical reduction in catch on Georges Bank due to the presence of platforms is probably closer to 0.06 percent.

If space between platforms were not to be available for fishing, the estimates given above would be increased by at least a factor of 3.3. It is important, therefore, that gathering lines between platforms be buried in the more heavily fished areas.

2. *Obstructions.* Subsurface obstructions and debris are a major hazard to fishermen because they can lead to the loss of both gear and time.

Possible damage to subsurface installations from heavy fishing gear is also a hazard for the petroleum industry.

A variety of steps can be taken to minimize the problem: the full burial of pipelines to at least a three foot depth, designing bottom protrusions so as to minimize the snagging of fishing gear, and maintaining adequate surface markings of subsurface installations.

The problem of the dumping of debris on the bottom from supply boats during development operations is a sensitive one for fishermen and a potential source of much friction between the industries. Good housekeeping practices must be required of its subcontractors by the petroleum industry.

3. *Platform Benefits.* Permanent platforms at sea can be of potential benefit to fishermen. They can be helpful for navigation and will be a continuing source of information on weather and sea conditions. Platforms can also be helpful to fishermen requiring emergency assistance.

At a later stage when the installation of platforms is being planned, it will be important for both industries to work together to see how such platforms can be of most use to fishermen without impairment of their principal functions.

4. *At Sea Operations.* There will be many daily encounters at sea between boat operators in the two industries. Particularly in the early stages of petroleum operations, frictions between individual boat operators at sea will occur and could create widespread resentment among fishermen if such problems are not anticipated. The problems can be minimized by maintenance of good communication between the industries, the development of inter-industry forums for the hearing of complaints, and the willingness of both industries to come to mutual agreements about operating practices and information exchange.

Numerous foreign fishing vessels operate in the Atlantic offshore areas. These may well present more problems to the petroleum industry than domestic vessels, particularly since the petroleum industry will not be able to deal directly with the foreign fishermen on a daily basis.

5. *Port Operations.* In ports used by both the fishing and oil industries there is a potential of both conflict and cooperation. The local fishing in-

dustry could be severely disrupted by the competition for services and facilities, harbor space, labor, and possibly capital if the port is small and fully utilized. In larger ports where harbor, docking and shore space are now underutilized, even though there may be some conflicts in the initial stages, the introduction of support activities could eventually benefit fishermen by creating long need port improvements. The effects, for example, would be different in Boston, New Bedford or Narragansett Bay than they would in Provincetown, Chatham or Point Judith.

The proper location and planning of shore based facilities for the support of offshore development, therefore, is critical for the fishing industry. The character of the impacts is very much dependent on the ports selected and the degree to which petroleum industry planning is done in cooperation with state and local authorities early in the decision-making process.

6. *Pollution.* The possible effects of pollution from offshore oil operations cannot be shown at the present time to be a major hazard to the offshore fishing industry. The situations of potential concern are:

a) Increases in coastal pollution from new offshore oil being transported to land. Whether pollution problems nearshore are increased or decreased by offshore development is a function of the changes caused by offshore oil in the entire network of transportation, handling and processing of petroleum in the coastal area. This is not now known. The problem will need continuing attention as the development process goes on to insure that the effects of nearshore dredging as well as oil pollution are minimized.

b) A major offshore spill which physically interrupts fishing activities. Although not expected to be a frequent occurrence, one or more spills can be expected over twenty or thirty years which could prevent fishing in a sizeable offshore area for periods of up to a few weeks.

c) A major offshore spill which could affect fish stocks. A fresh spill could destroy planktonic juvenile life in the surface layer of the ocean. The expected size and duration of a single spill does not appear to be great enough to have an appreciable effect on fish stocks in this way. Because of many uncertainties in our knowledge of offshore effects (particularly if fresh oil is incorporated in sediments) the problem requires continuing research attention. Present evidence, however, does not suggest that a single major offshore spill could be a long-term threat to total fish stocks.

d) Chronic pollution near the production platforms. Possible chronic effects from small spills and discharges are not thought to be a problem to fish stocks. If such effects did exist they would be very localized and would be subject to monitoring and control.

e) Spoils from the drilling of wells. While substantial quantities of inert drill spoil material is dumped at the site, their effects are very localized and would not have significant affects on fish stocks.

7. *Research and Monitoring.* Efforts will be required to ensure that oil pollution will not become a threat to fish stocks. BLM is in the process of starting an environmental baseline program. The development of a long-range research strategy for such a program, however, is not simple and needs considerable attention. In developing such a program the following points must be clearly kept in mind:

a) Offshore petroleum development is not the only new activity which will affect the OCS in the years ahead. For example, fishing activities, ocean dumping, shipping, dredging, sand and gravel mining, land runoffs and atmospheric inputs will all change significantly in the years ahead. These man-made stresses on the OCS waters must be viewed in an integrated way because they do not have separable effects.

b) There must be a concerted effort to identify *key* environmental research issues since there can be no hope of measuring every possible aspect of the offshore environment. Any approach which assumes that an inventory or catalogue can be made which describes the "normal" state from which changes can be measured will have limited success. Understanding the *processes* at work is at least as important as building a catalogue of "facts" which were true only at the time they were measured.

c) Most of the basic processes which control oil pollution are not dependent on the fact that oil is the pollutant but are basic physical, chemical and biological processes. Any research program, even though motivated by petroleum developments, must deal with broad questions and should attempt to increase *general* understanding of the processes which occur on the continental shelf.

8. *Legal Framework.* We have identified three areas where the present legal framework is deficient in dealing with problems between the offshore oil and fishing industries:

a) Planning. A large number of potential conflicts between the oil and fishing industries may be avoided or minimized through proper planning. Given the variety of interactions at sea, as well as the onshore impacts from offshore oil development, coordination between the Federal government, state and local governments is a necessity. This has been inadequate in the past and a lack of planning and needless conflict have resulted.

To improve this situation federal agencies, in particular BLM, must provide information to the states concerning the location and specific requirements of petroleum development as early as possible in the leasing and exploration process. The states will then be better able to state their interests and take part in the planning for offshore oil. Such federal-state cooperation is mandated by the Coastal Zone Management Act of 1972.

b) Regulation. The rapid increase in federal offshore oil development, coupled with the unique environmental and social conditions of the Atlantic coast, will place a heavy burden on the federal regulatory agencies for OCS operations. USGS OCS orders for the Gulf of Mexico and regulations of the Office of Pipeline Safety may prove inadequate to meet the needs of Atlantic OCS development. Pipeline and gathering line burial, for example, will pose a more serious problem off the Atlantic coast than it has in the Gulf. The Coast Guard too will face an increase in duties as navigational problems mount on the OCS. The manner in which the various federal agencies meet their new responsibilities will in a large part determine the level of conflict between the fishing and oil industries.

c) Compensation for Damages. The question of compensation for loss of fishing gear or fishing time due to the oil industry's activities is foremost in the minds of working fishermen. The question deserves special attention because the East Coast fishing industry is composed primarily of individual operators who can ill afford the time and cost of litigation.

Under current federal statutory law there is no general remedy for one harmed by oil pollution. Statutes cover only cleanup costs. While it is true that several states have acted to provide compensation for pollution victims, and that several admiralty decisions provide some hope for the injured party, the need for a comprehensive law of compensation is clear.

Damage to fishing gear which results from debris on the bottom rather than pollution may not be so susceptible to a broad, statutory solution. The cause of the injury is often not as clear as in the case of pollution. Inter-industry claims boards with government participation may provide a partial solution to this difficult problem.

9. *Inter-Industry Relations.* Emphasis must be placed on establishing and maintaining productive lines of communication at the earliest possible time among the industries and government regulatory agencies. Toward that end we recommend that regional inter-industry councils be established (one in each of the two areas of petroleum interest), patterned after the Fisheries and Offshore Oil Consultative Group in Scotland.* Minimum functions which might be considered by the councils are:

a) To act as a clearing house and investigative body for certain allegations and damage claims;

b) To provide information to each industry of the day-to-day activities occurring in areas of simultaneous fish and oil operations;

c) To act as an information source for regulatory agencies responsible for activities of the two industries on the OCS;

d) To establish a forum which will provide an "early warning mechanism" of potentially conflicting activities, and to work out other problems as they arise;

e) To continually review the changing importance of fishing grounds to both industries;

f) To act on any other matters of mutual interest, such as the foreign fishing effort and the dissemination of public information.

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*Report from the Fisheries and Offshore Oil Consultative Group. Edinburg, Scotland: Department of Agriculture and Fisheries for Scotland, July, 1975.

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CHAPTER II

The Physical Environment

The possibility of conflict between the petroleum and fishing industries exists because oil is formed in shallow marine environments so that much of the world's undeveloped petroleum deposits are submerged beneath the continental shelf waters which support some of the world's most productive fisheries. The potential for oil depends upon the geological structure beneath the sea floor but the distribution of fish and shellfish is governed by bottom sediment and the condition of ocean and weather, which also determines how effectively both fishermen and oilmen can recover the resources they seek. This chapter summarizes the physical environment of the Atlantic shelf off the Northeast Coast of the United States to the extent that it may affect oil and fishing operations. The physical environment is discussed in the following three sections in Subsurface Structure, Bottom Sediment and Morphology, and Sea State, Weather and Circulation. For more thorough descriptions, the references should be consulted.

SUBSURFACE STRUCTURE

Petroleum has been formed where the past environment favored dense accumulations of plant or animal matter as a source of organic carbon — probably in regions similar to the shallow marine basins, marshes and estuaries in which the same process is occurring today. Voluminous sedimentation must have taken place to bury the detritus before it could be decomposed or eaten. Eventually the ever-increasing weight of overburden — half a mile or more of sediment — produced the temperatures and pressures necessary to convert organic matter into oil and fine sediments into shale or similar rock.

Oil becomes commerically important if it has been squeezed out of the relatively impermeable source beds into new reservoirs of more porous rock, such as sandstone or limestone, and then eventually trapped in large quantities. Some possible entrapment features in the northeast Atlantic shelf are shown in Fig. II-1 (Schlee et al, 1975): where reservoir beds are arched (A), faulted (B), or pierced by shale or salt domes (C), where fossil reefs intrude (D), or where sediment wedges out at unconformities (E).

More than 80 percent of the world's past oil production has come from relatively young reservoir rock, 50 to 100 million years old. The continental shelf, slope and rise along the northeastern United States consist largely of such young rock. The best chance of finding oil appears to be in two regions (Frontispiece) where seismic surveying has identified thick alternations of fine grained potential source beds, and porous, permeable coarse-grained reservoir beds, together with potential trap formations. Only actual exploratory drilling, of course, can determine whether oil in commercial quantities is actually present.

The Baltimore Canyon Trough complex is a group of deep sediment pockets extending from about 35 miles offshore approximately to the shelf edge. The trough ranges in width from 35 to 125 miles, with an axis of subsidence which parallels the shelf edge from Maryland to Long Island and lies about 60 miles offshore. The greatest potential for oil is considered to be in an area of approximately 12,000 square miles extending from 38° to 40° N, where the beds are at least two miles thick. The greatest accumulations (USGS 1975) are 5 to 6 miles thick and date back 130 million years.

Another series of fault depressions starts about 60 miles southeast of Nantucket and extends eastward about 125 miles beneath the sourthern half of Georges Bank. This basin, known as the Georges Bank Trough, is about 50 miles wide and contains approximately 14,000 square miles of sedimentary formations from 2 to 5 miles thick (Ballard 1974).

Together, the potentially productive areas of the two troughs occupy about one third of the total shelf area. (Actually, the potentially oil-rich structures extend seaward beyond the shelf edge but present technology generally limits development to water depths less than 100 fathoms.) Within these larger regions, much smaller areas have been identified as containing possible petroleum entrapment features. The precise locations of such favorable structures are best known to the oil companies who assume the exploratory risk and consider such information proprietary. However, it can be safely assumed that they all lie where the sedimentary crust is thickest, along the shelf edge well beyond sight of shore.

It should be noted that the faulting and earthquakes which may have formed petroleum traps belong to the geologic past. The northeast continental shelf has been tectonically inactive for millions of years and is now free of the seismic hazards which threaten the California coast. Furthermore, no abnormally high fluid pressures have been found during exploratory drilling on the nearby Canadian shelf (O.J. Shirley, Shell Oil Co., personal communication) so that this drilling hazard may be absent from the Baltimore Canyon and Georges Bank Trough.

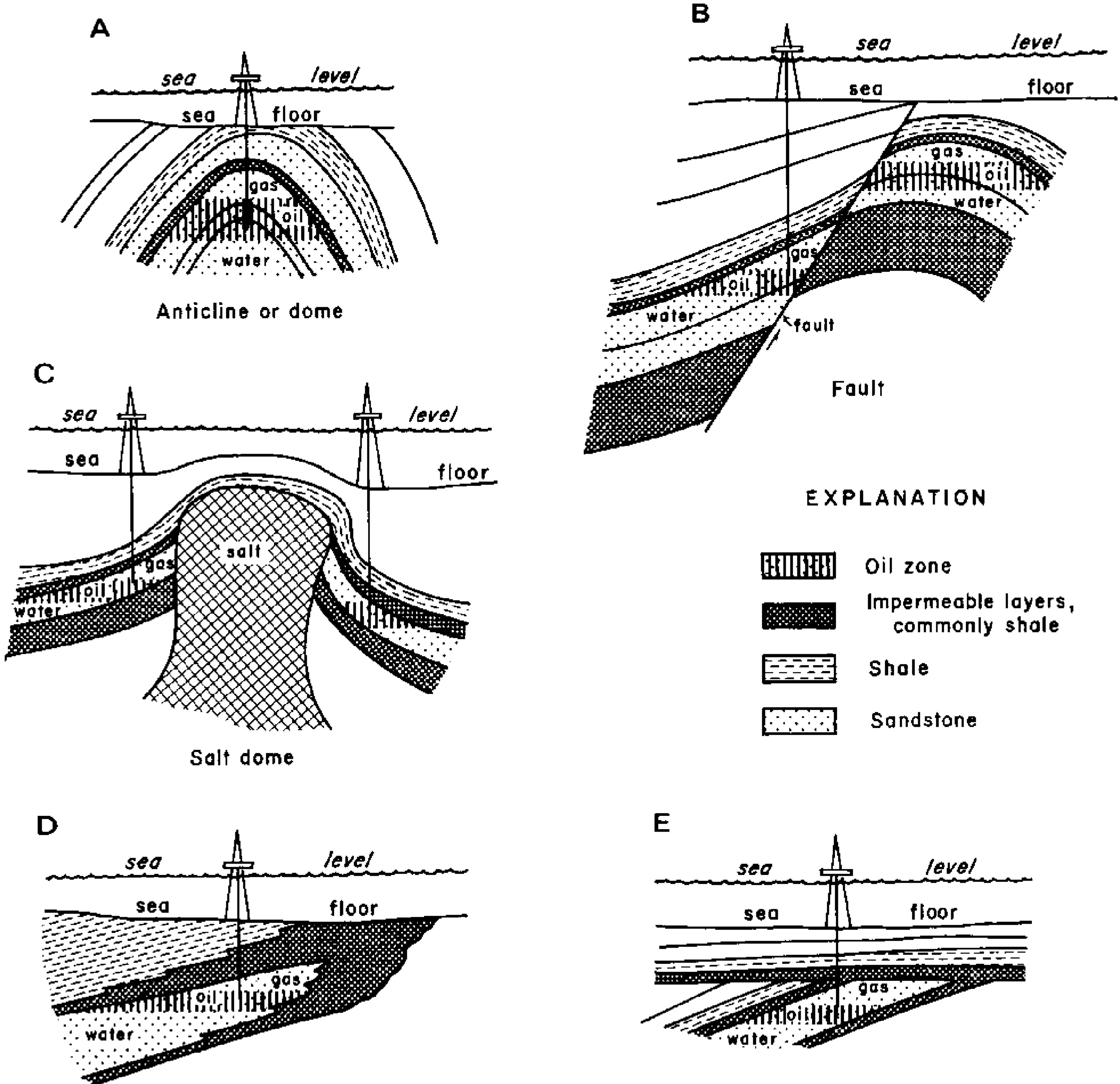

FIG. II-1 GEOLOGICAL TRAPS

BOTTOM SEDIMENT AND MORPHOLOGY

Northeast of Cape Hatteras the continental shelf widens so that the 100-fathom curve that marks its edge is 60 to 100 miles offshore. The resulting gradient on the shelf is very gentle – only a few feet per mile – but it steepens sharply beyond 100 fathoms on the continental slope, reaching the 1000-fathom curve within a few miles, then gradually flattens across the continental rise to the abyssal plain (Fig. II-2).

The morphology and unconsolidated sediment of the shelf reflects the history of the past million years, a time when Pleistocene glaciers periodically covered the entire shelf north and east of northern New Jersey. Most of the features that distinguish the Baltimore Canyon region from Georges Bank result from this glacial division.

South of the glacier front, the shelf was repeatedly exposed out to the present 100-fathom curve. Six or seven river channels (Fig. II-3) still provide pronounced relief across the shelf. The canyons that cut deeply into the shelf edge and slope are found in both regions, and are not all clearly associated with ancient or present rivers.

The shelf surface is covered almost exclusively by relict sediment, either distributed by rivers flowing across the exposed shelf or scoured by gla-

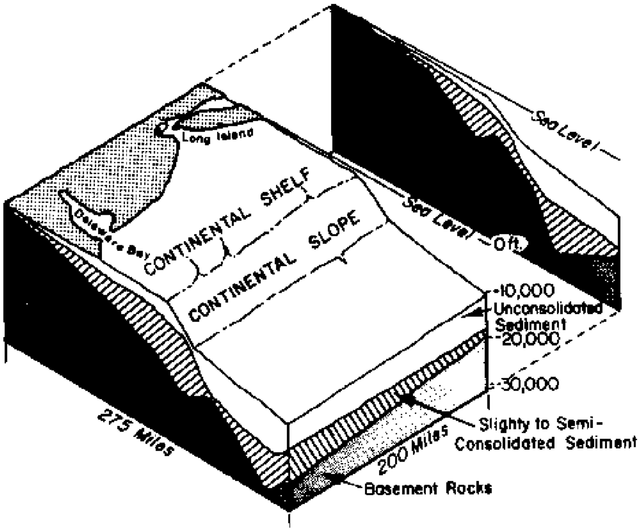

FIG. II-2 COASTAL ZONE PROFILE

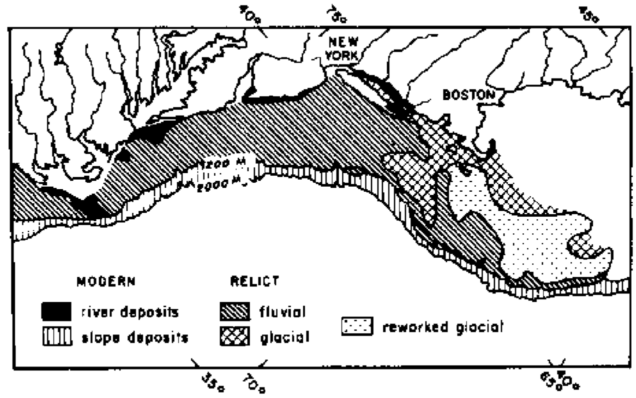

FIG. II-4 SOURCE OF SEDIMENTS

ciers from older inland rock and deposited along the ice edge (Fig. II-4). Since the sea advanced back across the shelf the bottom has remained relatively undisturbed, for currents are generally weak and most modern river sediment is trapped in estuaries and barrier lagoons along the shore. In depths greater than 20 fathoms, where storm waves seldom penetrate, the bottom is consequently compact and stable.

In shallower depths, sand waves characterize several areas. Shoals of residual glacial sediment cover Nantucket Shoals and the northern half of Georges Bank (Fig. II-5a) with ridges several fathoms high. Many are so shallow that storm waves break over them. Wave agitation and tidal currents cause these shallow sand waves to migrate, resulting in continually shifting of bottom deposits and significant changes in relief. South of Long Island, the rising sea level re-worked sediment into bars (Fig. II-5b) which are generally more stable than those to the east. However, in nearshore waters the grains are in fairly constant motion and ridges migrate as much as 20 feet per year. In both regions the low ridges in water more than 20 fathoms deep appear quite stable.

The sediments on the continental shelf can be classified according to the fish and shellfish species they support. Three general faunal environments can be distinguished (Fig. II-6): clean sand, silty sand, and silty clay.

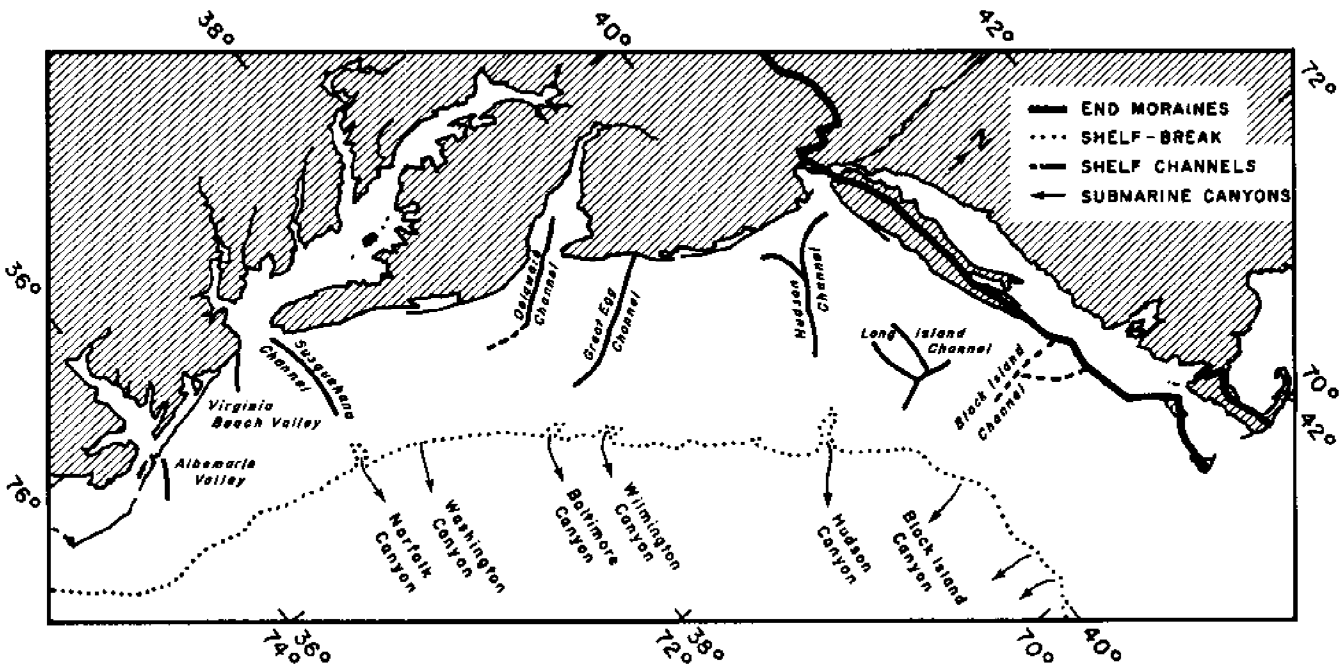

FIG. II-3 CHANNELS & CANYONS

FIG. II-5a

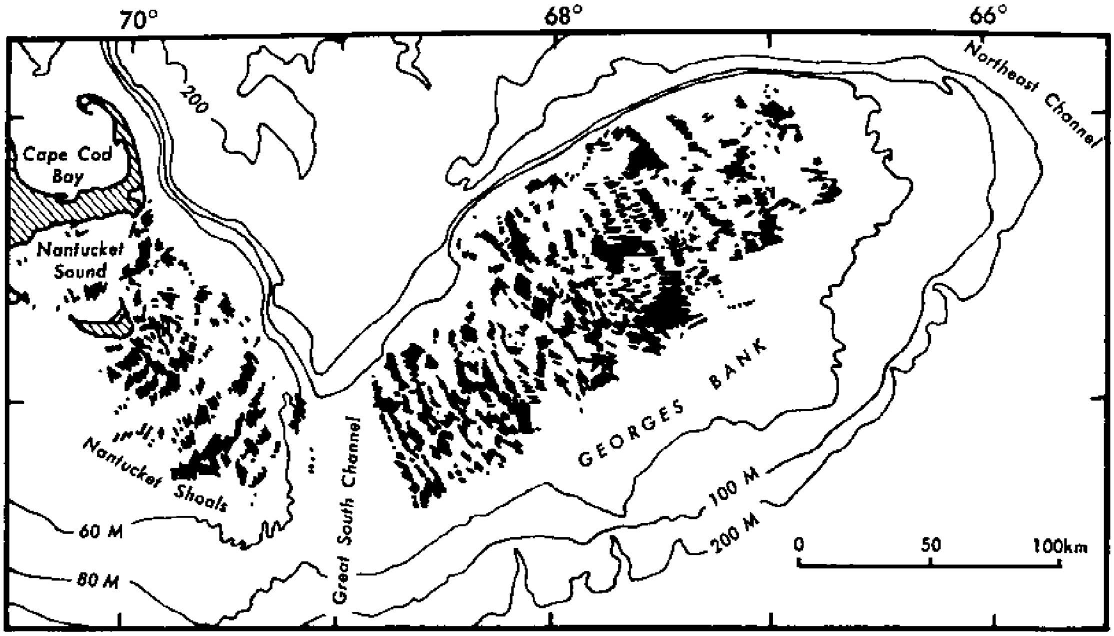

FIG. II-5b

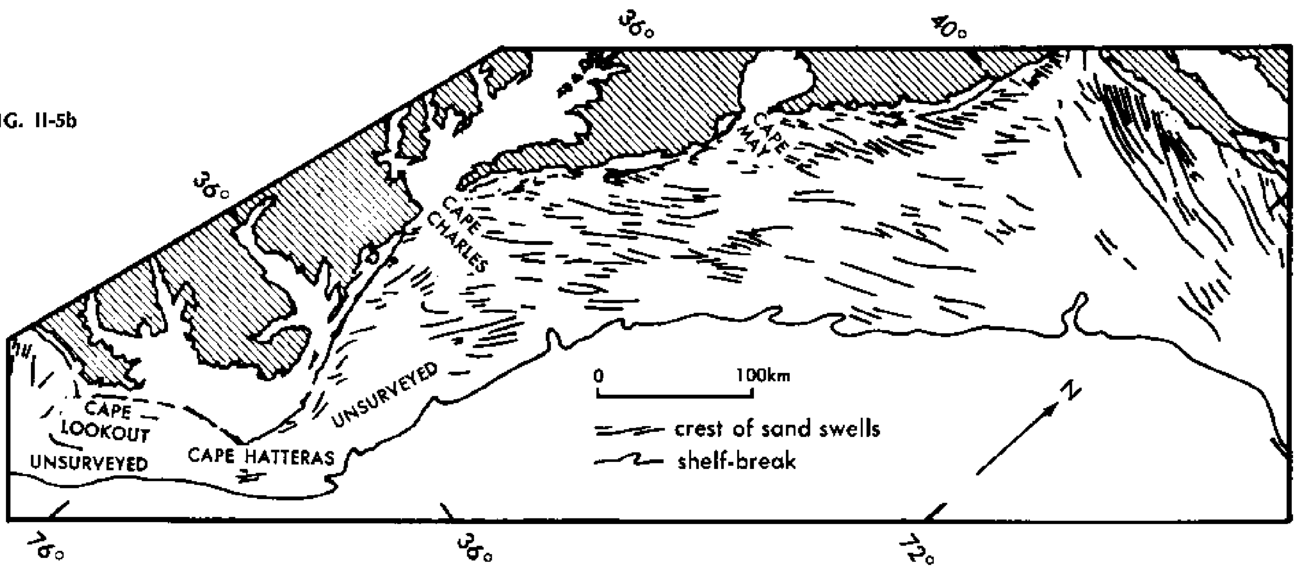

FIG. II-5 SAND RIDGES AND SWALES. (a) Nantucket and Georges Bank (b) on the shelf between Long Island and Cape Hatteras

Except for the shoals of Nantucket and Georges Bank, most clean sand lies within 10 miles of shore. Because of continual turbulence, oxygen levels in the water and sediment are high. Clean sand bottom supports large populations of a few species adapted for purchase in moving sand and recovery from burial. It is also the growth center for young flounder.

Silty sand covers most of the shelf between 10 and 90 fathoms. It forms a stable bottom with a much higher detrital organic content than the disturbed sands of the shoals, and supports large populations of benthic invertebrates; it is thus more productive than clean sand in terms of numbers of marketable bivalve suspension feeders and demersal fish. Southern Georges Bank is one of the most productive fishing grounds in the Northwest Atlantic, leading in production of sea scallops and yellowtail flounder. The silty sand of the Baltimore Canyon area supports large populations of ocean quahogs, scup, butterfish, and summer flounder in shallower areas through much of the year, while ground feeders graze the deeper areas.

A silty clay bottom forms a narrow band along the shelf edge and widens to about 40 miles northeast of Hudson Canyon. Because fine sediment clogs the filters of suspension feeders, this area does not support a commercial yield of bivalves. However, it is rich in some varieties of ground fish, as well as lobsters and red crabs.

Geologically, then, the northeast Atlantic continental shelf is quite different from other offshore oil producing areas of the United States. There is very little rock outcrop, except along canyon walls.

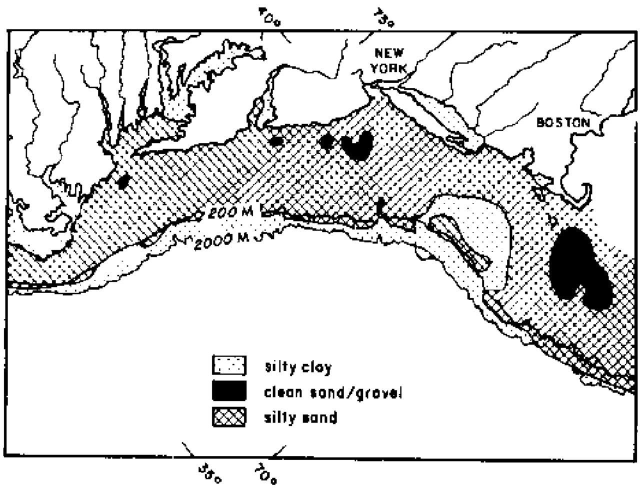

FIG. II-6 SEDIMENT TYPES

The silty sand and gravel covering most of the shelf form a compact, stable bottom, in contrast to the soft deltaic clays of the Gulf Coast. The gentle gradient and lack of steep topographic breaks help to increase the stability of the sediments, and surface slumping should be a problem only in canyons and along steeper slopes beyond the shelf edge.

The region should be generally free of the topographic difficulties common to other areas, such as pipeline rupture or drilling problems arising from unstable sediments or faulting. On the other hand, pipelines will not sink spontaneously into the compacted bottom as they do in the clays of the Gulf shelf, nor will sedimentation cover them, so that they must be buried mechanically if they are to be immune to dredge and trawl operations. The absence of stormy currents also means that displaced materials such as drill tailings and trench spoils will remain relatively unidisturbed where they are dumped, and may have a localized effect on bottom life.

The only areas of the outer shelf not geologically suited for drilling and construction are the few ancient river channels crossing the Baltimore Canyon Trough and, more important, the shallow migrating ridges of Georges Bank and Nantucket Shoals. These highly mobile sand waves create a special problem for pipelines that might be used to transport oil or gas to coastal distribution sites. A pipeline from any Georges Bank production site to shore must skirt the shoals and cross the 40-fathom Great South Channel; if the shore facility is west of the Cape the pipeline must also detour south of Nantucket Shoals. The sand waves further west and south are less of a problem although even their migration may present a technical challenge to pipeline construction across the shallow near shore zone.

SEA STATE, WEATHER AND CIRCULATION

Geology is less of a hazard for both the oil and fishing industries than are the wind and water movements which redistribute any spilled and jettisoned oil and the weather conditions which can interfere with navigation, construction, deployment of gear and cleanup operations.

The density structure of the water column, the speed and direction of surface currents and winds and the weather extremes possible on the northeast Atlantic shelf are highly variable short-term natural phenomena. Unlike geological factors, they can be predicted only in a statistical sense, and the actual conditions at any time may differ considerably from what the probabilities suggest. Thus any predictions, particularly those such as spilled oil trajectories that are generated by mathematical models based upon such statistical probabilities, must be interpreted with caution.

However, even though day-to-day conditions cannot be predicted with accuracy, some important generalizations can be drawn from historical data. The seasonal temperature and salinity distribution of the water on the continental shelf, which determines the density structure, is well known. The annual cycle (see Bumpus 1973) reflects the spring freshening of near shore surface water by river runoff, the renewed salting and warming of offshore bottom water by oceanic intrusions, and the seasonal warming and cooling of the sea surface by sun and wind. The cycle begins each fall with the advent of cold northwesterly winds and longer nights. The cooled surface water becomes increasingly dense; as it sinks it is stirred deeper by gales, and by mid-winter the entire water column is nearly homogeneous so that there is no vertical barrier to deep mixing of emulsified oil or tarballs. However, both temperature and salinity increase in the offshore direction, and there is usually a horizontal density gradient sufficient to support a dynamic flow of a few miles per day toward the south and west.

Fifty percent of all river discharge along the middle Atlantic coast takes place in the spring. The fresh runoff and extended sunlight help to create a layer of warm, less dense water 10 to 15 fathoms deep. By mid-summer this upper layer is separated from the colder near-bottom water by a strong vertical density gradient or pycnocline which inhibits the downward mixing of particulate or dissolved matter. Only over the shallows of Nantucket Shoals and Georges Bank is turbulent mixing sufficient to prevent this development. Below the pycnocline the horizontal gradient at the edge of the shelf persists throughout the seasons, along with the associated slow southwestward drift.

Wind stress is probably more important than density currents in moving water on the continental shelf, and particularly in the transport of oil floating on or near the sea surface. The offshore waters of the northeastern United States lie in the zone of the prevailing westerly winds of the northern hemisphere. The winds and weather are controlled to a large extent by the relative strength and position of two semi-permanent pressure centers: the Icelandic Low and the Bermuda-Azores High. In winter, when the Icelandic Low is strong, the prevailing winds and waves are northwest; in summer the Bermuda-Azores High strengthens and shifts westward, and southwest winds and waves predominate. The U.S. Department of Commerce (1968) statistics indicate that normal wind velocities on the shelf are concentrated in the 4 to 21-knot range with average non-storm winds at 8 to 12 knots in the summer and 10 to 20 knots in winter. Surface waters move slightly to the right of the wind direction at a few percent of the wind speed. However, as the Offshore Oil Task Group Study (1973) points out, the average persistence of wind from any one direction is only 3 to 6 hours so that the resultant surface drift is virtually unpredictable except in gales. This directional variability also means that the region is normally not one of noticeably high waves: waves are normally two to four feet and exceed 20 feet only 2 percent of the time.

The actual transport at any location on the shelf is further complicated by the tides. Tidal rise and fall are negligible but tidal currents can move a particle of water or oil along a circular or elliptical path as much as 20 miles in a 12-hour cycle even though the particle may complete the cycle close to its starting point, The unpredictable, short term spatial and temporal vagaries of both wind stress and tides significantly modify the density-induced drift and usually mask it locally. Bumpus (1974) reports that near-surface currents may flow in any direction and with speeds ranging from 1 to 10 miles per day. The tidal action also adds to wind-induced dispersion and consequent spreading of surface oil.

Despite all this, there is persistent evidence of a long-term net motion from northeast to southwest, generally parallel to the shelf edge, of a few miles per day. At the surface this flow appears to have a shoreward component during the warm half of the year and a seaward component during the cold half. In the deeper water the seasonal effects are less pronounced, and there seems to be a shoreward component over the nearshore half of the shelf and a seaward component over the outer half. But knowledge of long-term residual drift is of little help in predicting the movement of a particular oil spill subject to all the possible combinations of wind and waves and tides.

The weather over the continental shelf introduces other complications for both fishermen and oilmen. Cyclonic storms of both tropical and non-tropical origin provide dramatic exceptions to the local weather patterns, with high-velocity winds rotating counter-clockwise around a migrating low pressure center. Generally storms traverse the shelf from southwest to northeast wreaking havoc with ships and shore installations alike. Tropical hurricanes, with winds over 65 knots, average one or two a year and have been observed in the area from June to November although the peak occurrences are in late summer and early fall. From October through April the shelf is one of the hemisphere's major areas for northeast gales which intensify rapidly as they move northeast from Cape Hatteras gaining energy from the strong temperature gradients of the winter sea surface.

The Atlantic coast experiences more frequent, greater sustained winds and higher waves from hurricanes and northeast gales than the North Sea does from its storms (C.E.Q., 1974). In the Gulf of Mexico, hurricane frequency is about the same as on the Atlantic coast, but there are not the severe winter gales. Sustained winds of 80 knots or more and the waves they generate are generally considered the hazard threshold for offshore oil operations and manned platforms are shut down if this state threatens. Such winds are associated with only a few hurricanes; the BLM, Draft Environmental Statement (1975) gives a probability for sustained winds over the Atlantic shelf of once in 10 years for 80 knots, once in 20 years for 100 knots, and once a century for 120 knots.

Another hazard in the region is fog, particularly as small wooden fishing boats are relatively poor radar reflectors. (Large steel platforms, on the other hand, are excellent reflectors.) The incidence of fog is greatest in late spring and early summer when warm moist oceanic air is blown in over the still-cold surface shelf waters and condensation occurs. The hazard increases toward the east: in the Baltimore Canyon Trough region visibility less than half a mile occurs about 5 percent of the time in the fog season; from Long Island to Nantucket Shoals about 13 percent and over Georges Bank perhaps 16 percent for one day out of six (U.S. Navy 1970).

Neither rain nor snow is a dominant feature of the shelf climate at any season but both, of course, reduce visibility when they occur. Precipitation is usually greater in the winter, with the ratio of snow to rain increasing toward the north, but hurricanes can produce rainfall maxima in late summer. Icebergs are not a problem — none has been sighted in the region for more than 60 years — but spray freezing in the rigging in winter gales can destroy radar and loran reception and make small vessels dangerously top-heavy.

Weather statistics for the shelf, combined with the long distance offshore of probable production sites, suggest that present cleanup equipment will not be generally useful in the event of an oil spill. Boom containment is not effective in waves higher than about 5 feet. In summer this height is exceeded 10-20 percent of the time and in winter 40-60 percent, increasing from west to east (although the spilled oil itself would help calm the seas). Most spills would occur more than three hours from a staging area. Consequently, even under calm conditions a spill would probably spread over a large area before it could be contained.

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CHAPTER III

Atlantic Coast Commerical Fishing

INTRODUCTION

This chapter discusses the fisheries of the mid-Atlántic and New England areas and presents the attitudes of a sample of the commercial fishermen toward offshore oil development. Information on domestic commercial fishing operations was gathered in two primary ways. Group meetings and individual interviews were held to obtain information on fishing grounds. The potential areas of conflict between fishing and oil development were also discussed at these meetings. More detailed information was obtained through questionnaries distributed to approximately 450 commercial fishermen or fishing vessel owners from Maine to North Carolina (see Appendix II). The major sources for the names of these fishermen were the Federal Government's groundfish certificate holders' list, which should include all bottom fishermen on the coast who operate in the ICNAF (International Commission for the Northwest Atlantic Fisheries) Convention area, and the Atlantic Offshore Fish and Lobster Association's mailing list, which includes both fixed and mobile gear fishermen.

Group meetings were held in Cape May and Point Pleasant, N.J., and Montauk, N.Y. These meetings included fishermen from other ports as well, including Atlantic City, N.J.; Wanchese, N.C.; and Shinnecock, N.Y. Individual contacts were made in these ports as well as Pt. Judith, R.I.; New Beford and Boston, Mass.; Belford, N.J.; Lewes, Del.; Ocean City, Md.; and Chincoteague, Cape Charles, Oyster, Little Creek, Norfolk and Hampton, Va.

In addition to these primary sources, NMFS (National Marine Fisheries Service) statistics were used. Information on fishing gear and techniques is presented largely from personal knowledge with assistance from fishermen and some published sources.

The area of potential petroleum development off the Atlantic coast between Cape Hatteras and Georges Bank provides the livelihood for commercial fishermen from more than 17 nations operating a variety of vessels and imploying many types of fishing gear. The total volume of fin fish and squids taken from the offshore waters in this area in 1974 was 938,610 metric tons, of which the U.S. took 24 percent, or about 225,000 metric tons (ICNAF 1975). The annual world catch, for comparison, is about 65 million metric tons. The ICNAF figure excludes shellfish and the strictly inshore fisheries, including the very productive menhaden fishery which is largest in volume and second in dollar value on the East Coast but takes place almost entirely nearshore. Including these would bring the U.S. total to about 332,000 metric tons, or 15 percent of the total U.S. catch, with a value of $165,214,000, or 18.5 percent of the U.S. total (NMFS 1975). The U.S. catch is harvested by 26,000 full-time and about 29,000 part-time commercial fishermen, using more than 1000 vessels of 5 tons or more and 16,000 smaller craft. The region includes nine of the 25 highest volume ports in the U.S. and seven of the 25 highest value ports (Fig. III-1).

The species taken in greatest volume on the northeast U.S. shelf are menhaden, sea herring, yellowtail flounder, ocean perch, surf clams, cod, whiting, lobsters, northern shrimp and scup. In value, the highest ranking species are lobsters, menhaden, yellowtail flounder, sea scallops, surf calms, cod, northern shrimp, blackback flounder, striped bass, and ocean perch. Stocks of haddock, formerly one of the highest volume species, have been severly depleted and catches have been low in recent years. In fact, there has been an overall decline in catch volume in this region since the early days of the century (NMFS 1975).

The decline in tonnage can be attributed to overfishing of certain species and to the big increase in foreign fishing off the northeast coast since 1963. In the future, the fishery could yield greater tonnage if certain conditions are met. First, there must be strict catch limits for popular species to allow stocks to increase to a level which will support a consistently larger catch in the future. Second, species which are currently underutilized can be caught and processed as commercial products. Finally, the division of the industry between domestic and foreign fleets could change with the adoption by the U.S. of a 200-mile resource zone and subsequent stricter regulation of the foreign fishery. Biologists estimate that the northeast U.S. shelf could eventually produce an annual catch of 1.5 to 2 million metric tons with careful management.

FISH PROCESSING

An important land-based segment of the fishing industry is processing and wholesaling. Much of the fish and shellfish brought into Middle Atlantic and New England ports is sold fresh, but processing in plants was valued at $412 million in 1971. Major processing methods are: fresh and frozen packaging,

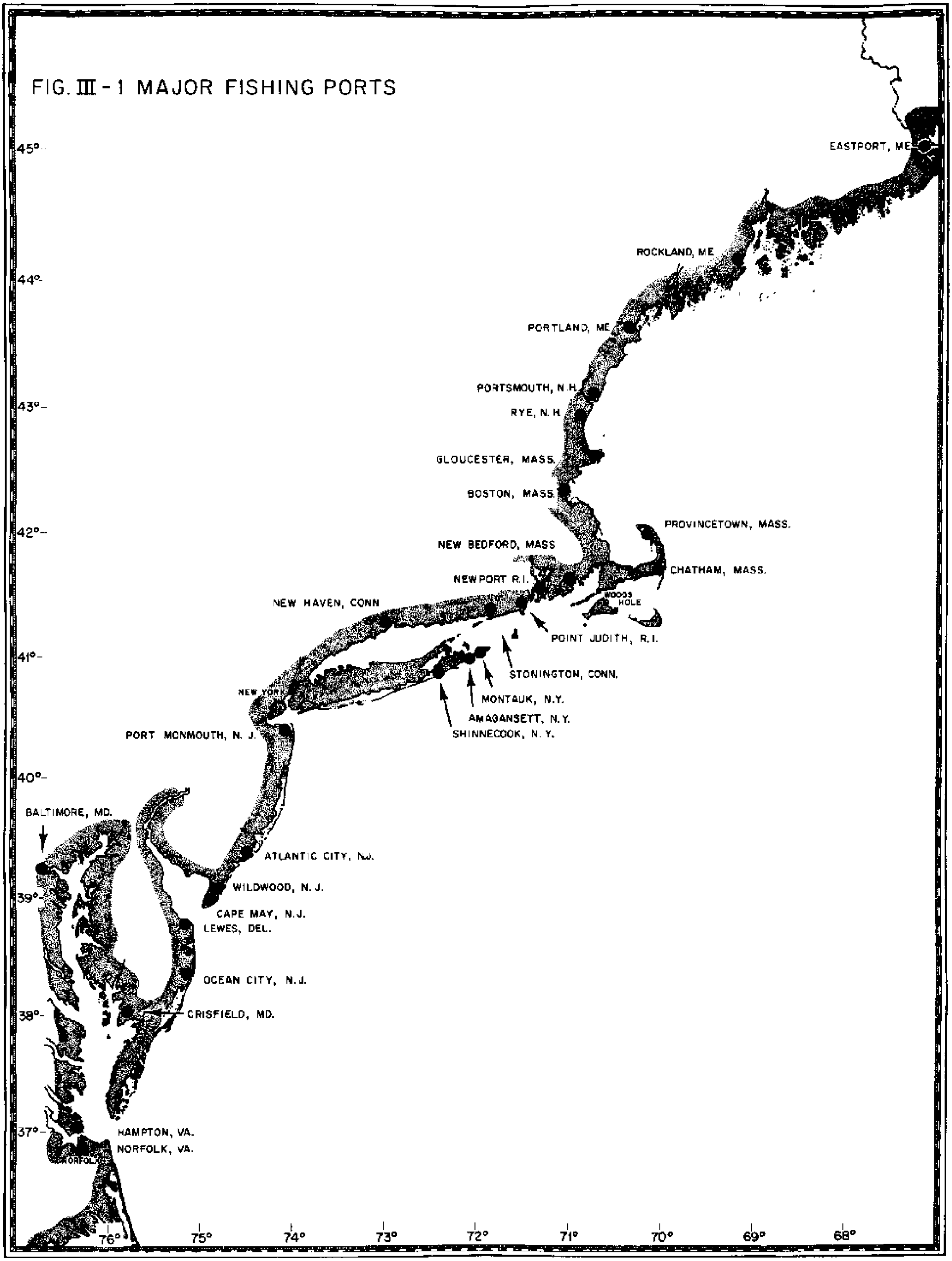


FIG. III-1 MAJOR FISHING PORTS

canning, curing, and industrial processing such as fish meal or fish oil. Table III-1a. shows the value of various processed products in New England and the Middle Atlantic in 1971. The number of plants and employment for processing and wholesaling establishments in the two regions is in the bottom half of the table. Average seasonal employment in wholesale and processing establishments was 17,782 for the two regions.

Table III-1

a. Value of Processed Products, 1971 (in thousand dollars)

Packaged:	*New England*	*Middle Atlantic*	*Total*
Fresh	43,646	25,245	68,891
Frozen	152,009	65,501	217,510
Canned	38,188	36,498	74,686
Cured	1,729	31,461	33,190
Industrial	16,021	2,031	18,052
Total	251,593	160,736	412,329

b. Processing and Wholesaling Establishments and Employment, 1971

	New England	*Middle Atlantic*	*Total*
Processing Plants	239	118	357
Employment Av.			
Season	9,910	4,714	14,624
Year	7,450	3,976	11,426
Wholesale Plants	268	265	533
Employment Av.			
Season	1,438	1,720	3,158
Year	1,202	1,679	2,881
Total Plants	507	383	890
Employment Av.			
Season	11,348	6,434	17,782
Year	8,652	5,655	14,307

*Source: NMFS, Fisheries Statistics of the United States, 1965–1971.

U.S. VESSEL AND GEAR TYPES

U.S. fishing vessels operating in the northeast range from large modern trawlers with expensive and sophisticated electronic and hydraulic gear to small wooden boats with a minimum of equipment. New construction is now dominated by steel-hulled vessels, but much of the fleet consists of wooden boats built as many as 30 years ago. Most of the U.S. boats operating in the Middle Atlantic and New England states are under 100 feet long. The major types are described below.

Purse Seines:

The fishing gear which harvests the greatest volume of fish on the Atlantic coast northeast of Cape Hatteras is the purse seine, primarily used in the large menhaden fishery. A significant volume of herring is also taken in the Gulf of Maine with purse seines.

A purse seine (Fig. III-2) is basically a long, flat piece of webbing with floats along the top edge and lead weights and purse rings along the lower edge. The net is set in a circle around a school of fish and when the two ends of the net are brought together the bottom is closed by means of the purse line running through the purse rings. When fully pursed the seine completely encloses the school of fish. One or both ends or wings of the net are then hauled in until fish are concentrated in a small section of the net called the bunt. From the bunt the fish are taken from the seine either by a pump or a dip net. The purse seine is very effective on pelagic schooling fishes.

Purse seines are employed in different ways in the various fisheries. The large menhaden operations utilize a carry boat capable of holding a mil-

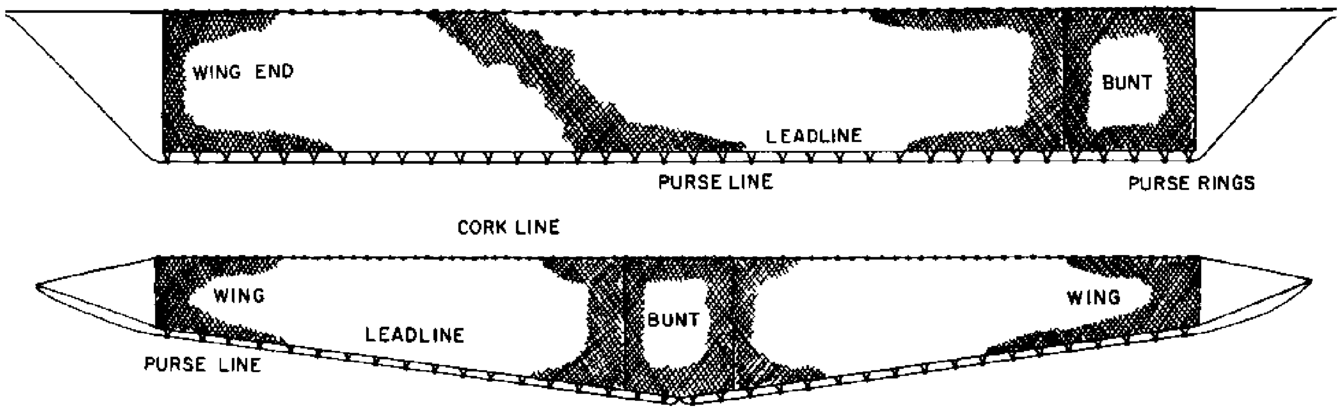


FIG. III-2 PURSE SEINES

lion or more pounds of fish, with two smaller boats that actually work the net. (Fig. III-3). A menhaden seine may be over 200 fathoms long and 25 fathoms deep. The seine boats are usually about 36 feet long and work in pairs. The two boats are tied together with half the net in each boat and the center bunt between them. When a school of fish is sighted, the boats spread apart as they approach the school, feeding the net out as they go. They come together on the opposite side of the school, surrounding it. The net is then pursed and hauled in.

Other menhaden and some herring seiners use one small boat to carry and set the net and a larger vessel to carry the fish. When one seine boat is used it drops one end of the net after surrounding the school. (Fig. III-4). The net is then pursed and hauled in from one end to concentrate the fish in the bunt of the net at the other end. The fish are then loaded on the carry boat. Most menhaden and tuna seiners use an airplane to spot the schools of fish and to direct the seine boat in setting the net. The wind, current, fish movement and water depth must all be analyzed to get the net around the fish and avoid a foul.

A few seining operations carry and set the net from the same vessel that carries the fish, to do this a large vessel is needed. This arrangement reduces maneuverability but can be used in rough weather. U.S. tuna seiners and the large foreign seiners seeking herring on Georges Bank use this method.

Otter Trawls

Otter trawls produce the second highest volume of catch on the Atlantic Coast. In New England the otter trawl catch is five or six times the purse seine

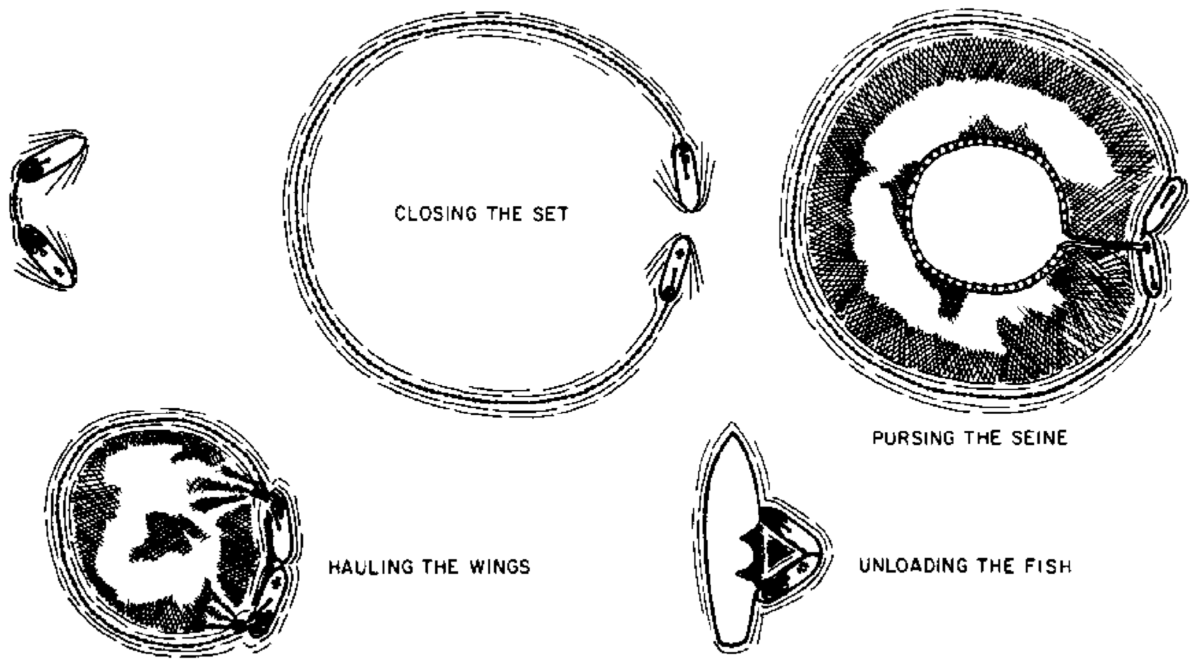


FIG. III-3 TWO BOATS AND MOTHERSHIP METHOD OF PURSE SEINING

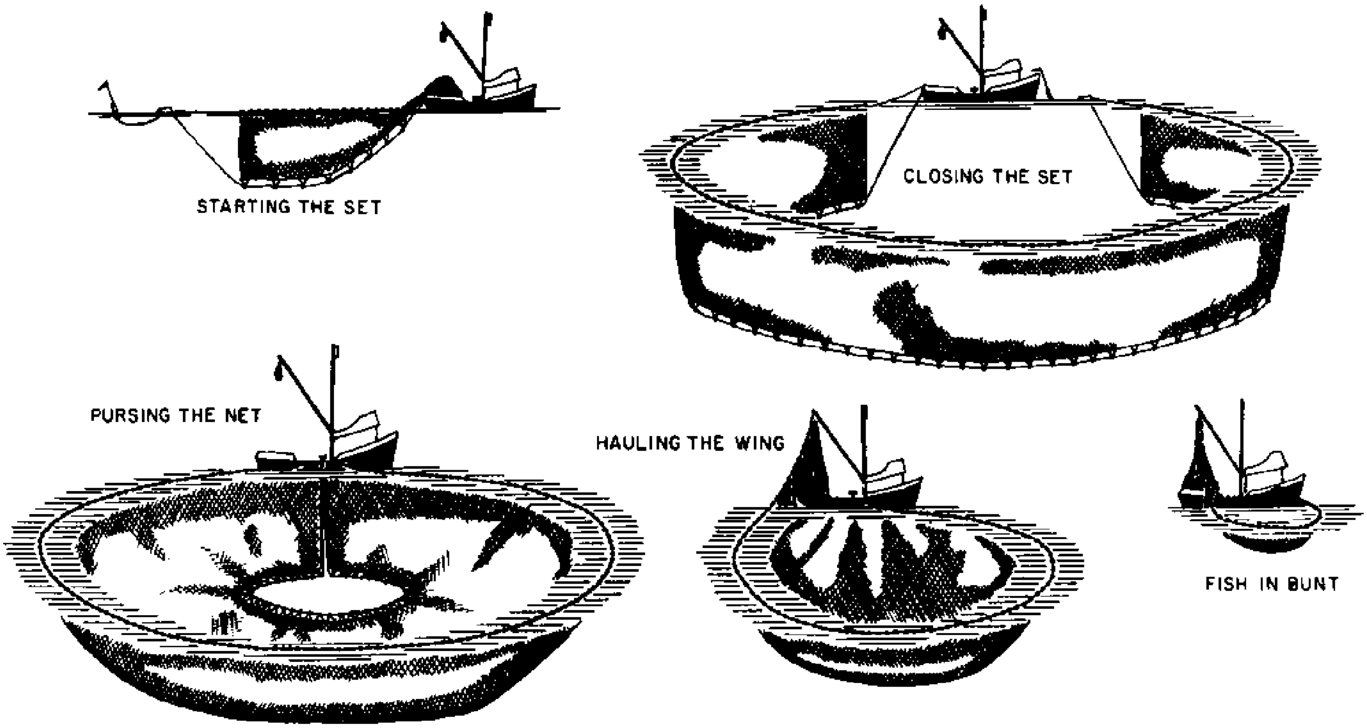


FIG. III-4 ONE BOAT PURSE SEINE OPERATION

catch but in the middle Atlantic otter trawls produce only one-tenth the volume of purse seines.

An otter trawl is basically a flattened funnel of webbing which is towed along the bottom, scooping up fish and shellfish which live on or just above the bottom. (Fig. III-5). The wings, or leading sections of the net are fastened to otter boards or trawl doors which spread the mouth of the net as they are towed through the water. A large part of the spreading action is caused by the shearing force of the shoe of the doors on the sea bottom. Correct trim of the doors and solid contact with the bottom is therefore necessary for proper spreading action. The movement of the doors across the bottom is an oblique scuffing action, rather than a straight, forward sliding movement. This reduces the door's ability to ride up over an obstacle on the bottom. Trawl doors on U.S. vessels range from a few hundred pounds up to 2,000 pounds each. Most exceed 700 pounds. They measure up to 6 feet high and 10 1/2 feet long.

Modern trawling gear used for fin fish on the Atlantic coast utilizes ground cables and legs between the net and the doors to increase the effective spread of the net and to decrease its angle of attack. Ground cables are generally made of wire rope and lead toward the net from the doors. The ground cables are attached to the legs which are in turn attached to the net. There are two legs on either side of the net, a top leg and a bottom leg. The top leg is usually made of wire and connects the ground cable to the head-rope of the net. The bottom leg is usually chain and is attached to the foot-rope of the net. Long ground cables up to 50 fathoms on each side are used wherever the bottom is fairly smooth and are very effective on flatfish such as the summer flounder or fluke, one of the major offshore species between Georges Bank and Cape Hatteras.

Trawl nets vary in size depending on the size and horsepower of the vessel and the mesh size of the net, usually determined by the species sought. A net constructed of 1 1/2 inch mesh for herring, whiting, northern shrimp, or industrial fish will have a much greater drag through the water than a net of the same dimensions made with 4 1/2 inch mesh for flounders, roundfish, butterfish, scup and so on. Most nets are graduated down from a larger mesh in the face, or leading portion of the net which merely herds the fish to a small mesh in the cod end, where the fish are concentrated and struggle to escape.

The smallest standard net in wide use on vessels of 150 horsepower and up is the Yankee 35 with 52 foot head-rope and a 72 foot foot-rope or sweep. The Yankee 41 is a larger net with a 60 foot head-rope and an 80 foot sweep and is also widely used. Various other nets of European and local design such as the URI High Rise, European wing trawls and others are commonly used. Most boats have different nets for different target species and the largest bottom nets may have sweeps of 120 feet.

Vessels concentrating on flatfish such as yellowtail flounder and blackback flounder use what is called a flat net. These fishermen are more con-

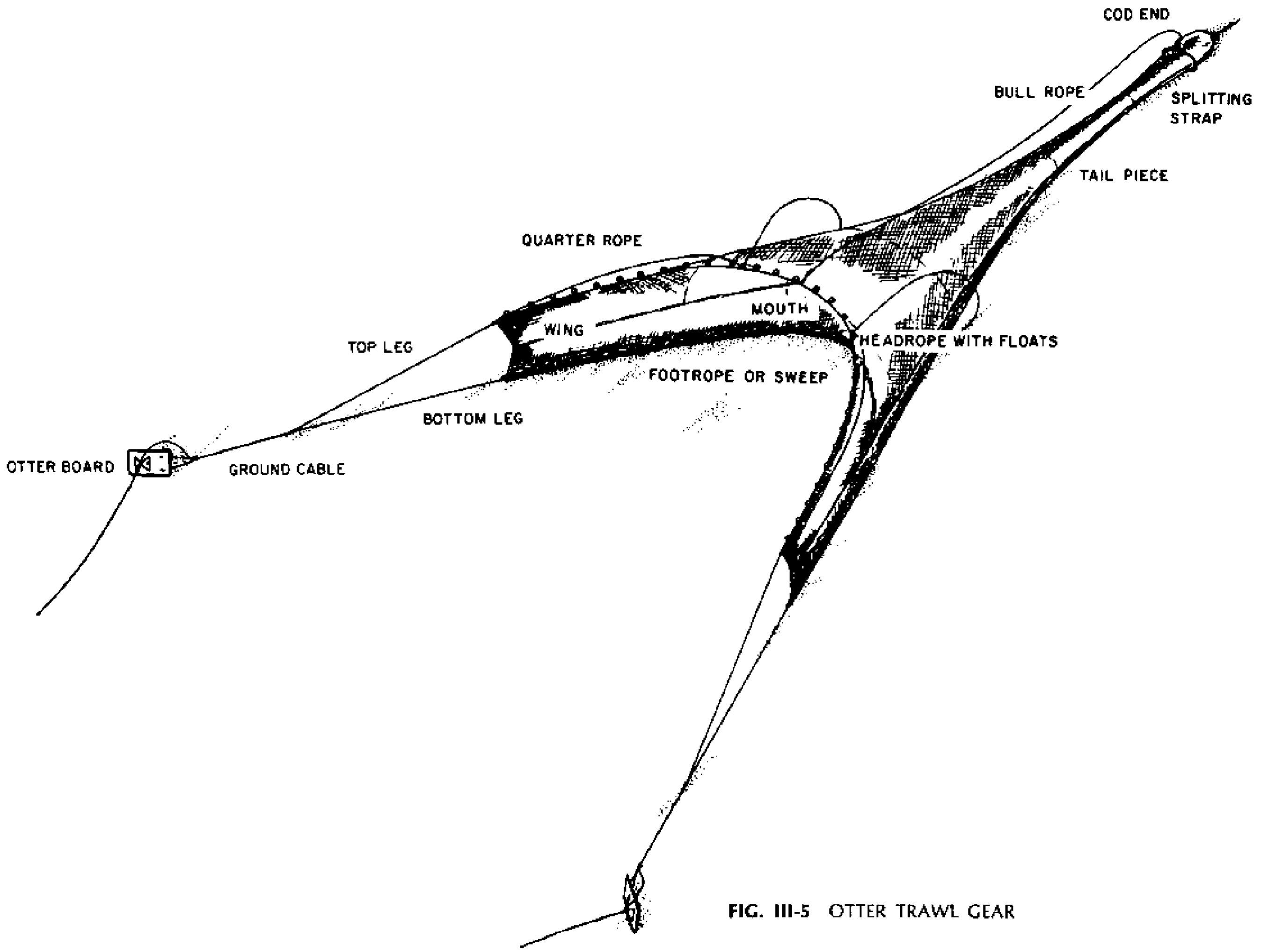


FIG. III-5 OTTER TRAWL GEAR

cerned with having the net tend bottom closely than in getting a high vertical opening in the mouth of the net. These nets will have a heavily chained sweep and few floats on the head-rope. Fishermen going after cod, haddock, whiting, pollock, scup and other higher swimming bottom fish attempt to rig their nets to obtain a higher mouth opening. These nets often have rollers up to 2 feet in diameter along the sweep to allow the net to pass over rough bottom. One of the greatest challenges in net design and development is to have a net that will tend bottom closely enough to catch flatfish well and also open high enough to catch large quantities of higher swimming fish. A head-rope height of 30 feet off the bottom is considered very good.

Although the ground cables, legs and net may total a distance of 150 fathoms from trawl door to trawl door when stretched out, the actual distance between the doors when towing is probably less than 35 fathoms for most U.S. draggers.

Most otter trawls in use today are manufactured from synthetic materials, generally nylon or polypropylene. A bottom trawl may cost $2,000 to $6,000 fully rigged and a midwater trawl designed to fish some distance above the bottom can cost $10,000. To reduce drag and enable the boat to tow as large a net as possible, the twine size is the smallest which will withstand the rigors of normal use. Fishermen must use special care to avoid areas of rough bottom or obstacles, called hangs, because any small piece of debris on the bottom can damage the net or reduce its fishing effectiveness. The damage may not be costly in terms of material, but the time lost in making repairs may be worth as much as the cost of the net, especially if it is so badly damaged that it must be brought ashore for mending. Particularly bad obstacles may cause the loss of the otter doors, ground cables, legs, or the entire net. On the other hand, fish tend to congregate near obstructions.

Fishermen maintain "black books" of loran bearings and depth readings showing where troublesome hangs are located, and they keep clear to a degree determined by weather and navigating conditions, the type of net they are using and the quantity and price of the fish they expect to catch by shaving the hang as closely as possible.

Side Trawlers

The most characteristic fishing vessel of the Atlantic Coast is the eastern rigged side trawler. The term "eastern" refers to the vessel's evolution from the Gloucester schooner, Gloucester being to the eastward of Noank, Connecticut, home of the Noank sloop which developed into the "western" rigged trawlers. Being derived from a schooner, an eastern rigged vessel has the wheelhouse aft and the working deck forward, with the winch typically just forward of the house (Fig. III-6). Towing frames, or gallows, are mounted on the deck close to the rail, one forward, usually abeam of the mast, and one aft near the pilot house. Towing wires are led from the winch to the gallows through deck blocks, called bollards. Hanging bollards on the gallows lead the wire overboard to the fishing gear.

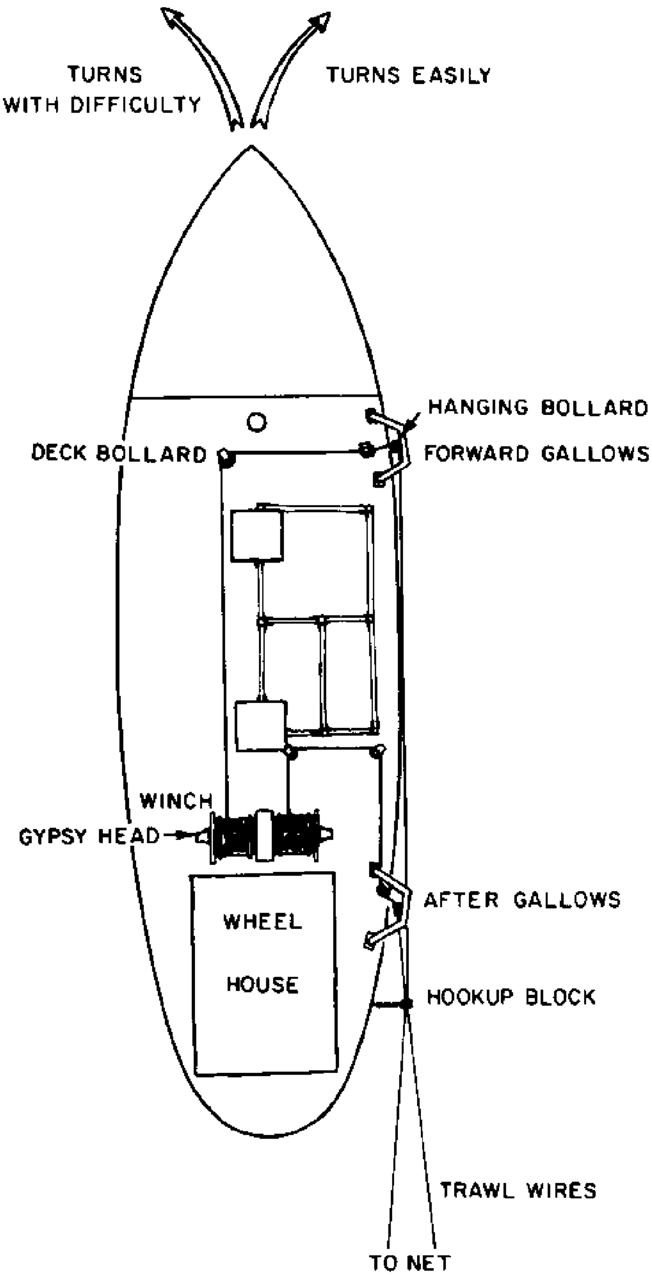


FIG. III-6 EASTERN RIGGED DRAGGER

Because of this arrangement a side trawler must turn broadside to the wind when setting and hauling its net (Fig. III-7). This is considered a major disadvantage. After drifting the net out from the side, the vessel makes a circle upwind, letting out the legs, ground cables and otter boards as it turns. This keeps the gear clear of the vessel and the propellor. Once the trawl doors are clear of the vessel the course is straightened and the wires are paid out. The entire procedure is tricky and much care is needed to avoid fouling.

After the desired amount of towing wire has been let out, usually about three times the water depth, the wires are hauled close to the vessel's side and fixed in the hook-up block mounted on the rail aft of the after gallows. This provides a constant towing point for the wires and assures uniform maneuverability, as well as keeping the wires from fouling the vessel as it turns. Hooking up and releasing the towing wires are two of the most dangerous operations on a side trawler because of the tension in the wire.

Because the gear is towed from one side, the maneuverability of a side trawler is very limited. It can turn easily toward the gear but not in the opposite direction. Sometimes a strong current on the disadvantaged side forces a vessel to make a complete circle over its gear. This puts a twist in the wires which must be removed by circling the vessel the opposite way before hauling back. Even in less extreme situations a side trawler suffers a severe loss of towing power whenever the rudder has to be kept cramped over to maintain course against a current.

To haul the gear back the vessel releases the wires from the hook-up block and winds them in on the winch. When the doors reach the gallows, the towing wires are disconnected, allowing the ground cables and legs to be hauled in (Fig. III-8). The vessel continues turning during this procedure and finally assumes a position broadside to the wind with the net to windward, so the vessel will drift clear.

When the wing ends of the net reach the gallows blocks, the mouth of the net is lifted over the rail and dropped inside, and one or both wings are hauled in. The body of the net is then lifted into the air, or "fleeted", forcing the fish toward the bag or cod end of the net. Then the cod end is hauled alongside by a rope attached to the splitting strap. The splitting strap runs through rings around the upper part of the cod end and is placed so as to split the desired amount of fish into the cod end for lifting aboard the vessel. The bag is brought aboard with the falls, or block and tackle. The line closing the bag is then untied or tripped, allowing the fish to spill out into deck bins. If more than

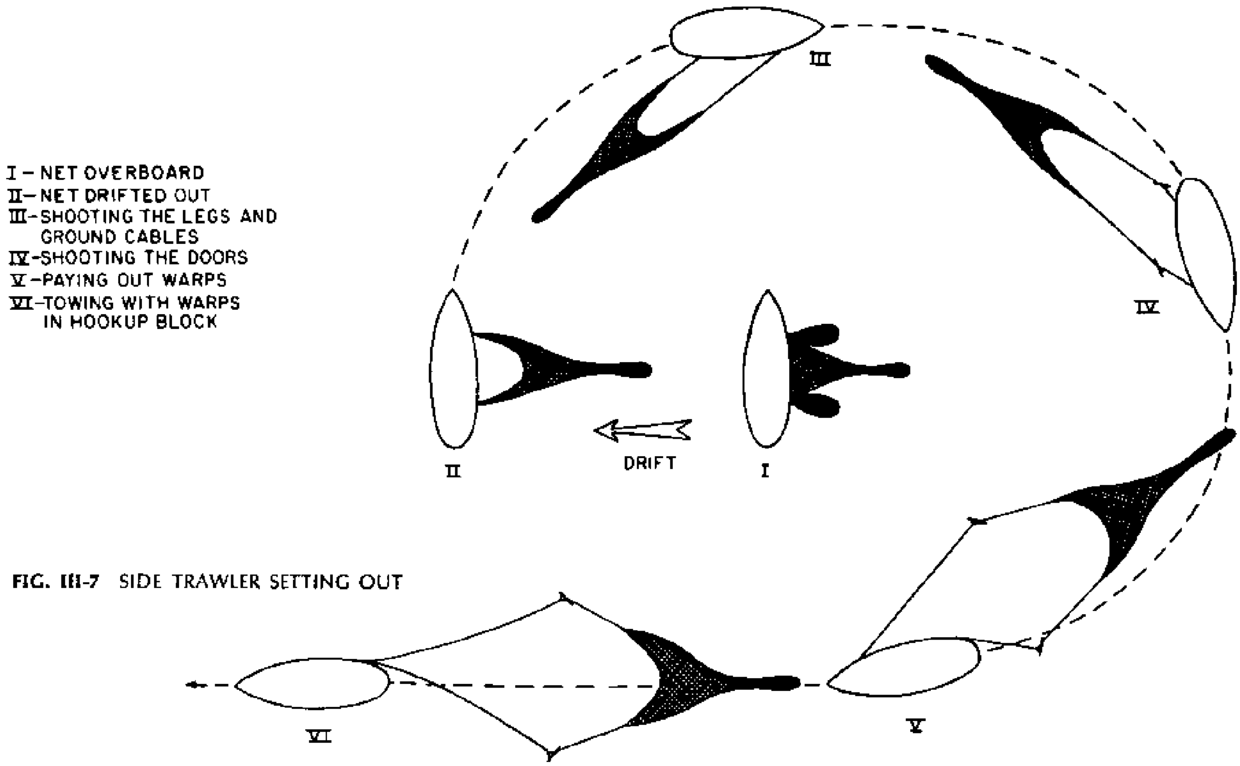


FIG. III-7 SIDE TRAWLER SETTING OUT

one bag was caught the cod end line is re-tied and the fleeting and splitting are repeated. If a fisherman says he had three splits and a hoist, he means he split the fish for three bags and then hoisted the final bag aboard. Depending upon the size of the boat some three or four thousand pounds of fish may be brought aboard in a single lift. The whole operation from setting until all the fish are aboard may take two to three hours. Towing at around two knots, a dragger can cover 20 miles of bottom in a long day, sweeping 30 or 40 acres.

When the last bag is aboard the setting procedure is repeated for another tow. During the tow the crew sorts, cleans, washes and stores the previous catch in ice in pens in the hold. A large percentage of the fish caught may be returned to the sea – usually dead or dying by then – because they are unmarketable species. This incidental or by-catch

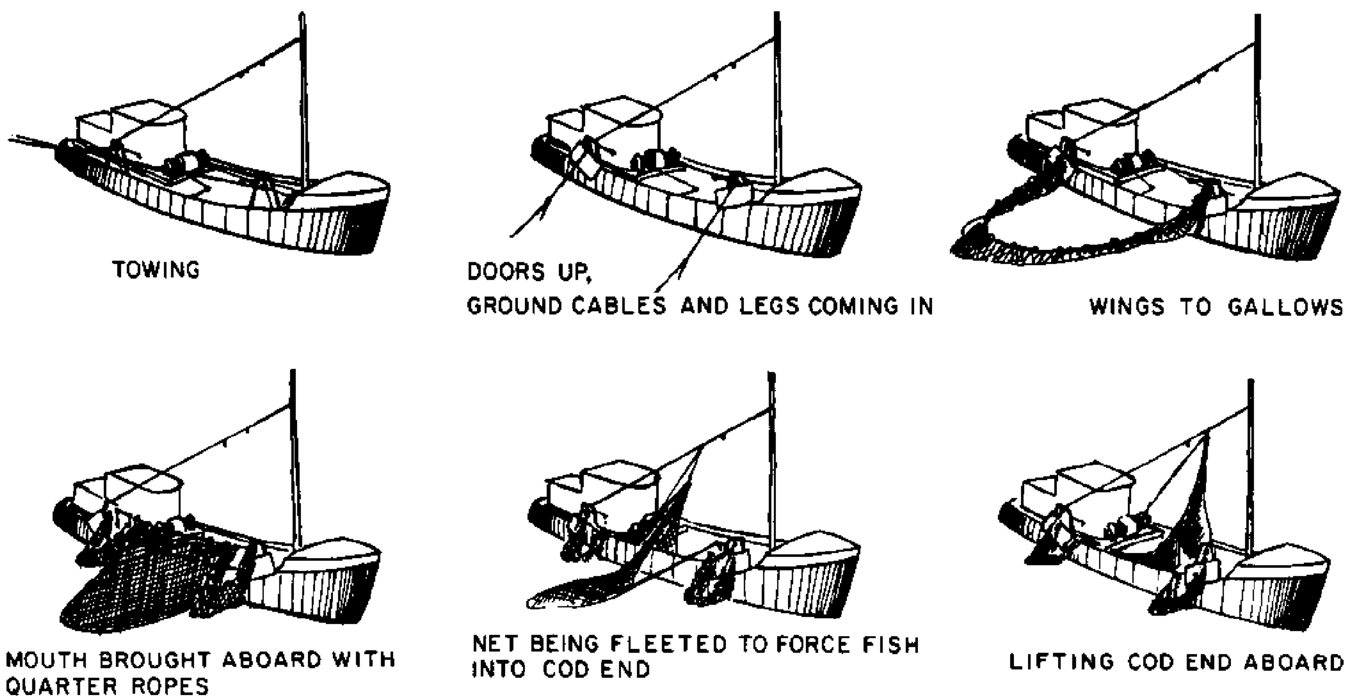


FIG. III-8 SIDE TRAWLER, HAUL BACK

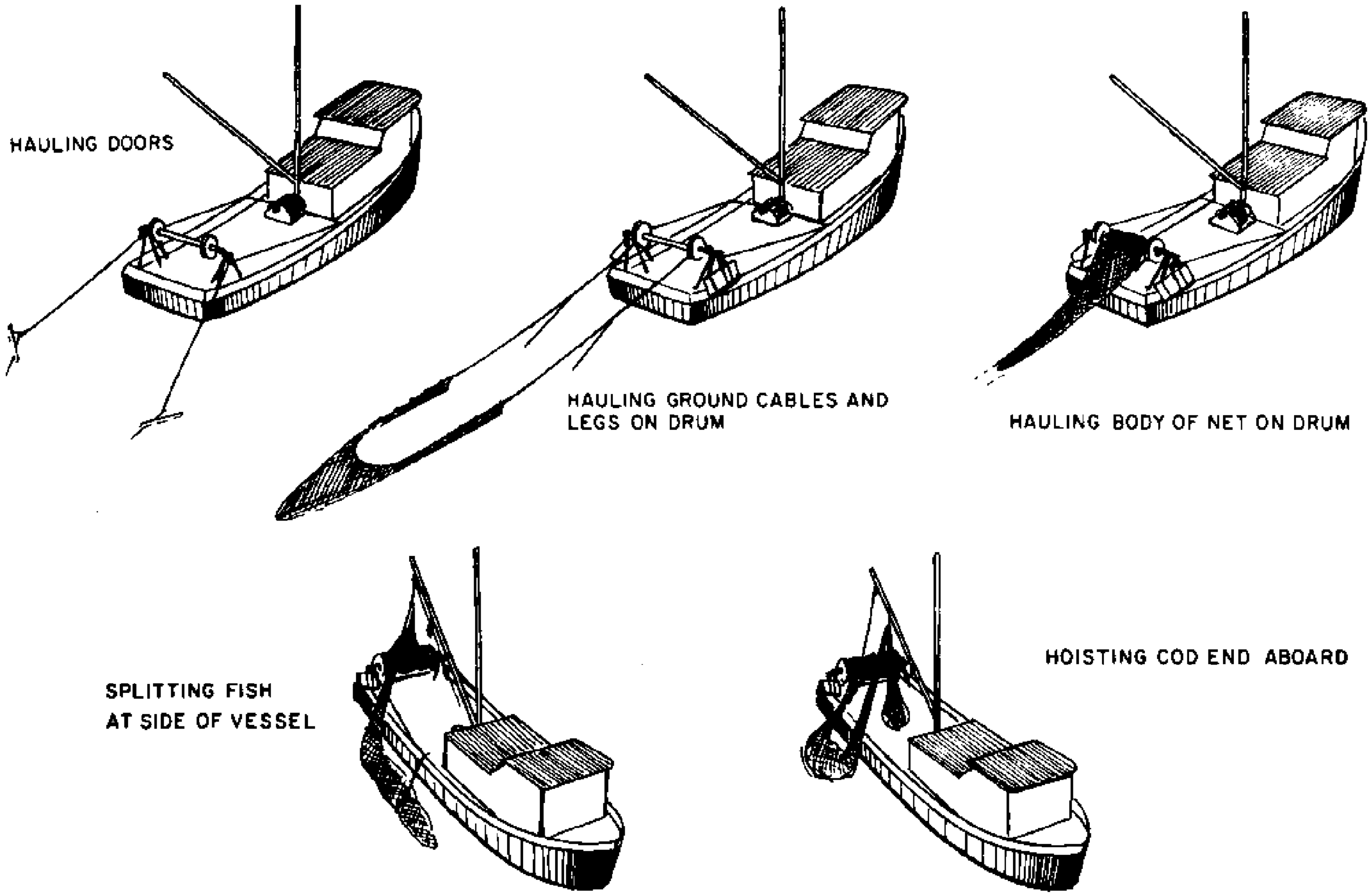


FIG. III-9 WESTERN RIGGED STERN TRAWLER, HAUL BACK

is considered a potential for increased production.

A recent development for side trawlers has been the introduction of net drums, especially along the New Jersey coast. This development, introduced from Scandinavia, has resulted largely from a move toward nets made of large mesh, up to 60 inches. These large-mesh nets are highly productive but easily tangled. Winding the net on a drum as it comes in eliminates the problem.

Western Rigs

Western style boats with the wheelhouse forward are rigged in a wide variety or arrangements. Vessels with a standard double drum winch generally mount it just aft of the wheelhouse with the drum axis fore and aft. The winch controls are handy to the wheelhouse door. Most of the older and smaller boats have both towing bollards hung from a single gallows or a pipe which is mounted at the rail opposite the winch. With this arrangement the doors come up to the gallows together, with the rest of the gear trailing astern. With the doors hanging, the ground cables and legs are brought in until the wings reach the gallows. The mouth of the net is pulled aboard, the net is brought in and a rope is used to pull the bag alongside and hoist it or split it as necessary. The arrangement is fairly simple and can be handled by a small crew, even by one man. However, it requires particular care in setting and hauling back to avoid running over the doors.

Other western style boats, especially the larger ones, use a fairly typical two-gallows side rig, with the wire fairleaded down the side of the vessel to the after gallows. The general procedure is the same as for eastern rigged trawlers.

Stern Trawlers

Most of the newer western style boats are being rigged as stern trawlers. Vessels with a standard double-drum winch have it mounted as above but with one wire leading to a bollard at each rail and then aft to the gallows which are mounted on each quarter. A more modern arrangement utilized a split-drum hydraulic winch, with one drum facing aft on each side of the vessel, generally in a straight run to the hanging bollards.

Vessels without a ramp stern usually bring the mouth of the net over the transom and then haul the cod end around to the side of the boat for splitting and hoisting (Fig. III-9). Those with a ramp stern are usually fitted with a net drum mounted over or forward of the ramp. The ground cables, legs, wings, mouth and body of the net are then wound on the drum until the fish are packed tight in the bag. The bag is then dragged up the ramp and onto the deck where it is lifted and tripped, spilling the fish into the deck bins for sorting and washing. The net is then wound back onto the drum and the cod end is pushed out the ramp for another set.

Some ramp trawlers operate without a net drum, hauling the wings and body of the net right up onto the deck (Fig. III-10). However, this often causes problems in getting the net back overboard, so that an outhaul is required.

The principal advantages of a stern trawler are: greater towing efficiency because of the balanced placement of the towing points, greater maneuverability, a greater degree of weather protection on the working deck, and elimination of the need to lie broadside when setting and hauling. However, for large volume catches it is generally considered more practical to split the bag over the side rather than the stern even if it means turning across the wind.

The position of the hanging bollards is critical to the proper rigging of a stern trawler: the further forward, the greater the maneuverability of the vessel. However, as the bollards are moved forward, the towing wire is more likely to catch on the quarters as the vessel turns, which transfers the towing point to the worst possible spot. This can be avoided somewhat by raising the bollards but then the stability of the vessel suffers. A transom which slopes forward from the waterline is an attempt to overcome this problem, but the position of the bollards always represents a compromise.

Midwater Pair Trawling

Midwater pair trawling is a fairly recent innovation in the United States and is used so far primarily during the winter on schools of herring which rise off the bottom at night. The method was introduced on the East Coast by Point Judith vessels which have passed it on to Gloucester fishermen; it is also used on mackerel and scup off Cape May.

Pair trawling is basically the towing of one net with two boats (Fig. III-11). This considerably reduces the horsepower needed because the drag of the trawl doors is eliminated, the width of the net opening being maintained by the distance between the two boats. The nets used are very big. They are made with large mesh webbing in the face tapering back to smaller mesh in the tail piece and cod end. The large mesh retains its effectiveness even on small fish because the pressure wave created by the net passing through the water creates a herding effect, which is augmented by the movement of the two boats and the towing wires. (Herring are very spooky fish, and the passage of a vessel or the shining of a light may cause them to disperse. Thus heavy traffic across the fishing grounds could interfere with this type of fishing.)

After a school of fish has been located on the echo sounder, or "fish finder", a pair trawling operation begins with one boat setting the net and bridles. The other vessel then comes alongside and takes one set of bridles which are attached to its towing wires. Both boats then set out the required length of wire and proceed to tow. The depth of the trawl is controlled primarily by the amount of wire — usually seven times the desired depth. The boats try to maintain separation of about half the wire length but this can be varied to change the depth of the net.

Pair trawlers vary their towing time according to the density of the signals on the echo sounder. Over-large catches are a danger and often nets have burst from too much weight. Net design and materials are continually being improved, and catches over 100,000 pounds in a single set have been obtained.

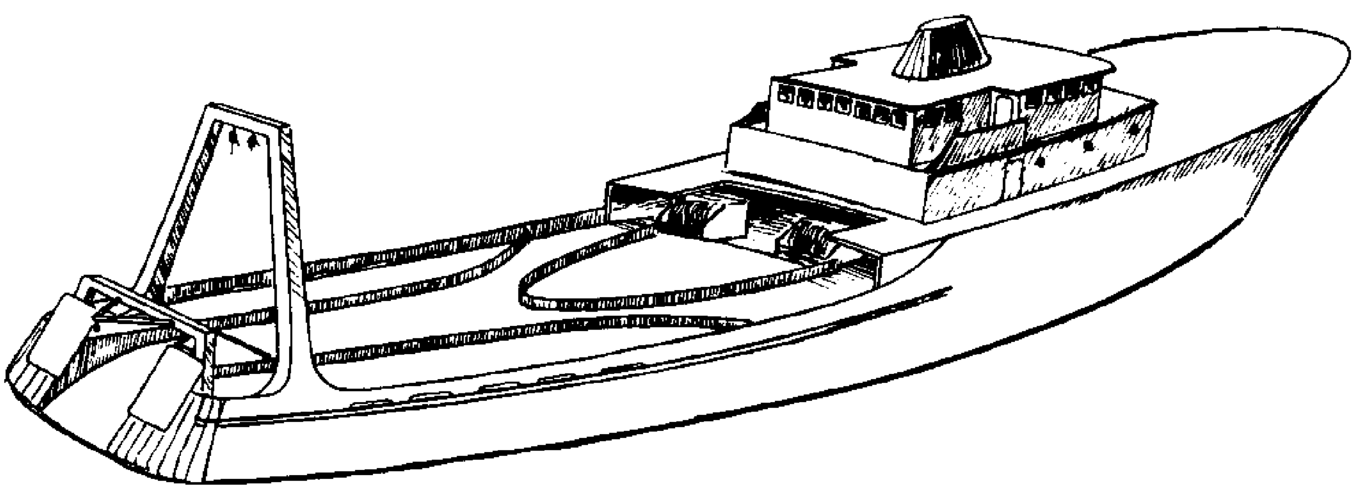


FIG. III-10 LARGE MODERN STERN TRAWLER

FIG. III-11 PAIR TRAWL

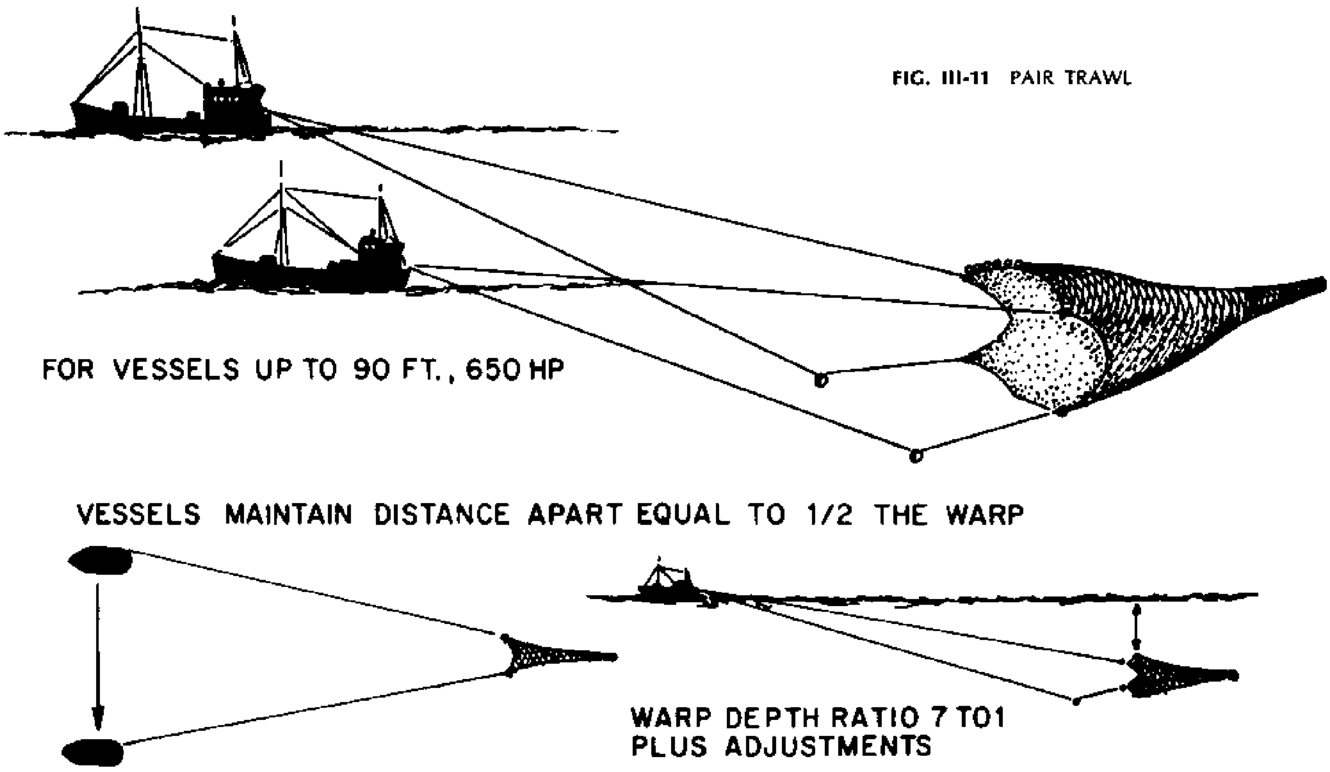
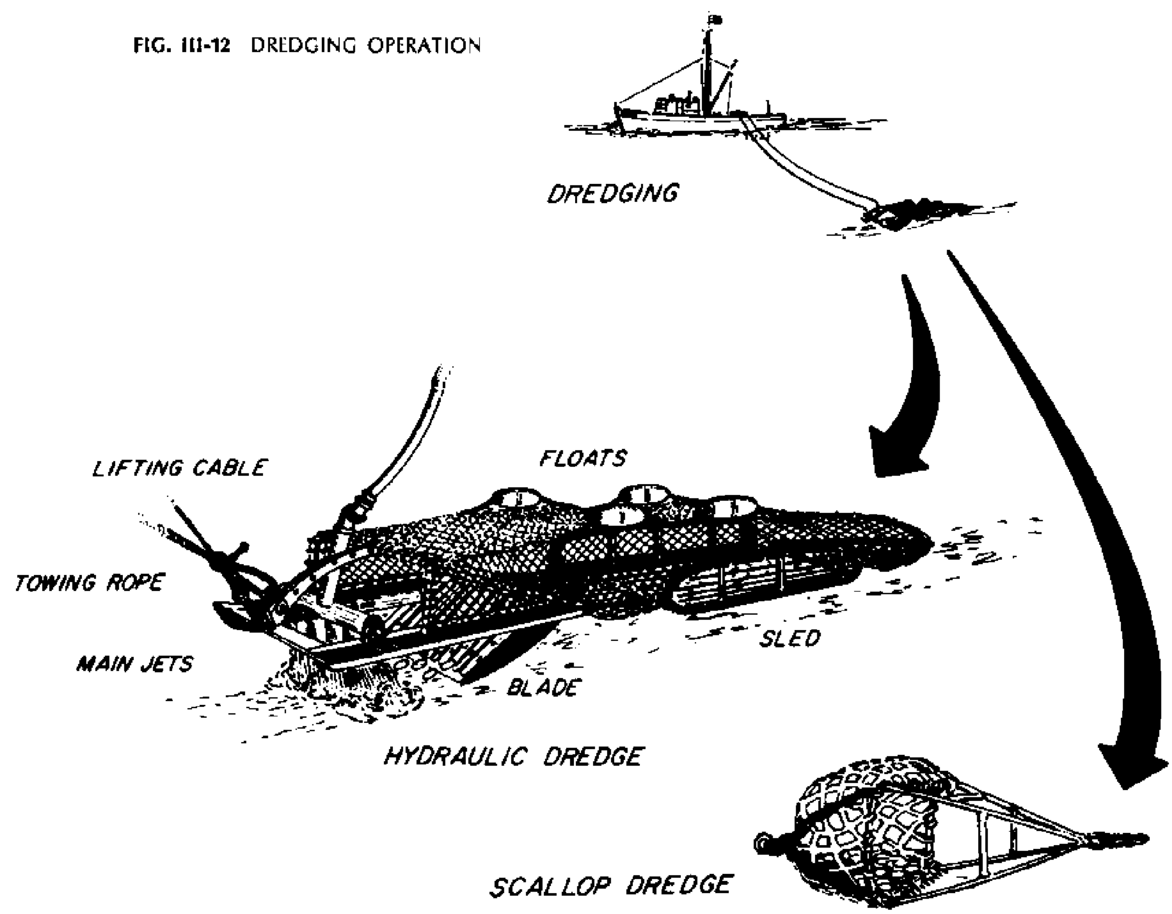


FIG. III-12 DREDGING OPERATION



Dredges

In the Middle Atlantic area dredges are second only to purse seines in volume of landings. The most important dredge catch is surf clams, but sea scallops also make a valuable contribution.

Hydraulic dredges are most popular in the surf clam fishery (Fig. III-12). This type of dredge requires a high-volume water pump on the fishing vessel to pump water through a hose to jets mounted on the forward edge of the dredge. These jets loosen the bottom sediment in which the surf clams are buried. A blade extending from the bottom of the dredge then forces the clams into the body of the dredge and back into the chain bag which holds the catch until the dredge is hauled on board the vessel and emptied. A hydraulic dredge may dig 10 or 12 inches into the bottom and deeper if a small area is worked repeatedly. These dredges are measured by the length of the blade and the largest is 140 inches. They weigh up to 8000 pounds and may cost $8,000. Similar dredges are used in the expanding ocean quahog fishery. There are approximately 100 vessels in the surf clam fleet ranging up to 120 feet in length and 900 horsepower. To handle the largest dredges the larger and newer vessels have an A-frame on the stern and the dredge is emptied from below while it hangs on the A-frame.

Sea scallops do not burrow into the bottom sediment and scallop dredges are not made to dig deeply into the bottom. But they are made heavy to tend bottom very closely and to resist wear and damage. A scallop dredge consists of a steel framework up to 16 feet wide and 14 to 16 inches high. A chain bag drags from the framework. The total weight of the dredge may be as much as 3000 pounds. Scallop vessels need large engines, generally around 700 hp, to tow efficiently. Most tow one dredge on each side of the vessel.

Trap Fishing

Another important type of fishing gear used both inshore and offshore along the Atlantic coast are traps, or pots, for lobster and sea bass. The traps vary from 2 1/2 to five feet in length, 16 to 36 inches in width and 10 to 18 inches in height. In cross section they may be half-round, trapezoidal or rectangular. They can be fished singly, with one buoy for each pot, in pairs, or on trawls with as many as 100 pots on a single line more than a mile long with a buoy at each end (Fig. III-13). Offshore buoys usually have masts with flags and radar reflectors as well as identifying marks. The offshore fishery takes place along the entire outer shelf from Georges Bank to Cape Hatteras. The trawls are set along the general direction of the depth contours, to minimize interference. Nevertheless,

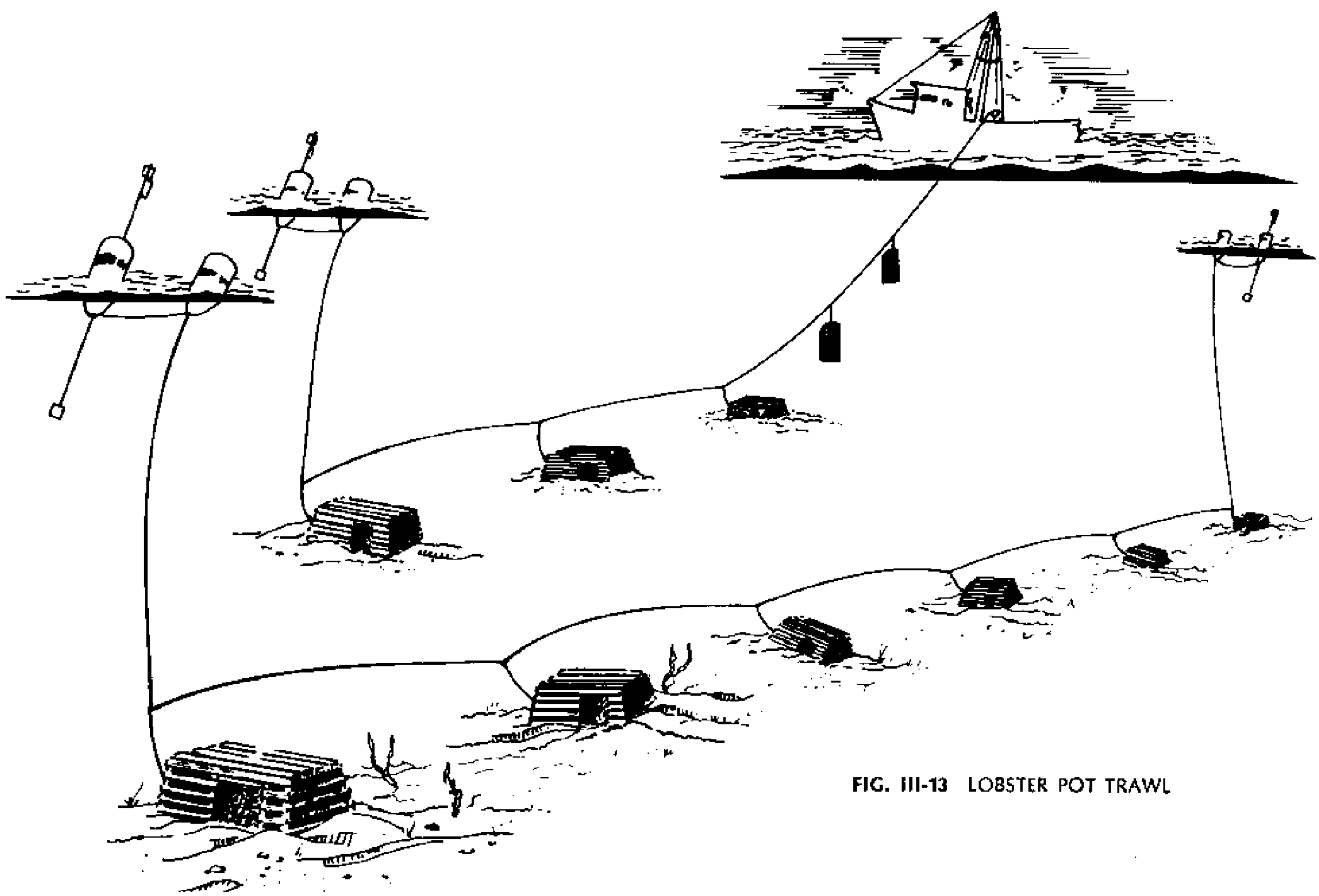


FIG. III-13 LOBSTER POT TRAWL

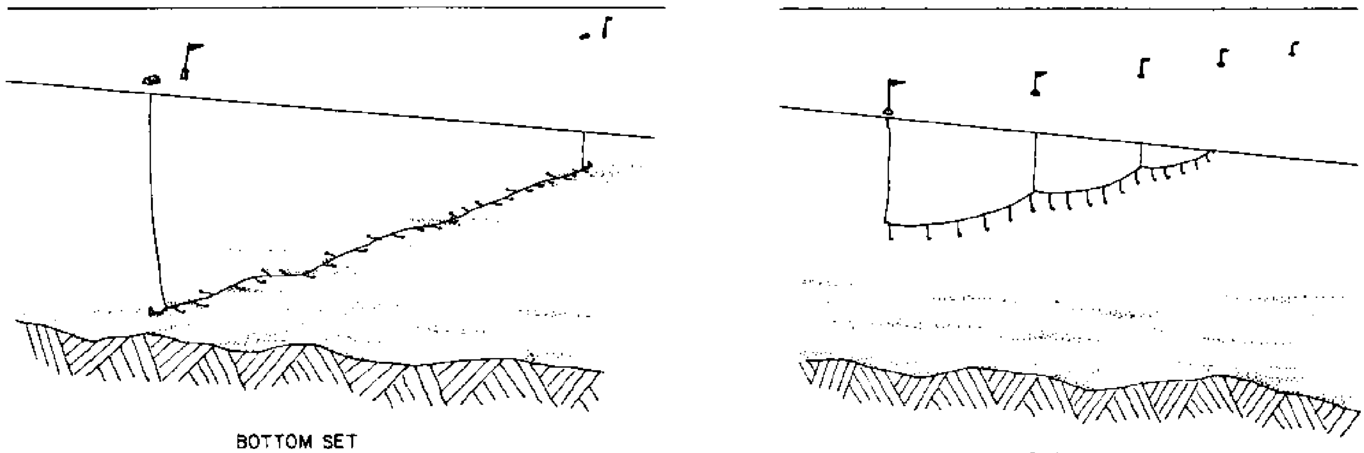


FIG. III-14 LONGLINE GEAR

because of the congestion on the grounds, crossed trawls are fairly frequent and are a time consuming and troublesome problem. Increasing numbers of traps and a tendency of lobsters to concentrate in fairly limited areas are making this competition for space more and more severe.

Because the traps stay put on the bottom until they are hauled, the potential for fouling oil industry equipment appears significantly less than for the mobile gear fisheries. However, pot trawls are not lifted straight off the bottom as may be imagined, but tend to be dragged across it as they are hauled. They could become entangled in irregularly shaped obstructions such as pipeline valves, Subsea Production Systems or similar equipment. There may also be direct competition between lobster fishermen and oilmen for prime locations.

Long-Lining

Long-line fishing gear is of two basic types, bottom set and floating (Fig. III-14). The use of bottom set long lines for groundfish, cod, haddock, and hake off the Atlantic coast dates back to the early development of the fisheries of the Northwest Atlantic. This type of gear is still important in the area, particularly for the fleet out of Chatham on Cape Cod. These boats are generally 40-42 feet long and they set from 1,000-8,000 hooks which, if stretched out in a line, would cover up to 10 or 12 miles.

The hooks are fastened to the long ground line by short lines, or ganglions, spaced at regular intervals. A certain number of hooks, usually 500, and their ground line are placed in a wooden or plastic tub for baiting and setting. The method of fishing is thus often called tub trawling, or just trawling. Care should be taken not to confuse this with net trawling, which is usually called dragging on the Atlantic coast.

Long-lining is a labor-intensive fishing method and baiting the hooks is regarded as the most burdensome part of the operation. Automatic long-line handling equipment has been developed both in Norway and on the U.S. West Coast. This may reduce the dreary labor involved and bring about a resurgence of long line fishing, particularly among larger vessels.

A number of the Chatham long-liners have been expanding their efforts to the offshore areas for tilefish in water depths of fifty to eighty fathoms from Veatch Canyon to Hudson Canyon. A sizable fleet from New Jersey is also entering this tilefish fishery.

Floating or pelagic long-line gear is used primarily by swordfishermen. This fishery is regaining momentum after a lull of a few years in the early seventies. The gear is similar to bottom-set long lines, consisting of several miles of line with ganglions and hooks attached at regular intervals. The swordfish long line, however, is suspended from buoys on the ocean surface and drifts freely, rather than being anchored along the bottom.

The ground line on most swordfish boats is wound on a large drum rather than being coiled in tubs. The ganglions are attached with snaps and are removed as the line comes in and snapped back on as it is set. One boat may set up to 35 miles of long line with 2800 hooks in a single string. These lines may drift 50 miles or more overnight. They are frequently cut or fouled by sharks or passing vessels.

All of the swordfish long-lining on the Atlantic coast is done in water depths over 100 fathoms. The migration patterns of the fish are temperature dependent and the fishery begins in New England in late spring and proceeds northward around Georges Bank during the summer and back down the coast in the fall. The winter fishery for these boats is in the Gulf of Mexico. About 50 boats were involved in this fishery in the summer of 1975, most in the 60-80 foot class.

Harpooning

Another method of swordfish capture which is popular during the summer months in the Northwest Atlantic is harpooning. A number of draggers add top masts with crow's nests to their usual masts and add pulpits or stands to their bows from which the striker throws the harpoon at sunning swordfish as the boat comes up on them. This fishery follows the same general pattern as the longline fishery during the summer months, but it takes place in shallower water and does not continue to the southward in the fall and winter.

Gill Nets

Gill nets, like long lines, are both bottom set and floating, depending on the species sought (Fig. III-15). Basically a gill net is a sheet of webbing suspended between a corkline along the top and a leadline along the bottom. The mesh size is such that fish can force themselves partway through the net but can neither go all the way through nor back out. The leadline on a bottom set gill net is heavy enough to hold the net on bottom and the corkline floats above it holding the net vertical. Cod, haddock, hake, flounders and other bottom fish are caught with bottom set gill nets. These nets are anchored at each end and a buoyline to the surface marks their position.

On a floating gill net the flotation on the corkline is sufficient to keep the top of the net at the surface while the leadline stretches the web downwards. Pelagic species such as bluefish and mackerel are the primary targets of floating gill nets.

The gill net fisheries on the Atlantic Coast are primarily inshore operations and are spread out among a number of ports throughout the region.

Foreign Fishing

Foreign fishing off the Atlantic coast of the U.S. became noticeable early in the 1960's with intense fishing by the U.S.S.R. for stocks of herring and hake, although the Portuguese and Spanish had been fishing in these waters for centuries. The Russians were soon joined by fishermen from Poland, Rumania, Italy, Norway, Denmark, Iceland, the United Kingdom, Bulgaria, France, Japan, both East and West Germany and, most recently, Cuba. Fishing in the area, which includes both the Baltimore Canyon and Georges Bank potential oil fields, is now regulated by the International Commission for the Northwest Atlantic Fisheries (ICNAF), which sets national quotas and issues other fishing regulations. All the countries listed above belong to ICNAF except Cuba, which plans to join in 1976.

The foreign fleet uses gear similar to that described for the U.S. fishing industry but on a larger scale: side trawlers are in the 250-foot range and stern trawlers are commonly more than 400 feet long. Where American vessels may have 500-hp engines, those on the large foreign vessels are 2000 to 5000 hp. The additional power moves the large foreign vessels rapidly over considerable distances and allows them to fish with large nets. The net doors may weigh as much as 10,000 pounds, five times the weight of U.S. gear.

Although some foreign vessels work independently, more often the fleets operate in groups. For example, a number of Russian trawlers may all fish in a single rich area and bring their catch to a

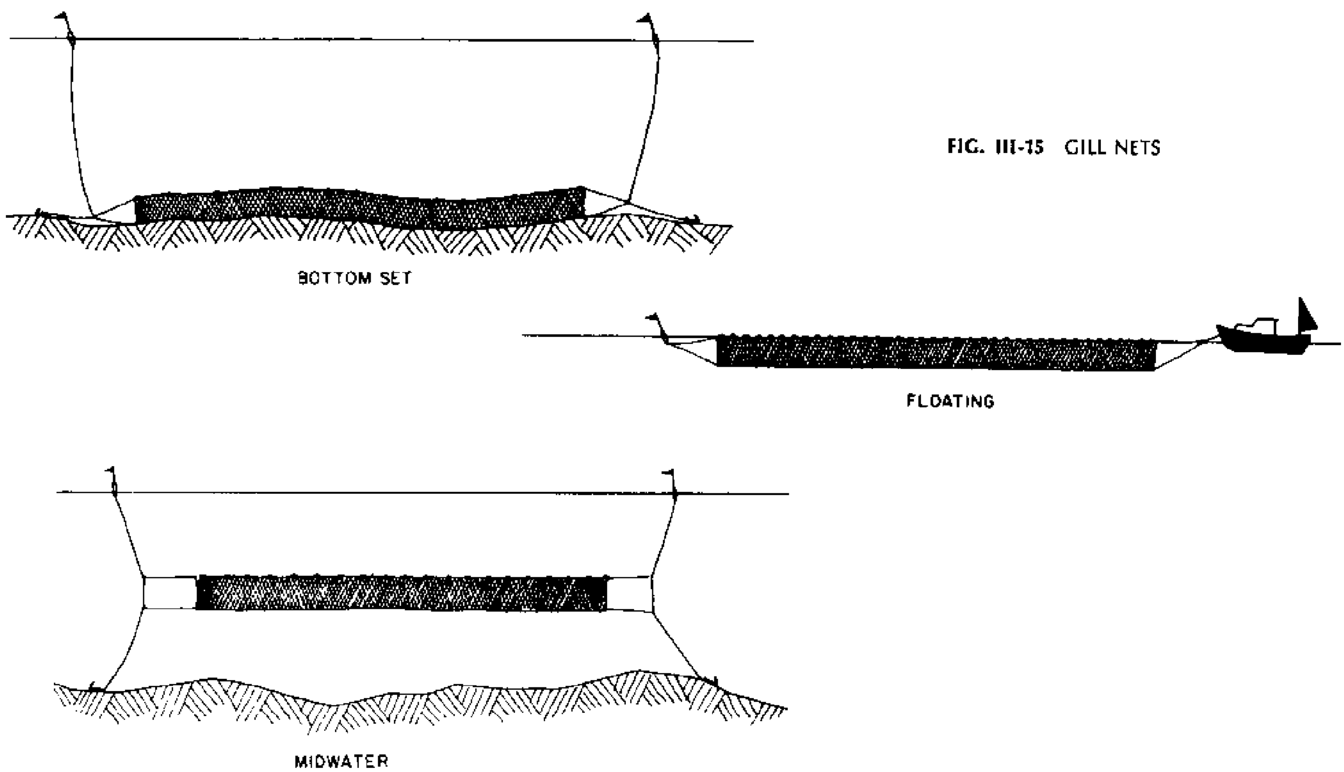


FIG. III-15 GILL NETS

Table III-2 Number of Fishing Vessels From Individual Foreign Countries Observed Monthly From December 1973-March 1975 In The Northwest Atlantic

U.S.S.R.	Ireland	Poland	E. Germany	Bulgaria	Romania	Japan	Spain	Italy	France	U.K.	Yugoslavia	F.R. Germany	Greece	Total	Period Of Observation
54	--	33	19	7	--	10	29	9	1	--	--	--	--	162	Dec. 1973
122	--	35	28	10	3	16	44	11	--	--	-	--	--	269	Jan. 1974
150	--	38	17	8	4	14	67	11	--	--	--	--	--	309	Feb. 1974
189	--	34	21	8	6	14	42	8	--	--	--	1	--	323	March 1974
207	--	32	19	6	1	7	27	3	--	--	--	--	--	302	April 1974
120	--	29	7	4	4	6	9	1	--	--	--		1	181	May 1974
90	--	15	--	2	3	5	42	1	--	--	--	--	1	159	June 1974
91	--	4	3	--	3	6	14	1	--	--	--	4	--	126	July 1974
69	--	12	35	--	3	16	17	1	1	--	--	18	--	172	Aug. 1974
47	1	19	44	--	1	32	6	1	2	6	--	17	--	176	Sept. 1974
54	1	36	32	--	--	25	3	1	3	--	--	6	--	161	Oct. 1974
52	1	27	14	--	--	15	1	3	--	--	--	1	--	115	Nov. 1974
32	1	38	17	8	--	14	--	6	--	--	--	--	--	116	Dec. 1974
136	1	41	16	9	--	12	13	6	--	--	--	--	--	234	Jan. 1975
204	1	40	13	8	--	13	48	7	--	--	--	--	--	334	Feb. 1975
175	1	27	11	7	--	11	28	6	--	--	--	--	--	266	March 1975
792	7	460	296	77	28	216	390	76	7	6	--	47	2	3405	

Table III-3 Number of Fishing Vessels From Individual Foreign Countries Observed Monthly From December 1973-March 1975 for The Middle-Atlantic Area

U.S.S.R.	Ireland	Poland	E. Germany	Bulgaria	Romania	Japan	Spain	Italy	France	U.K.	Yugoslavia	Greece	F.R. Germany	Total	Period Of Observation
12	--	--	--	--	--	4	17	--	--	--	--	--	--	33	Dec. 1973
60	--	35	28	7	3	6	6	5	--	--	--	--	--	150	Jan. 1974
60	--	38	17	8	4	8	30	4	--	--	--	--	--	169	Feb. 1974
29	--	8	21	8	6	6	28	3	--	--	--	--	--	109	March 1974
10	--	--	9	6	--	5	22	2	--	--	--	--	--	54	April 1974
5	--	--	--	--	--	3	9	1	--	--	--	1	--	19	May 1974
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	June 1974
--	--	4	3	--	3	6	--	1	--	--	--	--	3	20	July 1974
2	--	--	--	--	--	9	5	1	--	--	--	--	--	17	Aug. 1974
10	1	--	--	--	--	15	7	1	--	--	--	--	--	34	Sept. 1974
8	--	--	--	--	--	20	3	1	--	--	--	--	--	32	Oct. 1974
21	1	--	--	--	--	15	1	3	--	--	--	--	--	41	Nov. 1974
13	--	38	17	7	--	5	--	6	--	--	--	--	--	86	Dec. 1974
41	--	35	17	2	--	6	--	6	5	--	--	--	--	112	Jan. 1975
51	1	22	17	4	--	7	13	4	--	--	--	--	--	119	Feb. 1975
12	1	24	17	3	--	10	19	4	--	--	--	--	--	90	March 1975
334	4	204	146	45	16	125	160	42	5		--	1	3	1085	

Source: *Summary of Foreign Vessel Observations* (Monthly Reports) published by National Marine Fisheries Service.

centrally located factory ship for processing, or a group of large vessels with processing equipment on board may intensively fish an area where large schools have congregated.

Tables III-2 and III-3 give information on the number of vessels from each country on a monthly basis for the entire Northwest Atlantic area and for the Mid-Atlantic region (a subset of the former). The information is collected by the National Marine Fisheries Service, which monitors foreign fishing under provisions of the ICNAF agreement. There is at present no requirement that foreign fishermen declare in advance their intentions with respect to location, species sought and gear to be used.

Although a member of ICNAF, Canada is excluded from the tabulation because Canadian fishermen catch only a small amount of groundfish in U.S. waters. Canada's ICNAF quota for Georges Bank and Southern New England is only 1800 metric tons compared with 230,000 tons for the United States. On the other hand, the Canadian scallop boats harvest catches off the coast of New England and the Middle Atlantic states.

Although in the last two years, ICNAF has begun to enforce its regulations designed to conserve fish stocks, fin-fishing activity outside the 12-mile boundary is regulated *only* by international law. By act of Congress, lobsters and other shellfish are now considered "creatures of the continental shelf" and are under U.S. regulation out to a depth of 200 meters. Otherwise, domestic laws, and therefore domestic sanctions, apply only to U.S. fishermen. Violations of regulations established by international agreement are punishable only in the country of origin of the perpetrator. Apart from the specific agreements concluded through ICNAF, there are no general vessel regulations except standard rules of the road that apply to all ships.

Two hundred mile extended jurisdiction is likely to provide more information on both domestic and foreign fishing activities, because vessels could be required to report facts such as exact locations of catch, species sought and gear used.

Although the number of foreign fishing vessels is likely to decrease under extended jurisdiction, it is unlikely that foreign fishing will stop, because the domestic fleet is not capable of catching the volume or variety of fish available. Besides, historic fishing rights and foreign policy will also exert pressure for some continued foreign fishing. Continued foreign fishing will undoubtedly be more closely regulated by the U.S. Presumably regulations controlling foreign fishing activity would be formulated with attention to the requirements and stresses of simultaneous OCS oil development.

FISHING GROUNDS

Three major fishing grounds in the area of oil potential off the Atlantic Coast can be identified as Georges Bank, Southern New England, and the Middle Atlantic. Further divisions can be made as one considers the fisheries in more detail, for example, the Southwest Part of Georges Bank, Nantucket Shoals, the various submarine canyons, and other limited features. One noteworthy characteristic of the fisheries as they progress from north to south is the diversity of the harvest. This appears to be as much a result of the onshore marketing structures as of the availability of species on the grounds, but it is reflected in the fishing operations of the various grounds.

The following discussion of fishing grounds is organized as far as possible from south to north and from offshore to inshore. Starting at the southern end of the Baltimore Canyon area, at the edge of the continental shelf, the lobster fishery is a major deep water fishing activity for U.S. fishermen. Lobsters are sought by both trap fishermen and otter trawlers. Traps are set across the entire breadth of the continental shelf but the major offshore fishery occurs in water depths from 40 to 180 fathoms. The otter trawl fishery for lobsters takes place primarily in the narrow band between 100 and 300 fathoms depth. Submarine canyons are the most productive areas and also the most difficult to fish. The bottom gradient is steep, depth contours change direction abruptly, and natural obstructions tend to be more predominant in the canyons. These areas are among those identified by fishermen as having the highest potential conflict with petroleum development.

The Hudson Canyon is a major division point in the offshore lobster fishery as well as many other fisheries. Although a number of New Jersey lobster draggers work the east side of the Canyon intensively, in general the boats from New Jersey and southward stay to the south of Hudson Canyon and the boats from Long Island and southern New England stay to the east of the Canyon. Trawlers have remained a significant segment of the offshore lobster fishery to the south of the Canyon while traps have become the major gear to the east, especially between Hudson Canyon and Veatch Canyon, south of Nantucket. The trawl fishery resumes once again east of Veatch Canyon.

For the latter part of the year a major foreign otter trawl fishery for squid occurs just inside the primary lobster fishing grounds, from just over 100 fathoms to approximately 65 fathoms. With enactment of a 200-mile limit and increasing demand for squid on the world market this fishery is likely to become of greater importance to U.S. fishermen, who now seek squid only during seasonal periods of high prices. This fishery also extends from south of Baltimore Canyon to Georges Bank.

Fluke, porgy (scup), sea and river herring, sea bass, mackerel (also near shore at times) and butterfish grounds range from 50-100 fathoms. These species make up the major otter trawl fishery in the Middle Atlantic. The migratory pattern of these fish takes the heaviest concentrations from south and offshore in winter to the north and inshore in summer. To the south of Hudson Canyon the primary depth range for this fishery has been 38-60 fathoms in recent years. For U.S. fishermen working east of Hudson Canyon the range is now from 50-150 fathoms with increasing importance of butterfish and tilefish in the catch. During winter periods when silver hake or whiting receive a good price the fishermen may concentrate on them.

Scup, butterfish, mackerel and sea bass are schooling fishes which are also migratory. Successful fishing for these species depends to a large extent on good fish finding equipment. Whereas fluke concentrations may be located by repeated trail net tows, a great deal of time is usually spent with the fish finder before the net is set. Because the fish are concentrated in schools it is important to maneuver quickly to get the net through the schools for the largest possible portion of the towing time. The wide ranging and unpredictable movements of these fish and the special requirements for their successful capture make this fishery one of potential conflict with petroleum development. Much of the area of highest interest for petroleum in the mid-Atlantic coincides with the grounds for this fishery.

Inside the 40 fathom contour in the mid-Atlantic is a major sea scallop area. The southern portion of this fishery extends from the Virginia Capes to Long Island in depths of twenty to forty fathoms. To the eastward the sea scallop fishery resumes in the Great South Channel between Nantucket Shoals and Georges Bank. Sea scallops are also heavily fished in the twenty to forty fathom band around Georges. Both U.S. and Canadian scallopers are active in these areas.

The most productive sea scallop beds vary in location over time. As with other living marine resources, the abundance of the scallops varies from year to year with a resulting migration of boats into and out of the fishery. The summer of 1975 brought a high abundance of sea scallops in the Middle Atlantic and almost every dragger south of Cape May was rigged out for scalloping, including boats from the Carolinas. The boats which have sufficient power tow scallop dredges while the others use simple otter trawls, generally towing two nets per boat.

A variety of fisheries are carried out from the thirty fathom contour right up to the beach in the Middle Atlantic area. This includes the major surf clam dredge fishery as well as otter trawl, gill net, and trap fisheries for scup, flounders, mackerel, etc. The area does not at present appear to be of interest for oil drilling and potential conflicts will be limited to pipelines and vessel traffic.

The importance of the Hudson Canyon to the fisheries of the region extends from the outer edge of the continental shelf to the shoreward extension called the "Mud Hole" by Middle Atlantic fishermen. This is an especially productive ground for whiting and red hake, the major fishery for the draggers out of Belford, N.J. Fishing fleets overlap substantially in the immediate vicinity of Hudson Canyon because of the concentration of many major species there, but just as in the lobster fishery, generally the boats to the south of the Canyon are fishing out of New Jersey ports and those to the east are from Long Island and southern New England.

East of Hudson Canyon the 20 to 100 fathom band contains the major traditional groundfish fisheries of the Atlantic coast south of the Gulf of Maine. This fishery is made up of yellowtail flounder, codfish, haddock, pollock, lemonsole, dabs, greysole, hake, cusk and others.

Depending on their overall abundance and various climatological and oceanographic conditions, yellowtail flounder generally begin to appear in commercial quantities just below the Hudson Canyon or south of Long Island. They extend across the southern New England grounds off Block Island, Martha's Vineyard and Nantucket to the southwest part of Georges Bank and along the broad southern shelf of Georges to the eastern portions of the Bank. The primary depth for yellowtail fishing is 20 to 40 fathoms.

Codfish are found east and north of Cape Cod and Nantucket throughout the year but most move into the inshore waters of southern New England and the Middle Atlantic during the cold winter months. Haddock are usually not found in quantity to the west of Nantucket. The primary otter trawl fishery for codfish and haddock encompasses the Great South Channel between Nantucket Shoals and Georges Bank and the Northern Edge of Georges as well as the deeper sloughs between the very shoal patches on Georges. The Northern Edge of Georges has a much steeper gradient than the southern portion of the Bank and the groundfish fisheries there tend to extend deeper, out to 100 fathoms and beyond.

Most of the remaining species landed at this time by U.S. fishermen from this area are incidental to the yellowtail, cod, and haddock fisheries but some concentration on secondary species occurs depending on relative availability and price. This extends the fishing areas, for example, out to 50 to 55 fathoms on the southern portion of Georges Bank for greysole, dabs and sand dabs. Pollock exhibit a circular migratory pattern from the Canadian coast down around Georges and back again. Directed fishing for pollock is currently limited by low prices but changing market conditions could increase the effort on this relatively abundant species. Other species with potential for development into commercial fisheries should be considered when planning offshore development.

A major long line fishery is carried out from ports on Cape Cod for cod, haddock, pollock, halibut, hake and tilefish. The grounds for all but tilefish extend from the tip of Cape Cod out to the western portions of Georges Bank and down across the Great South Channel to Nantucket Shoals. The tilefish grounds are further offshore in fairly deep water just inside the edge of the shelf from Veatch Canyon to the west.

The inshore fisheries in this area include a variety of trawl, pot, dredge, and hand gear fisheries. Although surf clams have ceased to be of major importance, the ocean quahog dredge fishery is expanding. This resource extends along the entire New England and Middle Atlantic coast out to depths of 30 fathoms.

Additional potential for the development of a major offshore U.S. fishery lies in the large herring and mackerel stocks currently exploited by the foreign fleets. U.S. fishermen have begun to exploit herring with mid-water nets in limited areas but the expanding use of this gear and new developments in means to transport the fish may see this fishery spread to the entire Atlantic OCS area.

The adoption of other fishing methods developed in Europe such as seine netting and automatic long lining may also contribute to a changing character in the offshore fisheries.

FISHING PORTS

The primary ports for the major offshore fisheries in the area of petroleum interest are Gloucester, Boston, Provincetown, and New Bedford, Mass.; Newport and Point Judith, R.I.; Greenport, Montauk and Shinnecock, N.Y.; Pt. Pleasant, Atlantic City, and Cape May, N.J.; and Hampton, Virginia. A number of smaller ports such as Plymouth, Chatham and Westport, Mass.; Stonington, Conn.; Freeport, N.Y.; Belford, N.J.; Ocean City, Md.; Chincoteague, Va.; Wanchese, N.C., are important to the fishing fleets in the area. These ports are generally associated with a particular species or mix of species and a particular type of vessel.

Gloucester

Gloucester and Boston are the home ports for a number of large ground fish trawlers which work on Georges Bank and throughout the Gulf of Maine. Gloucester is the largest volume port in New England and the seventh largest in the U.S. A considerable volume of sea herring, whiting, and ocean perch, as well as cod, haddock, cusk, pollock and northern shrimp is landed in Gloucester from smaller inshore boats which exploit juvenile fisheries as well as from the large trawlers which fish the adult stocks offshore. Purse seining produces the largest quantity of sea herring. Based on the experience of the first few months of 1975, it appears that a mid-water pair trawl fishery for herring may develop in Gloucester.

The present fleet in Gloucester numbers 116 commercial fishing boats. About 30 large draggers up to 125 feet in length and 5 offshore lobster trap boats would be capable of fishing regularly on Georges Bank and a few of the 80 groundfish longline boats would also fish this area occasionally. Herring purse seiners from Gloucester are expanding their area of operation with the development of improved methods of transporting their catches and Georges Bank will probably be one of their primary targets.

Port facilities are extensive but are apparently used to their maximum. In addition to the large fishing fleet, the port services freighter traffic delivering imported frozen fish to processing firms in the Gloucester area.

Boston

The port of Boston has declined in recent years but it was still ranked as the fifth largest port on the Atlantic coast in terms of volume in 1974. Boston has always been the home port for some of the largest fishing vessels on this coast and it continues to berth large side trawlers, along with modern stern trawlers of 130 feet in length. Boston vessels also have the largest engines of U.S. fishing vessels on the Atlantic coast, up to 1300 horsepower, and fish the largest gear. Because of the capital investment required for these large vessels, the fleet in Boston tends to be company owned in contrast to the owner-operated vessels predominant in other East Coast ports. Cod, pollock, haddock, cusk, and hake are the major species landed in Boston.

Twenty-four fish buyers and processors operate in Boston but much of their supply is now received over the road from Canada as well as from smaller

New England ports. Landings of fish in Boston have declined to less than one-quarter of their former volume. Approximately 15 large vessels are now berthed in Boston and an additional 10 boats land their catches in Boston frequently. A large fleet of inshore lobster boats works the waters around Boston harbor and Boston is a center of the New England lobster market.

Boston is a major seaport and the fishing fleet uses only a small portion of the available harbor area. It would appear that space and services for offshore support could be made available without necessarily displacing the fishing fleet. However, small boat fishermen who do not use the existing fish pier area are concerned that they will be forced from their present berthing spaces by oil and other developments. They are considering a request to the city or state to assure them of dock facilities.

Provincetown

Provincetown on the tip of Cape Cod has a substantial dragger fleet as well as gill netters and longliners. Most of these vessels are fairly small and fish the local waters of Massachusetts Bay, Stellwagen Bank, the back side of Cape Cod and the inner edge of Georges Bank.

Both survey respondents from Provincetown indicated that there is a lot of unused space in the port but that dock space and repair services are very limited. These fishermen thought that increased demand for services in the port might benefit them by making more and better services available and increasing the prosperity of the area. New construction would be necessary to supply this need. The *Atlantic Coast Pilot* calls Provincetown one of the best harbors on the Atlantic Coast. Depths of 13 feet are available to the town pier.

Chatham

Chatham, at the elbow of Cape Cod, is home port for a number of small groundfish, long-line and lobster boats. These boats generally fish from Chatham to Provincetown out to the edge of Georges Bank and down to Nantucket shoals. Some of the long-liners from Chatham fish 100 miles offshore for tilefish on the edge of the shelf during the winter, a long trip in a small boat. The adjacent town of Harwichport has recently become a popular landing port for a number of offshore lobster boats. These are generally small boats in comparison to the average for the fishery and they usually do not fish the winter months. Their fishing grounds include most of the canyons on the southern edge of Georges Bank. The size of the boats which sail from Chatham is limited by the sand bar across the mouth of the harbor which is covered by only 3-4 feet of water at low tide.

Although from a purely geographic point of view Chatham may appear to be one of the best places for an offshore supply base for the Georges Bank area, it is not really suitable. The present harbor is only 6 feet deep and is crowded with fishing boats to what has become an unacceptable degree. There is no room for expansion without major dredging and construction. It is not likely that this type of activity would meet the approval of the town residents.

New Bedford

New Bedford is the leading port in value in New England and has the largest fleet of offshore draggers, approximately 100. Yellowtail flounder is the primary species but cod, blackback flounder, haddock, greysole, lemonsole and sand dabs are also important. Georges Bank is the major fishing ground for these vessels. They also do a substantial amount of fishing around Nantucket shoals and south of Nantucket and Martha's Vineyard, particularly in the winter. New Bedford is also the home of most of the full-time sea scallop dredge boats on the Atlantic coast, approximately 15-18 boats. Despite the relatively small volumes of scallops landed (scallop catches are down substantially from the 1960's), their high unit value increases their contribution to the total value of landings. The scallopers range from Georges Bank to the Virginia Capes.

New Bedford is currently in the midst of a downtown urban renewal project which began about five years ago with the demolition and reconstruction of two major waterfront areas. The new South Terminal area is the site for a number of new, relocated fish processing plants. New Bedford is the major fresh fish processing center on the Atlantic coast, with flounder fillets being the primary product. A significant number of support services for the fishing industry are also located in New Bedford and it is said that the total value of the fishing industry to New Bedford is 60 million dollars annually (Nickerson, personal communication). The North Terminal redevelopment area remains largely vacant and offers 14 acres of open storage area fronting on 1000 feet of bulkhead with 30 feet depths alongside.

At present most of the fishermen find their berths on an *ad hoc* basis after each trip. Boats raft together at the state piers or at the various shipyards in the area. Five of the eleven survey respondents from New Bedford indicated that there was no unused dock space in the port and another said there was lots. The remaining five said there was some.

Newport

Newport, Rhode Island, is a major port in its own right, but its importance has increased in recent years because of the number of New Bedford boats which land their fish in Newport. In the summer many of the "southern" boats from New Jersey and North Carolina unload in Newport also. Newport has a few offshore trawlers of its own and a number of offshore lobster trap fishing boats use Newport as a home port although most of the owners are from north of Cape Cod.

The existing facilities for berthing the fishing fleet in Newport are not really adequate and vessels must raft together in a haphazard manner. Abandoned Navy land in Newport, especially that at the former destroyer base at Coddington Cove, may become available for development by the State. This area has been viewed with interest by the fishing industry and recent news reports indicate that a boat building and metal fabrication yard may be located there. Several boatyards are currently operating in Newport with capacities up to 180 feet and 500 tons.

Another sizable piece of bulkheaded waterfront land and associated warehouses and repair shops are located across Narragansett Bay at the former Naval Air Station and Construction Battalion Training Center at Quonset Point-Davisville. Although the main shipping channel to Quonset runs up the East Passage of Narragansett Bay to Newport, vessels drawing less than 25 feet of water can use the more direct West Passage from the mouth of the Bay to Quonset.

Pt. Judith

Pt. Judith, Rhode Island, is generally viewed as one of the most successful and progressive fishing ports on the Atlantic Coast. Cooperation among the Pt. Judith Fishermen's Cooperative, the University of Rhode Island, and individual fishermen has resulted in the introduction of successful fishing techniques and an awareness of better business practices. The Co-op marketing structure has also allowed the fishermen to maintain a flexibility with regard to species which enables them to even out many of the normal depressions in fishing. Although many of the vessels in Pt. Judith have been primarily day boats, more and more are now making trips to the offshore grounds. The average size of the vessels has shown a marked increase over the years, vessels of 80 feet and more being common now. These boats harvest a wide variety of species which migrate over quite a broad area of the continental shelf.

Pt. Judith has a severe shortage of both dock space and bulkhead loading space which is likely to worsen with continued expansion and development of the fisheries. Vessels of 10-12 feet draft have a limited area of maneuverability because of shoaling conditions in the harbor. Maintenance dredging is scheduled to begin soon but the authorized size of the dredged harbor is still quite small. Outside the fishing harbor a breakwater encloses the Pt. Judith Harbor of refuge with depths up to 24 feet.

Stonington

Stonington, Connecticut, was a major fishing port until the last few decades but the fishing fleet now consists mainly of inshore lobster boats and a few small draggers. There is no buyer in Stonington, so fish landed there must be trucked directly to New York and then sold. Most of the draggers therefore land their fish at Pt. Judith or Greenport, Long Island. The local fishermen's organization is very active in attempting to improve facilities in Stonington, with support from the town government and the State University. An agreement was reached during the summer of 1975 with an established Massachusetts fish buyer to set up facilities in Stonington. The town has a well-protected inner harbor with depths of 11 feet and a breakwater-enclosed outer harbor of 15-18 feet depth.

Greenport

Although Greenport, Long Island, does not have a large fleet of boats of its own, a number of vessels from other ports sell their catch to the fish processor at Greenport at different times of the year. This includes vessels from small nearby ports as well as the "southern" boats.

Montauk

Montauk is home port for a number of draggers and offshore lobster boats. Although the draggers tend to be smaller than average offshore boats, Montauk is relatively close to the offshore grounds, and the boats do participate in the mixed species fishery on the outer continental shelf. Most of the fish packed out in Montauk is shipped directly to New York.

The existing enclosed harbor at Montauk is crowded with the commercial fleet of approximately 25 vessels and pleasure boats presently using it. However, Fort Pond Bay to the west of the fishing harbor is a mile wide semi-circle of deep water with railway tracks and former military bases along its perimeter. One former military installation now houses the New York Ocean Science Laboratory. Commercial developers have proposed the construction of a marina adjacent to the Laboratory but this development is being resisted for fear that the quality of the water supply to the laboratory will be adversely affected. It would appear that some type of protection from northerly winds would be necessary for winter use of berthing facilities on Fort Pond Bay.

Shinnecock

Like Montauk, Shinnecock is close enough to the offshore grounds to allow fairly small draggers and lobster boats to fish offshore. The harbor at Shinnecock is fairly shoal, 8-10 feet, and the inlet is quite difficult, fronting on the open ocean. Facilities for the fishing fleet are limited in Shinnecock and the fish is packed out for shipment to New York.

Port Monmouth/Belford

Port Monmouth/Belford, New Jersey, is a combination port, with a fish meal plant for menhaden in Port Monmouth and a food fish port across the town line in Belford. Belford is a small port, merely a hole in the shorefront, but it supports a considerable amount of fishing effort in the "Mud Hole," the inner reaches of the Hudson Canyon. Ten draggers and 15 lobster pot fishermen work out of Belford along with a few other inshore fishing boats. The harbor is 12 feet deep and the largest vessel is 73 feet. Space is very limited.

Pt. Pleasant

Point Pleasant is the next major port along the New Jersey coast, both in numbers of vessels and fishing activity. Pt. Pleasant is home port to a fleet of ten surf clam dredge boats and 30 finfish and lobster draggers, as well as lobster boats, gill netters and other varied inshore craft. The total fleet numbers approximately 60 boats. The Pt. Pleasant fleet exhibits a rather unique trait in that most of the draggers harvest finfish during the winter but go offshore to the edge of the shelf after lobsters during the summer. A few of the draggers harvest lobsters all year round. Pt. Pleasant is crowded with its existing fleet and any expansion would appear to require large-scale dredging and bulkheading.

Atlantic City

Atlantic City has declined in importance in recent years but still serves as the base for a number of fishing vessels of varied types. These vessels engage in fishing activities similar to those in Pt. Pleasant and Cape May, but their principal fishing grounds are between the major concentrations of boats from those communities. The Atlantic City waterfront is deteriorating and the inlet at Atlantic City is considered dangerous during rough weather.

Cape May

Cape May is the southern-most major port for a large number of offshore vessels which fish in the area of high oil potential. It compares with Boston, New Bedford, and Pt. Judith. About 20 large draggers, 12 small draggers, 5 lobster and sea bass pot fishing boats, 3 sea scallopers and other varied craft are based in Cape May in addition to the vessels from other ports which land in Cape May on a seasonal basis. Large volumes of surf clams are landed in Cape May by approximately 15 dredge boats.

The Cape May Inlet is considered the best on the New Jersey coast and the harbor has depths of 13-14 feet.

Other Middle Atlantic Ports

Although ports to the south of Cape May do not support intensive fishing activity in the area of oil potential, they may nevertheless be affected by offshore petroleum development.

Lewes, Delaware, does not have any significant large-scale commercial fishing activity since the fish meal factories closed about five years ago and the plants, docks and accompanying waterfront property were sold to a private developer. Permits are being sought to perform extensive dredging operations and for a helicopter landing pad. This particular area is on fairly open water protected by a breakwater. Additional harbor area with water depths of 12 feet exists inside the inlet. About 5 offshore lobster boats work out of Indian River on Delaware's ocean coast and small-scale fishing operations are spread throughout the state. A major oyster fishery exists in Delaware Bay.

Ocean City, Maryland, is the home port for 3 offshore lobster boats, 3 offshore finfish draggers, 5 inshore draggers, 2 gill netters and 11 surf clam dredge boats. Fluke, sea bass, rockfish, sea trout, surf clams and lobsters are the major species landed. Vessels of 10 feet draft can use the harbor but little space is available. The harbor at Chincoteague, Virginia, can be used by vessels drawing up to 8 feet of water. In addition to a small fleet of draggers berthed in Chincoteague, the port was used during the summer of 1975 by approximately 15 draggers from Carolina ports rigged out for scalloping. Four surf clam dredge boats, 2 sea bass pot boats and 25-30 small gill netters are also based in Chincoteague.

Cape Charles and Oyster, Virginia, have a number of small inshore fishing boats as well as some large surf clam dredge boats. A fish meal plant is located on Cape Charles harbor. Cape Charles has a harbor depth of 17 feet while Oyster has 10 feet. The inlet at Oyster has more than 30 feet and deep water runs quite far in.

Hampton, Virginia, is a major port relying primarily on boats from the Carolinas and Texas to supplement the landings of the 14 local draggers. Up to 75 vessels may use the port during the course of a year. During the summer of 1975 most of the local boats had converted to scalloping, 7 using nets and 8 using dredges. Many of these vessels fish off the New Jersey coast from Hudson Canyon to the south, both for finfish and for scallops. The size range of the vessels is 80-110 feet with engines ranging from 365-850 horsepower. The harbor can accommodate vessels up to 15 feet draft.

Hampton is within the area known as Hampton Roads which includes Hampton, Newport News, Norfolk, Portsmouth, and Chesapeake, Va. The

Hampton Roads area has about 200 piers and 30 miles of improved waterfront. The area is a major shipping port and includes the Norfolk Navy base and other military installations. People in the fishing industry claim that valuable waterfront property is being used up by urban renewal and condominium construction.

FISHERMEN: *Attitudes and Experiences*

Although descriptions of fishing techniques and ports provide necessary background, understanding the operation of the fishing fleet requires knowledge of the attitudes and experiences of fishermen. Fishermen's perceptions of the interaction between offshore petroleum development and fishing operations were investigated by distributing a questionnaire to about 450 fishermen and by holding group and individual meetings along the coast. Sixty-three of the questionnaires were returned, about 14 percent of those distributed. Returns spread from Maine to North Carolina with some concentration in Chatham, New Bedford, Pt. Judith and Long Island.

Techniques of offshore petroleum development are foreign to most Atlantic coast fishermen: almost two-thirds of the questionnaire respondents did not feel they knew enough to judge what effect it would have on their operations. However, three quarters favored having their fishing grounds withheld from oil operations; of the remainder, the majority were fixed-gear fishermen.

Loss of fishing grounds through physical obstructions, such as drilling rigs, platforms, wellheads, subsea production systems, pipelines, and debris, is the major problem envisioned by Atlantic coast fishermen. Debris thrown overboard by supply boat crews, such as barrels, pieces of pipe and other materials that can snag and damage fishing gear, is perceived as a potential problem by many fishermen.

Pipelines are viewed as the next most severe threat to fishing grounds. Over ninety percent of the survey respondents said that all pipelines crossing fishing grounds should be buried. Those who would not require burial were all fixed-gear fishermen. A trenched pipe which has not been backfilled may be as much of a hazard as a pipe lying on the surface, since fishing gear may be caught and damaged by the dredge spoils from the trench.

The likelihood of fishing gear damaging a pipeline is unresolved, although cases have been documented in the North Sea of pipeline damage by fishing gear or anchors. Apart from rupture, the possibility of tearing loose the cement covering a pipeline would appear to be significant. Cement torn loose from the covering would not only harm the pipeline but could cause an increased chance of damage to fishing gear.

Single isolated platforms are not generally viewed as being particularly troublesome. Some fishermen actually view an occasional platform as an aid in times of distress or emergency, or even as a navigational aid. Most fishermen do not feel that platforms will be of any significant navigational value to them. However, platforms are viewed as a problem when they multiply along with associated pipelines and other installations into field and area developments.

The U.S. does not have a mandatory safety zone around oil installations, but fishermen must maintain sufficient distance from obstructions to avoid damaging vessels and gear. More than half of the fishermen who responded indicated that they fished up to 300 feet from submerged obstructions. The remainder were split almost evenly between those saying they could fish within 300 feet and those who stayed more than 1500 feet away. One fisherman commented that he would probably stay further away from an obstruction which was visible on the surface than from a bottom obstruction. In the case of an unmarked obstruction, a fisherman can approach until it is under him and shows on his depth recorder and then turn off to miss it with his net.

Fixed gear fishermen can fish closer to obstructions without fear of extensive damage than can mobile gear fishermen. Under present circumstances, a fisherman's only consideration in crowding an obstruction is possible damage to his own gear. His self-imposed safety zone might become larger if there were also risk of and liability for damage to oil equipment such as pipelines or subsea production systems. On the other hand, the introduction of LORAN C equipment in the Northwest Atlantic is expected to increase the navigational accuracy available to fishermen and should therefore allow them to fish closer to known obstructions with greater certainty of avoiding them.

On platform spacing, three quarters of the respondents thought that minimum distances between platforms of anything less than two miles would be a problem; over half thought that three miles was a minimum. The remaining quarter thought that the platforms either would not be a problem or would be a problem only if spaced closer than one mile.

When asked if it would be helpful if the oil industry was willing to move the desired location of their platforms either a few hundred feet or one mile, 38 fishermen responded: 20 said one mile would help but not a few hundred feet, five said a few hundred feet but not one mile, and 13 said both would be helpful. Fishermen have a saying that fish live on streets, and you have to be on their street to catch them. The problem is that the streets are always changing so a fishermen cannot readily pick out a small area which will be most important to him over a long period of time.

Another physical obstruction to fishing activities is additional vessel traffic on the fishing grounds. Fishermen in relatively small wooden boats are concerned that they will not be visible to supply boats during bad weather either by eye or on radar. These fishermen are particularly strong in their agreement with three quarters of the survey respondents that supply boat traffic should be confined to lanes. Fishermen are more concerned about traffic while they are actually engaged in fishing than while they are steaming. While fishing, their maneuverability is limited and less attention is paid to purely navigational considerations.

In addition to physical obstructions on the fishing grounds, fishermen are concerned about competition from the oil industry for port facilities and services, and for labor. More than half of the respondents foresaw difficulty in obtaining crewmen because of offshore oil development.

Competition for port space on the Atlantic coast would appear to depend on the willingness of the oil industry to locate in areas other than the heavily used fishing ports. In some areas this can mean moving to an entirely different port while in others it means only utilizing underdeveloped or dilapidated sections of waterfront which are not used by the fishing fleet. Sixty-three percent of the respondents thought that their port had no unused space while 26 percent thought they had some and eight percent thought they had lots. Most respondents indicated some present difficulty in obtaining dock space, electronic repairs, haul outs or engine and machinery repair. They generally expected that these services would become more difficult and more costly with increased demand from offshore oil support activities.

The questionnaire also had a number of broad questions relating to the fishermen's attitudes toward their own industry, the government and offshore oil development. There were three sets of questions of this sort, each sent to one third of the recipients, so that only about twenty fishermen actually responded to each question. Two questions asked directly if offshore oil development was desirable or undesirable and whether fishermen should engage in political action to try to stop it. About half of those responding felt oil development was desirable and half did not; some of the former admitted some interest in working for the oil industry. Only one third of the respondents favored efforts to stop oil development. Reasons given by the others ranged from "it won't do any good to oppose the oil industry, anyway," to hope that development could take place in a way which would not disrupt the fisheries, thanks to the financial and technological resources available to the oil companies. Similarly, most of the respondents felt that the undesirability of oil development could be greatly diminished if the oil industry would take pains to consider the needs of fishermen. Only three insisted there was no way that oil development could be anything but harmful to fishing. Some fishermen also expressed concern about possible pollution from oil.

The fishermen were asked if they had even thought of going into another business: seven said yes, twelve said no. Some said they had given up other employment to go into fishing; others simply answered that they had always fished for a living and would until they died.

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CHAPTER IV

Offshore Petroleum Industry Operations

INTRODUCTION

Attempts at extracting petroleum hydrocarbons from offshore sources date back to 1896 in California, when offshore wells were drilled from rigs built on pilings and wharves extending from the shore. All of the limited in-water activity was accomplished with an "umbilical cord" arrangement to dry ground until the late 1930's. The first open water drilling operation took place in 1938 in the Gulf of Mexico off the coast of Louisiana.

Activity beyond the sight of land did not begin in earnest until the late 1940's and the offshore industry did not really come into its own until the 1960's, when advances were made in technology which allowed the use of both fixed and mobile deep water platforms.

Before 1950, most of the domestic offshore oil was taken from California. However, with the passage by Congress in 1953 of the Outer Continental Shelf Lands Act, the emphasis of production shifted to the Gulf of Mexico. By 1965 approximately 80 percent of offshore production was from Louisiana. About 8,000 wells had been drilled by then, mostly in the Gulf and mostly single well sites. Between 1965 and 1975 the technology advanced to a state which permits routine drilling from a single platform of 20 to 60 wells in depths out to 200 fathoms; another 10,000 wells were drilled during the decade.

It should be borne in mind that the oil operations in the Gulf of Mexico and the socio-economic reactions in waterfront communities are not necessarily comparable to those that might be expected in the northeastern United States. There are several reasons for this. First, the Gulf experience represented a gradual offshore extension of oil industry activities which had existed for many years in the onshore portion of the coastal zone. The people of the Louisiana bayou and Mississippi delta regions had become accustomed to the industry's presence, and many were earning a living from it. The importance of easing a society into the ways of an activity as overpowering as the oil industry cannot be overemphasized, and that will not be the case for the northeast states. Second, the physical environment of the northeast region offers the oil industry challenges different from those faced in the Gulf (see Chapter II). In particular, weather and climate will test the most advanced technology currently being used off Louisiana and Texas. Another important difference is the Atlantic shore itself: there are no waterways and bayous into which onshore pumping, processing and support activities can settle with little apparent disruption of the physical and cultural environment. A more appropriate comparison would be with the offshore oil development in the North Sea. Both the physical and the cultural setting there are more analogous to the northeastern United States: development is taking place in a virgin area, far offshore, in deep water, under severe environmental conditions, on the continental shelf of highly industrialized, energy-intensive states, all within a rapid time frame (White 1973). In the following sections comparisons are avoided; the object is to describe the development of the offshore petroleum industry as it might develop off the northeastern U.S., emphasizing the operations both ashore and at sea that could have direct effect on the domestic fisheries.

To do this requires some basic assumptions about the nature and extent of the oil and gas reserves in the Baltimore Canyon and Georges Bank troughs. The assumptions made here are reasonable on the basis of present information but it should be recognized that they are only assumptions and the actual operations may differ in many respects from what is described below.

An oil or gas field represents a single resource-bearing geologic structure. Only about 35 percent of the liquid hydrocarbon present is recoverable under normal formation pressure. With additional treatment, such as injection of water or gas to increase flow pressure and use of steam or chemicals to reduce the viscosity of the crude oil, up to 50 percent of the total may be economically recovered. Although it costs between five and eight times as much to produce a well offshore as on land, the yield of offshore wells in proved reserves is about four times as great, on the basis of footage drilled. Some estimates of the amounts of recoverable resources in the two areas now under consideration are given in Table IV-1; they give an idea of the range of opinions in the absence of actual exploratory drilling. It is assumed here that the actual find will be somewhere in the middle of the estimates in the table, and that it will translate in terms of production into a peak yield in each region of 500,000 barrels of oil per day and 1 billion cubic feet of gas per day at the end of 10 years after the first lease sale.

The rationale behind those figures is based on the estimate that about one million acres will be offered in the initial lease sale in each of the two regions.* The acreage is leased by tracts or blocks

*The actual tentative offerings were approximately 900,000 acres in the Baltimore Canyon Trough and 1.1 million acres in the Georges Bank Trough, according to BLM public announcements in late 1975.

Table IV-1. ESTIMATED RECOVERABLE OIL AND GAS RESOURCES

	U.S.G.S.[a]		URI[b]		Industry Sources[c]	
	Oil (10^9 bbls)	*Gas* (10^{12} ft^3)	*Oil* (10^9 bbls)	*Gas* (10^{12} ft^3)	*Oil* (10^9 bbls)	*Gas* (10^{12} ft^3)
Baltimore Canyon (12,000 mi^2)	0.2 (1.1) 3.2	0 (5.3) 15	---	---	0.2 - 2.0	4.0 - 7.5
Georges Bank (14,000 mi^2)	0.4 (0.9) 2.4	0 (4.2) 12.5	0.4 - 3.0	2.0 - 10.0	---	---
Atlantic Potential*	0 - 6	0 - 22				

a. Based on totals given in U.S. Department of Interior, Geological Survey, *Geological Estimates of Undiscovered Recoverable Oil and Gas Resources in the U.S.* Circular 725, 1975. Estimates by author are interpolations of U.S.G.S. totals reported at the 75 and 25 percent probability levels. The number in parenthesis represents an approximation of the Statistical Mean. *Reported at the 95-5 percent probability range for the entire Atlantic offshore area.

b. T.A. Grigalunas, *Offshore Petroleum and New England,* University of Rhode Island, 1975.

c. Based on a range of estimates given to author by various informed industry sources.

of 5760 acres (nine square miles) each, so that about 175 tracts should be available in each region. Probably 35 percent of the tracts will be purchased in the initial sale, and only one quarter of those purchased will prove to have commercially valuable hydrocarbon deposits, so that perhaps 15 tracts in each region will actually be developed with producing wells. Each tract will probably support two platforms, each with about 20 wells. The wells should produce on an average about 750 barrels of oil per day (a 1,000 bpd well is considered a very healthy producer in the Gulf of Mexico), or 15,000 bpd per platform. Gas production is estimated at 30 million cubic feet per day, per platform. Multiplying by 30 platforms in each region gives the daily totals estimated above. We have not speculated here on the size of the actual oil fields but it is probable that several tracts will be required to cover each field.

The figures given above are similar to those prepared for the Bureau of Land Management by the oil industry although some representatives think they are high. Only exploratory drilling can give the answer.

OFFSHORE DEVELOPMENT

Geophysical-Geological Survey

The first step is a series of prospecting activities which are undertaken to locate promising geological formations. The usual technique involves a research ship towing a string of instruments for seismic, magnetic and gravity surveying Fig. IV-1. So far nearly 60,000 miles have been covered on grids of 3 to 4 mile spacing.

Until a few years ago the principal energy source for seismic surveying at sea was a charge of explosive material, but the method killed many fish and lacked precise timing. It has been replaced by more sophisticated systems using electronic vibration or controlled ignition of a gas mixture, neither of which appears to have any significant negative environmental effect.

The information obtained from this general surveying is needed for determining the value of tracts being offered for sale, and is used by both industry and government. Usually, more detailed surveys follow, concentrated on promising locations. Infrequently, oil companies are allowed to take bottom samples and cores as part of the detailed survey. Permits for exploratory surveying must be obtained from the U.S. Geological Survey.

Although several oil companies may combine to hire the services of a survey boat, the interpretation of the data acquired is not always a shared venture. Individual companies spend considerable time and money in data processing and interpretation and consider their conclusions to be proprietary information. This phase of the operation may present a temporary problem because of a shortage of trained manpower for interpreting the survey data (National Petroleum Council, 1974).

Survey activity at sea is generally not so intensive that it interferes with other users of ocean space, but there have been some complaints from

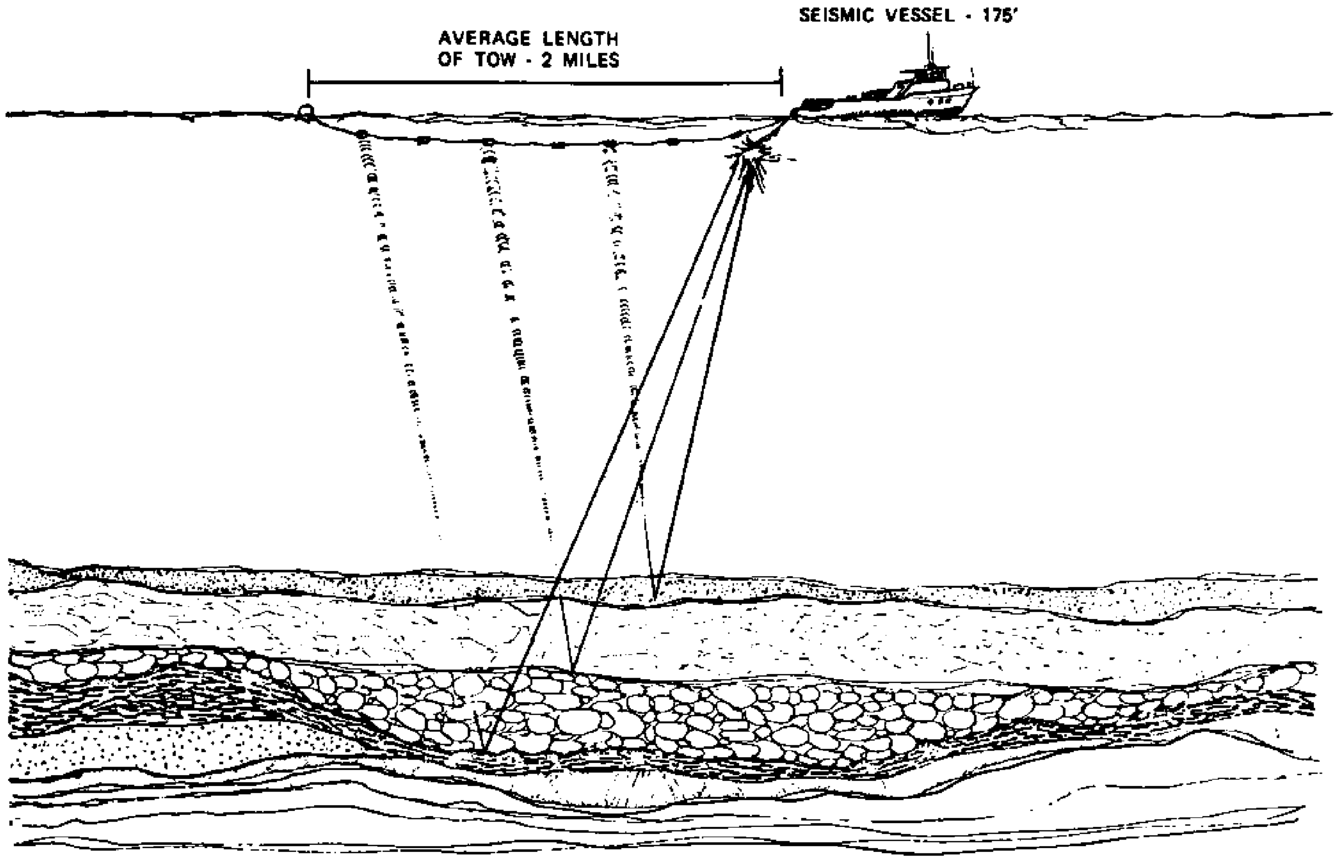


FIG. IV-1 SEISMIC OPERATIONS

fishermen that during the more detailed exploration phase, survey boats and their trailing sensors have interfered with fishing operations.

Exploratory Drilling

Once a tract has been purchased from the government in a lease sale and the appropriate permits have been obtained (as described in Chapter V), a company can begin actual drilling to determine whether commercial accumulations of oil or gas are present. There is no other way to find out. Criteria used to determine the economic worth of an oil or gas discovery are:

a. distance from shore
b. depth of water
c. size of field in terms of retrievable resources
d. depth of reserves
e. gas to oil ratio
f. lease costs, royalties and taxes
g. availability of land, labor and capital
h. market price of gas and oil
i. attitude of coastal states toward petroleum operations
j. delays caused from action by private interest groups

Usually more than one exploratory hole is drilled to determine the nature of a petroleum bearing structure and the size of a field. The drilling equipment and techniques for offshore exploratory wells are similar to those used on land. The major difference is the supporting structure (platform) for the drill rig and equipment. Three types of mobile drilling rigs are likely to be considered: drill ships, jack-up rigs and semi-submersibles.

Drill ships (Fig. IV-2) are self-propelled, self-contained drilling units. The big advantage is mobility and the principal problem is platform motion although there are new techniques which permit some lateral and vertical motion of the drill string. Position is maintained on location either by anchoring or dynamically with a series of propellors and thrusters coupled to sensors which automatically detect and compensate for movement.

Jack-up rigs (Fig. IV-3) have legs which can be extended to the bottom in 350 feet or less of water depth and jacked up to elevate the platform above the sea surface. When the legs are retracted the structure floats and can be towed to another drill site.

Semi-submersibles (Fig. IV-4) have flotation underwater and the working platform above the surface. They can be either towed or self-propelled and are generally secured in position by anchoring. They can drill in as much as 2000 feet of water. The semi-submersible is the rig most likely to be used if available in sufficient quantity.*

*As of 1975, worldwide there were 304 marine drilling rigs in action and 139 planned or under construction: 127 semi-submersibles, 192 jack-ups, 101 drill ships and barges and 23 submersibles (*Ocean Industry*, Sept. 1975).

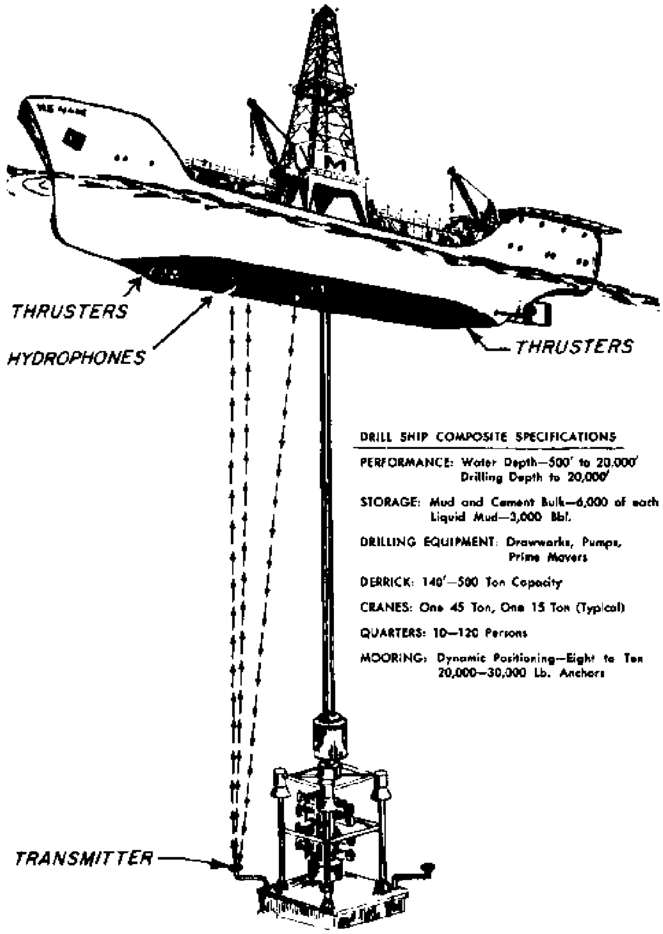


FIG. IV-2 TYPICAL DYNAMIC POSITIONED DEEP WATER DRILL SHIP

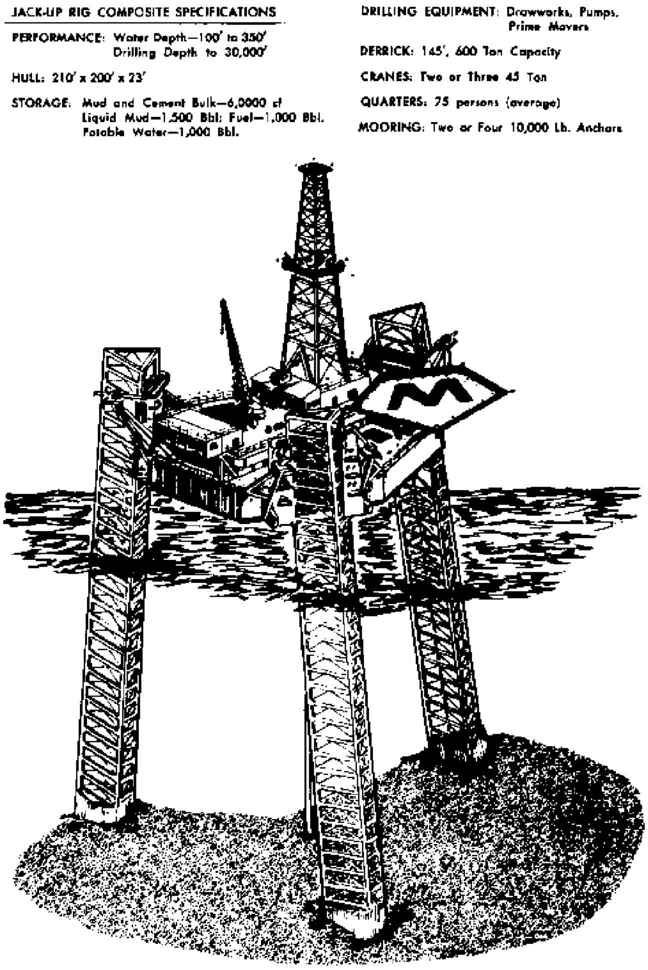


FIG. IV-3 JACK-UP RIG

The actual hole is drilled with a rotating bit at the bottom of a string of drill pipe. Sedimentary cuttings are removed by a fluid called drilling mud which is pumped down through the drill string, out the bit and back to the surface. The mud and cuttings are separated; the mud being reused and the cuttings washed overboard. The mud also helps to control the pressure in the hole, along with steel pipe casing and mechanical blowout preventers. The casing, a liner for the bore hole, is installed and cemented in place to a depth specified by the U.S. Geological Survey Supervisor for the area. The hole itself can be as much as 36 inches in diameter. Exploratory holes are rarely used for production. Instead they are filled in and cemented over and new holes are drilled for producing wells. The abandoned holes should not be obstructions to fishing.

The number of mobile rigs actually in service will depend upon the oil industry's judgements about the commercial potential of the tracts offered for sale. It is likely that many holes will be drilled before substantial reserves are located; the historical average is that some oil is found in about one hole out of every 10 drilled, and commercial accumulations in about one out of 50. It is reasonable to expect that there should be eight to ten exploration rigs searching for oil and gas in each of the regions by 1981 provided some success is achieved.

At sea a rig will stay in one operating site for two or three months, and fishing activities would be excluded within about a quarter of a mile of the platform, more if the anchoring system is extensive. A minimum of two support boats, one each for crew and cargo, would be in almost constant use between each rig and its shore base (Fig. IV-6). One generally remains near the rig.

The period of exploration is one of relatively high employment. The total number of workers per rig, at sea and ashore, will be 110 to 115, with perhaps 40 recruited from local communities. Monthly wages (at 1974 levels) would be about $125,000. Purchase of equipment and materials, and rental of land, boats and aircraft would of course add to the economic impact.*

*All estimates of manpower, equipment, and costs, unless otherwise stated, were derived as the result of numerous conversations and interviews with knowledgeable individuals of oil companies and contractors, as well as with the research staff of the American Petroleum Institute.

SEMI-SUBMERSIBLE RIG COMPOSITE SPECIFICATIONS

PERFORMANCE: Water Depth—600′ to 3,000′
Drilling Depth—30,000′

HULL: 350′ x 220′ x 120′

STORAGE: Mud and Cement Bulk—14,000 cf
Liquid Mud—15,000 Bbl.
Fuel—5,000 Bbl.
Water for Drilling—10,000 Bbl.
Potable Water—1,000 Bbl.

DRILLING EQUIPMENT: Drawworks, Pumps, Prime Movers

DERRICK: 160′—1,000,000 Pound Hook Load Capacity

CRANES: Two 45 Ton

MOORING: Eight to Ten Point Anchoring System at 30,000 Lbs. each

QUARTERS: 50—100 Persons

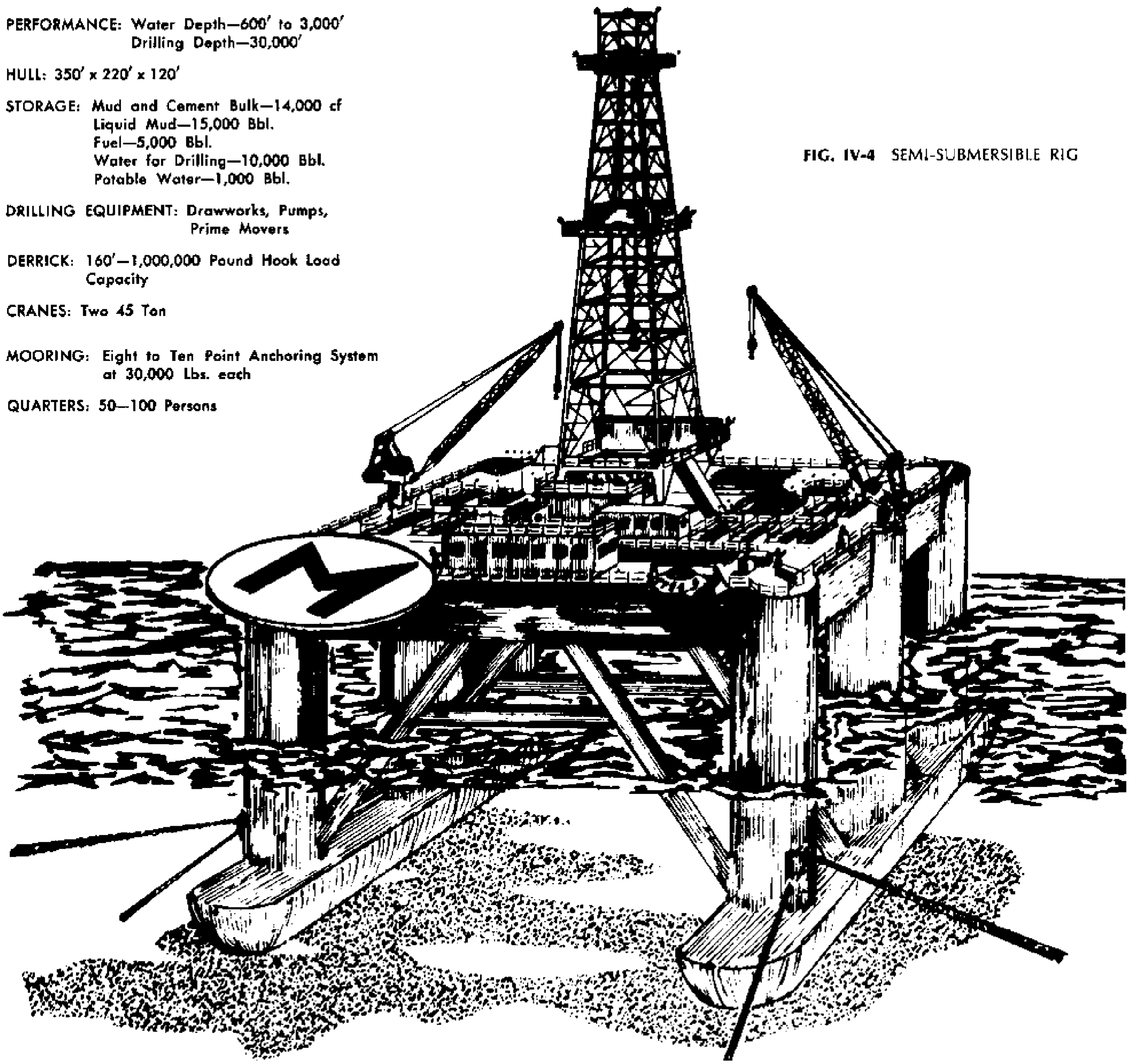


FIG. IV-4 SEMI-SUBMERSIBLE RIG

The breakdown of job categories is:

a.	drilling rig crew	70
b.	service support	10
c.	dockside support	5
d.	supervision from lessee	5
e.	transportation	20

Well Development

When a commercial reserve has been discovered and the extent of the field determined, one or more permanent platforms are placed within the field.

Before any fixed platform can be installed offshore, a field development plan and an application for permission to drill must be submitted to the U.S.G.S. Area Supervisor. As with the exploratory drilling plan, this plan must describe the geologic structure of the field, the location of each well to be drilled and all platforms and other structures to be used. The Area Supervisor may require any other information which might be useful from the viewpoint of safety, planning or monitoring.

Since the structure used for well development will also serve as the facility for production, the kind used represents a major decision on the part of the oil company. There are currently three choices: steel truss structures attached to the ocean floor by steel pilings, concrete gravity platforms held in place by their own weight, and subsea production systems with the entire mechanism located on the ocean floor except for the actual drilling, which is done from a drill ship (Fig. IV-5). The subsea system is best employed in depths greater than 1000 feet, and concrete gravity platforms require deep water construction sites, so it is most likely that the fixed steel platform which can be used in depths up to 800 feet, will predominate. A typical steel platform (Fig. IV-7) has several decks which provide the crew's work and living spaces, pipe and equipment storage and a helicopter landing zone. A single large platform could measure 350 by 300 feet and cover 2 1/2 acres of ocean. From such a platform up to 36 diagonally-drilled wells (Fig. IV-8) could tap as much as four square miles of reservoir. (A slanted hole can reach oil two miles deep at a radius of about one mile from the platform.)

Where several companies hold tracts within a single field, operations are generally "unitized" to reduce construction costs and platform density. Otherwise the drilling procedures are similar to those carried out during the exploration phase. Development crews are generally smaller than those used in exploratory drilling, but otherwise similar. Each rig will require:

a.	development drilling rig crew	50
b.	service support	8
c.	dockside support	2
d.	supervision from lessee	3

Monthly wages per rig average $95,000 (1974) with approximately 60 percent of the total going to employees hired locally. Transportation needs, both air and marine, would remain stable if exploration activity decreased as field development increased. In actual practice it is quite likely that if a major find occurs, exploration will be increased while development and production take place.

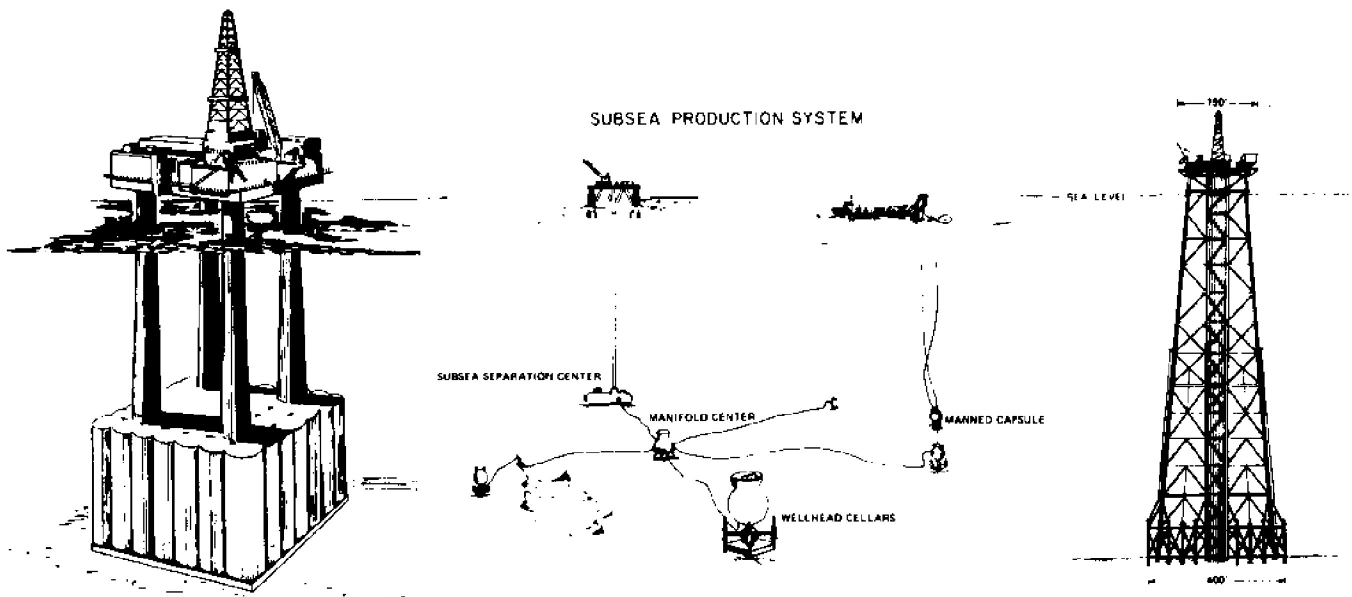
Production

Not all the wells drilled from a fixed platform will produce oil or gas. If a well is dry, it is filled and plugged with cement like the exploratory holes. If oil or gas in commercial quantities is found, the well is then "completed." The steps required to complete wells are specified in various OCS Orders issued by the U.S.G.S. Area Supervisor. The procedures are designed for maximum production while insuring the safety of both the environment and the oil crews. Completion can include the following:

a. placing and cementing steel casing
b. setting pipe or tubing within the casing
c. fracturing and acidizing of the sediments to increase permeability
d. placement of downhole safety valves and surface blowout preventers

Once the well has been prepared for production and petroleum is being extracted, various processing operations take place. An assortment of valves and pipe fittings, known as the "Christmas Tree", is installed at the well head to regulate flow and facilitate servicing. Normally, sand and water are brought up along with the hydrocarbons and must be cleaned of oil before they can be discarded. According to OCS Order 8, which applies to both the West and Gulf coasts, water discharged after separation may not exceed 50 parts of oil per million of water.

It is unlikely that installation of the first fixed platform in either region will begin sooner than four years after the lease sale. The estimate is based on the assumption that two to four years of exploratory drilling will take place before a platform construction contract is awarded. Fabrication takes



CONCRETE GRAVITY PLATFORM　FIG. IV-5 PRODUCTION PLATFORM　PRODUCTION PLATFORM

1 1/2 to 2 years. Once a platform is in place it takes another two years to develop all its wells and bring them into production. When operations are well under way it is expected that from five to eight platforms will be under construction at any time.

Employment during the production stage is considerably less than during exploration or development. Company employees will fill most of the positions on the platforms; contract crews will perform the nontechnical and workover services. Approximately 15 workers are required to operate a production platform, working seven days on, seven days off. It is quite possible that most crew members will come from shoreside communities as a pool of experienced workers should have accumulated by this stage of oil development. Transportation requirements for crew and supplies to support each platform will remain about the same, but with as many as 60 platforms in operation there will be considerable support boat and stand-by vessel activity both at sea and in port.

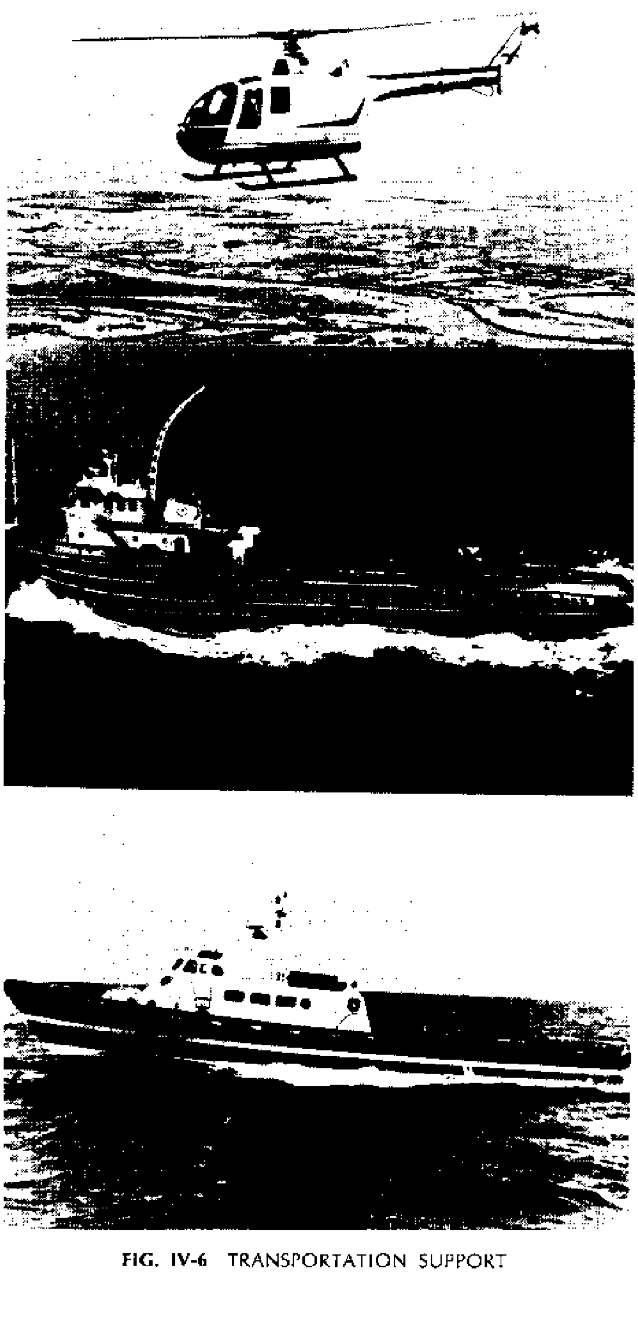


FIG. IV-6 TRANSPORTATION SUPPORT

Production systems installed on the outer shelf are expected to remain in place for the life of the field — 20 to 30 years. Problems will occur during that period and workover activities will be required as well as normal maintenance and well servicing. It is often necessary to reenter the well hole to perform a variety of cleaning, retrieving or installing tasks. These remedial duties require special equipment and trained crews and are subcontracted by the oil companies to a specialized industry group.

Natural gas is normally found along with oil in a petroleum reservoir. The gas can be extracted either in association with oil production or from non-associated wells for gas only. In the first instance limited amounts of gas can be burned off (flared) or used as an energy source at the production site; shut in and held for future pipeline installation; reinjected to maintain pressure in the field for a higher oil yield; or processed, sold and pumped to shore distribution points. The option chosen depends on the stage of oil development, the composition of the gas and oil mixture, and the market price. Under present market conditions it is likely that the oil companies would want to extract the oil first and then the natural gas. If the gas is sold it must be separated from the oil and transported to shore through its own pipeline. Sometimes another platform is built for the separation process.

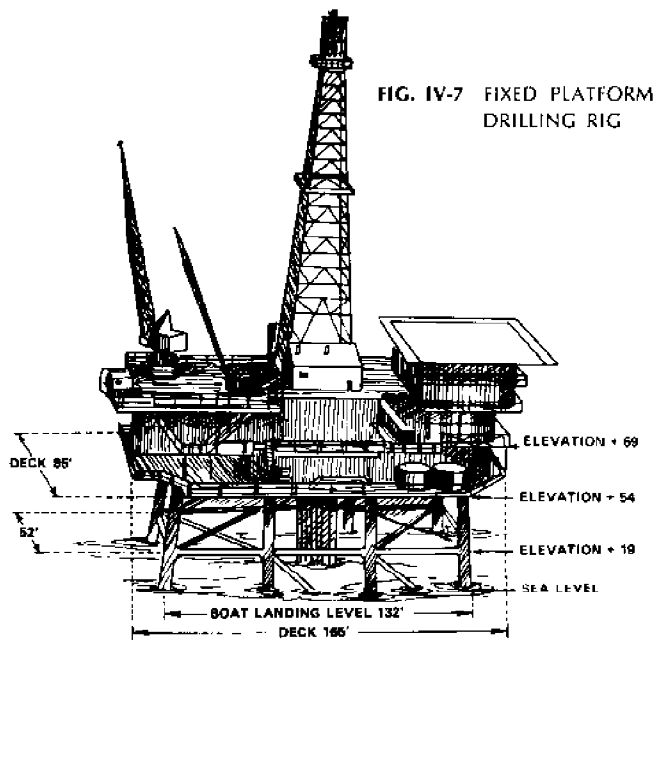


FIG. IV-7 FIXED PLATFORM DRILLING RIG

Gas operations in both associated and non-associated fields are similar to those of oil development and can be considered part of the same activity for purposes of this study. The estimate made here is that at peak production – ten years after the first lease sale – gas sales will be shared equally between associated and non-associated sources.

Transportation and Storage

Oil and natural gas may be moved from the production areas either by pipeline or by tankers. Current plans of the oil industry, and recent history on both the West and Gulf Coasts as well as the North Sea, indicate that within 200 miles from shore and in depths up to 400 feet, pipeline will be the primary transportation mode. However, given the large amounts of "front end" money which must be paid out by companies for tract purchases and initial capital investment, the earliest possible return from the sale of oil and gas will be desirable. Tanker transportation may be used in the following situations:

a. good early production but future of the field unknown
b. good early production and a need to move the product before pipeline completion
c. good production in an isolated field or in a field located in a prime fishing area where pipeline burial would be difficult
d. absence of regional refinery, so that crude oil must be shipped some distance.

A shortage of pipe could also result in a larger role for tankers. Mill output has not kept up with the increasing needs of pipe users and in the recent past there has been a serious shortage of tubular goods (National Petroleum Council 1974). Oil production on the northeast shelf will place increasing demands for pipe on the steel industry.

Losses of crude oil due to collision and during transfer operations make the use of bulk carriers undesirable especially in nearshore areas. An additional factor against the use of tankers has been their inability to remain on station during severe storms. However, with the perfection of submerged storage tanks, single point mooring buoys and over-the-bow link-up systems, interruptions of production because of storms can be kept to a minimum even with tankers.

There is no simple method of determining when a pipeline is justified over bulk carriers. Pipelines are expensive – estimates of cost are based on pipe diameter times distance and vary from $10,000 to $25,000 per inch-mile. One mile of 20-inch pipe could cost $500,000. Water depth, tides, currents, bottom composition and weather must all be considered in estimating pipeline cost. It is understandable that a final decision on pipelines must wait until the worth of an oil field has been evaluated

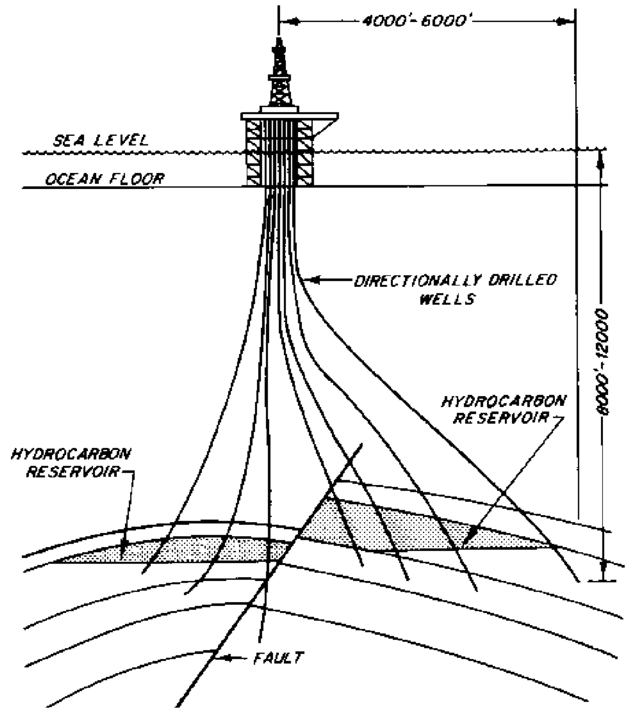


FIG. IV-8 TYPICALLY DIRECTIONALLY DRILLED WELLS

and the possibility of tying in with nearby fields has been determined.*

Nevertheless, we expect that there will be at least two 30-inch trunk lines (one each for gas and oil) running ashore from each of the two offshore regions. We anticipate that the most likely shore entry points will be Delaware Bay for the Baltimore Canyon development and Narragansett Bay for Georges Bank. Both shore areas have a history of petroleum and related activity and are within reasonable pipeline distance of the potential oil fields; in both there appears to be better than average prospects for increasing present storage and refinery capacity or building new facilities.

In addition to the trunk lines to shore, a network of gathering lines of smaller diameter will be needed to collect the petroleum from the various production platforms, and transport it to the trunk lines or to other processing platforms. Generally, before the oil or gas is pumped to shore all but a small fraction of the associated sediment and water is separated out. This operation usually takes place on a separation platform with a variety of chemical, heating and pressure techniques. Compressors are used when natural gas is involved.

The most common method of laying pipeline offshore is from a lay barge with three or four accompanying tug boats and additional service vessels to transport crew and materials. Sections of pipe,

*Pipeline diameters range from 4 to 52 inches, and are usually laid in 20-40 foot sections. It is unlikely that lines in excess of 36 inches will be used on the Atlantic Shelf. Gas companies are responsible for laying their own lines independent of crude oil laying operations.

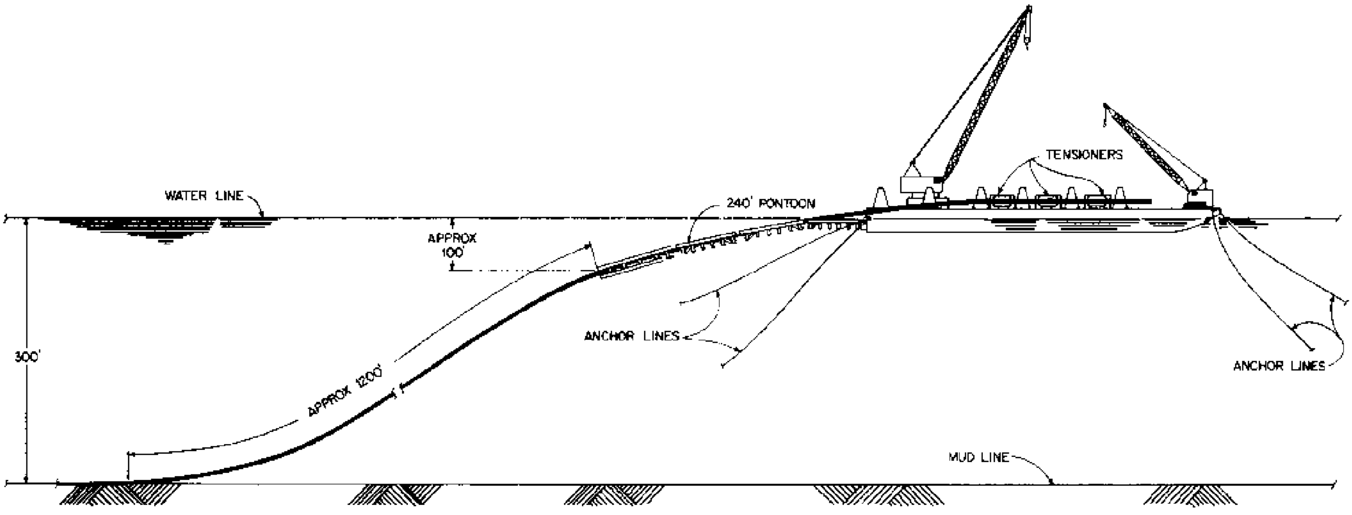


FIG. IV-9 PIPE LAY BARGE

coated with concrete and welded together, are released into the water as the barge moves forward (Fig. IV-9). Burying or trenching is accomplished by a separate dredge barge (Fig. IV-10) which uses a water jet system to excavate a trench into which the pipe is laid. When the pipeline is on the bottom it is inspected by free divers or submersibles to make sure it is in the trench and to check the security of the welds. Although burying lines in the looser sediments of the Gulf of Mexico has been generally successful, the hard clays and sand waves of the North Sea have caused some difficulties, and there may be similar problems off the northeastern U.S. One barge handicap, regardless of bottom conditions, is its operational restriction to seas of six feet or less.

Crews for the new generation of lay barges and dredge barges run well over a hundred people each, and the supply boats and tugs will add to the total. There are normally at least two of each kind of barge engaged in a pipeline-laying operation.

It should be noted that there is no law requiring the burial of pipeline, but it can be required by the Area Supervisor. The practice has been to require burial of pipe a minimum of three feet in water depths of less than 200 feet. Although kept to a minimum offshore, exposed coupling valves are often needed to facilitate tie-in with other lines and

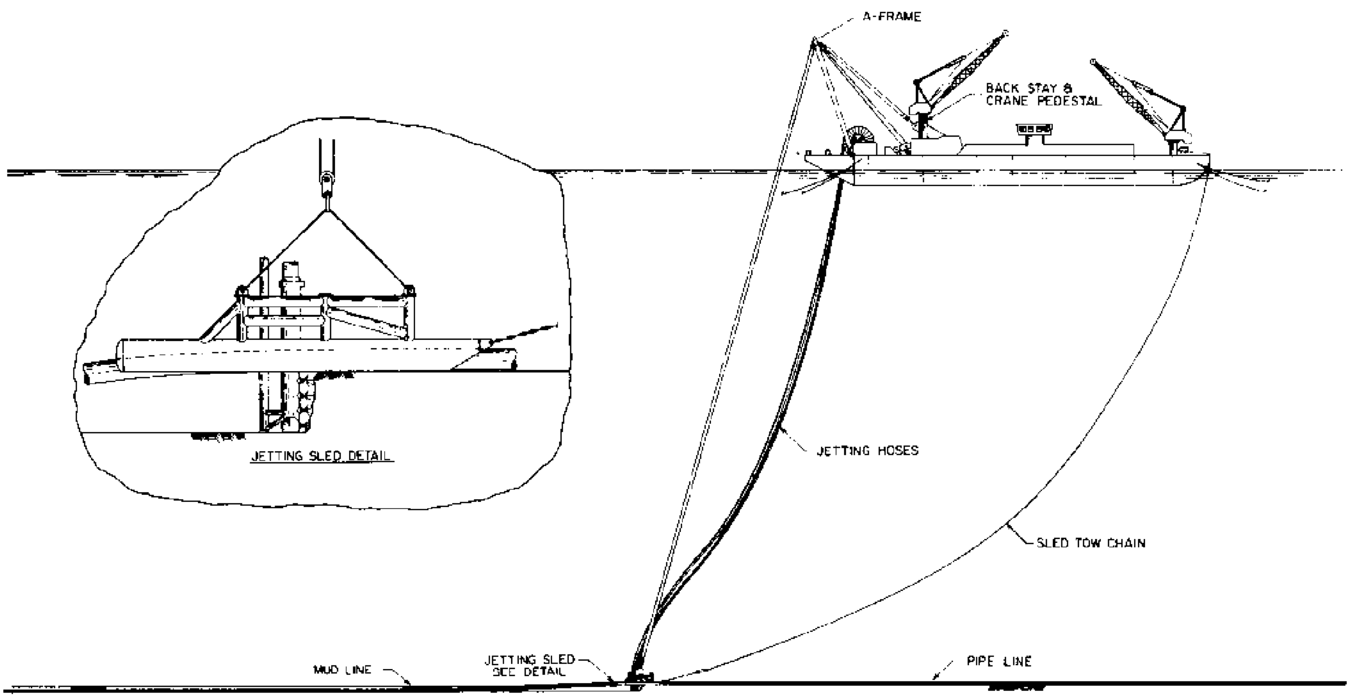


FIG. IV-10 PIPELINE DREDGE BARGE

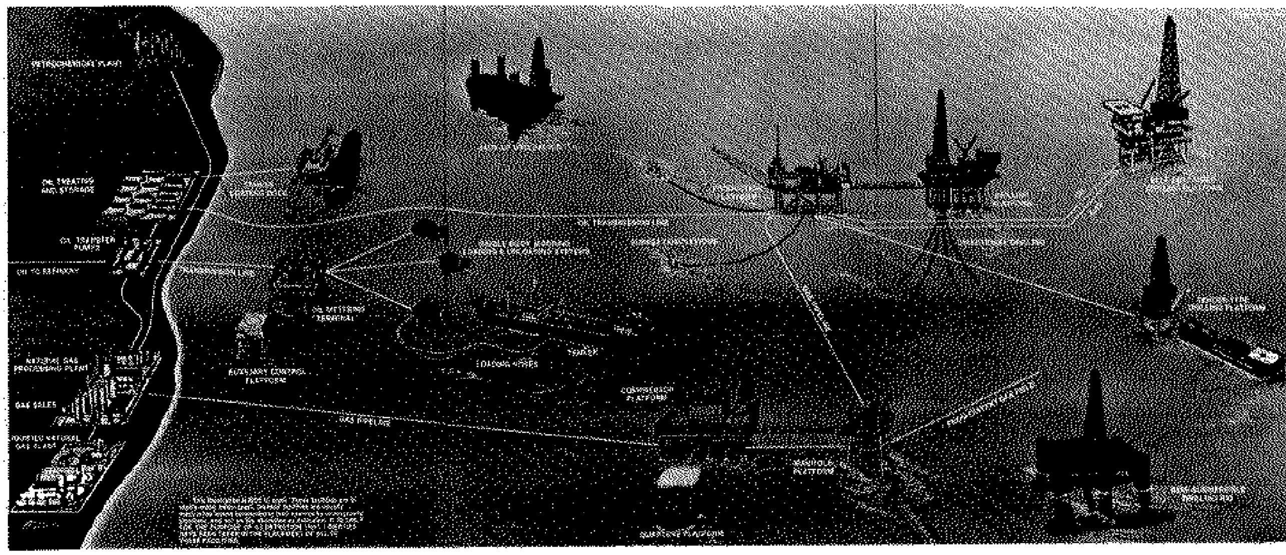


FIG. IV-11 SCHEMATIC OF O.C.S. DEVELOPMENT SYSTEM

for general inspection purposes. More valves are needed for gas lines than for oil. Various techniques can be employed to shield the valves from anchors and fishing gear, but not always with a great deal of success.

Once onshore, the crude oil may continue through land pipelines to a refinery site inland, or it may be stored in a tank farm at a tanker terminal for transshipment to a distant refining point. In either case pumping relay stations and storage tanks will be required. Additional separation and processing of the crude oil may take place at a shore site to facilitate handling and transport (Fig. IV-11).

SAFETY, POLLUTION AND ACCIDENT RESPONSE

"Finding, developing, producing and transporting oil and gas on the OCS is a potentially hazardous undertaking. In the past, accidents have occurred from time to time during the conduct of those activities, and for all practical purposes, it will be impossible to prevent them from occurring in the future. The best that industry and responsible government agencies can do is to take every possible precaution to prevent accidents and be prepared to respond rapidly and effectively when they do occur" (Kash 1974).

In order to meet the challenges of hazardous working conditions and threats to the environment, most oil and gas companies have instituted corporate safety and environmental policies which are at least equal to the minimum requirements of federal law and administrative regulations. Policy generally covers pollution of the air, land and water environments, and goes beyond the petroleum itself to include fire, noise and visual pollution. Safety features and redundant safety systems can be found in all stages of operation from drilling and production to pipelines and tankers. But accidents will happen; the very nature of the activity, and the unpredictable environment which constantly strains men and technology, cannot remain in constant harmony.

Through 1971, some 15,000 offshore wells were in various stages of development in the United States, more than 10,000 of them in production. A National Academy of Engineering study (1972) identified the following numbers of accidents:

- 11 blowouts involving loss of control of the well
- 11 explosions
- 26 fires
- 729 pollution incidents

This record is relatively good considering the amount and kind of activity, and in fact is quite low in relation to major accidents of all kinds from all industries. But it does not present the entire picture. There is considerable pollution associated with offshore oil which occurs not from the platforms but from the support activities, and some of which does not get reported. There is also oil industry pollution which does not involve oil. Some of this is preventable. North Sea fishermen complain about dragging up quantities of industry-related debris which has simply been thrown overboard.

On the other hand, some accumulations on the sea floor are inevitable companions of drilling. A single 10,000-foot offshore well produces about 2,100 barrels (920 tons) of drill tailings (Shinn,

1975) which are discarded directly into the ocean. Rock fragments from this typical well cover about half an acre surrounding the drill site and attain a maximum elevation of about 3 feet by the time the well is completed (Zingula, 1975). Each additional hole drilled from a fixed platform increases the height and extent of the pile. Even so, the tailings discarded from a thousand discrete wells would bury less than a single square mile of bottom. In addition, a volume of bottom sediment is disrupted during underwater pipeline burial.

Several months of compaction, current redistribution, and fragment disintegration substantially reduces a pile in shallow water, and a high sedimentation rate tends to partially bury it. In deep, clean water, on the other hand, spoils are not likely to be reduced very much and twenty-foot high accumulations still remain around multiple well locations several years after drilling (Carlisle, 1964).

On the northeast U.S. shelf probable drill sites are at depths where storm agitation and bottom currents are unlikely to displace sand and chip-size particles. Since there is also little modern sedimentation, piles of spoils and tailings would normally remain unburied, and some permanent shoaling can be expected around drilling sites and pipeline trenches, unless the latter are refilled mechanically to minimize the adverse effect on bottom fishing.

Although sediment displaced during oil operations does not chemically or pathogenically degrade its surroundings, it does disturb sessile bottom communities, but probably no more so than the repeated trawling and dredging by fishermen.

Considering that most fish graze far beyond the localized area of platforms or pipelines, the relatively small volume of spoils associated with these activities and the restricted areas they affect would have little impact on the yield. However, because of the importance of channels and canyons in the shelf biological scheme, tailings and other spoil debris should not be dumped where they can enter this system.

The same typical 10,000-foot well requires about 253 tons of dry drilling mud components during its drilling and completion. Over 85 percent is fine, inert material such as bentonite clay, powered limestone, and barium sulfate which can be suspended in the ocean without altering it chemically. Most mud is reclaimed on site for use at other drilling locations, but about 80 tons are discharged directly into the sea (Shinn, 1975) and dispersed by currents.

Increased turbidity, resulting from high concentrations of suspended particulate matter can temporarily degrade the optical properties of sea water, especially in its adsorption spectra (Swanson, MESA Project, personal communication, 1975). As a result, less solar energy penetrates the water column, and the standing crop of phytoplankton – the base of the marine food web – may be locally depressed. Turbidity generated by temporary drilling activities is on such a small scale that it should have little effect on life in the water column.

In addition, 28,000 lbs of soluble caustic sodium hydroxide is included in the mud for pH control. About 4,000 lbs of potentially toxic ferric iron, chromium, and sulfur are part of an emulsifying solution. Most of this is discharged directly into the marine environment together with inert waste.

Assuming approximately three weeks to drill a 10,000-foot well, 24-hour operations, and uniform discharge of mud and tailings, 63 lbs of additives are released each hour into the ocean from a point source. If 18 or more wells are drilled from a single platform, over 250 tons of salts are released in a year span. Shinn and Zingula both suggest that toxic material is immediately diluted by sea water to insignificant concentration, and they find no indication that drilling mud components significantly affect pH, soluble chromium levels, turbidity, or have a detrimental impact on marine life surrounding a rig.

Given the total area of the shelf, the debris just described does not loom as a major problem. The intrusion of moderate to large quantities of oil into the water column is still the hazard to be avoided most, or contained in the event it occurs. Elaborate containment and cleanup techniques have been developed by the industry and by government agencies. The use of floating booms with a skimming mechanism to pick up the surface oil is perhaps the most common method, but the technique is limited to seas of 5 feet or less. Rapid deployment to the spill site is essential, and helicopter-transportable systems have been developed to reduce the response time. Even so several hours will elapse before the booms are in place. Once contained, a spill must be cleaned up by mechanical collection or sponging by absorbent materials. Straw is effective because it is cheap and can absorb a wide variety of petroleum products at various temperatures, but polyurethane materials which can be reused are replacing straw. The use of dispersants should be limited to areas well offshore where the chance of grounding is slim. Sinking agents should not be used where there is any fishing activity.

FACTORS AFFECTING ONSHORE DEVELOPMENT

The impact of offshore drilling on port and hinterland activities may be of more importance to the future of commercial fishing in the northeast U.S. than the actual operations on the shelf. An assessment of the many social and economic adustments required of a shoreside community by oil and gas development is outside the scope of this report. Several extensive studies of these effects exist and should be referred to for information on coastal planning, population effects, housing, employment, income, recreation and municipal services (Baldwin, 1975; Grigalunas, 1975). The purpose here is to describe the nature and extent of only those onshore developments which will directly affect the day to day operation of fishermen. The table below is an attempt to identify all the activities associated with each stage of offshore development that will have an impact onshore. Data were accumulated from trade journals and directories, interviews with oil industry representatives, financial institutions, and analysis of existing operations by U.S. oil companies, whether in this country or abroad (Table IV-2).

Table IV-2
Classification of Support Activities Related to Stage of Offshore Oil and Gas Developments

	Exploration	*Well Development and Completion*	*Production*	*Transportation and Storage*
A. Marine Element				
1. Rigs	X			
2. Platforms		X	X	
3. Supply boats	X	X	X	X
4. Crew boats	X	X	X	X
5. Tug boats	X	X	X	X
6. Standby vessels	X	X	X	
7. Pipelaying services			X	X
8. Marine supply and repair	X	X	X	X
9. Diving services and equipment	X	X	X	X
10. Navigation & weather services	X	X	X	X
11. Tank barges			X	X
12. Barge and tanker terminal			X	X
13. Pipeline terminal			X	X
14. Seismic surveys	X			
B. Transportation Elements				
1. Helicopters	X	X	X	X
2. Fixed wing aircraft	X	X	X	X
3. Trucking	X	X	X	X
4. Railway		X	X	X
5. Freight handling service	X	X	X	X
6. Warehousing	X	X	X	X
7. Pipelines			X	X
C. Operations Services				
1. Drilling crews and equipment	X	X		
2. Well service crews and equipment			X	
3. Well head equipment		X	X	
4. Cement supplies	X	X	X	
5. Well casing and pipe	X	X		
6. Welding services – general	X	X	X	X
7. Welding and pipecoating			X	X
8. Anti-corrosion services		X	X	X
9. Machine supply and repair	X	X	X	X
10. Engineering services	X	X	X	X
11. Contract maintenance		X	X	X
12. Inspection services		X	X	X
13. Gas processing plant			X	X
14. Gas lift service			X	X
15. Core analysis, well testing, oceanographic services	X	X	X	
16. Communications and radio service equipment	X	X	X	X
17. Property and accommodation services	X	X	X	X
18. Catering service	X	X	X	X

ONSHORE ACTIVITY RELATED TO STAGES OF OFFSHORE DEVELOPMENT

Exploration

The initial phase of exploration – the geological and geophysical surveying – should have little effect on fishing operations in port. Only a few vessels are required, usually of specialized design and from outside the region, with their own crews and supplies. Their needs for docking, repairs and materials should not tax the capacity of existing port services nor hinder normal fishing port operations.

The second and much larger phase, exploratory drilling, could have a major impact on any port selected as a full scale onshore operations base. It is probable that two or three harbors in each of the New England and Middle Atlantic regions will be used for this purpose, as development of onshore support facilities for fewer than 10 drilling rigs and platforms cannot be economically justified. In the early stages of exploration, before that density is reached, existing port facilities will probably receive oil related business. Later it is likely that separate service facilities will be established exclusively for oil. Approximately 50 acres are needed in port to back up an offshore operation of 10 to 15 rigs and platforms. Employment would range from 150 to 200 people, exclusive of those needed for marine and air transportation services, with about two-thirds coming from the local labor pool.

Transportation would employ another 100 to 150 for the same number of drilling rigs, but the jobs would be geographically more widespread. Personnel and supply boats may work from a number of ports. Helicopter facilities will be located on land as close to the drilling sites as possible. The range of a 4-6 place helicopter is about 200 miles.

Well Development and Completion

During this stage, additions to the already considerable onshore activity will take place in several support areas. Directional drilling and completion service crews will augment the rig and platform crews, and more supply boats and services will be needed.

The greatest impact, if it occurs in the region, will be the development of sites for fabrication of the huge production platforms. The first such platforms will probably be fabricated outside the region and towed to the drilling site, but as the field develops and particularly with a major oil find, pressure for a local fabrication site will intensify. Suitable large sites and coastline characteristics away from densely populated regions will be difficult to find along the eastern seaboard north of Cape Hatteras. The only initiative to date has been the effort of Brown & Root, a Texas construction company, which bought a 2,000-acre site for $5 million at Cape Charles, Virginia.

It is unlikely that existing shipyards would be used for platform fabrication, as the cost of modifying the yard could well be more than the cost of delivery from a Gulf Coast site. However, platform construction would be a boon to employment; it is a labor-intensive activity and a single steel platform could employ more than 2,000 welders and other workers for as much as two years. Usually a new platform is started before completion of an earlier one, providing job continuity.

Also beginning onshore during this stage will be preparations to receive the crude oil from the drilling sites. There are two options. If oil comes ashore by pipeline and is also piped overland to a refinery, a shore terminal occupying 40 to 50 acres will be needed. Such a terminal does not have to be in a harbor or on a protected shoreline. One would be needed at each trunk-line landfall, with pump station and storage tanks. About 20 employees would operate each terminal. If there is no refinery in the region or an overland pipeline is not feasible, or if bulk carriers are used to bring the crude ashore, a harbor terminal covering 50 to 70 acres of waterfront with 35 to 40-foot depths will be necessary. Probably one such terminal, employing 25 to 30 people, would suffice for each of the offshore regions.

Production

Onshore activity during this stage will be similar but with a shift in emphasis. There will be a gradual phase-out of the employees used for exploration and development support. Since production is for the most part automated, only maintenance and service crews will be required offshore and a corresponding adjustment would be made in work force levels ashore. On the other hand, if as many as 30 platforms are operating in each of the two offshore areas, there will continue to be a substantial supply boat operation.

In the event of gas production, from two to five gas processing plants will be needed on land. Each site would occupy from 75 to 100 acres but they need not be located on the shore if land pipelines are feasible. Each plant would employ about 20 people.

Transportation and Storage

Several transportation options are open to the decision makers in the oil industry. The choice depends on both the economic and the environmental situations. If pipelines are used, as expected, their number and location will depend on several factors, including the number of companies involved and the regulations that cover pipeline sharing.

The preparation of pipeline landfalls and the accompanying tank farms, processing plants and pumping stations are likely to be disruptive to some shoreside fishing-related activities, and visually unpleasant at least during construction. However, pipelines can be buried, gas processing plants are usually inland where there is better access to rail and highway networks, and even tank farms can be camouflaged or put underground.

The tanker terminal, where needed, remains the single major shoreside transportation facility which cannot be blended into the landscape; it is also one which may compete with the fishing fleet for port space.

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CHAPTER V

The Legal and Institutional Framework

One purpose of the law is to regulate human behavior to prevent conflict. Another purpose is to resolve conflicts peacefully when they occur. To predict what the effects of offshore oil development will be upon the fishing industry, it is necessary to have a basic understanding of the legal framework in which offshore development takes place. This chapter sketches that framework.

INTERNATIONAL LAW

On September 28, 1945 President Truman issued a proclamation which stated that the resources of the continental shelf "appertaining to the United States" were subject to the control and jurisdiction of the United States. A press release which accompanied the Truman Proclamation asserted that the continental shelf extended to the 100 fathom line. Significantly, the American claim was limited to the resources of the shelf itself. The Proclamation made clear that the waters of the shelf were to retain their character as high seas. Freedom of navigation would not be affected (Brownlie, 1973).

While the Truman Proclamation was not the first attempt by a nation to claim mineral reserves off its shores, it served as a powerful precedent for other nations. Nine sheikdoms in the Persian Gulf under British protection made similar claims in 1949. Several Latin American countries made even stronger claims, asserting partial control over adjacent waters as well. Finally in 1958 the Law of the Sea Conference at Geneva established a Continental Shelf Convention (Brownlie, 1972).

The Continental Shelf Convention basically followed the principles of the Truman Proclamation. The right of the coastal state to exploit the natural resources of the adjacent continental shelf was recognized. At the same time, freedom of the seas over the shelf was maintained. Thus an adjacent coastal state could not restrict navigation, fishing, or the laying of submarine cables.

Of course, when a nation develops the resources on its shelf it may in fact interfere to some extent with freedom of navigation and other rights associated with freedom of the high seas. Oil rigs, platforms and pipelines, for example, may make trawling operations hazardous for a fishing fleet. The Continental Shelf Convention recognizes the right of the coastal state to take "reasonable measures" to develop the shelf's resources. Thus rigs, platforms, and pipelines are clearly allowed. However, Article V of the Convention requires that the coastal state give notice of such installations and properly mark them as hazards to navigation. The Convention allows the coastal state to establish safety zones of up to 500 meters around each installation.

The Convention defines the continental shelf in a rather curious fashion: The continental shelf is the seabed and subsoil extending to water depths of 200 meters or beyond that limit, to where the depth of the superjacent waters admits of the exploitation of the natural resources. Thus, the Continental Shelf of a nation may expand as its technology improves. Over forty nations have ratified the Continental Shelf Convention including the United States.

The existence of the Continental Shelf Convention has not prevented boundary disputes. Currently Canada and the United States disagree as to whether northeast portions of Georges Bank are part of the Canadian shelf or the American shelf.

It should be noted that the Continental Shelf Convention does not concern itself with fish. The 1958 Geneva Convention on Fishing and Conservation of the Living Resources of the High Seas does, however, and calls for conservation programs through bilateral and multilateral agreements with the acknowledgement that coastal states have a special interest in preserving fish stocks. The Fishing Convention has been signed by only 33 nations, of which the U.S. and four others have an interest in fishing off the U.S. East Coast.

The 17 countries which fish off the East Coast of the U.S. have created the International Commission for the Northwest Atlantic Fisheries (ICNAF). ICNAF attempts to regulate the catch rate for all fish stocks found outside the coastal state's 12-mile fishing zone. However, ICNAF has been unable to prevent the decline in fish stocks because it lacks effective enforcement provisions. Under present international law, fishermen who overfish their quotas or disregard other regulations are punished only in their home country if they are punished at all.

Because of their obvious interest in and concern for these fish stocks, East Coast fishermen have been actively seeking an extension of the 12-mile zone to a 200-mile zone under U.S. jurisdiction. Several versions of legislation to extend U.S. jurisdiction are now before Congress, and an interim bill (in effect until agreement at Law of the Sea Convention) is likely to pass both houses in 1976.

Regardless of whether a 200-mile zone is achieved by unilateral or multilateral action, future fishing activities on Georges Bank and in the mid-Atlantic will be regulated and enforced under U.S. law rather than under international law. Thus a change in the foreign fishing activity can be expected as U.S. fisheries managers attempt to stop the rapid decline in fish populations.

FEDERAL JURISDICTION

Challenges to United States authority over areas of the continental shelf have not only come from Canada. Individual American coastal states have on occasion attempted to wrest control of continental shelf resources away from the Federal Government. Discoveries of oil on the shelf precipitated a series of state claims for extension of state jurisdiction.

In 1947, in *United States v. California*, 332 U.S. 19, the Supreme Court rejected California's claim to seabed resources out to three miles from the low water mark. Louisiana and Texas made even greater jurisdictional claims over continental shelf areas, but these claims were also rejected by the Supreme Court in 1950.

Congress reacted to the Supreme Court's decisions by passing the Submerged Lands Act of 1953.[1] In essence the Act deeded seabed mineral rights to the coastal states out to three miles from each state's coastline. In addition, the Act was interpreted as recognizing the claims of two Gulf Coast states to submerged lands to three marine leagues (nine miles) since these states asserted such boundaries at the time they were admitted to the union. The Constitutionality of the Submerged Lands Act was upheld by the Supreme Court in *Alabama v. Texas*, 347 U.S. 272, (1954).

As concerns the Northeastern seaboard of the United States, (the geographical area of this study) the jurisdictional issue was settled in March of 1975. In *United States v. Maine*, the Supreme Court held that Maine and the other states of the Northeast had no jurisdiction over seabed resources beyond the three miles specified in the Submerged Lands Act. Thus the Federal Government will regulate any oil development activity that takes place in the Baltimore Canyon Trough area or Georges Bank.

The Supreme Court's resolution of the jurisdictional dispute between the Northeastern states and the Federal Government does not mean that the states will be unaffected by offshore oil development. As has been made clear in previous chapters, what happens on federal continental shelf lands can seriously affect what happens in a state's coastal zone.

In 1953 Congress also enacted the Outer Continental Shelf Lands Act.[2] This Act coined the phrase "outer continental shelf" (abbreviated as "OCS"). This phrase referred to that part of the continental shelf not ceded to the states and thus under federal jurisdiction. The phrase as used here is not a scientific term.

The Outer Continental Shelf Lands Act (OCS Lands Act) did more, however, than coin a phrase. The Act established the basic administrative framework for federal regulation of offshore oil development. Under provisions of the statute the Secretary of the Interior was given full authority to administer the leasing of offshore lands. Further, the Secretary was given rule making power so that offshore mineral development could be properly regulated.

The powers vested in the Secretary were delegated. The leasing process is now administered by the Bureau of Land Management (BLM). Once tracts are leased, most regulation of offshore oil development is done by the United States Geological Survey, Conservation Division (USGS). Both agencies are in the Interior Department.

Today, twenty-two years after its enactment, the Outer Continental Shelf Lands Act remains the basic charter for federal administration of offshore oil development. While twenty-two years is not a long time as statutes go, American attitudes towards natural resources and environment have changed since 1953. When the Lands Act was adopted there seemed little doubt that the Interior Department's primary responsibility under the Act was to get offshore fields into production. Certainly the traditional role of BLM has been to facilitate the exploitation of natural resources.

However, in the late 1960's and early 1970's Americans became increasingly aware of the environmental costs that could result from unplanned natural resource development and industrialization generally. The result of this change in public attitudes was environmental legislation. Congress enacted pollution control laws, such as the Clean Air Act of 1970,[3] and the Federal Water Pollution Control Act of 1972.[4] Congress enacted planning statutes such as the National Environmental Policy Act of 1969,[5] and the Coastal Zone Management Act of 1972.[6] These laws were designed not only to regulate industry's behavior, but to regulate the Federal Government's actions as well. The National

[1] 43 U.S.C.A. 1301
[2] 43 U.S.C.A. 1331

[3] 42 U.S.C.A. 1857
[4] 33 U.S.C.A. 1251
[5] 42 U.S.C.A. 4321
[6] 16 U.S.C.A. 1451

Environmental Policy Act, for example, requires that a federal agency file an "environmental impact statement" prior to taking any action that would significantly affect the environment.

The Interior Department, like every other federal agency, must file environmental impact statements. BLM prepared a "programmatic" impact statement for the proposed increase in OCS oil and gas development. This impact statement has been criticized by various state officials, congressmen, and federal agencies as being superficial and incomplete. Some of this criticism seems justified. For example the BLM impact statement is 1498 pages long but only 9 pages is devoted to assessing the impacts of offshore oil development on commercial fishing.

Underlying the current criticism of BLM and the Interior Department is a belief that Interior is not terribly concerned with planning or environmental protection. The Interior Department seems more concerned, critics suggest, with facilitating the rapid exploitation of natural resources (U.S. Congress, 1974).

In response to some of this criticism U.S.G.S. proposed a major change in its regulation of the offshore oil industry. The regulation requires oil companies to supply information concerning onshore and offshore impacts to coastal state officials so that the states can better plan for offshore oil development. Also, the Congress is currently considering several bills to amend the Outer Continental Shelf Lands Act and thus alter the way in which the Interior Department administers offshore oil development. What follows, however, is a brief and simplified description of the offshore leasing and regulation process as it currently exists.

REGULATION OF OFFSHORE PETROLEUM INDUSTRY

A. The Leasing Process

The basis of the OCS leasing program is encompassed in the Outer Continental Shelf Lands Act of 1953 and the implementing regulations promulgated by the Department of the Interior. The Bureau of Land Management (BLM), Office of the Assistant Director for Minerals Management, is responsible for overall coordination of the leasing program. The Division of Mineral Resources, Branch of Marine Leasing, administers the leasing procedures.

BLM performs its leasing functions in pursuit of two statutory goals: 1) Orderly and timely development of the resource, and 2) receipt of fair market value for the resource (a maximum lease bonus with a royalty rather than a participatory interest in oil development). With the addition of the National Environmental Policy Act of 1969 (NEPA) BLM should place environmental considerations on an equal footing with the criteria contained in the OCS Lands Act.

Section 102 of NEPA gives BLM the responsibility of evaluating the environmental effects of proposed leasing actions, subject to review by the Council on Environmental Quality. For each lease sale BLM issues an Environmental Impact Statement (EIS). The EIS is made available to other government agencies and the public for comment, and public hearings are held.

In addition to the EIS for each lease sale, BLM has prepared a "programmatic EIS" for the January 1974 presidential decision to lease 10 million acres on the OCS in 1975. The EIS was circulated among government agencies and hearings for public comment were held at Trenton, New Jersey, in February, 1975.

Under BLM's nomination system, areas for leasing are identified and ranked in order of preference. This order is based upon responses from industry and other interested parties. The first step in the leasing process is the Call for Nominations. BLM publishes the call in the Federal Register, requesting formal nominations from industry for the specific tracts to be leased (these nominations are made upon an Official Protraction Diagram which has 5760-acre tracts arranged in grids). Other interested parties may designate specific tracts to be excluded from the proposed lease sale. This latter procedure is characterized as a "negative nomination". A negative nomination may be based on environmental concerns, or fear of conflict at sea. BLM is not bound to accept any nomination.

Beginning with Mississippi, Alabama and Florida Lease Sale in 1974, BLM has initiated a baseline studies program in all frontier areas and has sought to detect and ameliorate practices which cause adverse environmental effects. Under the auspices of the Outer Continental Shelf Research Management Advisory Board, the coastal state governors' appointees advise on the establishment and implementation of the baseline studies program. In addition, BLM has sought suggestions from the scientific community for studies concerning the effects of oil in the marine environment. It is within BLM's authority to impose environmental safeguards on a lessee through lease stipulations.

Tract selection involves coordination between BLM and USGS. USGS has at its disposal seismic data it has collected or bought. A notice of availability is published in the Federal Register, specifying where the tentative list of tracts is available for public and agency scrutiny. The list may eventually by winnowed to a fraction of the total tracts nominated by industry. Specific responsibilities of the various offices of BLM and USGS are detailed in an interagency agreement of August 1971.

When tracts are selected, BLM drafts site-specific environmental impact statements. State and federal agencies, including the National Marine Fisheries Service (NMFS), state coastal zone management agencies; environmental and commercial interest groups — including fisheries, will comment on the draft EIS. Hearings will be held in the states adjacent to the proposed leasing. The Secretary of the Interior makes the final decision to lease, or not, at least thirty days after the final EIS is submitted to Council for Environmental Quality. Until the moment of a lease sale, the BLM Area Manager can delete tracts for environmental or other reasons.

During pre-sale evaluation, the Conservation Division of USGS calculates estimated values of the tracts to be offered for lease. BLM audits and reviews these figures.

Authority to conduct a lease sale is delegated by the Secretary to the BLM Area Manager. Following a lease sale, the Area Manager is responsible for review of the bids to determine if particular leases should issue. Another joint agreement between BLM and USGS of December 1971 details the duties of the agencies in the pre-sale evaluation and in a post-sale evaluation to determine if the statutory criteria have been fulfilled and whether leases should issue.

B. USGS: Regulation of Offshore Operations

Once BLM has leased an offshore tract to a company for exploratory drilling and development, USGS (Conservation Division) assumes responsibility for regulation of offshore operations. The agency has issued a variety of regulations, called "OCS orders". These orders suggest the broad scope of USGS work. OCS Order #2 for the Gulf of Mexico, for example, regulates well casing, blow-out preventers, and drilling mud. Order #3 prescribes procedures for plugging and abandonment of wells. Order #5 requires the installation of certain sub-surface safety devices. Order #7 is concerned with pollution prevention. In all, twelve OCS orders have been issued for the Gulf of Mexico. Orders for the Atlantic have not yet been issued but will be issued prior to drilling.

OCS orders are the heart of the federal regulatory program for offshore oil development. In the context of the present study, these orders assume fundamental importance. OCS orders can go a long way in reducing conflict between oil and fishing operations, if, the orders are rigorous and enforced.

On October 1, 1974, the House Committee on Government Operations issued a report which was critical of USGS regulatory practices in the Gulf of Mexico. * The report cited a Government Accounting Office study which concluded that USGS inspection of OCS operations was inadequate. The GAO found that only half of the fifty wells started in fiscal year 1972 were inspected for compliance with pollution and safety regulations during drilling operations. Only four of sixty-nine producing platforms were inspected within the six month interval required by regulations. Average frequency of re-inspection was about ten months.

In response to the congressional criticism USGS began a new inspection policy on March 1, 1974. This policy requires that all major platforms be inspected at least once every six months and all minor platforms be inspected at least once every fifteen months. "Major platforms" are defined as those having six or more well completions. "Minor platforms" have less than six completions.

The Government Operations Committee Report stated that USGS did not give reasons for the distinction between major and minor platforms; nor did the agency discuss its decision on time intervals for inspection. The Committee also learned that for fiscal year 1975 USGS has appropriations for 82 people for its OCS program. This count includes support personnel in Washington. Thus, the agency was unable to state how many inspectors would be in the field. There are 1,084 major platforms and 943 minor platforms in the Gulf of Mexico according to the report.

In 1970 USGS issued OCS Order #9 for the Gulf of Mexico. This order dealt with offshore oil and gas pipelines. Given the significance of pipelines in assessing the impact of offshore oil development on fishermen, Order #9 is worth looking at in some detail.

Order #9 sets forth several specific requirements for pipeline construction and maintenance. All pipelines going to or from producing platforms must be equipped with shut-in valves. All pipes must be hydrostatically tested prior to service. And all pipelines must be inspected on a monthly basis.

Beyond these specific regulations, OCS Order #9 contains more general requirements. The order states that all pipelines shall be constructed so as to be protected from corrosion. All pipelines shall be designed so as to be protected against "water currents, storm scouring, soft bottoms, and other environmental factors". Finally, the order states, "All pipelines shall be installed and maintained to be compatible with trawling and other uses".

These general requirements seem quite rigorous. However, OCS Order #9 does not make clear what is required to meet the general design requirements. The order states that pipelines must be protected

*(U.S. Congress, 1974)

against weather and environment. Yet the order is silent as to specifications for the construction of pipe. The order states that pipelines are to be made compatible with trawling. Yet the order is silent as to whether pipelines must be buried.

It is true that a USGS Area Supervisor can orally require the burial of a pipeline. However, the lack of specific, written regulations makes it difficult to determine exactly what the government's policy is on pipelines.

One reason that USGS has not issued detailed regulations for pipelines is that the agency has been engaged in a jurisdictional dispute with the Office of Pipeline Safety of the Department of Transportation (OPS). OPS regulates onshore pipelines and believes its jurisdiction should naturally extend offshore. However, USGS points out that it has had more experience with OCS matters.

This jurisdiction dispute now appears to be moving towards a solution. In September, 1975, the Office of Pipeline Safety issued proposed pipeline regulations. These proposed regulations are more specific than OCS Order #9 and explicitly cover gathering lines. However, the OPS proposals require pipeline burial in only a limited number of situations. Pipeline interference with trawling operations at sea is apparently not considered.[12]

Under the OCS Lands Act the Secretary of the Army has the authority to prevent obstruction to navigation by fixed structures on the outer continental shelf. This authority has been delegated to the Army Corps of Engineers. Thus the Corps has permit power over pipelines, but only to assure that navigation is unimpeded. Obstruction to fishing operations is not considered by the Army Corps of Engineers.

Right-of-Way permits for pipelines are granted by BLM with cooperation from USGS. In granting a pipeline route across the OCS, BLM considers only the potential impacts the pipeline might have outside the three-mile limit of state waters. Inside that limit a variety of state and other federal agencies have jurisdiction.

A traditional problem faced by regulatory agencies is that agencies must rely upon the industries they are regulating for information. It seems clear that if federal regulation of offshore oil development is to minimize conflict with fishermen, USGS and BLM must provide a forum for public comment prior to making regulations. Fishermen and other interest groups will then be able to provide the agency with the facts it will need to regulate oil development properly.

Currently anyone may comment on proposed USGS regulations, but notice of proposed regulations usually appears only in the Federal Register. The Federal Register is not read by many people and is thus an inefficient way to gather information and views from the public. USGS should hold well-publicized, public hearings whenever it is considering OCS regulations of general importance. The agency would hear more opinions and gain information from non-industry sources. This would improve the regulatory process.

C. Other Federal Agencies: The Coast Guard, Environmental Protection Agency, Army Corps of Engineers

The Coast Guard's responsibilities under the OCS Lands Act are limited to prescribing and inspecting navigational aids for installations. Under other statutes they are responsible for safety at sea and for enforcement of domestic law and coordination of containment and cleanup in the area of marine spills of oil or other hazardous substances. They serve as the On-Scene Coordinator for any major oil spill under the National Oil and Hazardous Substances Pollution Contingency Plan.

A Memorandum of Understanding between the Secretaries of Interior and Transportation specifies the response of both the Coast Guard and the USGS to an oil spill on the OCS. Still, USGS retains responsibility on the OCS for pollution from offshore oil operations. Under provisions of the Federal Water Pollution Control Act the Coast Guard has authority over platform spills in the territorial sea and over vessel spills out to twelve miles from shore. From twelve to fifty miles the Coast Guard regulates oil dumping from vessels under the Oil Pollution Control Act of 1961. Finally the Coast Guard is also responsible for enforcing the Ocean Dumping Act, and, along with NMFS, enforces U.S. laws on foreign fisheries, where applicable. This latter responsibility will grow with adoption of the 200-mile limit.

The Environmental Protection Agency (EPA) has just recently become involved in the regulation of offshore platforms. Asserting jurisdiction over the platforms under Section 402 of the Federal Water Pollution Control Act, the agency has issued its first interim pollution control regulations.

The Army Corps of Engineers, unlike EPA, has specific authority under OCS Lands Act, to prevent obstruction to navigation by installation of fixed structures or artificial islands on the OCS. Approval for these is limited to a review of their impact upon navigation only. However, the Corps, under the Rivers and Harbors Act of 1899, does conduct environmental assessment of proposed activities, including construction, or dredging and filling associated with pipeline installation.

A. The Coastal Zone Management Act

In 1972 Congress enacted the Coastal Zone Management Act.* The Act states that "(the key to more effective protection and use of the land and water resources of the coastal zone is to encourage the states to exercise their full authority over the lands and waters in the coastal zone)." To provide the proper encouragement the Act makes federal funds available to any coastal state which develops a comprehensive plan for its coastal zone.

The statutory definition of "coastal zone" includes waters out to three miles, the adjacent shoreline, "and includes transitional and intertidal areas, salt marshes, wetlands, and beaches." To provide a comprehensive plan or "management program" for its coastal zone a state must inventory the resources within the coastal zone, designate areas of particular fragility or concern, define permissible land and water uses, and develop the political structures necessary to implement the program.

Given that drilling for offshore oil on Georges Bank and Baltimore Canyon Trough will occur under federal jurisdiction, and that numerous impacts from the offshore development will occur within state jurisdictions, to plan properly for oil development, the Federal Government and the coastal states must work together.

In enacting the CZMA Congress envisioned such state-federal cooperation. Section 1452 of the statute states that it is the policy of Congress that all federal agencies engaged in programs which affect the coastal zone should cooperate with state and local programs. Section 1456 is more specific. It requires that no federal license or permit be granted for any activity which affects a state's coastal zone unless the state has certified that the activity is consistent with the state's management plan. However, the Secretary of Commerce is given the authority under the statute to override a state's objection if he finds that the activity in question is "in the interest of national security."

Currently, Section 1456 of the Coastal Zone Management Act is not yet effective because the majority of coastal states have not implemented their final management plans. The management plans take time to develop. Substantial scientific and socio-economic data must be gathered if a state is to make rational decisions about its coastal zone. Also, the states were delayed at the outset when the Nixon Administration impounded coastal zone funding. Some of the coastal states will have their final management plans ready by 1976. Under Section 1455 the Secretary of Commerce must give final approval to each state's plan. The Secretary will make his decision on the basis of criteria stated in the statute. One criterion is that the state's management plan provide for adequate consideration of the national interest involved in the siting of facilities necessary to meet requirements which "are other than local in nature."

*16 USCA 1451

In 1972, when the Coastal Zone Management Act was enacted, the idea of federal-state coordination on coastal matters did not seem particularly controversial. However, more recently the widespread realization that energy supplies are no longer plentiful, coupled with the decision by the Nixon and Ford administrations to rapidly increase American offshore oil development, has placed the question of state-federal relations at the center of the national energy debate.

The Interior Department has been eager to get OCS lands into production. However, some of the coastal states have argued that it would be a fundamental mistake to rush ahead with oil development, particularly since the state management plans have yet to go into effect.* The result has been suspicion between the Interior Department and the states.

Some officials in the Interior Department have suggested that the coastal states, particularly the New England states, are simply opposed to oil development and that these states are using arguments about the need for better planning to delay development. Coastal Zone Management officials in Maine and Massachusetts have stated this is not the case, that the states are rightly concerned because the Interior Department is making decisions on offshore oil development which will affect the state coastal zones for years to come. Further, state officials believe that the Interior Department simply does not have the information necessary to assess the social and environmental effects of oil development upon the states.

Thus, at present, friction between the coastal states and the Federal Government makes planning for offshore oil particularly difficult. Since proper planning is the best way to avoid conflicts between the oil and fishing industries, this friction is not insignificant.

Of course, the coastal states are not unanimous in their attitudes toward offshore oil development. Laws, political structures, and public attitudes vary from state to state. Thus, a fisherman or oil company representative may find he has more influence in the politics of one state than another. A brief look at the affected states follows.

B. The Mid-Atlantic States

Baltimore Canyon will probably be exploited before Georges Bank, thus the four adjacent states of

*California, for example, brought suit against the Interior Department alleging that the Department was going ahead with offshore development without proper consultation with the state.

New Jersey, Delaware, Maryland and Virginia should feel the onshore impact of OCS development before the New England states.

The Governors of New Jersey and Delaware formed the Middle Atlantic Governors Resources Council to develop a regional policy toward east coast oil drilling. The New England Governors Conference has joined with them in meeting with the Secretary of the Interior to discuss common issues. Progress to date includes the review of tentative tract selections before publication by BLM. A joint communique was issued at a meeting in Princeton, New Jersey, January 3, 1975, elaborating a plan for coping with OCS impacts.

Onshore impacts in the Baltimore Canyon area will tend to concentrate on Delaware Bay and Chesapeake Bay. The Delaware River Basins Commission, which includes the Governors of New York, New Jersey, Pennsylvania, and Delaware, as well as the Secretary of the Interior and representatives from other federal agencies, operates under a mandate to control and plan for water quality and quantity in the Delaware River area. The Commission has requested the oil industry to make a projection of potential development on the Delaware Bay. An interstate compact has been proposed for Chesapeake Bay as well, and will no doubt gain impetus from the unfolding of events.

Virginia's planning for offshore oil will be based upon its Wetlands Act, and the creation of development plans by the regional planning commissions. The Wetlands Act contains a model wetlands ordinance, which may be adopted by counties as a regulatory tool. Almost all have done so. Permit authority is required for virtually all activity likely to have adverse effects on wetlands. Offshore activity such as dredging and filling requires a permit from the state Marine Resources Commission which also oversees the state's fishing industry. The Commission also reviews all decisions on appeal from the local wetlands boards from either party. The appropriate state court reviews decisions of the Commission.

The key agency in Virginia's approach to coastal zone management is the Virginia Institute of Marine Sciences. The Institute plays an advisory role to the wetlands boards at the permit level and assumed education responsibilities for the Regional Planning Commissions under the Division of State Planning, and for the wetlands boards under the Marine Resources Commission.

The planning area for Coastal Zone Management is larger than the wetlands regulated areas. The former encompasses one-third of the state east of the fall line. Virginia has opted for vigorous public participation. Fishing industry participation will be sought in the context of development plans for each planning district.

Maryland has designated its Department of Natural Resources (DNR) to supervise both the state's CZM program and OCS development. The state has a recent land use act which directs the Division of State Planning to prepare a state-wide land use plan and allows the state to intervene as a matter of right in local zoning decisions. Maryland has a wetlands act requiring DNR review of wetlands alteration after local government action. Maryland, lacking a coastal zone management act, has channeled its intial efforts into a physical and biological inventory of the coastal areas. The need for input from the large bay and coastal fishing industry is recognized. Maryland also has a state environmental impact statement requirement. This requirement is the only legislation in the Middle Atlantic area specifically aimed at oil-related activity. Maryland law requires that an economic, social and environmental impact statement prepared by a neutral third party be submitted prior to the issuance of a permit by DNR. Facilities included are: ports and harbor facilities, platform assembly and staging areas, pipelines, refineries and oil storage areas.

Delaware has extensive legislation that bears upon OCS activity onshore. The Delaware Coastal Zone Act precludes certain types of heavy industrial development in the coastal zone, including pipelines. Staging areas would be permitted, however. The Division of State Planning is the designated Coastal Zone Management agency. Delaware also has a wetlands act.

New Jersey has three state acts which are relevant to offshore oil development. The Riparian Act, the Wetlands Act of 1970, and the Coastal Area Facilities Review Act (CAFRA). The Department of Environmental Protection (DEP) is New Jersey's Coastal Zone Management agency. The first act cited regulates development on the state's submerged lands. The second Act regulates riparian lands in private ownership seaward of the high water mark. The third Act requires a permit review of all industrial and large residential activity in the Coastal Zone.

New York state is in the planning stages for projected onshore impacts of OCS development. These impacts are expected to occur on Long Island. Fishing ports may be used as staging areas. New York is presently developing state coastal zone management. The Department of Environmental Conservation is the state CZM agency. They have permit authority over all development in wetlands. The agency administers pertinent air and water quality permits.

Zoning changes are strictly a local matter even in wetlands. Suffolk County on Long Island has review power over local zoning decisions. However, only in inter-municipal jurisdiction does this constitute a veto power. Nassau County does not have a similar provision in its county charter. The twin Long Island counties are involved in OCS onshore planning. In fact, the Joint County Regional Planning Board is currently involved in litigation with the Department of the Interior (DOI) involving the question whether local participation concerning onshore impacts must be considered by BLM before leases may issue.

C. New England

Attitudes in New England towards offshore oil development and coastal zone matters are not uniform. Maine, for example, has been deeply concerned with protection of the marine environment and its natural resources.

Maine has enacted a tough oil pollution control law.* The statute states:

> The legislature of Maine finds and declares that the highest and best uses of the seacoast of the State are as a source of public and private commerce in fishing, lobstering, and gathering other marine life. . . .

This declaration of legislative purpose does not mean that no oil facilities can be constructed anywhere in Maine. In fact, state planners have targeted Casco Bay and Machias as potential sites for industrial development. What the Maine statute does suggest is that at present legislative attitudes in Maine will support a coastal management program which takes the interest of fisheries strongly into account.

In New Hampshire attitudes toward oil development are a bit more difficult to read. The present governor of New Hampshire strongly favors offshore development. However, as a result of a fight over the siting of a refinery at Durham, New Hampshire, a law was passed which gives towns the power to veto refinery proposal by referendum.

New Hampshire's Office of State Planning is developing a coastal zone plan. Given the Governor's attitude towards development and the local referendum power in the towns, predictions as to the future oil development in New Hampshire are hazardous.

In Rhode Island a state commission which is charged with encouraging economic development has taken advertisements in oil industry trade journals. These advertisements offer large tracts of land on Narragansett Bay as potential sites for rig construction. The state is able to make such an offer because it has recently acquired these sites from the Federal Government. Previously the land was used as Navy bases. It is also true that the state is working on a comprehensive coastal zone plan. The state coastal zone agency will have jurisdiction over petroleum-related development.

If attitudes in the various coastal states differ as to the relative importance of oil development and fishing, so do the governmental structures in each state. In planning for offshore oil state governmental structure can be as important as the state policy.

In Massachusetts there is a strong tradition of home rule. Under the current Massachusetts law towns retain considerable planning power. In addition to local zoning power, Massachusetts wetlands legislation vests in the individual towns permit authority over any dredging, or alteration of a wetland. Wetlands under the terms of the statute include beaches, dunes, flats, marshes, meadows, swamps, estuaries, rivers, streams, lakes, and coastal wetlands. Thus any onshore oil facility, such as a tank farm or refinery, would likely be subject to local wetlands jurisdiction as well as local zoning.

The state also has a role in coastal planning in Massachusetts. First, the state does have a coastal zone management agency which is working on a coastal zone plan. Second, under Massachusetts' wetlands law a state agency has power to review local wetlands decisions. Finally, a law passed in 1975 places petroleum development under the jurisdiction of a state-level Energy Facility Siting Council.

In Maine decisions on development are made differently. Under the Maine Site Location Act any development of twenty acres or more must be licensed directly by the state. The statute requires that developer prove that the development "will not adversely affect existing uses, scenic character, or natural resources." Thus the burden is placed on the applicant to prove that a license should be granted, not on the state or another interest group to prove that it shouldn't.

In Connecticut the Coastal Area Management Office in the Department of Environmental Protection is working on the state's coastal zone plan. At present, Connecticut has no law like the Maine Site Location Act, so towns can retain considerable authority over petroleum facility siting through local zoning powers. Of course, the state and the Federal Government retain authority to enforce air and water pollution law.

Whether Connecticut will assume greater state control over petroleum facility siting in the future is difficult to predict. An official in the Coastal Area Management Office has stated that it is unclear what the state legislature will do in authorizing the state's coastal zone plan.

The above examples make clear that the New England coastal states have different approaches to coastal planning. While the New England states have engaged in some regional cooperation through

*38 M.R.S.A. 541

the New England River Basins Commission and the New England Regional Commission, there is no regional position on OCS development. The interests of the fishing and oil industries will be weighed differently in each state.

The differing policies of the New England coastal states do not make federal-state coordination any easier. However, such coordination is still a necessity if conflicts between the fishing and oil industries are to be minimized.

COMPENSATION FOR DAMAGE FROM OIL POLLUTION

As has previously been stated, the U.S. Geological Survey and the Environmental Protection Agency regulate pollution from offshore rigs and platforms. And the Federal Water Pollution Control Act does provide a mechanism to assess clean-up costs against a spiller. However, despite these regulations and statutes, there still exists a basic gap in the federal law of oil pollution.

Currently there is no general, federal statutory remedy for an individual who has been harmed by oil pollution. In other words, while clean-up costs will be paid by the spiller (and/or a statutory fund), there is no federal act which provides for compensation to one injured by oil pollution.

It is true that the federal admiralty jurisdiction may provide federal courts with a means to compensate victims. In fact, recently the United States Court of Appeals for the Ninth Circuit held that fishermen could recover lost profits from an oil company, if the fishermen could prove that a well blow-out resulted in the killing of fish and a loss of fishing time.*

Despite this case, admiralty law has not established a scheme for compensating oil pollution victims. There simply does not exist a body of comprehensive case law on OCS operations. Also, the Limited Liability Act (shipping) of 1851, as amended, limits compensation for damages resulting from ships. The Act limits the liability of an owner of a vessel to his dollar interest in the ship and its freight *after* an accident.

Union Oil Co. v. Oppen, 501 F. 2d 558 (1974)

Given this absence of federal remedies for damage from oil pollution, one would expect the states to provide such remedies. Several coastal states have acted. Maine and Florida, for example, have particularly tough compensation laws. However, many states may be hesitant to act from fear that a state oil pollution compensation act might conflict with federal admiralty law (the Limitation of Liability Act) or the federal commerce power. Provisions of the Florida Compensation Act have already been upheld by the U.S. Supreme Court. However, the constitutional limits on state action in the area of pollution remain cloudy.

Given this current state of confusion in the law of compensation for oil pollution, we recommend the Congress either pass a comprehensive compensation act or expressly declare that it is Congress' intent not to restrict state action in this area.

Should Congress choose to enact an oil pollution compensation statute, a critical question will be whether or not the statute provides for strict liability against the polluter.

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