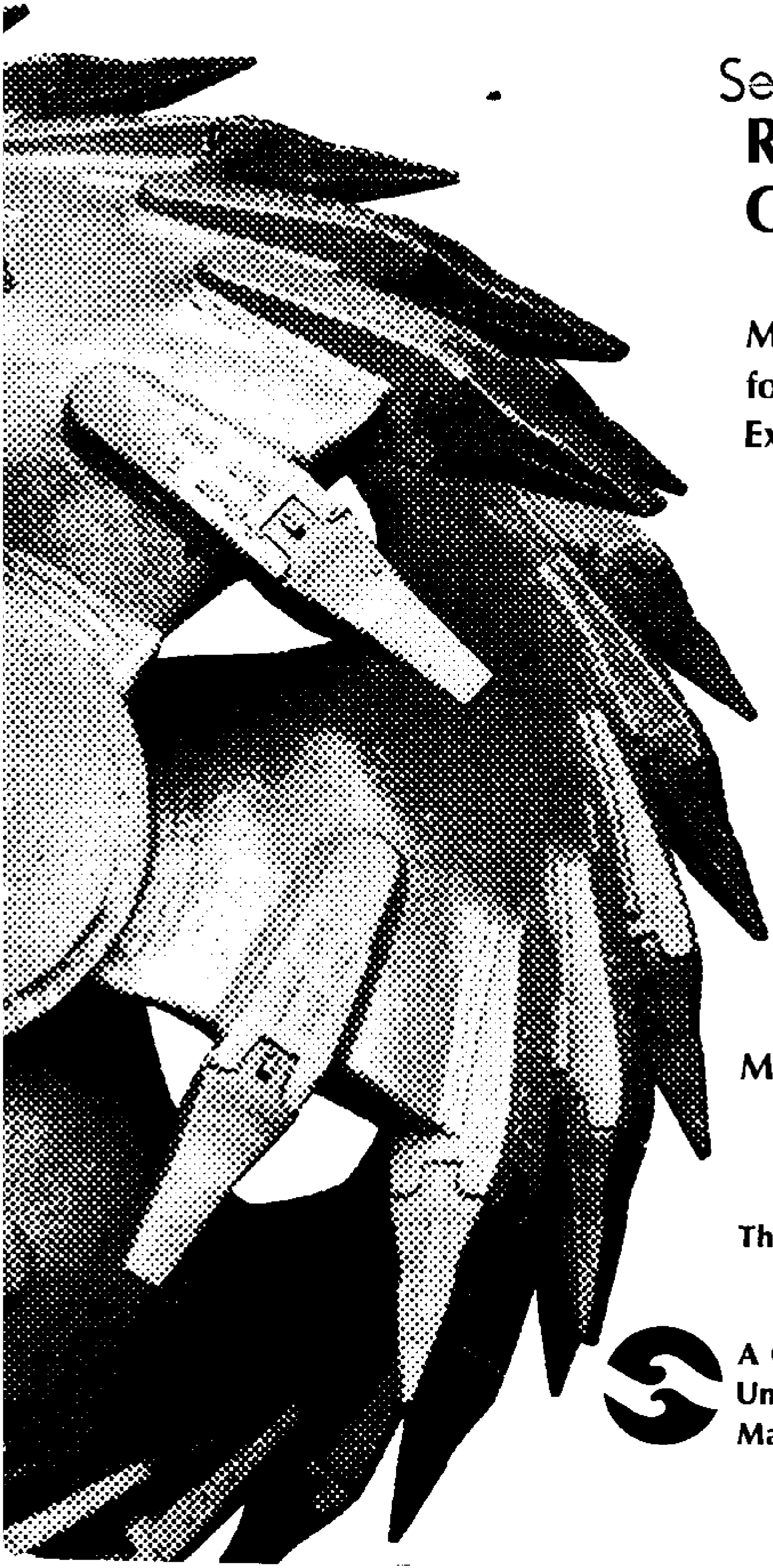

Rhode Island's Ocean Sands:

Management Guidelines for Sand and Gravel Extraction in State Waters

Malcolm J. Grant

The Coastal Resources Center

A Coastal Management Publication
University of Rhode Island
Marine Technical Report No. 10

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Acknowledgments

This report, while the work of Malcolm J. Grant, resource analyst on the staff of the Coastal Resources Center, could not have been completed without the assistance and cooperation of many individuals and agencies. State and federal officials shared their experience in marine hard-mineral management and forwarded to me basic research material, administrative and legislative regulatory proposals and personal comments and recommendations.

Officials of the Rhode Island Department of Transportation, Maintenance Division, and the Rhode Island and River Sand and Gravel Companies were generous with their time and experience in providing a picture of the state's land sand and gravel industry. Officials of the state Department of Natural Resources, Enforcement and Coastal Resources Divisions, and the state Water Resources Department were equally helpful.

Stephen Olsen, staff resource analyst, and Stuart O. Hale, the acting director of the Coastal Resources Center, assisted in editing initial drafts of this report, and Mrs. Anne Barrington did the typing and proofreading.

The Coastal Resources Center is not an official arm of the Coastal Resources Management Council. As a voluntary public service, it draws on a small technical staff and, as needed, the experience of the marine science and marine affairs faculty of the University of Rhode Island. Current financial support consists primarily of University funds, a portion of the institutional grant to the University from the Office of Sea Grant Programs, U. S. Department of Commerce, and a matching fund grant made available by former Governor Frank Licht through the state Department of Natural Resources.

Additional copies of Marine Technical Report 10 may be obtained from the Marine Advisory Service, University of Rhode Island, Narragansett Bay Campus, Narragansett, Rhode Island 02882.

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1. Background Considerations

Introduction

In 1971 the Rhode Island General Assembly created the Coastal Resources Management Council to ". . . preserve, protect, develop, and where possible, restore the coastal resources of the state for this and succeeding generations through comprehensive and coordinated long-range planning and management designed to produce the maximum benefit for society. . . ." As part of its overall management task the Council was directed to inventory the state's marine and coastal resources and to propose and implement plans for their use. The Coastal Resources Center of the University of Rhode Island has been assisting the Council in developing the inventory and plan.

In its Interim Coastal Resources Management Plan (September 18, 1972) the Council declares its intention "to develop management regulations for sand and gravel and mineral extraction which will permit exploitation only in ways which will not prevent other uses or damage marine life." The following study examines the marine aggregate mining industry and attempts to project its probable impact on Rhode Island's marine environment and on other uses and users of this environment. A management response to foreseeable problems is proposed and incorporates declared Council objectives. The study concludes with a model legislative proposal for the regulation of hard mineral mining in Rhode Island State waters.

The Need for Management

Three trends in the sand and gravel industry will make it necessary to manage Rhode Island's offshore and estuarine sand and gravel resources. (Throughout this report the terms sand and gravel and aggregates will be used interchangeably.)

1. Rising Demand. U. S. consumption of sand and gravel is accelerating. An annual consumption of 500 million tons in 1954 had nearly doubled to 980 million tons by 1970, and it is projected that 1,670 million tons will be consumed in 1985 and 2,530 million tons in 2000 (Commission on Marine Science, Engineering and Development, 1968: VII-152). With a 1970 per capita annual demand of five tons, consumption of sand and gravel has already outstripped that of all mineral commodities except water (McKelvey *et al.*, 1968; Hess, 1971).

2. Decreasing Land Supply, Rising Cost. The demand for aggregate material is greatest in metropolitan areas where residential, industrial and construction users are concentrated. The low unit-value of the resource and the high cost of transportation dictate minimal separation of quarry and market. The producers of sand and gravel, however, are being prevented by suburban expansion, zoning restrictions and high land costs from developing new close-in deposits as those presently worked are depleted. They are consequently forced to move farther from their markets. This increases production costs which are, in turn, passed on to the consumer (Davenport, 1971). The effects of increased distance between deposit and market can already be seen in Rhode Island (Altieri, McHale, 1972; interviews).

3. Increasing Exploitation of Ocean Deposits. As land supplies dwindle and costs rise, it becomes increasingly attractive to look elsewhere for cheap and reliable sources. Extensive, nearby and high quality deposits are found in several areas off the New England coast (McMaster, 1960; Emery, 1965). While little commercial use has yet been made of U. S. offshore sand and gravel deposits, there is no reason to believe this will continue. The United Kingdom, faced with increasing supply and demand problems, is already producing over 13 percent of her aggregate from the sea. The British industry supports 32 companies operating 75 ocean-going dredges worth some $100 million (Hess, 1971). In all probability an industry similar to England's will develop around the major coastal metropolitan areas of the United States. Rhode Island waters contain large and potentially valuable offshore aggregate deposits and the state should be ready to see pressure for their exploitation rise.

Management Responsibilities

The Coastal Resources Management Council is charged with broad responsibility "to develop resource management plans compatible with the needs of the people of Rhode Island, while preserving and enhancing as far as possible the natural qualities of the marine environment" (Interim Policy Statement, 1972). The Council has specifically committed itself to permit mineral exploitation "only in ways which will not prevent other uses or damage life" (Interim Policy Statement,

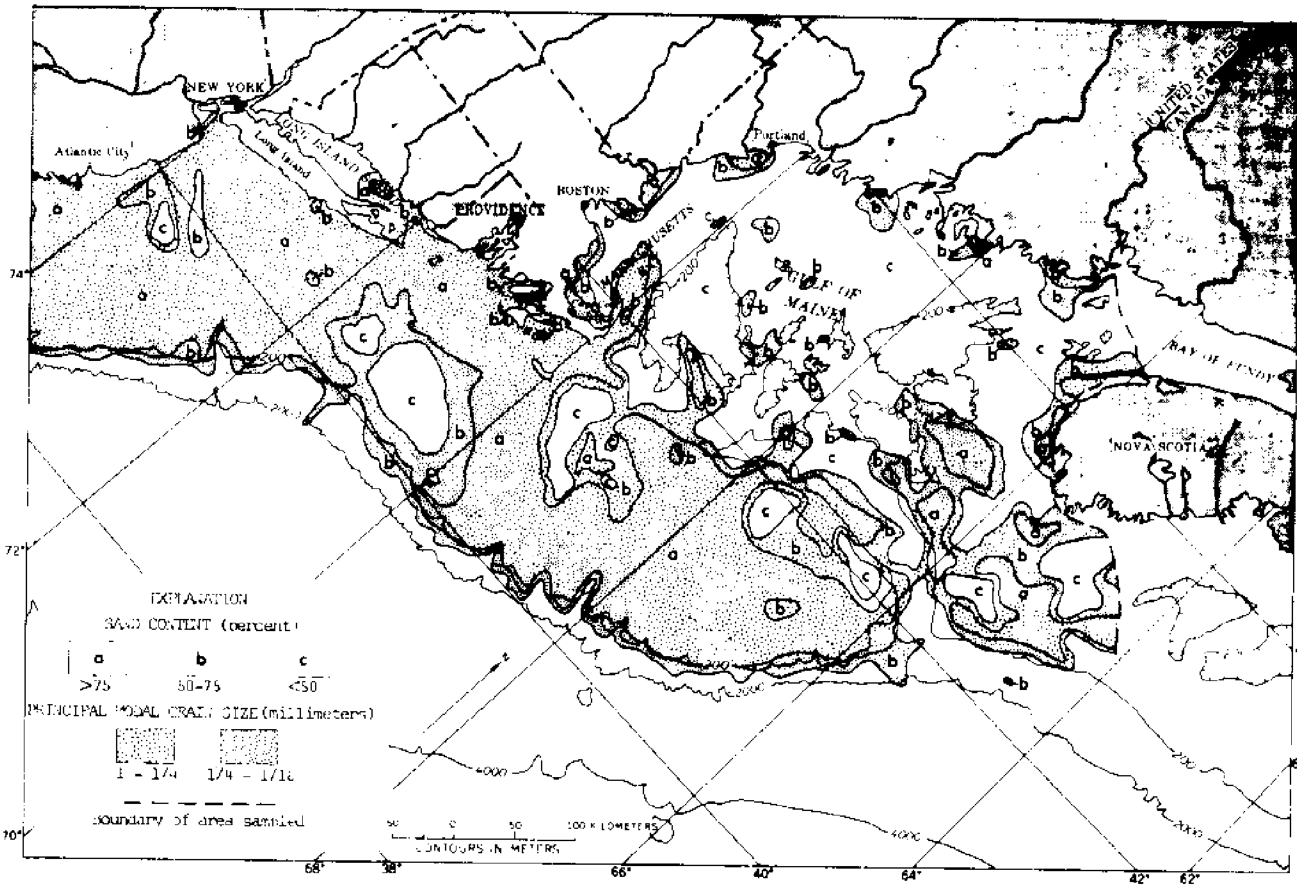

Figure 1. Distribution and principal modal size of sand on the continental margin off northeastern United States. Reprinted from Schlee, John. 1968. *Sand and gravel on the continental shelf of the northeastern United States*. U.S. Geological Survey Circular 602.

1972). Under Chapter 279, Public Laws 1971 (46-23-6 Sub A) the Council is charged to:

a. Identify the state's coastal resources.

b. Evaluate these resources in terms of their quantity, quality, capability for use, and other key characteristics.

c. Determine the current and potential uses of each resource.

d. Determine the current and potential problems of each resource.

e. Formulate plans and programs for the management of each resource, identifying permitted uses, locations, and protection measures.

f. Carry out these resource management programs through implementing authority and coordination of state, federal, local and private activities.

g. Formulate standards where these do not exist, and reevaluate existing standards.

All plans and programs are to be developed around the following basic standards and criteria: (a.) The need and demand for various activities and their impact upon ecological systems; (b.) the degree of compatibility of various activities; (c.) the capability of coastal resources to support various activities; (d.) water quality standards set by the State Department of Health; (e.) consideration of contiguous land uses and transportation facilities, and (f.) consistency with the state guide plan.

The form and content of this study have been shaped by the above considerations.

The Ocean Resource

Sand, and to a lesser extent gravel, deposits cover more than 50 percent of the United States' Atlantic continental shelf. These deposits range from the

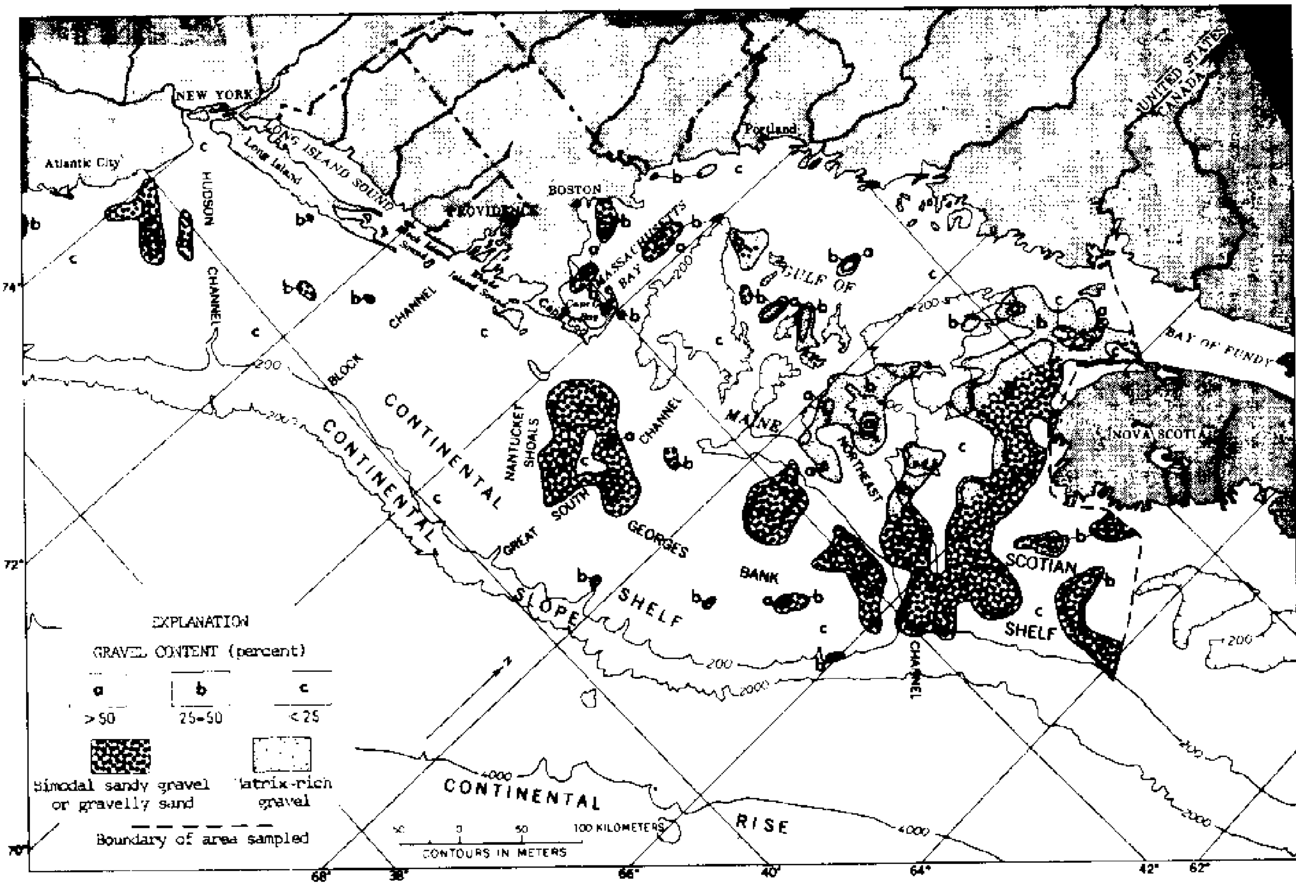

Figure 2. Distribution of gravel on the continental margin off northeastern United States. Reprinted from Schlee, John. 1968. *Sand and gravel on the continental shelf of the northeastern United States,* U.S. Geological Survey Circular 602.

shoreline 100 miles or more offshore and from depths of 0 to 600 feet (Ocean Science and Engineering, 1967). The southern New England and central Atlantic shelf from Cape Cod Bay to southern New Jersey is especially rich in deposits of Pleistocene (glacial) origin (figs. 1 and 2). These deposits reached their present locations suspended in moving glacial ice or transported by glacial streams that crossed the then exposed continental shelf. The largest portion of Rhode Island's offshore resource was deposited by retreating glaciers (McMaster, 1960). Deposits laid down during the Pleistocene are clearly distinguishable by their coarser texture from the sands of present beaches (Ocean Science and Engineering, 1967). The coarseness of the deposits, their great age and the persistence of features such as ancient drowned beaches, dunes and river beds formed during periods of lowered sea level indicate that deposits have been largely inactive since their deposition.

At depth between 60 and 80 feet (Emery 1965; McMaster, 1960) inactive Pleistocene deposits give way to presently active deposits. Sediments in this zone are subject to wave action, current and nearshore transport patterns. Because these processes affect beach erosion and building and are active to depths between 60 and 80 feet, this shallow zone should be of great concern to those managing offshore sand and gravel resources.

Two aspects of nearshore sediment transport are particularly important in determining the effects of aggregate extraction from the beach area. These are the onshore and offshore seasonal migration of sand and the longshore (littoral) drift of material in the surf zone. Both processes involve movement of sand particles by wave action (Bascom, 1971).

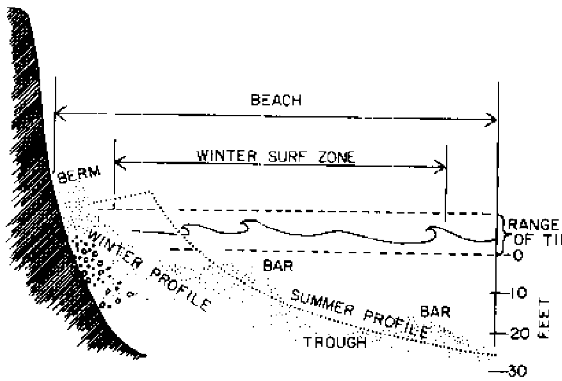

Figure 3. Profile of a beach is characterized by a berm (the deposit of material at the top of the beach) and bars. In winter heavy surf removes sand from the berm and deposits it on the bars; in summer, light surf builds the berm. Vertical scale is exaggerated 25 times. Reprinted from Bascom, Willard. 1971. Beaches (August 1967). In *Oceanography: readings from* Scientific American. San Francisco: W. H. Freeman and Company.

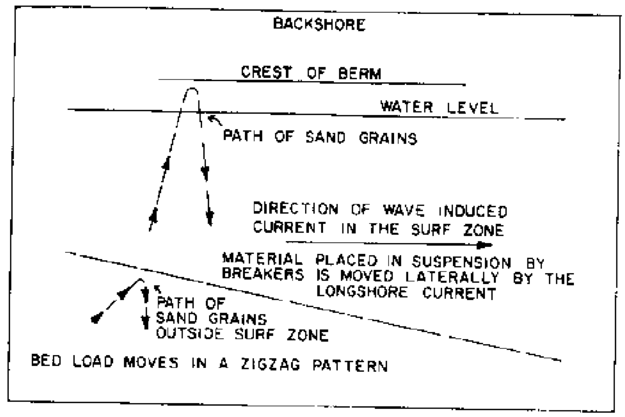

Figure 4. Longshore or lateral movement of littoral drift. Reprinted from Department of the Army, Corps of Engineers. 1971. *Shore protection guidelines.* Washington, D.C.: U.S. Government Printing Office.

Net transport of sand during the winter months is off the beach face and onto submerged offshore bars. The eroded beach face is then replenished by shoreward transport of sand off the bars and back onto the beach face by gentler summer wave action (Bascom, 1971; fig. 3). The on-offshore movement of sand is not a closed system. During severe winter storms material is lost offshore beyond the depth from which summer swells can move it back onto the beach. Lost material is replaced and the equilibrium of the beach maintained by the lateral transport of sand by longshore currents along and immediately seaward of the beach face. These currents are driven by waves that hit the beach at an angle and set up a movement of water and suspended material along shore in a direction opposite to the wave direction (Bascom, 1971; fig. 4).

A Recommendation

A delicate equilibrium maintains the natural contours of existing beaches. Removal of material from either the beach itself or offshore bars will upset the equilibrium and may result in excessive beach erosion. The beach's dependence on littoral drift to replace sand lost offshore through storm erosion further suggests that removal of material from deposits not immediately adjacent to sandy beaches may also upset the natural equilibrium. It would not seem advisable, therefore, to protect only those shallow water deposits directly seaward of beaches. Until the source of longshore material for all beaches is pinpointed, the exploitation of nearshore deposits, regardless of location, should be avoided.

The relative inactivity of Pleistocene deposits indicates that mining them is unlikely to affect beach processes. Sand within the 0-80-foot depth range is involved in active beach processes (Emery, 1965; McMaster, 1965). It is, therefore, recommended that mining in coastal areas shallower than 80 feet be forbidden. The 80-foot depth contour is shown in figures 5 and 6.

Rhode Island Deposits

McMaster (1960) found extensive sand deposits in Narragansett Bay. Coarse sediments were found off Tiverton, Newport Neck, Bristol Point and Warwick Point. Particularly high concentrations of sand are found along the northern and western sides of the upper Bay, the mouth and lower reaches of West Passage, the entrances of East Passage and the Sakonnet River and in Rhode Island Sound off the Sakonnet River and East Passage (fig. 7). Sediments in the upper Bay, West Passage and the Sakonnet River have a higher proportion of sand than those in the East Passage. High ratios (greater than 30 to 1) of sand to clay exist in the upper Bay, the lower West Passage and at the East Passage and Sakonnet River entrances (fig. 8).

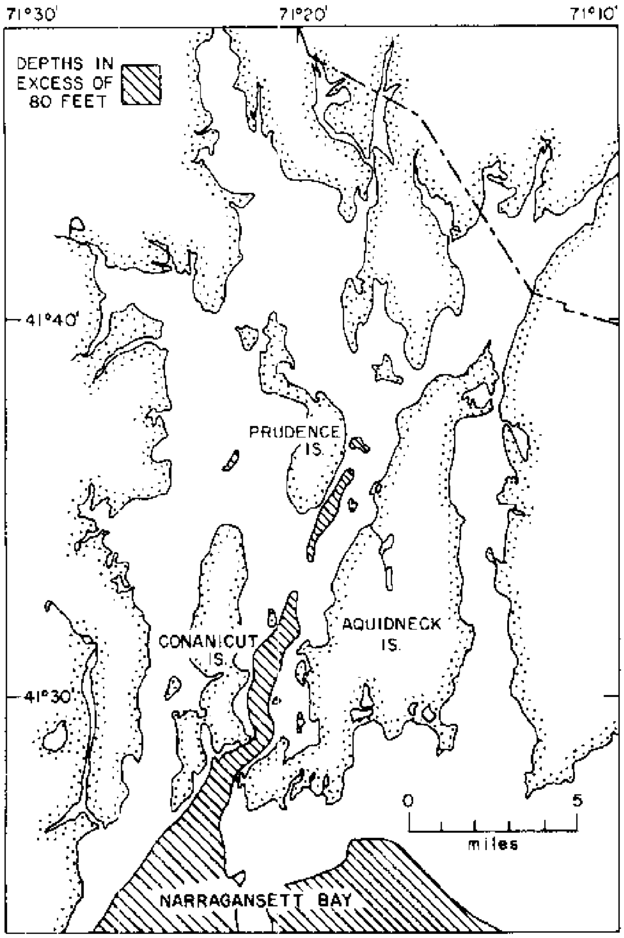

Figure 5. Eighty-foot depth contour. From U.S. Coast and Geodetic Survey chart 353.

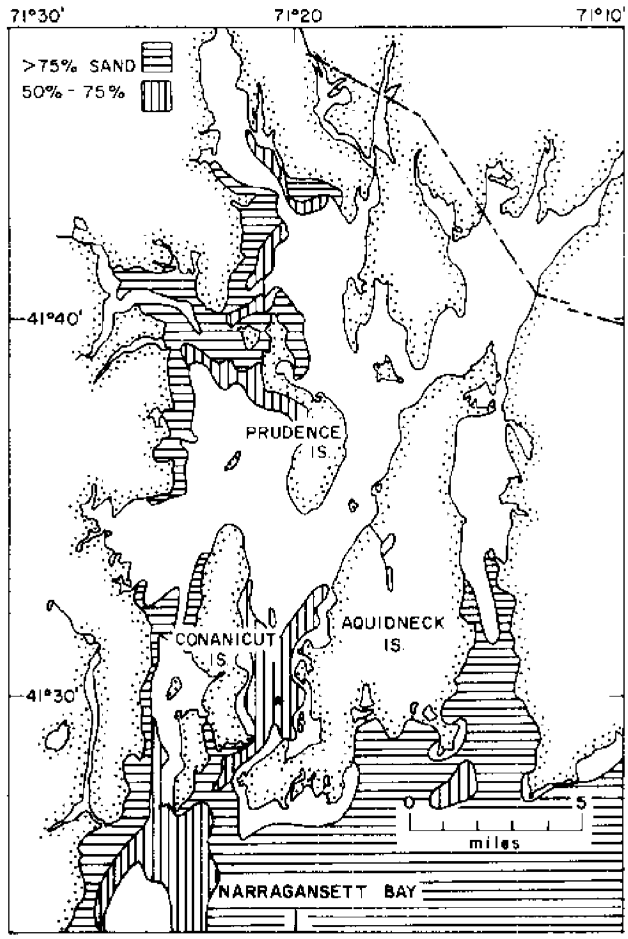

Figure 7. Sand content distribution. From McMaster, Robert L. 1960. Sediments of Narragansett Bay system and Rhode Island Sound, Rhode Island. *Journal of Sedimentary Petrology* 30 (2).

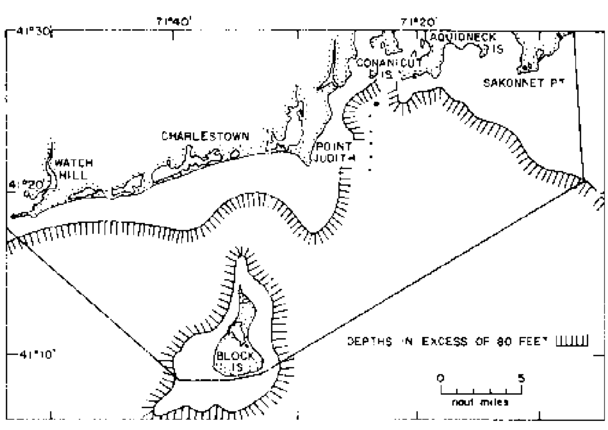

Figure 6. From U.S. Coast and Geodetic Survey charts 1210, 1211.

Sediments in Rhode Island Sound are predominantly sand with several large patches of gravel and mixed sand and gravel southeast of Block Island and off Sakonnet Point. A belt of scattered sand and gravel extends southeast from Point Judith and bends back to the northeast to join a belt running southeast from the mouth of the Sakonnet River. Another broader belt lies southeast of Block Island and extends eastward (figs. 9 and 10).

McMaster (1960) found that Bay sediments are primarily reworked glacial deposits with little contribution from recent river-borne sediments or

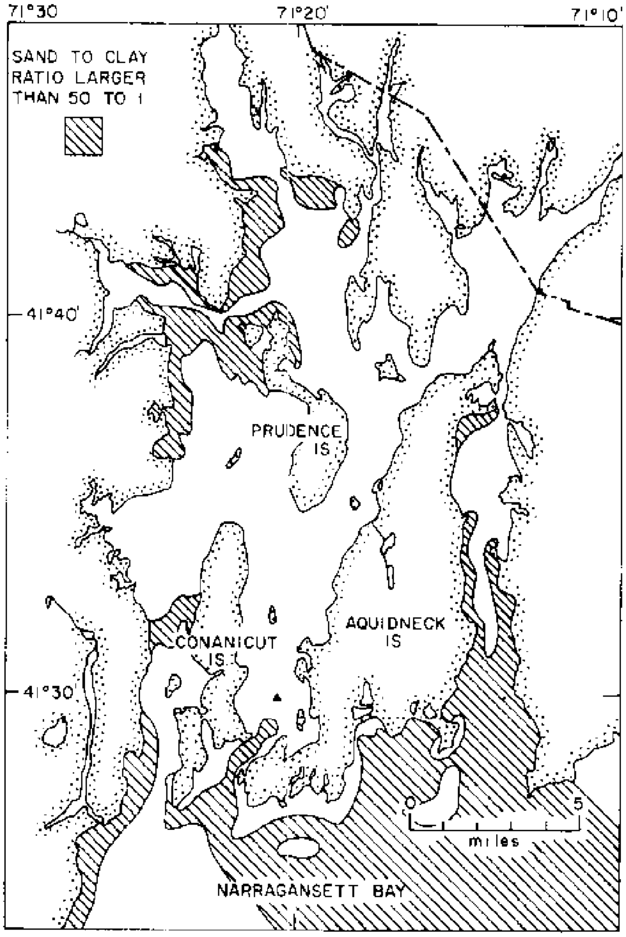

Figure 8. Sand-to-clay ratio. From McMaster, Robert L. 1960. Sediments of Narragansett Bay system and Rhode Island Sound, Rhode Island. *Journal of Sedimentary Petrology* 30 (2).

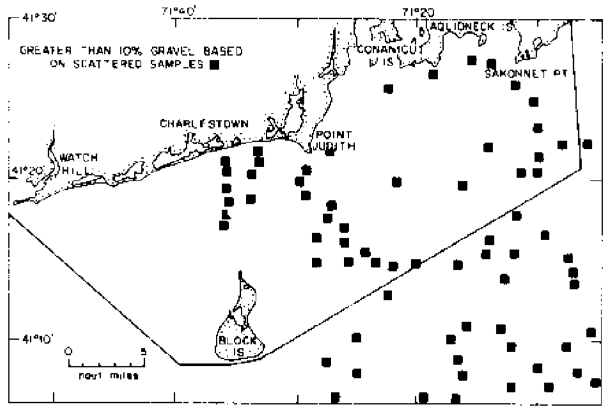

Figure 9. Gravel distribution. From McMaster, Robert L. 1960. Sediments of Narragansett Bay system and Rhode Island Sound, Rhode Island. *Journal of Sedimentary Petrology* 30 (2).

shoreline erosion. Sediment distribution in the Bay is controlled by the pattern of tides and currents. The cleanest and best-graded sand deposits are located in the lower reaches of the Bay in shallow waters subject to tidal and ocean turbulence. South shore beaches are subject to well defined patterns of sand movement determined by littoral drift in a predominantly northerly direction (fig. 11). A tongue of sand extending from Point Judith up into the mouth of the West Passage is an extension of this drift. The contribution of sediments to beach processes in the shallower areas of the Bay and off the south shore suggests, again, that shallow water mining should be prohibited.

Research Needs

McMaster (1960), Schlee (1968), and McKelvey *et al.* (1969) have frequently spoken of the need for more accurate and detailed information on sediment depth and deposit delineation. Detailed mapping of bottom topography, bathymetry (structure and vertical profile) and sediment type, distribution and depth is necessary to determine the potential value of deposits to both the producer and the state.

There are many methods of surveying the sea floor. Sediment samples can be taken by gravity, piston and vibratory corers or by a grab bucket or dredge. The distribution of sub-bottom materials can be determined by magnetic, gravity, and seismic methods (Tracey, 1969; McMaster, 1972), but physical sampling is needed to determine the exact composition of the sediment. Coring devices work poorly on sandy bottoms, and grab buckets and towed dredges may not penetrate hard bottoms. These methods are both slow and expensive. Drill sampling guarantees penetration and is quicker, but it is even more expensive. Hess (1971) indicates that it costs approximately $25,000 per month to operate an exploratory drill ship off Great Britain. A complete prospecting program costs between $180,000 and $240,000 per year (1970 dollars). It becomes questionable, therefore, whether the potential value of the offshore resource justifies further detailed surveying by the state. It does not seem probable that a full-scale prospecting program

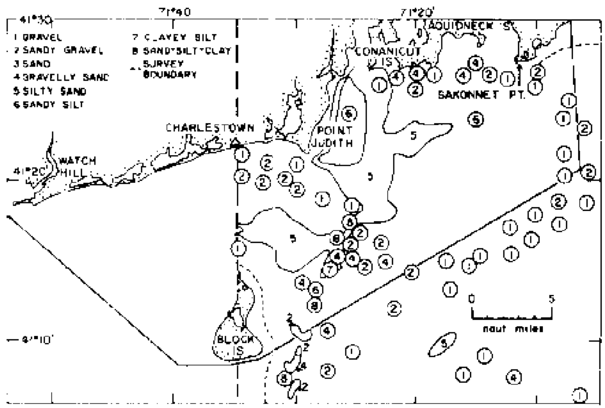

Figure 10. Sediment distribution in Rhode Island Sound. From McMaster, Robert L. 1960. Sediments of Narragansett Bay system and Rhode Island Sound, Rhode Island. *Journal of Sedimentary Petrology* 30 (2).

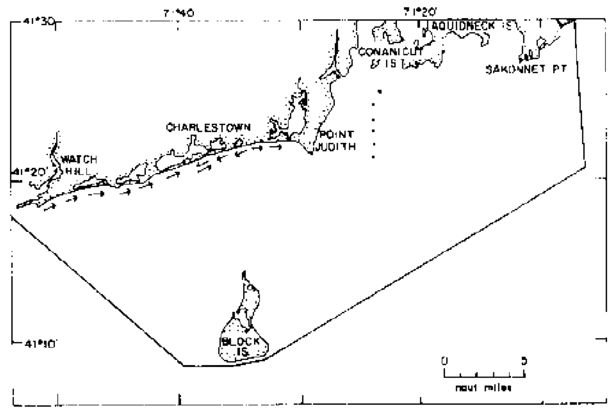

Figure 11. Pattern of sand movement along south shore. From McMaster, Robert L. 1960. Mineralogy as an indicator of beach sand movement along the Rhode Island Shore. *Journal of Sedimentary Petrology* 30 (3).

could be mounted in the immediate future, but there are several ways Rhode Island can increase her knowledge at reasonable cost.

The Graduate School of Oceanography should be encouraged to expand sediment research efforts in the state's coastal waters. Greater use can be made of surveys undertaken by the U. S. Geological Survey and the Army Corps of Engineers; both of these agencies would be willing to cooperate with Rhode Island in better defining her bottom resources. The state should make a concerted effort to participate through the University of Rhode Island or the Coastal Resources Center in research conducted by other institutions in our state waters. The Raytheon Corporation of Portsmouth and the University of New Hampshire are currently engaged in a study of Rhode Island bottom sediments funded by the Sea Grant Program, U. S. Department of Commerce. The five-year study began in 1970 and is aimed toward developing advanced acoustic profiling devices and improved vibratory corers, developing mathematical modeling techniques for analytical bottom mapping, locating and evaluating sand and gravel deposits, and determining the environmental consequences of dredging (*Sea Grant 70's*, Vol. 1, No. 1, 1970 and *Nautilus: On Station*, Vol. 2, No. 43, 1971). Each of these research objectives should be of great interest to the state and would justify the Council's participation at the earliest possible date.

The Land Resource

The domestic consumption of sand and gravel is accelerating. At present the demand is satisfied by the mining of land deposits. Supply problems, however, are beginning to develop in the major metropolitan areas due to increasing demand and restrictions on supply caused by urban expansion, increased land costs and zoning (Davenport, 1971). Producers are being forced to range farther from their markets to find suitable supply sources. This trend has a strong impact on both the producer and the consumer because of (1) the large volumes of aggregate needed to support an industry and meet demands, (2) the low unit value of the material, and (3) the high cost of transportation from the quarry to the consumption point. The value of the aggregate at the quarry is seldom more than $1.00 per ton (loaded). While 80 percent of the sand and gravel produced in the United States is consumed within a 30-mile radius of the quarry, even a 20-mile truck haul doubles the delivered cost of the unprocessed aggregate (Davenport, 1971). Davenport, working with New York prices, estimates a $1.00 extraction and loading cost, an average haul of 20 miles at $1.00 and a processing cost of approximately $1.00 per ton. The cost to the consumer, therefore, will be $3.00 or more per ton, depending on the amount of processing involved and the volume being purchased.

The Rhode Island Situation

Rhode Island's sand and gravel industry is beginning to feel the effects of rising demand and urban expansion. Our situation, however, is not as serious as that of New York or Boston. Major Rhode Island producers haul, on the average, 12 to 15 miles from extraction to processing point and have a lower cost structure than that estimated by Davenport (Altieri, McHale, 1972). A rough cost per ton breakdown for the Rhode Island industry would be as follows:

$ .25	extraction
.20	loading
.75	hauling (quarry to processing plant)
.75	processing
$1.95	Total cost to consumer (1972 prices)

This figure checks well with the average pit cost of the eight types of aggregate in this price list:

	F.O.B. Pit	Delivered in Truck-Load Lots Within Radius of 8 Miles
Washed screened brick sand	$1.90 Ton	$2.75 Ton
Washed screened concrete sand	1.90 Ton	2.75 Ton
Bank run gravel	1.20 Ton	1.95 Ton
Crushed bank gravel	1.75 Ton	2.50 Ton
Washed screened gravel—¾" up	2.50 Ton	3.25 Ton
Washed screened pea gravel	2.75 Ton	3.50 Ton
Concrete mix	2.20 Ton	2.95 Ton
Fill	1.25 Cubic Yard	
Average cost	1.93 Ton	2.81 Ton
Differential between average pit and delivered cost		.88 Ton

Source: Rhode Island Sand and Gravel, Inc.; effective June 1, 1971.

The above figures show that Rhode Island pit prices must increase dramatically to reach the $3.20 to $3.50 per ton pit prices of New York and the $2.75 to $3.00 per ton prices of Boston. They also indicate the high cost of transportation to the consumer, a 41 percent mark-up for trucking within an eight-mile radius.

Preliminary investigations indicate that Rhode Island aggregate prices are not rising as quickly as might be presumed. The state Department of Transportation, for instance, paid the same average pit price for winter road sanding material, $1.44 per cubic yard, in fiscal 1970-71 and 1969-70. The 1971-72 average unit price increased only $.13 (Rongo, 1972).

None of the Rhode Island operators interviewed expect significant changes in their hauling distance or sources in the near future. They are now hauling from quarries in the western and southern parts of the state. They feel that available resources in these areas should meet their needs for the next 15 to 20 years. They point out that a large part of what remains of the state's estimated 54,317,000 cubic yards of aggregate (Moultrop, 1964) is in areas still open to mining. Zoning restrictions are recognized as a problem, but interviewed operators feel that the industry's present policy of excavating only to road level and then grading the property for industrial and residential development will do much to make them acceptable neighbors in rural communities. Future price increases, therefore, should reflect the increasing cost of labor more than a shortage of nearby supplies.

Economic Study Needed

It would be advisable to undertake an economic study of the existing industry. The study should measure the effect of the Big River Reservoir project on aggregate supply. The reservoir site as now defined will cover more than 13,000 acres, much of which is sand and gravel, in Coventry, Exeter and East and West Greenwich. The first of some 17 lease tracts has already been put out to bid. This 120-acre site contains some 6.6 million cubic yards of sand, gravel and overburden to be removed over a five-year period with a five-year renewal option. Bids ranging from $.15 to $.52 per cubic yard have been accepted by the state and excavation has begun (Russ, 1973). It may be presumed that if the Big River site is developed as planned adequate land supplies of sand and gravel will be assured for more years than might otherwise be anticipated.

Ocean mining will develop as land deposits are depleted and land sources become more costly. Britain, with a highly developed ocean industry, still meets much of her demand through land extraction (Hess, 1971). An ocean industry will develop when the cost of land aggregate rises to the level at which offshore sources can compete favorably. In order to predict when this will occur it is necessary to examine the ocean industry in some detail. This will also place us in a better position to anticipate the likely impact of ocean mining of sand and gravel on the state's other coastal activities and processes.

Ocean Mining

There are five stages to a marine mining operation. These are (1) prospecting, (2) evaluation, (3) extraction, (4) processing, and (5) transportation.

Prospecting and Evaluation

Ocean mining of sand and gravel in the United States is presently discouraged by the shortage of detailed information on which to base sound economic decisions. The difficulty and high cost of obtaining this information make it unlikely that industry will begin exploration until prohibitively high land costs force it to seek alternate supply sources. The consequences for the general public will be twofold: Aggregate prices will be driven higher than they otherwise might be before industry will risk prospecting for offshore sources, and the cost of exploration will be passed to the consumer in the form of higher prices. Both of these consequences may be avoided through improving our knowledge of offshore aggregate deposits by making better use of presently available information and encouraging research by other interests. If the state shares its information with industry it can encourage the earliest development of ocean resources compatible with wise management considerations and, by so doing, prevent an undesirable inflation of price.

The early development of ocean deposits at a reduced cost to the consumer can further be encouraged through modification of standard exploratory lease practice. It would be to the advantage of all concerned if parties to an exploratory lease were required to cooperate in a collectively financed survey of the lease area. Information developed by such a survey would be public knowledge. This policy would prevent wasteful duplication of survey work by competing bidders and allow for a consequent reduction of cost passed to the consumer. It will encourage the accumulation of valuable information on the state's marine mineral resources by guaranteeing public access to survey results. Individual companies could expect more and better survey information than they could afford to produce themselves. Their investment would be protected by restricting extraction bids only to those concerns party to the initial exploratory lease. This proposal represents a new approach to mineral exploration and, as a result, may meet with some opposition from within the industry. The administration of the exploratory survey would be subject to the directives of the Council. State control might be exercised through use of an independent survey firm hired by the state and paid by the lessees.

Extraction

Marine mining extraction techniques are controlled by four variables: (1) the physical nature of the deposit, (2) the unit value of the aggregate, (3) the depth of the working surface, and (4) the sea state (wind and wave). Unconsolidated sediments such as sand and gravel can be mined by a variety of techniques including draglining from the beach or wire line, bucket-ladder, clam shell or hydraulic dredging from floating platforms (Mero, 1963; figure 12). The low unit value of sand and gravel dictates a high volume, low cost method. Hydraulic suction dredging has become the most popular technique. In this method a pump lifts large volumes of water-aggregate slurry through an intake pipe drawn across the ocean bottom. Digging action is often improved by mechanical cutters (figs. 12 and 13). The aggregate slurry is either discharged into hoppers on board the dredge, pumped into a transport barge or pumped through a floating discharge pipe to the shore. In the first two cases excess water is discharged over the side.

There are two types of hydraulic suction dredges. The barge dredge (figs. 12 and 14) is designed for maximum production at shallow depths and in sheltered waters. The barge dredge is positioned over a deposit by sinking a spud on the stern into the bottom. The barge is then maneuvered in an arc across the deposit by working anchor lines running out several thousand feet diagonally from the port and starboard bows. Fore and aft movement is controlled by anchors set out at a similar distance from bow and stern ("Ocean Mining Comes of Age," 1971). The barge suction dredge is a cumbersome apparatus to move and is virtually immobile during operation. It depends on companion barges or shore-connected pipelines to transport the aggregate to processing facilities.

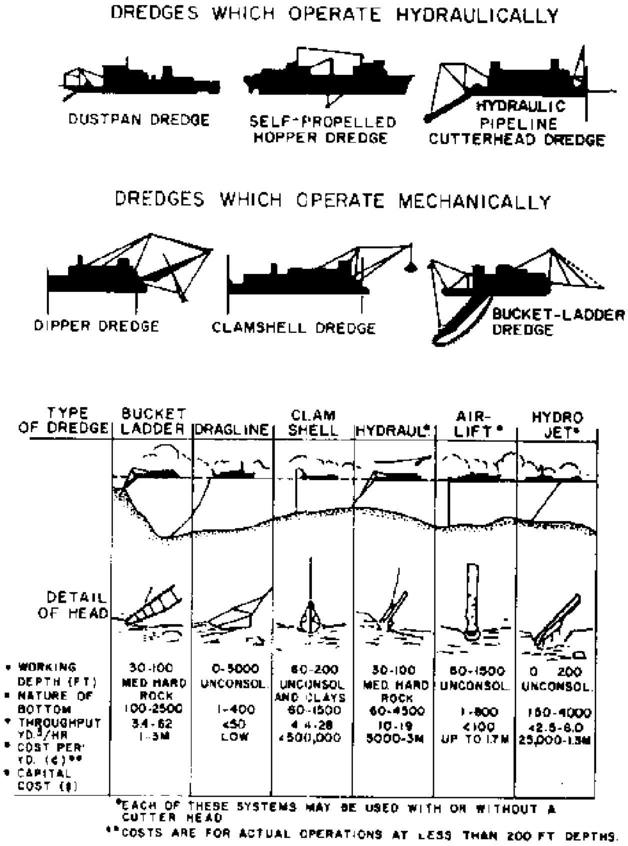

Figure 12. Basic dredge types and methods of marine ore exploitation. Reprinted from Mero, John L. Review of mineral values on and under the ocean floor. In *Exploiting the ocean*. Washington, D.C.: Marine Technology Society.

Barge dredging is the method best suited to operations in the sheltered and shallow waters of Narragansett Bay. Cost figures on barge dredges are difficult to obtain and are extremely variable. They are, however, considerably cheaper than ocean-going dredges of similar size due to their simpler engineering. The lower costs of building and operating a barge dredge, its suitability to work in the Bay and the proximity of Bay deposits to market areas suggest that pressure for marine aggregate extraction will be felt first in Narragansett Bay. The probable method will be barge suction dredging. However, if dredging is forbidden in depths less than 80 feet, most Bay deposits will be closed to commercial dredging (fig. 5).

If, on the other hand, dredging is allowed in shallower waters, much of the Bay may be opened

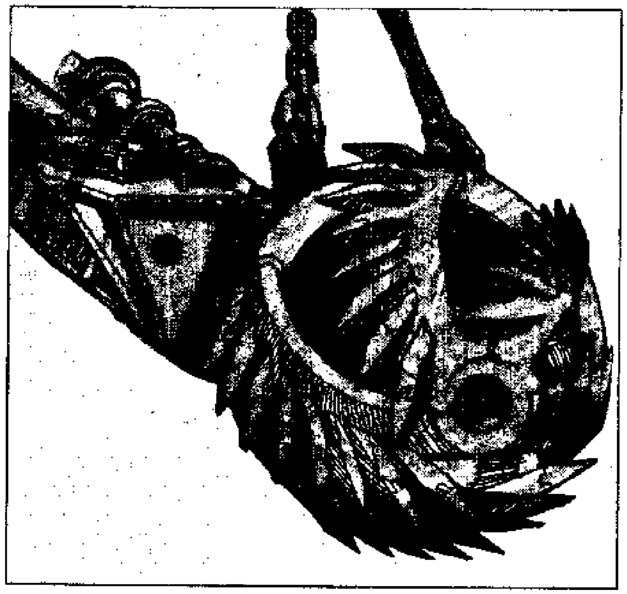

Figure 13. Hydraulic suction cutter head. From Florida Machine and Foundry Company advertisement.

to exploitation and the following considerations should be taken into account. The site occupied by the dredge and its anchor lines will cover a roughly oval area some 4,000 feet long by 2,000 to 3,000 feet wide (fig. 15). Navigation within this area by commercial traffic of any size would be hazardous to both the dredge and the passing vessel. Deep draft vessels might foul dredge anchor lines and would risk collision with work boats and transport barges moving between the dredge and the offloading point. Recreational craft within the area described in figure 15 will present little threat to the dredge, although dredge-related congestion might present enough of a hazard to recreational vessels to make their presence in the zone undesirable.

Since the dredge will be largely immobile, it will be advisable to discourage mining in areas such as narrow channels where undue interference with navigation can be expected. Navigational considerations also suggest that shore-linked floating discharge systems, especially those of any length, are poorly suited to a heavily traveled water body such as the Bay. At best a nuisance, they could be hazardous to small craft in bad weather.

Open-sea conditions and greater deposit depth dictate use of seaworthy vessels for open water dredging. European dredging experience in the

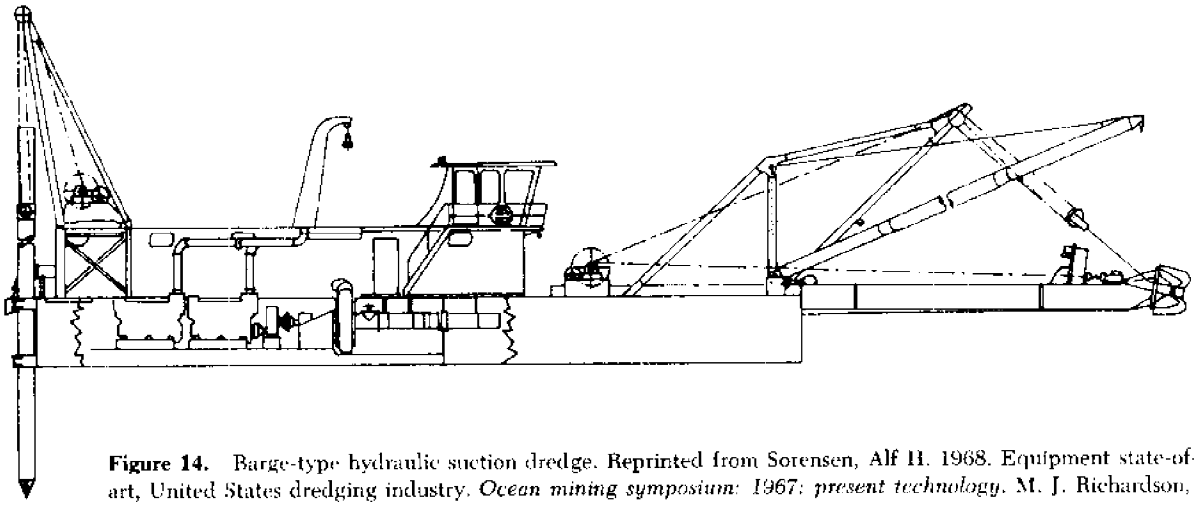

Figure 14. Barge-type hydraulic suction dredge. Reprinted from Sorensen, Alf H. 1968. Equipment state-of-the-art, United States dredging industry. *Ocean mining symposium: 1967: present technology.* M. J. Richardson, Inc.

North Sea has led to the development of the all-weather ocean-going vessel shown in figures 12 and 16. This is basically a conventional ship hull with dredge pipes trailed aft off the port and starboard bows. Because sea conditions frequently make loading onto barges impossible, these dredges load into hoppers built into their holds and later unload at pierside. Hess' (1971) study of the English marine industry provides much information on the hopper dredge operation. Hopper capacities range from 500 to 10,000 tons with the majority of vessels falling in the 1,000- to 4,000-ton range. A typical vessel is 350 feet in length and has a laden draft of 25 to 30 feet. New vessel costs (1970) vary considerably. A dredge with a 2,000-ton hopper capacity costs approximately $1 million and a 3,000- to 4,000-ton dredge costs from $1.5 to $2 million. Vessel costs, transportation distances, annual production, operating costs and per-ton costs to the operator for unprocessed material are shown in the table, page 12.

The loading period of a hopper dredge varies from one to eight hours depending on vessel capacity, water depth, sea state and deposit quality. Although large dredges can work at depths up to 120 feet, shallower deposits are preferred. The loaded dredge steams to port at eight to ten knots, unloads in one to two hours and returns to the dredge grounds. The length of the round trip, the vessel capacity, and loading and unloading time are the primary determinants of the operation's annual production and cost. Ocean dredging on the present European scale is likely to develop on the American

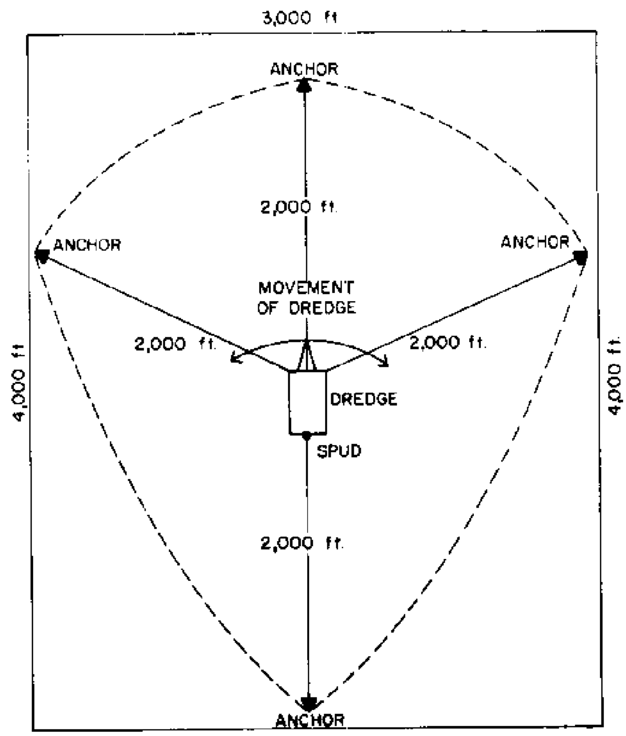

Figure 15. Operational zone of barge dredge. From information in Ocean mining comes of age—part I. 1971. *Oceanology International* 6 (11).

shelf only when demand justifies high capital investment. The economic subleties of the marine mining industry need further study before predictions can be made on when this will take place.

Five examples of sea dredging costs—capital investment and operations.*

Example	Cargo (ton)	Capital Cost ($)	Round Trip (miles)	Annual Production (tons)	Annual Operation Cost ($)	Cost Per Ton ($)
A	300	75,000	20	90,000	44,000	0.49[1]
B	500	200,000	8	191,800	78,500	0.41[2]
C	850	600,000	20	282,565	125,000	0.45[3]
D	1,200	600,000	30	300,000	105,000	0.35[4]
E	2,000	1,075,000	140	400,000	196,000	0.49[5]

Key: [1] Conversion 1948; [2] Conversion 1966; [3] New-built 1966 (Scraper discharge); [4] New-built 1967; [5] New-built 1967 (Scraper discharge).

* *From Hess* (1971) Marine Sand and Gravel Mining Industry of the United Kingdom, p. 66.

Processing

Processing of mined material takes place at two stages regardless of the dredge type. Water and fines (silt and clay particles) are discharged over the side of the dredge before the aggregate is loaded into barges or hoppers. When gravel is being dredged, a great deal of sand (as much as two to three tons for every ton of gravel recovered) may also be discharged during the dewatering process (Hess, 1971). The discharge of large quantities of fine sediment into the water column creates problems which justify extensive independent consideration (see Impact on the Natural Environment in Chapter 2). Of more direct concern here are problems related to unloading, final processing and storage of mined material. The more advanced hopper dredges avoid most of these problems by washing and sorting the aggregate on board so that a finished product is discharged at the unloading point. Operations of this sort however, are uncommon and still depend on having a port facility that is adequate to receive, stockpile and process the dredged material and located in an area open to deep-draft vessels and close to market sources.

These requirements limit available sites in Rhode Island to dredged areas of Providence Harbor and a few scattered locations in the lower East Passage of Narragansett Bay. The low unit-value of sand and gravel may put the industry in a poor position to compete with high revenue-producing users of valuable shorefront acreage. Such users are already well established in many desirable Bay locations. Sites on the lower Bay would avoid some competition, but would still require valuable acreage and lead to high additional transportation costs if material had to be trucked long distances to markets. The offshore industry might increase the number of possible unloading points by operating small hopper dredges or unloading large vessels into barges in the Bay. Since unloading and processing facilities will be large, active and potentially disruptive, their location should not be left to chance. It would appear desirable for the Council to petition the state legislature to include marine aggregate offloading, storage, and processing facilities among those specific activities and land uses which it is empowered to regulate under the provisions of the Coastal Resources Management Council Act of 1971. Problems may also be expected from the trucking or slurry piping of aggregate material to existing inland facilities for processing. If wash waters used in processing were discharged into rivers and streams, salt contamination could result.

Transportation

The extremely low unit cost of moving large volumes of bulk material in ships or barges is one of the most attractive features of ocean mining. While processing costs are comparable with those from land sources (Hess mentions a figure of $.55 per ton for the British industry) and extraction and capitalization costs are considerably higher, much lower transportation costs give the ocean industry a competitive position in high demand markets. Transportation is not likely to create insurmountable problems for resource management. Heavy barge traffic would contribute to congestion in the Bay, but adequate legal authority to regulate water-

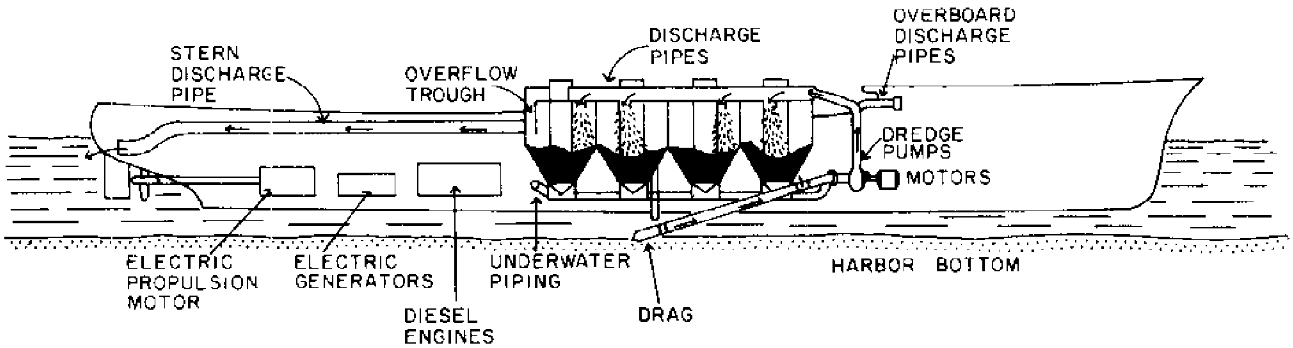

Figure 16. Operational sketch of hopper dredge (lengthwise section). Reprinted from Hanse, Ray S. 1971. Great Lakes dredging: problems and remedies. *World Dredging and Marine Construction* 7 (14).

borne transportation of dredge materials already exists under Title 46 of Chapter 47, Public Laws 1971. Under the provisions of this statute, a permit must be issued by the Director of the Department of Natural Resources to transport dredged material over state waters.

Hydraulic suction dredging by barges in the Bay and by self-loading hopper dredges in Rhode Island and Block Island Sounds appear to be the most likely methods for large-scale exploitation of Rhode Island resources.

Beach Mining

A little publicized and presently inactive operation of the M. A. Gammino Construction Company on the Portsmouth shoreline suggests that the Council also address itself to the problems associated with land-based operations. The company mined material from a pit behind, but in close proximity to, the existing shoreline for a number of years. Under pre-1971 legislation this was legal although of some concern to the Department of Natural Resources (Bolwell, Mulhearn, 1972). Some time ago the cofferdam between the gravel pit and the Bay was breached, creating a substantial cove separated from the Sakonnet River by a narrow sand spit. Similar activity, particularly behind south shore beaches, could have a serious impact on coastal processes. While mineral extraction is included among those land uses which the Management Council is specifically charged to regulate under present legislation, a more direct policy statement might prove helpful in such a situation.

The Future

Speculation as to when Rhode Island's ocean mining industry will develop would be premature until more information is developed. Several conclusions can, however, be drawn from what is known. Initial pressure is likely to be from small operations working from the beach and utilizing conventional drag-line techniques. The Gammino operation cited suggests that others of this type can be expected at any time and should be strictly regulated due to their potential for uncontrolled shoreline modification. Barge dredging of aggregate from shallow deposits in the Bay will be the "natural" second step in the development of the resource. Sheltered waters, easily accessible material and proximity to markets will make these deposits attractive to investors.

Ocean hopper dredging will be the final and largest stage in the development of ocean aggregate mining. This will be a highly capitalized and sophisticated operation which will ultimately extract material from considerable depths and distances from shore on the outer shelf.

The development of any marine mining industry will vary with the vitality of the land industry, with economic, urban and residential growth patterns, and with any restrictions which may be placed on its activities.

2. Impact Projections

Economics of Environmental Conservation

Present uses of natural resources and the effect these uses have on the natural environment are heavily influenced by economic considerations. The factors governing use decisions must be understood if the Council is to fulfill its charge to direct resource use towards maximum social benefit at minimal environmental cost. The economic variables affecting natural resource exploitation are numerous but two deserve particular consideration, the common property resource and spillover costs.

The Common Property Resource. A common property resource is a commodity such as air or water which in the broadest sense "belongs" to society as a whole, but over which no individual exercises an exclusive claim. A user will, therefore, assign it no dollar value. While the consumption of most resources is moderated by fluctuations in their price, the consumption of a common property resource with a value of zero is not so limited. It will be used in preference to materials which must be purchased and frequently will be used wastefully. No resource is inexhaustible and the uncontrolled use or misuse of a common property resource degrades its quality and lessens the quantity available for others.

Spillover Costs. The extravagant use of a common property resource, while providing the producer with lower production costs, imposes uncompensated (spillover) costs on society. Costs are of two types, the most evident being the degradation and waste of the free resource. Less apparent is the self-perpetuating nature of free resource consumption. The producer is able to market a product for less because he is not forced to pay for all of his raw materials. The dollar savings are passed on to the consumer who buys more than he would if a higher price reflected the cost of the degraded resource. His savings, however, are illusory. His increased consumption encourages continued wasteful exploitation of the resource which, in the end, may require costly remedial action.

Management Implications

Since the market does not regulate consumption of a common property resource, management must (1) check environmental degradation, (2) prevent wasteful use of the common property resource, and (3) balance the cost of environmental conservation against society's willingness to pay for it.

Management responses may involve restrictive regulation and/or expenditure of public funds for restoration. Both of these will involve major public financial commitments. While the cost of government-subsidized restoration may be more readily apparent, the cost of effective regulation is likely to be equally high. Regulations will force the producer to internalize the cost of using the common property resource. He will use it more frugally, but will pass on his increased costs to the consumer. Environmental maintenance must, therefore, be supported by higher prices or higher taxes. The public's willingness to tolerate either must be measured if management efforts are to be supported by public commitment.

Management, Economics and Offshore Aggregates

Rhode Island waters are a common property resource belonging to the people of the state and administered by the Coastal Resources Management Council. Marine mining will use the water in numerous ways, and abuses of the resource may occur. These should be anticipated and preventive measures taken. The major abuse is likely to involve the use of water to cleanse the aggregate of undesirable fine clay and silt particles. Wash-water discharged over the dredge side contains concentrations of these fine sediments. The extravagant use of water for aggregate cleansing reduces the miner's production costs and allows him to sell more of his product for less. Society pays the cost in the debased quality of the marine resource for other uses and users. The Council may protect the common property resource by setting quality standards for discharge water or by restricting dredging areas or seasons. This, however, will raise the price of sand and gravel to the consumer. A tolerable price increase will reflect the state's need for aggregate and the public's awareness of resource degradation. Future aggregate needs may justify greater or lesser environmental costs than are acceptable today and a flexible management position should, therefore, be maintained.

Impact on the Natural (Marine) Environment

In order to understand the effects aggregate mining can have on the marine environment, it is necessary to briefly consider the mechanics of marine life systems. A marine ecosystem consists of a complex web of vertical and horizontal energy (food) exchanges between organisms ranging from single-celled plants to large fish. While the web is vulnerable to change at all levels, it is especially so at the lowest and most important level, that of the primary producers. Unicellular phytoplankton need sunlight to produce organic material (food) and oxygen upon which the web depends. Any activity that interferes with primary productivity is a threat to the ecosystem.

The species composition of an ecosystem is determined by biological and physical factors. Biological factors include nutrient supply, competition, predation and behavior. Physical factors include light, salinity, temperature, pressure, currents, oxygen, bottom composition and water chemistry. Changes in the biological and physical environment may cause dramatic changes within the ecosystem.

Turbidity Effects

Turbidity is the optical interference with the passage of light through water caused by the presence of particulate and dissolved matter (Dominquez and Basco, 1971). The disturbance of bottom material by a dredge and the discharge of fine sediment during aggregate washing cause local increases of turbidity (fig. 17). The effect of such increases upon phytoplankton productivity has not been conclusively determined although there is evidence that dramatic short-term reductions can occur (Maltvaine, 1971). This is particularly true for plankton populations at greater depths (Maltvaine, 1971). Bella (1971) found reduced oxygen levels and organic content and increased respiratory activity in turbid areas. He noted, however, that a limited number of plankton species flourish under these conditions. While the evidence of long-term impact is as yet inconclusive, immediate local alterations in phytoplankton populations may be expected.

Research. Turbidity research has concentrated on the effects of channel dredging; the extension of results to marine aggregate mining may prove questionable. A great amount of new and useful data will, however, become available over the next few years as the results of new research projects are released. The most ambitious of these is a joint

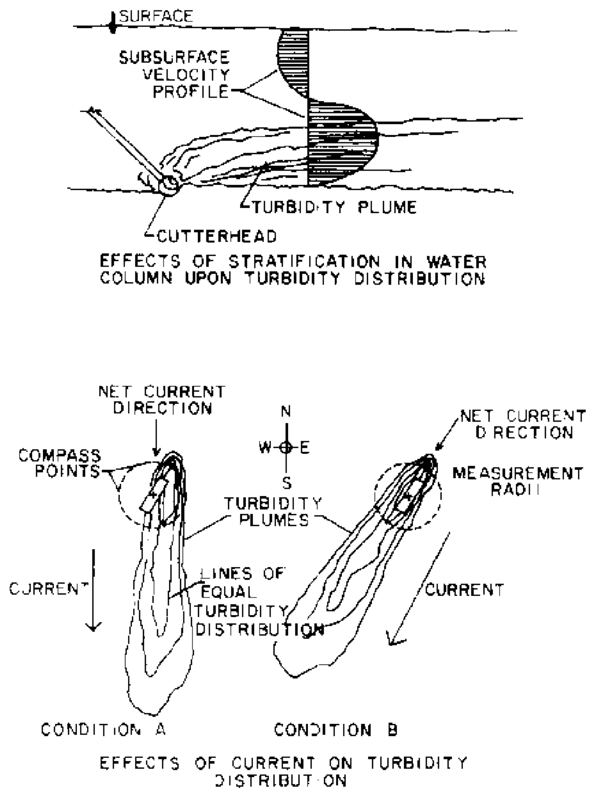

Figure 17. Effects of current on turbidity distribution. Reprinted from Dominquez, Richard F. and David R. Basco. 1971. Muddy aspects of water quality affecting dredges. *World Dredging and Marine Construction* 7 (14).

federal-state investigation of environmental effects associated with marine sand and gravel mining. This investigation will involve large areas of Massachusetts Bay and is described by Director Robert Blumberg of the Massachusetts Division of Marine Resources as follows:

> It (the study) will encompass a base line marine biological study systematizing benthic communities within the area to be dredged for a period of one year. A dredge will then be brought in and approximately 500,000 cubic yards will be extracted. During that time the entire dredging operation will be closely monitored to assess short term effects on the benthic communities and any interactive forces on the near shore and beach areas. After the termination of this phase, there will be a two-year observation phase during which long term effects will be analyzed. (Letter of February 11, 1972)

The Massachusetts project has begun and its scope has been expanded by increased federal participation and funding. Information developed will be specifically directed to marine aggregate mining and should be of great interest to Rhode Island in managing her marine resource.

Whatever the results of the Massachusetts Bay project, there are a number of turbidity processes which should be considered in managing dredge mining. We need to know how long sediment particles will stay in suspension, where they will come to rest and how they will get there. Further information is needed on particle behavior and the effect of size, density, distribution, shape and chemical attraction on settling rates. Variables such as discharge rate, currents, turbulence and water density must also be defined and analyzed.

Sedimentation

The settling of dredge fines will affect the benthic (bottom) environment. This should be an important consideration in managing sand and gravel mining. Probable effects are several.

Nutrient Release. Organic material stabilized in sedimentary beds will be disturbed and resuspended in the water column during dredging. This may benefit those species attracted to the nutrients released but at the same time may prove toxic to others. High biological oxygen demand may result from bacterial decomposition of suspended organic matter (Maltvaine, 1971; Bella, 1971). The possible harmful effect of resulting anoxic (low oxygen) conditions on desirable commercial and recreational species should be of considerable concern. Reliable information on the effects of nutrient release should include determinations of community composition, density and nutrient requirements and the organic content of bottom sediments in the dredge area.

Release of Toxins. Sediments in several areas of Narragansett Bay and Rhode Island Sound (figs. 18, 19) are contaminated with a variety of toxic pollutants. These include hydrocarbon and pesticide residues, sewage sludge and toxic heavy metals such as mercury and cadmium. Many of these substances are toxic in very low concentrations, especially to larval stages (Bella, 1971). Chemical analysis of sediments in suspect areas will be neces-

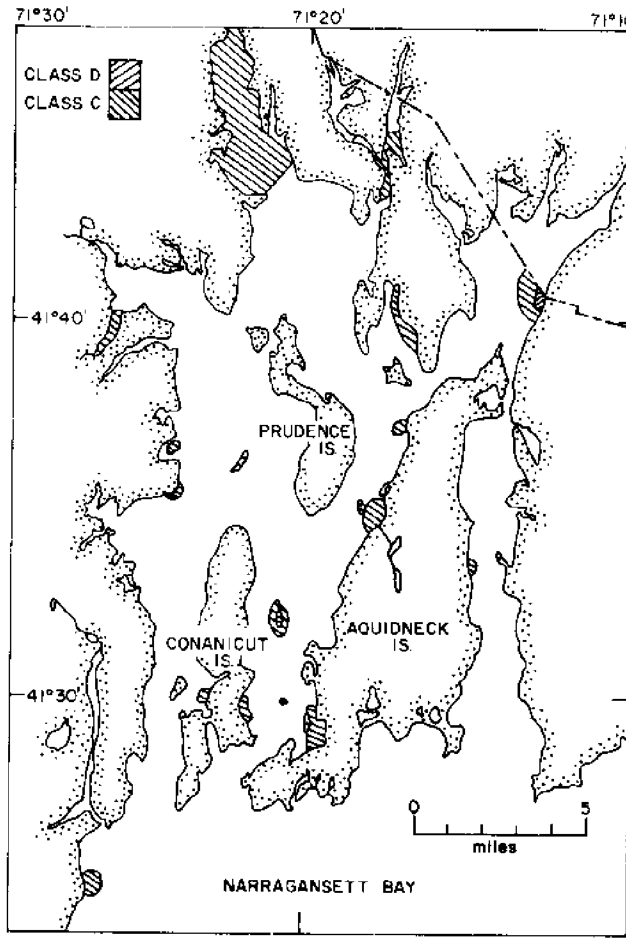

Figure 18. Polluted areas—Narragansett Bay. From State of Rhode Island. 1970. *Report of the Governor's Committee on the Coastal Zone.* Providence.

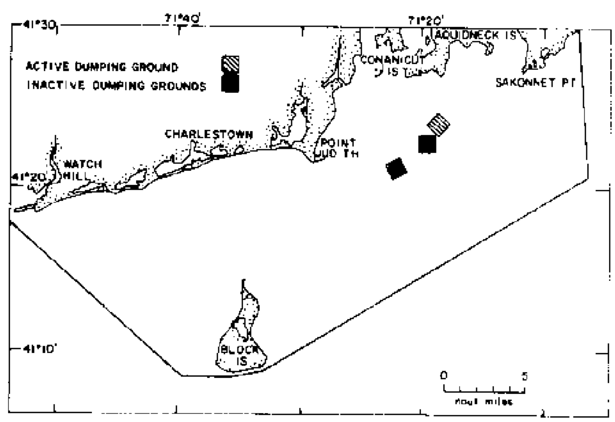

Figure 19. Dumping grounds. From U.S. Army Corps of Engineers charts.

sary to determine their toxicity and consequent suitability for dredging.

Effects on Diatoma. Microscopic plants (diatoms) are important producers of oxygen and food. They are especially abundant on shallow, organically rich bottoms (Maltvaine, 1971) and are vulnerable to sedimentation because of their limited powers of mobility. Even small sediment accumulations may destroy populations. The frequent coincidence of diatom mortality and high biological oxygen demand in deposited sediments increases the likelihood that anoxic bottom conditions will be created. Unacceptable mortalities can be avoided by careful *in situ* and laboratory investigations of species composition, density, productivity and migratory ability and by determination of probable dredge sediment load and settling rate.

Effects on Filter Feeders. Sedimentary effects on commercially valuable filter feeders such as hard- and soft-shell clams will be of concern in managing nearshore sand and gravel mining. One may expect acute problems in areas near active shellfish beds (fig. 20). Particulate matter may block gill chambers and food filters, causing suffocation or starvation of shellfish (Bella, 1971). High sedimentation rates may bury organisms or exhaust their energy reserves in their efforts to dig out. Definitive predictions are not, however, supportable by existing evidence. A 1959 study (Stringer) found that although Narragansett Bay hard clams were accustomed to low particulate levels, they could tolerate high sedimentation rates with no apparent ill effects. Cronin (1970), however, observed reductions of 65 to 70 percent in benthic population density and biomass (organic weight) in areas subject to deposition of dredge spoil. Until present uncertainties are clarified, dredging in areas of high biological productivity does not appear advisable. Greater flexibility will be possible when research determines shellfish tolerance to sedimentation, acceptable deposition rates and the effects of excess sediment on filter-feeder life systems, benthic biomass, population density and community composition.

Effects on Larval Stages. Larval forms of most marine species are extremely sensitive to changes in their environment. Increased sedimentation rates may clog gills and membranes, reduce egg

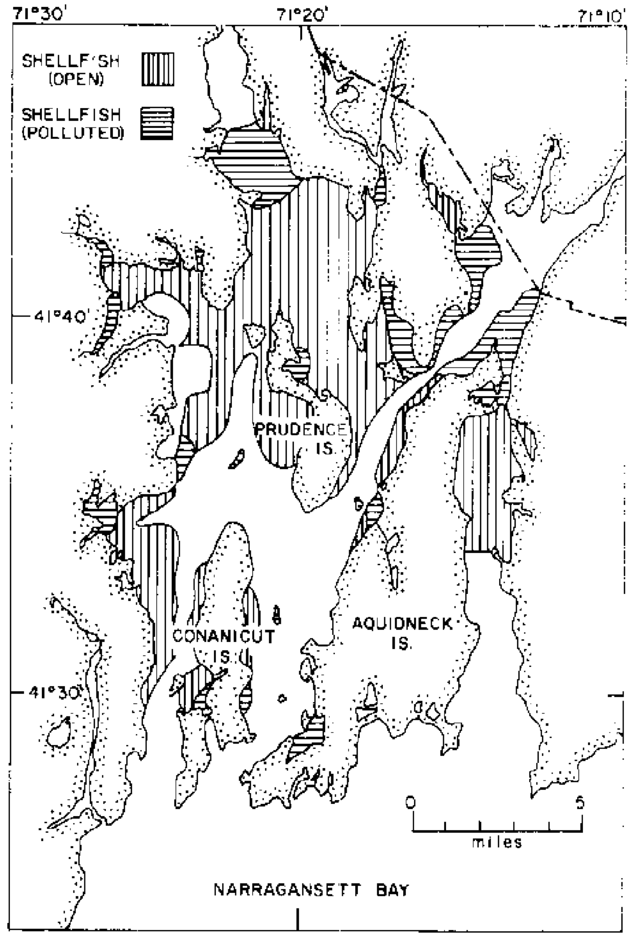

Figure 20. Shellfish beds. From State of Rhode Island. 1970. *Report of the Governor's Committee on the Coastal Zone.* Providence.

buoyancy or restrict movement between the bottom and the water column by accumulations of new material (Smith *et al.*, 1971; Bella, 1971). Since species propagation often depends on larval movement between the bottom and the water column interference with this process may prove fatal to the community (Bella, 1971). Cronin *et al.* (1970), while recognizing the sensitivity of larval stages, did not observe gross damage to fish eggs or larvae in their study of spoil deposition in Chesapeake Bay. Clarification of existing uncertainties will be necessary before dredging in or near spawning and nursery grounds is permitted. This information might include the species of larvae present in the water and bottom sediment, tolerance to sedimentation, effects of sub-lethal sediment concentrations, and the identification of known nursery areas and seasons. Some areas might require permanent or seasonal dredging restrictions.

Effects on Community Composition and Species Diversity. Communities of organisms able to adapt to the stress of high turbidity levels and sedimentation rates may replace natural populations in areas subject to heavy spoil deposition. Cronin *et al.* (1970) found a dramatic decrease in species diversity and population density to be associated with dredging activity. Density recovery was evident within one year after dredging had stopped although certain species appeared to have been permanently eliminated. Dredging in productive areas would not, therefore, appear desirable until we can predict with some certainty which species will be eliminated and which increased in number and/or size. We would also want to know the repopulation time of the dredged area and the effect depopulation had on new communities.

Deposition, Density Flows and Resuspension

The sedimentary processes associated with dredging are complex. In their study of dredging impact on Upper Chesapeake Bay, Cronin *et al.* (1970) found that fine sediments concentrated in flows (turbidity currents) directly above the bottom. With a density only slightly greater than the water in which they were suspended, particles in these flows settled very slowly, were sensitive to even the gentlest inclines and spread out over an area many times greater than anticipated. Even when deposited on relatively flat surfaces, the fine particles spread over large areas because they could hold only an extremely shallow slope. They were extremely sensitive to wave and current action and were resuspended in considerable quantities by currents and other natural forces. Deposition phenomena similar to those observed by Cronin are likely to result from dredging of Rhode Island deposits, especially those with moderate to high silt content. In order to protect the marine environment from unforeseen change it would, therefore, be desirable to determine current patterns, bottom topography, turbulent forces and the various other factors bearing on sediment-carrying capacity and transport patterns (see Turbidity Effects) in anticipated dredge areas.

Mechanical and Physical Effects

Many marine organisms will be destroyed as they are drawn through dredge machinery; others will be eliminated by shock caused by disruption of the mined area (Thompson, 1971). Destructive impact may be minimized by discouraging dredging during seasonal periods of high phytoplankton or larval activity. Some difficulty should be anticipated in (1) identifying these periods for all valuable species and (2) separating overlapping blooms.

The exposure of new bottom through removal of dredged material will attract a population whose composition will differ from the original in proportion to the change in substrate (Cronin, 1971). Beneficial or detrimental change may involve alterations in flow patterns, flushing rates, temperature and salinity distribution, water and sediment chemistry, turbidity and dissolved oxygen content. Minimal change may be anticipated if miners are encouraged to dredge along natural bottom contours, avoid steep-cutting slopes and leave enough of the original aggregate surface material to support recolonization by the original population.

Deliberate and controlled alteration of natural bottom topography during mining could be used in some cases to improve conditions for desirable species. Existing research suggests, however, that we may not yet know enough to prevent undesirable effects of deliberate alteration. Anoxic stagnation and destructive erosion are typical and frequent results of such activity (Bella, 1971). Experimental dredge alteration might be considered when the information generated by the Massachusetts Bay project becomes available.

Summary of Management Recommendations

A great deal more needs to be known about the effects of dredging on the marine environment. Every effort should be made to generate more and better information on the many processes involved. The state of Rhode Island cannot and should not undertake all the necessary research itself. It already has been suggested that the marine miner contribute to the gathering of knowledge necessary to manage our sand and gravel resources (Ocean Mining in Chapter 1). The industry could do this by submitting a statement projecting the environmental impact of its activities before the Management Council issues a mineral extraction lease.

The impact statement could be a product of a joint exploratory lease funded by the bidders. The contents of the impact statement would change as existing questions are answered and new ones raised. Many problems about which little or nothing is known must be studied. These include the effects of turbidity, toxicity, sediment deposition and resuspension and mechanical disturbance on bottom plants and animals; plankton and larval organisms; community composition; bottom features; water quality, and hydraulic processes. The impact statement could be used by the Council in establishing lease conditions.

Impact on the Human Environment

Questions of resource allocation demand consideration of human values to which it is difficult to attach quantifiable measurements. While the quality of the marine environment is clearly worth something to the general public, it is difficult to establish on what basis worth is defined or what commitment it represents. The aesthetic value that the public places on the marine environment depends on its scenic beauty, tranquility, spaciousness and the recreational pursuits it supports. In the absence of other indicators, aesthetic value must be measured in terms of willingness to forego or modify uses of the marine environment which would otherwise detract from its aesthetic attractiveness. The public will tolerate higher resource prices or restricted supply only in proportion to its commitment to aesthetic values. There are unfortunately no easy methods of determining the value which the public places on a "pleasing" marine environment. The Management Council can, however, try to be sensitive to public feeling. It can increase public knowledge and interest through the clarification of environmental and aesthetic consequences of various types of development.

The aesthetic impact of aggregate mining, especially in nearshore areas, may be considerable. Control could be exercised through concern for the visual and audible impact of a mining operation on nearby scenic, recreational and residential areas. Restrictions on seasons, hours, methods and areas of operation might prove necessary in some areas. Necessary restrictions should be identified and implemented before mining begins. Aesthetic problems should, therefore, be studied during the exploratory lease as a part of the environmental impact statement.

Use Conflicts

Management Priorities

Resources are of two general types. Renewable resources are not depleted if they are exploited intelligently. Fish are an example. Nonrenewable resources are those which are depleted by exploitation. Mineral materials such as sand and gravel fall in this category.

There are three management priorities to consider. First, when exploitation of a renewable and a nonrenewable resource come into conflict, it is usually preferable to favor the renewable resource. A renewable resource may have a lower annual dollar value, but its potentially indefinite production may yield a much greater long-term gain. It should not be assumed that concurrent renewable and nonrenewable resource exploitation will always be incompatible. Minor modification of operating practices may often reduce conflicts to an acceptable level. The possible compatibility of aggregate dredging and fish spawning through seasonal restrictions on mining has already been mentioned.

Second, a distinction must be made between the real and apparent value of a resource. Revenue generated is not in itself an adequate measure of value. Not only must environmental and aesthetic costs be considered, but the impact of the revenue on the state's economy must be measured. A high apparent value use will have little real value if the revenue generated does not stay in the community. If outside corporations develop the Rhode Island marine aggregate resource, little of the income generated may actually be spent in the state. If they do not market their product in the state, their activities will have even less impact on the local economy. Even though the apparent value of an aggregate industry may be greater than, for instance, that of a commercial fishery, its real value may be much less. In weighing trade-offs between the sand and gravel resource user and other marine resource users a number of points should be considered: (1) ultimate destination of income generated, (2) effect on the local economy through spending, wages, materials services, etc., (3) effect on the local economy through stimulation of other sectors (for sand and gravel, primarily construction), (4) direct and indirect effects on local prices, and (5) revenue realized by the state from royalties and rentals (minus management costs). Consideration of these factors should make the comparison of relative values easier.

Finally, the displacement of users who are limited to a particular location or environment by users who can operate equally well elsewhere should be discouraged. Sand and gravel mining should be discouraged in or near shellfish beds, valuable fishing or fish nursery grounds, beaches, navigation channels and cable and pipeline crossings unless it can be shown that extraction will not displace other users.

Use Categories

Rorholm (1963) identified three types of user relationships—complementary, supplementary and competitive. A complementary relationship exists when one use actually benefits another; a supplementary relationship when one has no effect on another; and a competitive relationship, when one use compromises another. Successful management will depend to a great extent on the careful definition of relationships between the sand and gravel industry and other resource users. Complementary relationships such as those that might exist if dredging projects can be directed to provide habitats for desirable fish species should be encouraged. Supplementary relationships as between dredging and navigation in open waters also are to be encouraged. Competitive relationships will require careful management along lines already suggested.

Navigation

The potential for conflict between aggregate dredging and marine navigation varies according to the location and the method of extraction. Narragansett Bay, Rhode Island Sound and, to a lesser extent, Block Island Sound are heavily traveled by commercial, military, fishing and recreational vessels.

Narragansett Bay is likely to present particularly severe use conflicts. Figure 21 indicates the narrow shipping channel leading up the East Passage to the port of Providence. Mining cannot be permitted in Bay channels because limiting depths confine

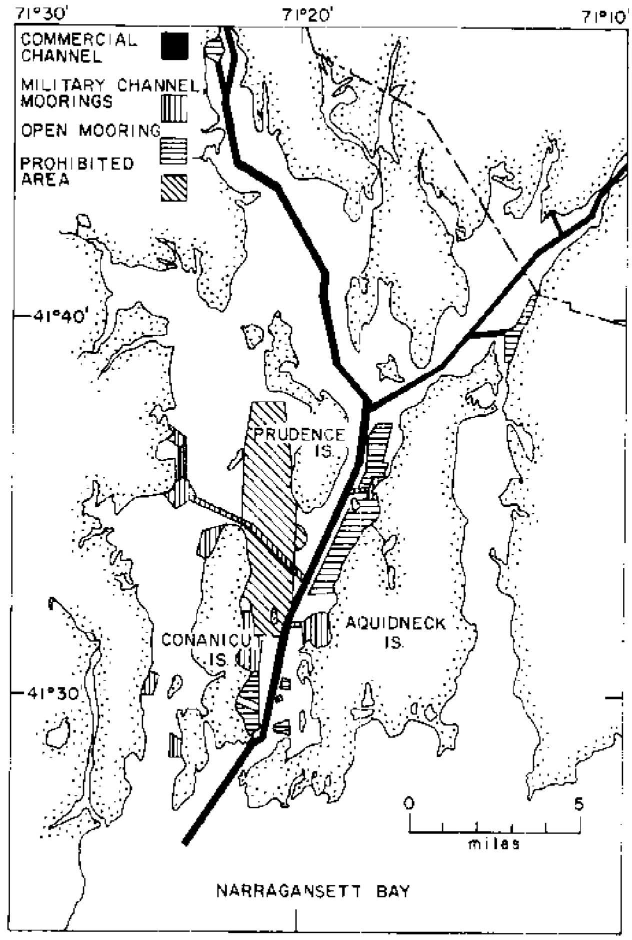

Figure 21. Navigation areas—Narragansett Bay. From State of Rhode Island. 1970. *Report of the Governor's Committee on the Coastal Zone.* Providence.

shipping to them. Dredging under strictly controlled conditions might be possible in commercial mooring areas (fig. 21), but work in Navy anchorages and torpedo test ranges (fig. 21) would require military approval.

Dredging in most of the West and Sakonnet Passages of the Bay should not have a major effect on infrequent military and commercial traffic. It may, however, interfere with recreational boating which is of considerable value to the state's economy. Rorholm (1968) estimated that total boating-related expenditure in 1967 was more than five million dollars. Much of this economic activity was attributable to the Bay's recreational attractiveness. Aggregate mining might decrease the Bay's value as a recreational resource through the creation of visual and audio nuisances, discoloration of the water by turbidity, and occupation of surface area. The physical presence of dredging during the recreationally valuable summer months is likely to create the most severe conflicts, especially if mining takes place in constricted areas or popular cruising, fishing or mooring areas (fig. 22). Seasonal restrictions on mining in these areas may prove desirable. Protection of areas shallower than 80 feet as beach conservation areas would prevent the great majority of Bay conflicts from materializing.

Hopper dredging in the offshore waters of the state should have only a limited effect on recreational boating. Effects on commercial and military traffic are likely to be more significant. Rhode Island and Block Island Sounds are crossed by a number of heavily traveled commercial shipping tracks and ferry routes (fig. 23). Traffic along these tracks consists largely of coastal vessels and barge tows of petroleum products, many of which are unpiloted (State Pilots Association, 1972). The heavy traffic in unpiloted petroleum barges suggests the desirability of discouraging dredging in the immediate vicinity of shipping routes. Great Britain has minimized navigational conflicts by forbidding stationary dredging in shipping lanes (Hess, 1971). It is suggested that Rhode Island pursue a similar policy within mile-wide fairways along heavily traveled routes.

Fixed fairways are unattractive to the shipping industry and military. Shipping is liable to cross any offshore area deep enough to permit safe passage. Dredge sites should, therefore, be carefully marked to minimize the danger of collision. Their location should be indicated in daily *Notices to Mariners* (published by the Coast Guard) and dredges should be lighted according to standard practice. Additional precautions may prove desirable. These might include distinctive painting, the installation of strobe lights and radar reflectors, and the closing of heavily traveled areas to dredges during fogs and storms.

Pollution

Aggregate dredging may contribute to water pollution through the release of high sediment loads in wash water or the resuspension of toxic bottom material. Resuspension of polluted bottom sedi-

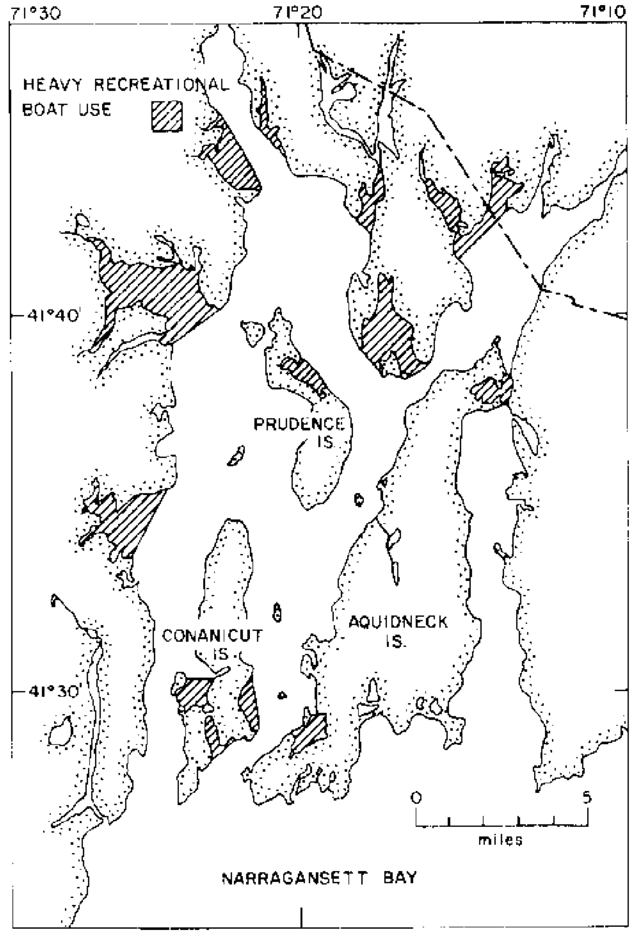

Figure 22. Heavy recreational boat use. From Coastal Resources Center field investigations.

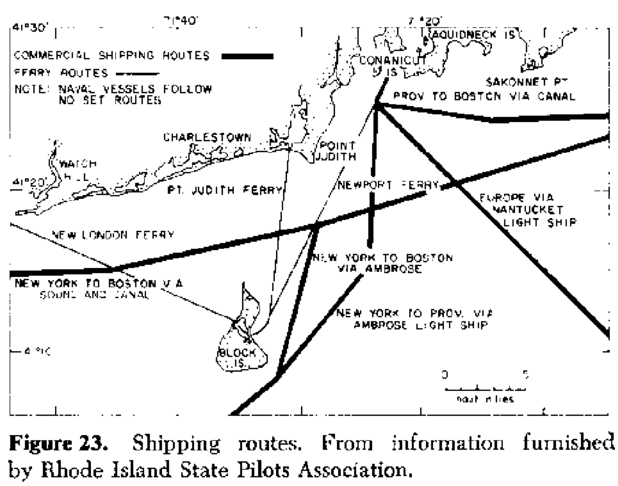

Figure 23. Shipping routes. From information furnished by Rhode Island State Pilots Association.

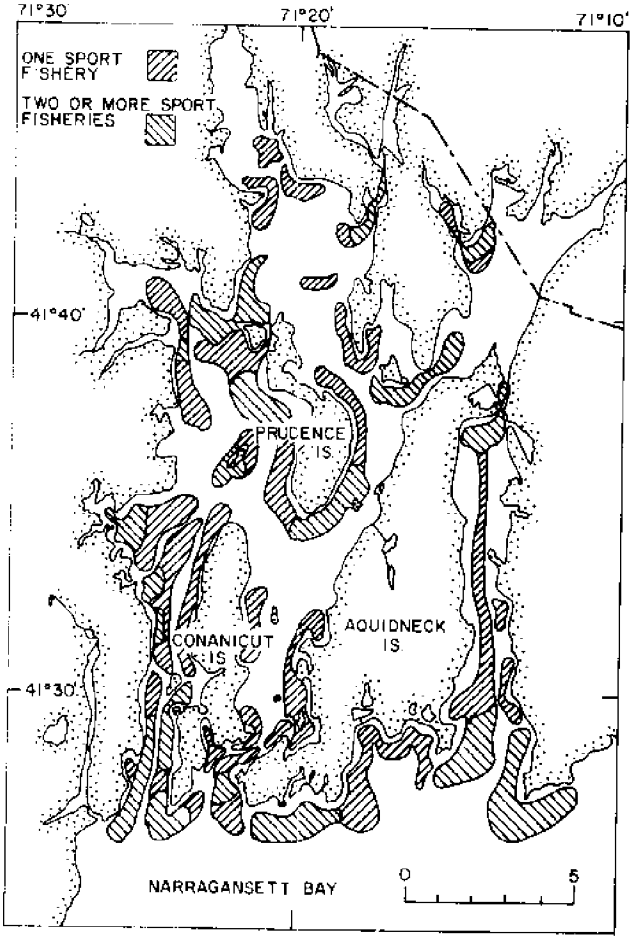

Figure 24. Narragansett Bay sport fishery. From Rorholm, Niels, et al. 1968. *A socio-economic study of Narragansett Bay*, Rhode Island. Kingston, Rhode Island: University of Rhode Island.

ments will have a particularly severe effect on other users of the marine environment and should be descouraged under existing federal (EPA) water quality standards. Polluted areas are indicated on figures 18 and 19. Problems of aesthetic pollution should be considered along the lines suggested in the section, Impact on the Human Environment, in areas where conflicts with residential or recreational uses are anticipated.

Fisheries

Sand and gravel dredging may conflict in varying degrees with a number of Rhode Island inshore, offshore, sport and commercial fisheries.

Sport Fishery. Sisson (1970) calculated that the sport fishery in Narragansett Bay was worth approximately four million dollars in 1970 (wholesale value of landings plus expenditures by fishermen). Rorholm (1968) found that a significant portion of Bay recreation is related to sport fishing (fig. 24). Large sport fishing fleets sail out of Galilee, Block Island and many ports in the Bay to fish offshore stocks. Farrell (1972) calculates that boats participating in two 1971 tuna tournaments alone generated over $211,000 in expenditures. Dredging may well prove detrimental to the state's sport fishery due to its possible adverse effects on navigation, primary productivity, benthic and larval life and physical processes (see Impact on the Natural Environment). The relative values of the sport fishery and the marine aggregate industry will need periodic reevaluation to manage conflicts between them.

Commercial Fishery. National Marine Fisheries Service statistics for 1971 show that the total Rhode Island catch was worth approximately $10.7 million with the following breakdown:

Fin Fish	$4.8 (million)
Lobster	4.5
Shellfish	1.4
TOTAL	$10.7

The Bay quahaug industry may prove particularly vulnerable to unregulated dredging. Adverse effects should be minimized if (1) dredging is discouraged in or near the productive beds (fig. 25), (2) the suggested 80-foot beach preservation zone is established, and (3) a detailed environmental impact statement is required.

Offshore conflicts between dredging and commercial fishing are likely to be extensive due to the variety of fisheries involved, the number of techniques employed and seasonal shifts in activity (fig. 26). A great deal more information on the commercial fishery needs to be generated before use conflicts can be effectively minimized. Such information should include intensity of fishing effort, value of the catch, seasonal fluctuations in landings and the impact of the industry on the state's economy. Pertinent research is currently being completed by the Coastal Resources Center and should prove useful in comparing the relative

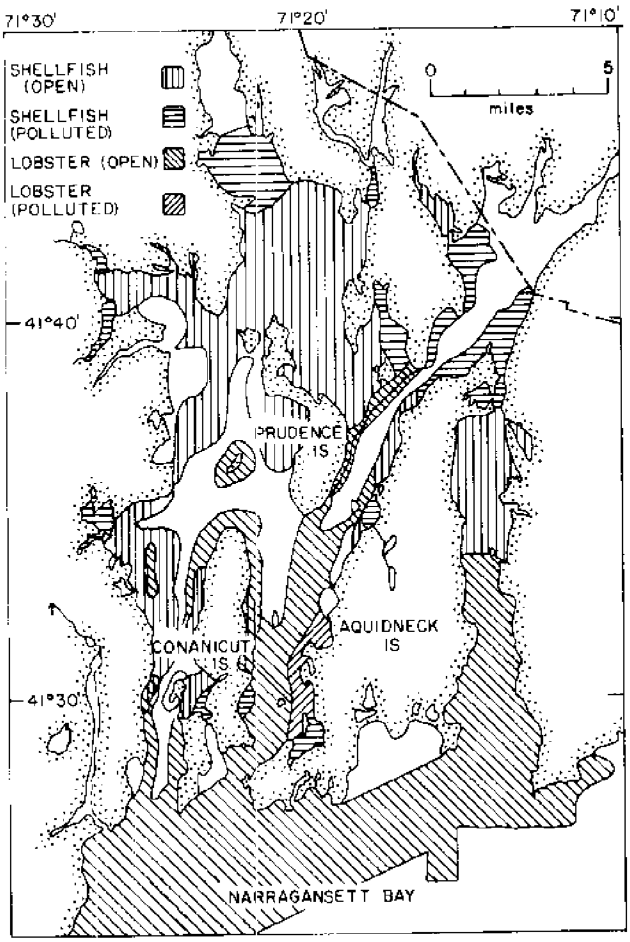

Figure 25. Shellfish and lobster areas—Narragansett Bay. From State of Rhode Island. 1970. *Report of the Governor's Committee on the Coastal Zone.* Providence.

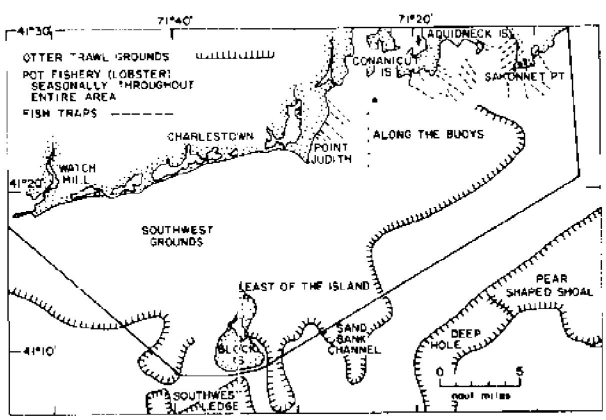

Figure 26. Commercial fishing grounds. From information collected by the Coastal Resources Center.

real values of aggregate and fishery resources. This comparison will be helpful to the Council in establishing use priorities.

Beaches

Sandy beaches are one of Rhode Island's most precious and fragile natural resources. The scarcity of ocean beaches with water warm enough for swimming increases their value yearly. Beach recreation areas are a "gate-way" resource; they not only provide diversion for state residents, but they draw users from other states who spend money for lodgings and services which provide a substantial seasonal stimulus to the state's economy. Rorholm (1968) estimated that in 1967 (a poor beach year) the total revenue generated directly by beach use was in excess of $1.73 million. This does not include the considerably greater economic activity generated indirectly by beach users, many of whom bring in money from out of state.

Beaches are one of the most fragile of coastal features and for reasons discussed in the section, The Ocean Resource, in Chapter I, it is felt desirable to protect them with a beach conservation zone extending out to the 80-foot depth contour. Possible turbidity effects and noise may make it necessary to extend the closed area even further off heavily used recreational beaches.

Cable and Pipeline Crossings

Narragansett Bay is criss-crossed by a maze of pipelines, sewage outfalls and cable crossings which will complicate dredge mining (fig. 27). Until such time as it becomes practical to move these installations it will be desirable to prohibit dredging in close proximity to them. The bottom area covered by the trans-Atlantic telephone cable terminating in Charlestown should be similarly protected. This cable has already been broken on several occasions by draggers and quahaug dredgers (Haley, 1972). It may prove useful to establish a one-quarter mile to one-half mile wide fairway along the existing cable route (fig. 28) to which all future cable connections will be limited. A chart delineating the precise location of the cable crossing has been provided by the American Telephone and Telegraph Company and is on file at the Coastal Resources Center.

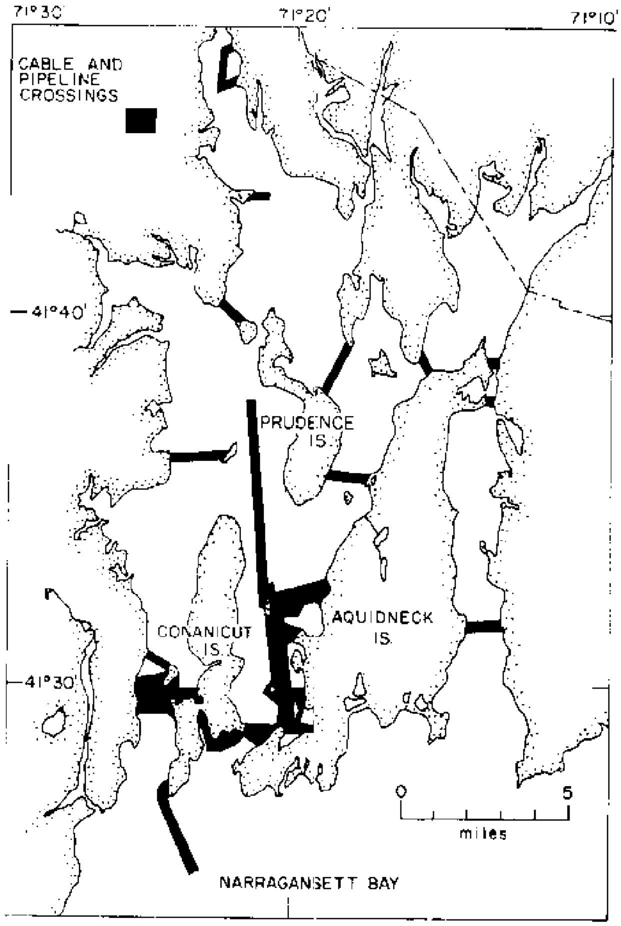

Figure 27. Cable and pipeline crossings—Narragansett Bay. From State of Rhode Island. 1970. *Report of the Governor's Committee on the Coastal Zone*, Providence.

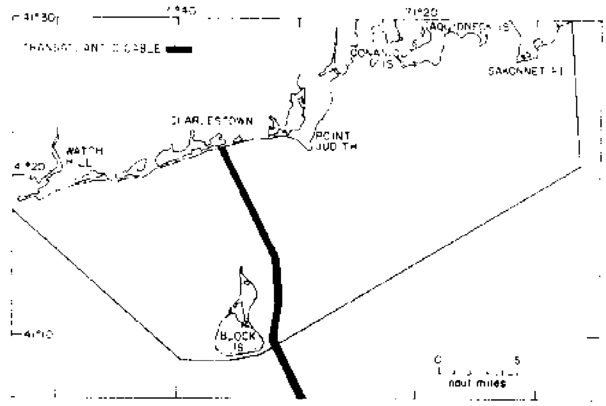

Figure 28. Transatlantic cable crossing. From American Telephone and Telegraph Company chart, 1972.

3. Legal Considerations

Existing Legislation: State of Rhode Island

Although too vaguely defined to be of any great value as an effective management tool, Rhode Island legislation relevant to marine mining is better than is generally recognized. Title 46, Public Laws 1956, establishes a number of powers which might usefully be applied to the regulation of marine sand or gravel mining. These powers have been greatly expanded by the authority granted the Coastal Resources Management Council under the current coastal management law (H2440, "B"; Chapter 270, Public Laws, 1971). It is felt that more specific legislation is needed and a "Proposed Regulatory System" is, therefore, included as an appendix to this study.

Title 46

Under Chapter 5, Section 10 the Director of the Department of Natural Resources is empowered to lease any state property under his charge in tidal areas "acquired by purchase or the process of law . . . for any term not exceeding twenty (20) years and for such rent and with such provisions and covenants as to said director shall seem to be advantageous to the state." Since the state exercises titular sovereignty over the seabed under state waters the director of the Department of Natural Resources might exercise similar powers over the seabed beyond the intertidal zone.

Under 46-6-1 the state has assumed powers which are directly applicable to the regulation of aggregate extraction:

> The director of public works shall regulate the depositing of mud, dirt and other substances in the public tidewaters of the state, and shall prescribe the places where the same may be deposited; and every person who shall place or deposit mud, dirt or other substances in said waters without obtaining proper authority therefor, shall be fined for each offense one hundred dollars.

46-6-1 was enforced by the former Division of Harbors and Rivers which is now the Coastal Resources Division and serves under the Coastal Resources Management Council. 46-6-1 provides the Council with specific power to manage the location of any dredge in state waters so long as that dredge is discharging "mud, dirt or other substances." Washing of the aggregate will deposit such materials.

Under 46-17.1-1.2 the director of the Department of Natural Resources is empowered to regulate through a permit procedure the transportation and dumping of waste and dredge materials over and in state waters. Silt and sand are specifically identified as materials subject to regulation. A fine of $1,000, one year's imprisonment or both are provided for violation. 46-16.1-2 further states that permission will be granted only if movement and disposal "would not be in conflict with the marine ecology within or adjacent to the state's waters and that existing fishing grounds would not be damaged or destroyed." Provision is made for the presence of a state inspector on board the tow vessel whose expenses would be paid by the permittee. 46-17.1-1.2 will be of considerable help in future management of aggregate dredging itself (dumping of material) and dredge-related barge traffic (transportation of material).

The Coastal Resources Management Council Act

The Council's power to regulate activities such as aggregate extraction is set forth under 46-23-6-D a and c and is as follows:

(a) Issue, modify or deny permits for any work in above or beneath the water areas under its jurisdiction.

(c) Licensing the use of coastal resources which are held in trust by the state for all its citizens, and imposing fees for private use of such resources.

Violation of Council directives and regulations is subject to prosecution as a misdemeanor by the Office of the Attorney General in state District Court (46-23-7). While no specific management mechanism for offshore mining regulation is proposed, activity of this sort is clearly subject to control under the above authority. This fact is formally recognized in the Council's Draft Statement of Policy Guidelines released in mid-April of 1972 and submitted to the Rhode Island Secretary of State in September of the same year.

Federal Regulatory Policy

Army Corps of Engineers

Several federal agencies are involved in the regulation of marine mining. The U. S. Army Corps of Engineers comes into frequent contact with state regulatory agencies through its control over work in navigable waters. The following outlines the Corps' responsibility for aggregate mining and clarifies its relationship with the "host" state:

> The basic statutory authority for Department of the Army regulation of commercial sand and gravel dredging operations is Section 10 of the River and Harbor Act of 3 March 1899. Under this provision of law, Congress has granted authority to the Secretary of the Army to issue permits for the performance of work in navigable waters of the United States. An important responsibility of the Secretary of the Army in the exercise of this authority is to determine whether any proposed work is consistent with the public interest. The issuance of a permit is based on the effects of the permitted activity on the public interest including such factors as navigation, fish and wildlife, water quality, economics, conservation, aesthetics, recreation, water supply, flood damage prevention, impact on ecosystems and, in general, the needs and welfare of the people. The permit program is administered by the Corps of Engineers in accordance with CFR 209.120.
>
> Proposed work in navigable waters is coordinated with State and local governmental bodies and other Federal agencies having an interest in such matters, and every effort is made to determine the overall public interest. In coordinating the Federal permit program, the Corps encourages State authorities to play a lead role in determining the public interest. This role is sometimes reflected through State regulatory programs or zoning regulations. Of particular interest in dredging operations are water quality and fish and wildlife considerations. As a result of Section 27 (b) of the Federal Water Pollution Control Act as amended, we require permit applicants to obtain certification that water quality standards will not be violated from the appropriate State agency. In accordance with the Fish and Wildlife Coordination Act we seek the recommendations of the State agency responsible for protection of fish and wildlife resources. In any event, the Corps always attaches a great deal of importance to State recommendations concerning proposed work in navigable waters. (Cousins, 1972)

The notable similarity between the Corps definition of public interest and the one proposed in this study suggests that Rhode Island can anticipate cooperation and support from the Corps in managing the state's aggregate deposits along recommended lines. In its revised procedural directives (*Permits for Work and Structures*, etc., 1971) the Corps furthermore specifically binds itself to deny all permits where necessary state approval has been previously refused. Its practice to date has demonstrated a reasonable sensitivity to state desires and objectives (Replinger, 1972).

Department of the Interior

Under provisions of the Outer Continental Shelf Lands Act (1953), as administered under Bureau of Land Management and Geological Survey Regulations, the Department of the Interior has assumed extensive powers over mineral resource development on the continental shelf beyond state jurisdiction. It is not within the scope of this study to examine these powers in any detail.

The presently strained relations between the Department of the Interior and the New England states suggests that the Department's attitude towards resource development may not be compatible with what the states have defined as their best interest. A situation has developed in which state officials feel that resource development is being forced upon them by a federal agency whose commitment to environmental quality is questionable. The present conflict highlights the difficulties posed by the arbitrary termination of state sovereignty three miles from an often ill-defined point on shore. Mining outside the three-mile limit may affect a state's marine environment as much as if it were taking place within state jurisdiction. It is suggested, therefore, that the state define the exact limitations of its sovereignty under present law and clarify ambiguities which complicate such definition. It is further suggested that the Council adopt and announce a marine mineral resource development policy for state waters. Every effort should be made to influence the Department of the Interior to respect this policy in its own activities on the outer shelf off our shores. A considerable amount of pressure can be exerted by a state which has clarified its own objectives.

Legislation of Neighboring States

A summary presentation of the marine hard mineral mining policy of the 30 coastal states is included in Appendix B. It will be advantageous for Rhode Island's regulatory system to be particularly compatible with those of her immediate neighbors. A brief examination of Connecticut and Massachusetts legislation, therefore, follows.

Connecticut

Under Section 25, 10-18 (1969 Supp.) the Connecticut Water Resources Commission controls through a permit system the removal of sand and gravel from lands under tidal and coastal waters. Permits are considered "with due regard for the prevention or alleviation of shore erosion, the protection of necessary shell-fish grounds and fin-fish habitats, the preservation of necessary wildlife habitats, the development of adjoining uplands, the rights of riparian property owners. . . ." Permits are not issued unless the above conditions are met and a price and payment schedule for mined material is established (25-11). Public hearings are required on all extraction permits with applications and supporting documents open for public inspection. In granting a permit the Commission prescribes "conditions regulating the removal and disposal of sand, gravel or other material to be taken and may make reasonable regulations and require bonds to enforce the conditions prescribed by it, and may revoke or suspend any removal permit upon a violation of such conditions" (25-12). Provision is made for a fine of $100, 30 days imprisonment or both for violation of Section 25-11, with each day of continuing violation construed to be a separate offense (25-18).

No permits for commercial extraction have been issued under the provisions of 25-10, although several applications have been made. "The defeat of these applications has generally been based on the adverse effects on environmental considerations" (Pelletier, 1972).

Connecticut regulatory authority bears a strong resemblance to the powers formally granted to the Coastal Resources Management Council under 1971 legislation. It appears that Connecticut legislation provides regulatory authority similar to Rhode Island's while sharing with it a common lack of specific management mechanisms and guidelines. The main thrust of the Connecticut law and its enforcement to date suggests that the proposals made in this study are compatible with the Connecticut approach to marine mineral development.

Massachusetts

Massachusetts management of offshore mineral resources is currently undergoing extensive revision. A division of Mineral Resources became operational in May of 1970 and according to Director Robert Blumberg is "just getting on its feet" (Blumberg, 1972). New rules and regulations have been drafted and were under review by appropriate state agencies when this study was written. The Commonwealth has declared a moratorium on all sand and gravel exploration and extraction within its marine boundaries "until such time as the Department (Natural Resources) can assess the extent of risk of harm such activities may have on the environment" (Blumberg, 1972). In addition, a number of bills establishing permanent marine mining sanctuaries have been passed by the state legislature to protect particularly valuable (and vulnerable) areas on Cape Cod and the Elizabeth Islands. The state is currently involved in the preliminary stages of a sand and gravel inventory and a federally sponsored environmental impact study of extraction in Massachusetts Bay (see Impact on the Natural Environment, Chapter 2). The careful attention which Massachusetts is giving to the possible effects of an aggregate industry and its conservative approach to development suggest again, as with Connecticut, that Rhode Island need anticipate no serious conflicts with its neighbor to the north in managing its resources along the lines recommended in this study.

Appendices

APPENDIX A: Summary of Management Recommendations

1. Forbid aggregate mining in coastal areas shallower than 80 feet. The natural equilibrium of a sandy beach is maintained through a number of physical processes involving sand deposits within the 80-foot depth contour. Until it is determined that extraction of shallow deposits is not detrimental to the beach or that some degree of change in present beach conditions can be tolerated it would appear advisable to protect the state's beaches with a conservation zone extending to the 80-foot depth contour.

2. Increase knowledge of ocean mineral resources. A full-scale state-funded research effort is not feasible due to the great cost of such a project. A wealth of information can, however, be collected from other sources: (a.) The Graduate School of Oceanography at the University of Rhode Island and related institutions such as Woods Hole Oceanographic Institution; (b.) federal agencies such as the Department of the Interior (Geological Survey in particular) and the Army Corps of Engineers, and (c.) on-going research by other institutions and agencies. The Raytheon-University of New Hampshire project and the NOAA Massachusetts Bay pilot project should be of great interest.

It is recommended that pertinent information be gathered by the Coastal Resources Center as it becomes available.

3. Require all parties to a lease for the right to extract hard mineral resources from any portion of the seabed of Rhode Island to cooperate in a collectively financed survey of that area. The results of such a survey will be public knowledge. Protect the interests of the lessees by restricting bidding to only those concerns involved in the collective survey. The advantages of this proposal are several. For example, it

1. insures the accumulation of valuable information on hard mineral resources.
2. prevents wasteful and expensive duplication of effort and reduces the end cost of aggregate.
3. encourages early development of the marine resource while it discourages inflation of price to the consumer.
4. increases the quantity and quality of information available to the bidder and the state.

4. Barge suction dredging should not be allowed in areas where the occupation of the space indicated in figure 15 (page 11) will cause unacceptable interference with commercial or recreational navigation. Crossing this area could prove hazardous due to (1) potential fouling of the barge's anchor lines and (2) interference with barge and work boat traffic.

5. Extended surface pipeline discharge systems from barge to shore should be discouraged where interference with navigation is probable. Semi-permanent structures of this sort could prove hazardous to recreational and commercial traffic.

6. Marine aggregate offloading, storage and processing facilities should be included among those specific activities and land uses which the Council is empowered to regulate under the provisions of the Coastal Resources Management Council Act of 1971. A simple indicator of dependency could be the presence of dock-side unloading equipment. The potential disruptiveness of large processing facilities in the coastal zone and the present absence of controls argues for the desirability of Council intervention.

7. The Council should announce its intention to strictly regulate land or water-based mining of the state's beaches, sand dunes and salt ponds. Small-scale land mining of beach material by conventional methods is likely to be the initial step from a land to an ocean industry. Left unregulated, it could contribute to coastal erosion.

8. Dredging in spawning and nursery grounds should be discouraged until long-term effects of such activity are determined. The recreational and commercial value of many species suggests that their propagation should be protected.

9. Dredging should follow natural bottom contours, avoid the creation of steep slopes and isolated holes and leave enough of the original aggregate surface material to support recolonization by the original population. These policies should minimize artificial alterations whose ultimate significance can seldom be predicted.

10. Parties to collective mineral exploration leases should be required to submit a common environmental impact statement as a product of their *survey.* This statement will allow the Council to anticipate environmental problems and provide for their resolution prior to the issuance of an extraction lease. The statement should consider the effects of turbidity, toxicity, sediment deposition and resuspension, and mechanical disturbance on bottom plants and animals, plankton and larval organisms, community composition, bottom topography, water quality and hydraulic processes.

11. The aesthetic impact of mining operations should be considered as part of the environmental impact statement (10 above). It is possible that nearshore dredging activity will create visual and noise problems for neighboring scenic, recreational or residential areas. These problems should be anticipated and acceptable tolerances established.

12. Anchored dredging in heavily travelled offshore shipping channels should be discouraged.

13. All dredges, whether anchored or steaming, should be distinctively marked and their operating areas should be included in the daily Notices to Mariners. *Restriction on poor weather dredging in some areas might be considered.* Heavy offshore traffic in petroleum barges, many of which are unpiloted, may make it desirable to take precautions to avoid collisions.

14. Bottom areas whose sediments are polluted according to state or federal standards should be closed to dredging. Resuspension of polluted bottom materials by mining activities may have a severe effect on the local environment and should be discouraged.

15. Dredging in productive shellfish beds should be discouraged.

16. Extensive research on the offshore commercial fishing industry must be completed before conflicts with marine mining can be effectively managed. The Coastal Resources Center is preparing a fisheries study which should prove valuable.

17. Dredging should be prohibited in areas occupied by cable or pipeline crossings and sewage outfalls. The trans-Atlantic cable crossing should be protected by a buffer zone. All future trans-Atlantic cables should be located in this zone.

18. The Council with the assistance of appropriate state agencies should delineate the offshore and lateral boundaries of state waters. Numerous discrepancies and ambiguities in existing legislation leave the extent of the state's territorial sea unclear.

19. The Council should adopt and announce a marine mineral resource development policy and inform appropriate federal agencies of its desire to see this policy reflected in their activities off our shores.

APPENDIX B: Regulation of Hard-Mineral Mining on the Continental Shelf

Table of Management Patterns in the United States.

Column 1	2	3	4	5	6	7	8	9
		Exploration Permit						
State	Agency	Term	Method of Obtaining	Exclusive?	Convertible?	Filing of Exploratory Information	Area	Term
Alabama†‡	Dep't of Conservation—State Lands Division.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Alaska	Dep't of Natural Resources—Division of Lands.	10 year maximum.	$20 application fee; $1 per acre for first 2 years; $1 per acre per year for next 8 years. Area must be an unexplored area. Claim staking allowed if 2 corners on or above mean high tide.	Yes.	To the extent workable deposits are shown.	The director may require at his discretion. ALASKA STAT. 38.05.035(9) (1968). Confidential.	2,560 acres	55 year term, renewable.
California	State Lands Commission—State Lands Division.	2 years—1 year extension at director's discretion.	Payment of $1 per acre plus filing fee.	Yes.	To the extent of workable mineral deposits shown not subject to upland 160 acre limitation.	Mandatory on 15th of each month; confidential.	N.S.	20 year term; 10 year renewable terms.
Connecticut	Water Resources Commission.	N.S.	Must apply for permit to remove sand and gravel.	N.S.	N.S.	N.S.	N.S.	N.S.
Delaware†	Water and Air Resources Commission.	2 years; renewable.	Apply describing area to be explored 60 days prior to contemplated approval date. Application fee: $250.	No.	No.	At Commission's discretion—Commission must hold confidential.	N.S.	10 years and so lon[g] as thereafter producing.

LEGEND:
† This state scheme is primarily for oil and gas mining.
‡ Mineral leasing laws for this state are substantially the same for onshore and offshore operations.
* No authorizing statute.
N.S. Not specified.

10	11	12	13	14	15	16
Mining Permit (Lease) — Method of Obtaining	Exclusive?	Area	Environmental Protection	Artificial Structures	Conflicting Uses Provisions	Authorizing Statutes and Regulations
Competitive bidding (may reject all bids).	N.S.	5,200 acres per tract.	Director may reject all bids if in the public interest.	N.S.	N.S.	Ala Code tit. 26, § 179 (1958), *as amended*, (Supp. 1969).
$20 application fee a) by conversion from exploration permit at $1 per acre per year b) explored areas —bidding competitively at $1 per acre per year plus highest cash bonus. There may or may not be a royalty rate.	Yes.	N.S.	Bond may be required. A permit does not relieve applicant from filing with other agencies, state or federal.	Work credit on structures and other tangible evidence of work done given against rental, plus excess allowed to be "banked" for future rental.	Alaska Stat. 38.05.082 (1968) provides for exclusive fisheries leases.	Alaska Stat. § 38.05.250 (1968). Alaska Reg. 25, tit. 6, c. 607 (1967).
a) by conversion —rental $1 per acre plus royalty specified in exploration permit; b) explored areas —competitive bidding at set rental plus $50 minimum deposit plus best royalty offer. In noncompetitive leases royalty is normally 20% of gross value of all minerals produced.	Yes.	No limit as long as tract does not substantially interfere with navigation and fishing or "public trust."	Attorney General (as protector of "public trust") must approve all exploration and mining permits before they are let. Commission must make finding at public meeting that lease will not have "significant detrimental environmental effect" and shall make environmental impact report available to the public.	Cal. Pub. Res. Code 6818 (West 1956) *as amended* (West Supp. 1970). Must apply to Attorney General before building.	(See preceding columns.)	Cal. Pub. Res. Code §§ 6890-6900 (West 1956) *as amended* (West Supp. 1970). Cal. Admin. Code tit. 2, §§ 2200-2205 (Supp. 1969). Cal. Pub. Res. Code § 6371 (West Supp. 1970).
Must obtain certificate from Commission.	N.S.	N.S.	Bond for possible damage must be posted.	"Due regard" for public interests involved; permit required.	Statute provides for "due regard for other uses"—*e.g.*, riparian owners, shell-fish gatherers, recreational interests and other factors of public interest.	Conn. Gen. Stat. Rev. §§ 25-10 to 25-18 (1958) *as amended* (Supp. 1969).
Mandatory public hearing—public interest considered, minimum ⅛ royalty of gross production; minimum 25c per acre rental deductible from royalty; exclusively competitive bidding.	Yes.	6 square miles (3,840 acres) for any single lease to any one person.	Bond requirement to protect public interest—injunction authorized for violation of Commission rules. Avoidable pollution and contamination prohibited. Refers to others to be consulted before lease is let. Substantial impairment standard. Use of lessee's employees to correct pollution problem under Commission's supervision authorized.	Upon termination visible area must be restored to substantially the same condition.	State may permit reasonable non-conflicting uses.	Del. Code Ann. tit. 7, §§ 6401-6462 (Supp. 1968).

Column 1	2	3	4	5	6	7	8	9
		Exploration Permit						
State	Agency	Term	Method of Obtaining	Exclusive?	Convertible?	Filing of Exploratory Information	Area	Term
Florida‡	Director Land Records Division, Trustees of the Internal Improvement Fund.	N.S.	Statute provides that those in charge of state lands "may sell or lease . . . upon such terms and conditions as may seem advisable to the said trustees, boards, departments or agencies and to the best interests of the state."	N.S.	N.S.	N.S.	N.S.	N.S.
Georgia†‡	State Minerals Leasing Commission.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Hawaii‡	Department of Land and Natural Resources.	N.S.	Permit required.	N.S.	N.S.	Required; held confidential 6 mos.	N.S.	65 years.
Illinois	Department of Public Works and Buildings.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	5 years.
Indiana‡	Department of Natural Resources.	1 year.	Permit needed but no fees except if other applicants, then cash bonus bidding.	Yes.	Yes.	N.S.	192 acres.	10 years primary term.
Louisiana†‡	State Mineral Board.	90 days renewable.	Permit needed where allowed but in general state does or supervises all of the prospecting.	N.S.	N.S.	Only after the least is obtained—confidential.	N.S.	Primary term 5 years and as long thereafter as producing.
Maine‡	Mining Bureau.	N.S.	$5 fee—good through end of the year obtained.	N.S.	N.S.	Only after lease is obtained.	N.S.	5 year maximum.
Maryland	Geological Survey Department of Chesapeake Bay Affairs.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

10	11	12	13	14	15	16
Mining Permit (Lease)						
Method of Obtaining	Exclusive?	Area	Environmental Protection	Artificial Structures	Conflicting Uses Provisions	Authorizing Statutes and Regulations
(See "Exploration Permit" column.)	N.S.	N.S.	N.S.	N.S.	N.S.	FLA. STAT. § 253.45 (1965).
Competitive bidding required.	N.S.	N.S.	Must cooperate with federal authorities as the Commission directs.	N.S.	N.S.	GA. CODE ANN. §§ 91-119, 91-123 (1963).
$100 application fee; $500 deposit. Public auction by rental; may reject all bids.	Yes.	No limit.	Must post bond to ensure compliance with terms of the lease.	Must comply with water and air pollution laws.	N.S. except in general language of "public trust."	HAWAII REV. STAT. §§ 182-2 to 182-15 (1968).
Competitive bidding specified.	N.S.	N.S.	Bond required.	Must get a permit.	N.S.	ILL. ANN. STAT. ch. 19, § 65 (Smith-Hurd 1963), *as amended*, (Supp. 1970).
Littoral owner has preferential right. Proven areas are by competitive bids; others by conversion, ⅛ maximum royalty, $1-$10 rental per acre per year.	Yes.	640 acres.	N.S.	N.S.	N.S.	IND. ANN. STAT. §§ 46-1601 to 46-1732 (Burns 1965).
$100 application fee bidding process—cash bonus plus yearly rental not less than ½ cash bonus plus royalty of $2 ton sulphur or 10c ton potash or ⅛ of other minerals.	Yes.	5,000 acres per tract. Must also be less than 3½ miles in length and width.	N.S.	N.S.	Oyster beds are protected.	LA. REV. STAT. §§ 30:121-30:179.7 (1950), *as amended*, (Cum. Supp. 1962).
Must record lease each year with Mining Bureau; $10 application $5 per acre per year rental. Rental credit allowed against 5% royalty.	Yes.	N.S.	Financial responsibility of lessee is required. Applicant's previous activities must have caused no unreasonable damage.	N.S.	Mining Bureau is made up of 7 members, each of whom is a member of a possible conflicting-use agency.	ME. REV. STAT. tit. 10, § 2101-2111 (Supp. 1969).
Permit needed to remove sand and gravel from Bay. Other statutory framework very vague; $10 filing fee.	N.S.	N.S.	N.S.	N.S.	N.S.	MD. ANN. CODE art. 66C, § 13B (1957), *as amended*, (Supp. 1967); art. 78A, § 15 (1957), *as amended* (Supp. 1965).

Column 1	2	3	4	5	6	7	8	9
		Exploration Permit						
State	Agency	Term	Method of Obtaining	Exclusive?	Convertible?	Filing of Exploratory Information	Area	Term
Massachusetts†	Department of Natural Resources—Division of Mineral Resources.	N.S.	Licensing of orderly exploration with public hearing.	N.S.	N.S.	N.S.	N.S.	N.S.
Michigan	Conservation Commission.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Minnesota	Division of Waters, Soils and Minerals, Minnesota Conservation Department.	N.S.	Must obtain permit.	N.S.	N.S.	N.S.	N.S.	N.S.
Mississippi‡	State Mineral Leasing Commission.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
New Hampshire*	Department of Resources and Economic Development.							
New Jersey	Department of Conservation and Economic Development, Bureau of Navigation.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
New York	Conservation Department Commissioner of General Science.	N.S.	N.S.	N.S.	N.S.	State has full right of inspection	N.S.	License expires at end of each year.
North Carolina	Department of Conservation and Development—Division of Mineral Resources.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Ohio*								
Oregon	State Land Board—Division of State Lands.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Pennsylvania*	Department of Forestry and Waters.							
Rhode Island	Department of Natural Resources.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

10	11	12	13	14	15	16
Mining Permit (Lease) — Method of Obtaining	Exclusive?	Area	Environmental Protection	Artificial Structures	Conflicting Uses Provisions	Authorizing Statutes and Regulations
Establish leases allowing a fair profit for lessee.	Yes.	N.S.	Public hearing mandatory; $10,000 fine for violation of statute; $1,000 fine for violation of applicable rule.	N.S.	Must be consistent with the harvesting and propagation of other natural resources.	MASS. GEN. LAWS ANN. ch. 21, §§ 54-56 (Supp. 1970).
N.S.	N.S.	N.S.	Policy does not allow drilling only dredging.	Permit required.	May lease only if lease will not substantially affect public use for hunting, fishing, swimming, boating, navigation or the public trust.	MICH. COMP. LAWS §§ 322.701-.715 (1948), *as amended* (Supp. 1952).
Must obtain permit.	N.S.	N.S.	N.S.	N.S.	N.S.	MINN. STAT. §§ 93.34-93.352 (1969).
⅛ minimum royalty; must obtain lease.	N.S.	N.S.	N.S.	N.S.	N.S.	MISS. CODE ANN. §§ 5947, 5948 (1942), *as amended* (1953).
Permit required.	N.S.	N.S.	Bond is normally required by permit agreement.	N.S.	Policy to protect shell fishery beds and recreational uses.	N.J. REV. STAT. §§ 12:3-21 to 12:3-25 (1937) *as amended* (1953).
$50 application fee and cubic yard rate.	N.S.	N.S.	N.S.	N.S.	N.S.	N.Y. PUB. LANDS LAW § 3(5) (McKinney 1951).
Leases are negotiated ad hoc with Department.	N.S.	N.S.	Detailed regulations on seismic exploration. Normal lease has condition making it subject to any future laws enacted in this area.	N.S.	Subject to rights of navigation and other terms that may be imposed by the state.	N.C. GEN. STAT. § 146-8 (1964).
Lease agreement reached on "conditions agreed upon by the state agency and the lessee."	N.S.	N.S.	N.S.	N.S.	N.S.	OR. REV. STAT. § 273.551(3) (1969).
N.S.	N.S.	N.S.	N.S.	Must get approval of Department for any structure.	Protects free right of fishing.	R.I. GEN. LAWS ANN. §§ 2-1-13, 46-6-1, 46-6-2 (1956).

Column 1	2	3	4	5	6	7	8	9
		Exploration Permit						
State	Agency	Term	Method of Obtaining	Exclusive?	Convertible?	Filing of Exploratory Information	Area	Term
South Carolina	State Budget and Control Board.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	10 year maximum.
Texas†‡	General Land Office—exploration; School Lands Board—leasing.	5 year maximum.	Apply and pay 25c per acre per year.	Yes.	Yes.	N.S.	0 acre minimum; 640 acre maximum per permit.	5 year renewable.
Virginia	Marine Resources Commission.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	5 year—10 year maximum.
Washington‡	Department of Natural Resources.	2 year maximum.	$5 application fee plus 25c per acre per year rental for 2 years only, then must wait 1 year to be eligible for lease if not converted before permit expires.	Yes.	Yes.	Required but confidential.	40 acres minimum; 640 acres maximum.	20 years renewable.
Wisconsin*								
Federal†	Department of the Interior—Bureau of Land Management.	N.S.	No fee. Apply to Regional Supervisor of Geological Survey of Department of Interior.	No.	No.	N.S.	N.S.	N.S.

10	11	12	13	14	15	16
Mining Permit (Lease)						
Method of Obtaining	Exclusive?	Area	Environmental Protection	Artificial Structures	Conflicting Uses Provisions	Authorizing Statutes and Regulations
Must get license.	N.S.	N.S.	Minimum of $5,000 bond required.	N.S.	N.S.	S.C. CODE ANN. § 1-361 (1962).
Competitive bidding or conversion—in any case $2 rental upon application plus $1 per year rental plus 1/16 minimum royalty.	Yes.	40 acre minimum, 640 acre maximum per lease.	N.S.	N.S.	Submerged Lands Advisory Committee established to help handle multiple use and conservation problems.	TEX. REV. CIV. STAT. ANN. art. 5421c (Vernon's 1948), *as amended*, (Supp. 1970).
Negotiated exploration permits and leases.	N.S.	N.S.	Commission has general authority over protection of marine resources.	Must obtain permit from Commission.	Oyster beds are specifically protected and revenue from leases goes to Special Public Oyster Rock Replenishment Fund.	VA. CODE ANN. § 62.1-4 (1968).
Conversion $5 fee plus $2.50 per acre improvements or rental plus royalty which is negotiated—no competitive bidding.	Yes.	40 acre minimum; 640 acre maximum.	Bond may be required.	N.S.	N.S.	WASH. REV. CODE ANN. §§ 79.01.614-.650 (1962), *as amended* (Supp. 1970). RESOLUTION 72 (Dec. 6, 1966, before the Board of Natural Resources).
Competitive bidding based on the highest cash bonus. Also includes royalties and rentals.	Yes.	5,760 acres.	Must not be unduly harmful to aquatic life in lease area; bond may be required.	Must be approved by Secretary of the Army.	Subject to rights of fishery and navigation and of the high seas.	Outer Continental Shelf Lands Act, 67 Stat. 462 (1953), 43 U.S.C. §§ 1331-1343 (1964); 30 C.F.R. §§ 250.1 to 250.100 (1971), 43 C.F.R. §§ 3380.0 to 3387.6 (1970).

APPENDIX C: Regulatory Proposals

The following regulatory proposals reflect the management suggestions made in this study, the best features of pertinent state and federal regulations and the suggestions of those experienced in their administration. They are presented in standard legal form to clarify organizational relationships between individual clauses.

A Proposed Regulatory System for Rhode Island

(1) Authority:

The Coastal Resources Management Council establishes and adopts the following Rules and Regulations pursuant to the authority granted by Chapter 23, Section 6, Part B of *An Act Creating A Coastal Resources Management Council and Making an Appropriation Therefor.* (State of Rhode Island Public Laws 1971, Chapter 279, Title 46, Chapter 23, H2440 "B").

(2) Statement of Policy:

It is declared to be the policy of the State of Rhode Island that (1) the development, utilization, and control of all hard mineral resources on the ocean bed under the jurisdiction of this state shall be directed (a) to make the maximum contribution to the public benefit, (b) to preserve, protect, develop, and where possible restore coastal resources, (c) to preserve and restore ecological systems, and (d) to increase public use of water bodies for a wide variety of purposes, and (2) the state, in the exercise of its sovereign power, acting through the Coastal Resources Management Council, should control the development and use of said resources of the State so as to effectuate full utilization, conservation, and protection of the same.

These Rules and Regulations are based upon the best information presently available. It is anticipated that they will be subject to review and revision periodically as additional information and methods of extraction become available.

The terms "shall" and "will," where used herein, indicate a mandatory requirement. The terms "regulation," "requirement" and "rule" are used interchangeably. If any part of these Rules and Regulations, or the application of any part thereof, is held invalid or unconstitutional, the application of such part to other persons or circumstances, and the remainder of these Rules and Regulations, shall not be affected thereby and shall be deemed valid and effective.

The failure of the State to enforce any of these Rules and Regulations shall not constitute a waiver by the State of any such Rule or Regulation.

(3) Scope and Applicability:

The regulations herein shall apply to all projects and the aspects thereof dealing with the exploration and exploitation of sand, gravel, [and other hard minerals (optional)] occurring within the boundaries of the State of Rhode Island.

(4) General Definitions:

4.1 Applicant: Any person who files an application under these rules.

4.2 Council: The Coastal Resources Management Council.

4.3 Conservation: The conserving, preserving, guarding or protecting of the marine resources of the State by obtaining maximal efficiency and minimal waste in their use.

4.4 Exploration: Geological, geophysical and other surveys and investigations including seismic methods.

4.5 Inspector: Any employee of the State duly authorized to act in that capacity.

4.6 Person: Any individual, firm, co-partnership company, business trust, association, private corporation, municipal corporation, public or quasi-public operation, county, city and county, district, political subdivision, department or other instrumentality of government, receiver, tutor, curator, executor, administrator, fiduciary, trustee, guardian, or representative of any kind.

4.7 Seismic Explorations: Any geophysical exploration method which involves the use of explosives or energy sources.

4.8 State: The state of Rhode Island.

(5) Exploration:

5.1 Preliminary Application

5.1-01. The Council shall divide the coastal and offshore waters of the State into plats of a size it considers appropriate to exploratory surveying. Groupings of more than one contiguous plat may be opened to exploration as a single unit. Not less than an entire plat will be opened.

5.1-02 The Council reserves to itself the right to determine the number of plats and their location to be opened for exploratory permits at any given time.

5.1-03. The Council, upon application by any person, may issue a permit for the geological, geophysical, or seismic survey, including the taking of cores and other samples, of any state-owned offshore lands.

5.1-04. The Council may, at its discretion, hold any such permits in abeyance until such time as it determines that enough have been submitted to justify collective exploration.

5.1-05. Applications for permits to conduct exploratory work shall be filed in triplicate on approved forms at least sixty (60) days prior to the desired approval date, and shall be accompanied by an application fee of $250.00. Applications shall include: (a) the name and address of the applicant or applicants, (b) either an original or certified copy of a birth certificate or other document substantiating proof of citizenship (Please note that certified copies of documentary evidence must bear an original certification by the legal custodian of the original document), or corporation papers if applicant is a corporation, (c) evidence of financial responsibility, (d) such other information as shall be considered desirable.

5.2 *Public Hearing*

5.2-01. On determination that sufficient permit applications have been filed, the Council will cause to be published legal notice of intent to open the described area to exploratory survey. Such notification will be published in the press and posted in prominent locations in each city and town at least 30 days prior to the holding of a public hearing.

5.2-02. A public hearing shall be held prior to approval of any application to explore state waters for mineral resources and before any designated permit area is actually opened to exploration.

5.2-03. This public hearing shall be held according to Rules and Regulations Adopted Pursuant to Chapter 42-35 of the General Laws of Rhode Island, 1956.

5.2-04. After notification and consultation with other State agencies and parties having an interest in such matters, the Council shall include such conditions in the permit as it deems necessary to protect the fish, game, wildlife, natural resources and private interests within the State.

5.3 *Granting of an Exploratory Permit*

5.3-01. Upon satisfaction that the public interest will be served by the opening of a designated area to exploration and after acceptance of any special modifications or conditions as in *5.2-03* and *04* by the permittees, the Council will notify them of its approval.

5.3-02. Exploration will commence no sooner than 30 days after Council approval is granted and is conditional upon: (a) posting of liability bond (for each permittee)—amount to be negotiated, (b) prepayment of one year's rent computed at a negotiated rate per acre (for each permittee).

5.3-03. Permits issued under this Section shall not exceed two years, and may be renewed for like periods upon application to the Council.

5.3-04. Permits are issued only for exploratory surveys.

5.4 *Execution of the Exploratory Permit*

5.4-01. All parties to a lease sale for the right to extract hard mineral resources from any portion of the seabottom of the State shall be required to cooperate in a collectively financed survey of that portion, as defined by the Council. The results of such survey will be public knowledge. No individual or concern not party to the collective survey will be allowed to submit a bid.

5.4-02. Such survey will be by an independent firm approved by the State *or,* if carried out by the permittees, shall be supervised by state inspectors whose expenses will be paid in advance for each month of exploration.

5.4-03. Such survey will define the deposits proposed to be developed, describe range of probable ore values and estimate cost of processing the ore to a salable product.

5.4-04. Such survey will produce an Environmental Impact Statement which shall address itself to questions of biological, chemical, physical and aesthetic effects of mining on the marine environment. (See Chapter 2, Impact on the Natural Environment and Impact on the Human Environment, accompanying study.)

5.4-05. Monthly records of all survey activity and results including information generated under *5.4-03* and *04* shall be submitted to the Council or its designated representative before the end of each month following that for which the report is issued.

5.4-06. The Council reserves to itself the right to rule on the acceptability of survey methods.

5.4-07. Seismic explorations involving explosives shall not be permitted unless it can be substantiated to the satisfaction of the Council that the use of explosives is essential to the nature of the exploration and there will be no resultant damages. Where explosives are permitted, the Council reserves to itself the right to set such conditions on their use as it deems necessary to protect human life and other marine resources. A State inspector will be on board any vessel approved to discharge explosives and will be empowered to terminate their use if unacceptable results are observed.

5.4-08. Exploratory pilot production is not considered an acceptable survey method and extraction of material for this purpose shall require specific application to the Council for each site proposed Approval will be conditional upon justification under the provisions of *5.4-03* and upon reasonable assurance that conditions of *5.4-04* will not be violated. Approval will be by written notice and shall be valid for a period determined at the Council's discretion. The Council shall set additional conditions on pilot production as shall be deemed necessary.

5.4-09. The issuance of permits shall be subject to any future rules and regulations which may be adopted by the Council. When such changes or additions are proposed, all permittees shall be given due written notice.

5.4-10. No permit, or portion thereof, shall be assignable without the prior written consent of the Council. Assignees will be bound by all obligations assumed by the original permittee.

5.4-11. Any permittee may voluntarily renounce his exploratory rights, but will not be entitled to refund of any rentals paid the State and will be prohibited from submitting a bid for an extracting lease to the plat or plats in question.

5.4-12. The Council may terminate the rights granted by permit for non-compliance or non-payment of legal rents and charges.

5.4-13. The Council shall fine the permittee for non-compliance with permit conditions. Such fine will be $2,000 for each violation, with each day of a continuing violation considered independently. The permittee may appeal such fines through State District Courts.

5.4-14. No permit shall be granted to any person then in violation of any laws or regulations applicable to such operations.

5.4-15. Avoidable pollution of the ocean, the waters covering submerged lands, the beaches, land underlying the ocean or other ground or surface waters or any substantial impairment of or interference with the enjoyment and use thereof, including but not limited to bathing, boating, fishing, fish and wildlife production and navigation shall be prohibited, and the permittee or lessee shall exercise a high degree of care to provide that no refuse of any kind from any works shall be permitted to be deposited on or pass into the waters of the ocean, any bay or inlet thereof, or any other waters of the State; provided, however, that this Section does not apply to the deposit on or passing into such waters of water containing bottom sediments in quantities and of chemical composition determined acceptable by the Council. Avoidable pollution means pollution arising from:

a. the acts or omissions of the lessee or permittee or its officers, employees or agents; or
b. events that could have been prevented by the lessee or permittee or its officers, employees or agents through the exercise of a high degree of care.

Methods acceptable to and approved by the Council must be used for the containment and release of any and all wastes generated by members of the working crew and from the operations. The lessee or permittee shall be held responsible for any damages resulting from avoidable pollution caused by the exploration and shall immediately notify the Council of such damages or pollution and move immediately to correct, alleviate or eliminate such damages or pollution. All such actions shall be subject to the direction of a Council representative.

5.4-16. All permits or leases granted pursuant to this Regulation shall be subject to prior approval by the Department of Defense.

5.4-17. The Council reserves to itself the right to set aside sanctuaries within areas opened to exploration. These shall be delineated when permits are negotiated under *5.3-01* and shall include: (a) shoreline areas of a depth less than 80 feet below mean low water, (b) active and inactive dumping grounds, (c) shellfish beds and fish spawning and nursery areas, (d) areas of polluted sediment, (e) cable and pipeline areas, (f) restricted navigation channels.

(6) Extraction:

6.1 Preliminary Application

6.1-01. Parties to joint exploratory permits to areas opened to exploration under Section *5.1-01, 02* and *03* shall notify the Council of their intention to submit bids for extraction rights upon completion of exploration under *5.4*.

6.1-02. No persons not party to joint exploration under *5.4-01* shall be allowed to submit a bid.

6.1-03. Applications for the right to submit bids shall provide the following information at least 90 days prior to the time Council action is desired:

a. All information required under *5.1-05* (original information shall suffice).
b. Department of the Army permit, issued by the United States Army Corps of Engineers, authorizing the proposed dredging.
c. Description of the deposit to be mined.
d. Statements as to the amount of material to be removed annually.
e. Final estimates of probable ore values and cost of processing under *5.4-03* including results of all pilot production activities carried out under *5.4-08*.
f. All monthly reports of activity and results under *5.4-05*.
g. Complete results of Environmental Impact Statement as defined under *5.4-04*.

6.1-04. Applications will be accompanied by a $2,000 filing fee.

6.1-05. Applications will not be entertained for any areas not included in the original exploratory permit issued under *5.4*.

6.2 Public Hearing

6.2-01. Notice of intention to entertain bids for extraction will be made as in *5.2-01*.

6.2-02. A public hearing will be held prior to consideration of bids as in *5.2-02*; such hearing to be held under procedures as in *5.2-03*.

6.2-03. All records and results of exploratory survey work, including all material submitted in support of applications submitted under *6.1-03*, but most especially the Environmental Impact Statement, shall be open to public inspection for a period not less than 30 days prior to the date of the public hearing. Sufficient copies of pertinent material will be made available to allow free access.

6.2-04. Any members of the interested public, state agency, or other organization may submit evidence or testify to its opinion before this public hearing under provisions of the Administrative Procedures Act.

6.3 *Lease Terms*

6.3-01. Upon consultation with interested State agencies, personnel of the Division of Coastal Resources and the Coastal Resources Center, and other interested parties, and after the holding of a public hearing under Section *6.2*, the Council shall include such conditions in the lease terms as it deems necessary to protect the fish, game, wildlife, natural resources and private interests within the State.

6.3-02. The Council, in setting such conditions, shall pay particular attention to the Environmental Impact Statement and to the several management recommendations and guidelines issued for its use by the Coastal Resources Center. Effects of proposed activity on other users of the marine environment shall be a primary consideration.

6.3-03. Lease conditions shall set forth areas closed to mining activity under Section *5.4-17* and shall delineate the size and shape of the parcel offered for lease.

6.3-04. A rental of $1.00 per acre per year will be charged for rights to areas covered by the lease and shall be credited towards royalty payments.

6.3-05. A lease shall grant the exclusive right to remove sand and gravel or other designated minerals in the leased land and shall be for a primary term of ten (10) years and for so long thereafter as minerals are produced in paying quantities from the leased land, or the lessee is diligently conducting, producing, repairing or other necessary lease maintenance operations on the leased land, or is excused from conducting such operations under the terms of the lease.

6.3-06. The State reserves the right to permit reasonable nonconflicting use (including seismic surveys but excluding core hole drilling of lands under lease) so long as: (a) such uses do not unreasonably impair or interfere with operations of the lessee, and (b) requirement is made that the permittee indemnify the lessee against any damage caused by such use.

6.3-07. The issuance of leases is subject to any future rules and regulations which may be adopted by the Council. When such changes or additions are proposed, all lessees shall be given due written notice.

6.3-08. Leases are further subject to approval by the Department of Defense as in *5.4-16*.

6.4 *Lease Bidding*

6.4-01. Bids may be for the whole or any particularly described portion of the land advertised.

6.4-02. Upon written notification of proposed lease conditions and restrictions, applicants under *6.1* shall have 30 days to submit sealed bids for extraction rights to all deposits identified in such notification.

6.4-03. Bidding shall be for a lump sum bonus to be paid to the State of Rhode Island under such conditions as the Council shall deem appropriate and for royalties to be paid to the State based on gross revenue generated by production.

6.4-04. The Council is empowered to establish what shall be considered a minimum royalty.

6.4-05. Submitting of a bid shall be construed as acceptance of any and all lease terms, conditions and restrictions.

6.4-06. The bid shall be enclosed in a sealed envelope, shall be on the form provided by the Council and shall be accompanied by a certified or cashier's check or checks payable to the State of Rhode Island in the amount of 25 percent of the bonus bid which sum shall be deposited as evidence of good faith and, except in the case of the successful bidder, shall be returned promptly. If the successful bidder fails to pay the balance of the cash bonus bid within a period determined by the Council or the annual rental within 15 days after the award of the lease, or fails to post any bond required by the lease within the time prescribed, the amount of the deposit shall be forfeited to the State and the lease rebid.

6.5 *Awarding Lease*

6.5-01. At the time and place specified in the notice to bidders, the Council shall publicly open the sealed bids and shall within thirty (30) days reject all bids or award the lease to a responsible bidder who, in addition to complying with all of the conditions for bidding, offers the highest cash bonus and royalty bid. The Council may reject any or all bids.

6.5-02. A bond in the amount of $100,000 for liability as a result of activities under the lease shall be posted by the successful bidder within such time as shall be determined by the Council, but no later than the beginning of operations. Failure to post bond in the specified time will lead to forfeiture of lease rights under *6.4-06.*

6.6 Lease Revenues

6.6-01. Annual rent as set forth in *6.3-04* shall be payable in advance on the first day of each lease year. Amount paid will be credited towards royalty payments.

6.6-02. Royalty payments as set forth in *6.4-04* and *05* shall be payable at the end of each lease year beginning with the first year of recovery.

6.6-03. If the Council or its designated representative directs the suspension of operations and production in the interest of conservation, no royalty or rental payments will be payable for this period, provided that suspension is not necessitated by violation of lease provisions.

6.6-04. Royalties will be subject to renegotiation, at the Council's discretion, upon termination of the primary ten year lease term and five year intervals thereafter.

6.6-05. The Council may reduce rental or royalty on a lease-hold or any portion of it if it is determined that the lease cannot be successfully operated under original terms and if promotion of further development is deemed desirable.

6.6-05. Revenues accruing to the state from application fees, royalties, rentals and other charges shall be disposed of as follows:

a. Application fees shall be applied to the costs associated with public hearings and shall include cost of publishing notices, copies of application materials, and holding hearings themselves. Any balance shall revert to the General Fund.
b. Royalty and rental revenues shall revert to the General Fund except that 25 percent of revenues generated shall be placed in a Marine Environmental Conservation Fund to be used to finance continued research directed towards enhancement of the State's marine resources.

6.6-06. Costs associated with the periodic monitoring of operational activities and auditing of production records by designated representatives of the Council shall be borne by the lessee.

6.6-07. The State shall have a lien upon all production for unpaid royalties.

6.6-08. When it appears to the satisfaction of the Council that any person has made a payment to the State of Rhode Island in excess of the amount he was lawfully required to pay, such excess shall be repaid without interest to such person if a request is filed within two years after the making of the payment.

6.7 Operational Obligations and Liability

6.7-01. The lessee shall be held accountable to observe all conditions set forth in his lease. In addition, he shall be held accountable for avoidable pollution as defined, and under conditions set forth in 5.4-*15.*

6.7-02. The lessee shall be held accountable to future rules issued under conditions of *6.3-07.*

6.7-03. Subject to the right to surrender, the lessee shall commence operations for the extraction of the minerals specified in his lease within five (5) years from date of the lease, unless the Council shall have, for cause, granted an extension of time for such act. In addition, the lessee shall observe such production requirements as the Council deems necessary to encourage the exercise of due diligence on his part.

6.7-04. Periodic mutual negotiations between lessee and lessor may be carried out to make conditions, rules and regulations current as warranted by changes in environment or operational methods.

6.7-05. The lessee may at any time file with the Council a written surrender of all rights under the lease or any portion thereof or any separate or distinct zone or geological horizon or any portion thereof. Such surrender shall be effective as of the date of its filing subject to the continuing obligation of the lessee to pay all rentals and royalties theretofor accrued and to restore the production site to a condition acceptable to the Council. Thereupon the lessee shall be be released from all obligations under such lease with respect to the lands, zones or horizons surrendered, but no such surrender shall release such lessee from any liability for breach of any monetary obligation of the lease with respect to which such lessee is in default at the time of the filing of such surrender.

6.7-06. The lessee may not assign title to his lease to any person without prior written permission of the Council as set forth in *5.4-10.* The assignee is then bound by all conditions of the original lease and such additional conditions as may be set by the Council.

6.7-07. The lessee shall keep open at all reasonable times for inspection by any duly authorized representative of the Council the leased area and all extraction sites, production units and machinery and fixtures thereon and all books, accounts, maps and records relative to operations and surveys or investigations on or with regard to the leased area or under the lease.

6.7-08. The lessee shall cause to be filed with the Council by the last day of each succeeding month a separate report of operations for each production site on his leased area for each calendar month beginning with the start of production. This report will disclose all operations, indicate their status to date, indicate the number of days of actual production and the quantity of mineral produced, the depth of operations, dates and reasons for shutdowns and any other information that the Council shall deem necessary.

6.7-09. In the event production on the leasehold shall cease at any time or from time to time after the expiration of the primary term of the lease, the lease shall nevertheless continue in full force and effect if the lessee shall within six (6) months after the cessation of production or within such longer period of time as the Council may authorize commence and thereafter prosecute with reasonable diligence repairing or other operations for the restoration of production.

6.8 *Enforcement*

6.8-01. The Council shall have the right to suspend production under *6.7-07* if it is determined that activities pose an unacceptable threat to the marine environment, whether by accident or design. Production may be recommenced upon satisfaction that adequate remedial steps have been taken.

6.8-02. Willful violation of lease provisions or legally binding Council directives shall be considered a misdemeanor and punished under *5.4-13* with a fine of two thousand dollars ($2,000) for each offense, each day of continued violation being considered a separate offense.

6.8-03. The Council shall reserve and may exercise the authority to cancel any lease upon failure of the lessee after thirty (30) days' written notice and demand for performance to comply with any of the provisions of the lease or of laws or regulations applicable thereto and in force at the date of the invitation for bids in pursuance of which the lease was awarded; provided, however, that in the event of any such cancellation the lessee shall have the right to retain under such lease any and all production sites as to which no default exists. In the event of cancellation of any lease, the lessee shall have a reasonable time within which to remove any property, equipment, and facilities owned or used by the lessee in connection with operations under the lease.

6.8-04. Cancellation shall be by legal action taken in State District Courts by the Office of the Attorney General at the request of the

Council. The lessee may contest cancellation of his lease at this time.

6.8-05. The Court will be asked to issue a temporary restraining order preventing continued production while cancellation proceedings are in progress.

6.8-06. The initiation of cancellation proceedings will have no bearing on the lessee's liability to fines levied under *6.8-02.*

6.8-07. The Council may summarily cancel any lease determined to have been obtained by fraud of misrepresentation.

6.8-08. Any person complaining of cancellation of a lease may have such action reviewed in State District Court by filing a petition for review within sixty (60) days after the action.

6.9 Additional Powers

6.9-01. Aggregate offloading, storage and processing facilities shall be included among those specific activities and land uses which the Council is empowered to regulate under the provisions of "46-23-6B" of Chapter 279, Public Laws 1971, where these facilities are determined to be dependent on marine aggregate supplies.

6.9-02. Recognizing the delicate balance of forces constituting an active beach and further recognizing the importance of said beaches to the State, it shall be considered a violation of law to alter existing topography for the purpose of mineral extraction from the face, berm, back slope or adjacent dunes of any coastal beach or shore without the express consent of the Council.

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