SAND AND GRAVEL ENVIRONMENTAL STUDIES WITHIN THE MINERALS MANAGEMENT SERVICE

A Framework for Decisionmaking

U. S. Department of the Interior
Minerals Management Service
Offshore Minerals Management
Leasing Division
Sand and Gravel Unit
Herndon, Virginia

Principal Authors:

Barry S. Drucker
Physical Scientist/Physical Oceanographer/Sand and Gravel Environmental Coordinator

Will Waskes
Biological Oceanographer

Roger V. Amato
Geologist

April 2003

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

ACOE	U. S. Army Corps of Engineers
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CZM	Coastal Zone Management
DOI	Department of the Interior
EA	Environmental Assessment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ESP	Environmental Studies Program
FONSI	Finding of No Significant Impact
FWS	U. S. Fish and Wildlife Service
GOM	Gulf of Mexico
MMAB	Marine Minerals Advisory Board
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
NEPA	National Environmental Policy Act of 1969
OCS	Outer Continental Shelf
OCSLAA	Outer Continental Shelf Lands Act, as Amended in 1978
PL	Public Law
PM	Particulate Matter
RFII	Request for Interest and Information
TSH	Trailing Suction Hopper Dredge
U.S.C.	United States Code
VOC	Volatile Organic Carbon

INTRODUCTION AND PURPOSE

This document provides background for the Minerals Management Service (MMS) management and staff on the role of sand and gravel environmental studies in decisionmaking for Outer Continental Shelf (OCS) marine mineral development. This document supports the Bureau's studies planning process and explains to its constituencies how MMS uses sand and gravel-related science in its decisionmaking.

By linking research endeavors to the Bureau's decisionmaking processes, this document addresses the following needs:

- To set logical boundaries on research needs, allowing the Bureau to identify what is necessary and sufficient;
- To develop a logical sequencing of studies, allowing the Bureau to better anticipate future data needs;
- To better direct the limited research budget toward upcoming decisions;
- To identify significant similarities among the MMS offshore regions (and sub-regional areas), allowing the results of studies to be generalized from one region to another; and
- To identify significant differences among the regions, allowing for the MMS Environmental Studies Program (ESP) planning process to account for them.

Finally, this document:

- Communicates the general direction of MMS sand and gravel research to interested constituents including industry, State and local governments, and environmental groups;
- Incorporates recommendations made over the years by the MMS's Scientific Committee; and
- Responds to comments received and concerns expressed by the coastal states, interested public, and environmental groups and organizations regarding the potential effects of offshore sand and gravel operations.

SCOPE OF THE DOCUMENT

The focus of this document is on activities that occur on the OCS within the jurisdiction of the MMS, the open-ocean area that lies beyond the 3-mile State boundary. Consideration is given to those operations which take place in, and may impact, OCS areas which might potentially be leased as sand borrow areas for beach nourishment, coastal restoration, or wetlands protection projects, or areas in which coarse sand and gravel deposits may exist which might be exploited for use as construction aggregate.

It is important to note that only open-ocean dredging operations and associated possible impacts of such are considered, not navigational or channel dredging activities. These types of operations are conducted in more spatially constricted areas or areas close to shore and the impacts of such activities are, and may be, entirely different. Where appropriate, impact studies associated with dredging for navigational or channel-widening/deepening situations are considered to the extent that they can be.

In addition, when considering the character and intent of MMS studies to assist in the evaluation of impacts associated with offshore dredging operations, one must consider the differences between the offshore oil and gas program and the sand and gravel program. The oil and gas program operates on a planned 5-year schedule in which a large area is put up for bid. Exactly where the eventual operation will be and to what scale is virtually unknown. Impacts are generally considered and evaluated in the NEPA document on a broad scale. Systems, both biological and physical, are considered usually on a regional level.

Sand and gravel operations, on the other hand, tend to be focused, site-intensive operations. Requests are for specific volumes of material in a well-defined area MMS receives requests for negotiated agreements throughout the year, on no set schedule. In many cases, the Agency has a clear indication of where a borrow site for a planned project will occur. MMS, however, often receives requests for use of offshore areas for which the Agency had no prior notice or knowledge.

In that all of the factors described above drive the environmental studies process relative to the MMS sand and gravel program, this plan describes in detail the sand and gravel negotiated agreement and competitive leasing processes, the State-Federal cooperative program in which geological and geophysical information is collected to assess the potential offshore coastal states as a source of sand borrow material, and the dredging process and associated potential impacts to the marine and coastal environments.

RATIONALE FOR CONDUCTING SAND AND GRAVEL RESEARCH

The MMS is charged with the orderly development of offshore energy and mineral resources on the OCS and with safeguarding the environment affected by this development. The Bureau's responsibilities include assessing the effects of OCS activities on natural, historical, and human resources and the appropriate monitoring and mitigating of those effects. The Environmental Studies Program (ESP) is required by the Outer Continental Shelf Lands Act, as amended in 1978 (OCSLAA), to provide information for sound decisionmaking and management. The ESP conducts research across the spectrum of the physical, biological and socioeconomic environments as required by the OCSLAA and the National Environmental Policy Act of 1969 (NEPA).

The ESP's sand and gravel research:

- provides information essential to understanding the environmental consequences of sand and gravel operations on the OCS in areas where the activities occur;
- helps to identify what constitutes significant impact to the marine, coastal, and human environments as a consequence of offshore dredging operations;
- provides relevant data and information necessary for the preparation of required NEPA documents;
- provides data and information for incorporation into sand and gravel lease documents;
- supports MMS's planning and management processes;
- provides information essential for effective interaction with the public about such effects; and
- is required by law.

REGULATORY, LEGAL, AND LEASING ISSUES

MMS JURISIDCTION

All mineral resources (oil and gas, sand and gravel, industrial minerals, etc.) found in Federal waters on the U. S. OCS are under the jurisdiction of the MMS, a bureau within the U. S. Department of the Interior. The Federal OCS is defined as the submerged lands, subsoil, and seabed, lying between the seaward extent of the States' jurisdiction and the seaward extent of Federal jurisdiction. For most States, offshore Federal lands begin 3 nautical miles (approximately 3.3 statute miles) seaward of the baseline from which the breadth of the territorial sea is measured. Offshore Texas and the Gulf coast of Florida, this boundary is at the 3 marine leagues (9 nautical miles) mark. The seaward limit of Federal jurisdiction is defined as the farthest of 200 nautical miles seaward of the baseline from which the breadth of the territorial sea is measured or, if the continental shelf can be shown to exceed 200 nautical miles, a distance not greater than a line 100 nautical miles from the 2,500-meter isobath or a line 350 nautical miles from the baseline.

LEGAL MANDATE FOR CONDUCTING SAND AND GRAVEL ENVIRONMENTAL STUDIES

The MMS's major legal mandates are the OCSLAA and NEPA. An objective of both laws is to provide the information needed for balanced decisionmaking. Both direct MMS to study the marine, coastal, and human environments and to include guidance relative to information needs for rational decisionmaking.

The OCSLAA does not apply only to OCS oil and gas, but to all minerals on submerged Federal lands:

TITLE 43 > CHAPTER 29 > SUBCHAPTER III > Section 1331. - Definitions
(q) The term "minerals" includes oil, gas, sulphur, geopressured-geothermal and associated resources, and all other minerals which are authorized by an Act of Congress to be produced from "public lands" as defined in section 1702 of this title
Accordingly, OCSLAA, with regards to the conduct of environmental studies, does not restrict study efforts to oil and gas operations:

Section 1346. - Environmental studies
(a)(1) The Secretary shall conduct a study of any area or region included in any oil and gas lease sale or other lease in order to establish information needed for assessment and management of environmental impacts on the human, marine, and coastal environments of the Outer Continental Shelf and the coastal areas which may be affected by oil and gas ***or other mineral development*** in such area or region.

The National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321-4347) is the foundation of environmental policymaking in the United States. The NEPA process, described in detail in a later section of this document, is intended to help public officials make decisions based on an understanding of environmental consequences and take actions that protect, restore, and enhance the environment.

REGULATIONS FOR NONENERGY MINERAL PROSPECTING, LEASING, and PRODUCTION

A series of regulations were prepared in 1988 that govern the prospecting, leasing, and mining and production operations of nonenergy minerals. These are parallel to the 30 Code of Federal Regulations (CFR) Parts 250/251/252/256 (regulations for oil, gas, and sulphur), although many of the procedures, terms and conditions are different. For example, the primary lease term for sand and gravel is 10 years, and for all other nonenergy minerals it is 20 years; the oil and gas lease term is 5 years (8 and 10 years for deeper water leases). The nonenergy mineral regulations are numbered 30 CFR 280 (prospecting), 281 (leasing), and 282 (operations). Although some of the activities covered in 30 CFR 280 apply to noncompetitive leases, those in 281 and 282 are only for leases obtained competitively; specific regulations for noncompetitive leases have not been prepared.

The regulations governing each activity for competitive leasing have specific references to environmental responsibilities:

30 CFR 280.10 states: "The potential of proposed prospecting or scientific research activities for adverse impacts on the environment will be evaluated by MMS to determine the need for mitigation measures."

30 CFR 281.11 – 281.22: Requires that environmental information be submitted, environmental analyses be completed, and special terms and stipulations be developed for the specific tracts to be leased.

30 CFR 282.28: Specifies environmental protection measures that must be carried out during the exploration, testing, development, production, and processing activities conducted under a lease. These include the collection of baseline data, monitoring activities, use of on-board observers, and development of special mitigation measures for mining operations.

Appendix A contains the three regulations, as well as the non-competitive leasing law.

THE LEASING PROCESS FOR OFFSHORE FEDERAL SAND AND GRAVEL

There are two processes for obtaining leases for sand, gravel, or shell materials for the OCS: competitive leasing and noncompetitive or negotiated leasing. As stated above, competitive leasing is covered by the OCSLAA and the nonenergy minerals regulations, while noncompetitive leasing is covered under PL 103-426. Each process has a series of prescribed steps to ensure compliance with applicable laws, regulations, and policies. Each contains steps for environmental impact assessment and development of terms and stipulations to mitigate impacts to the environment.

Competitive Leasing

The competitive sand and gravel lease process is initiated by a written request to the Director of the MMS. The request must specify an area and contain a justification for the lease. The agency has to respond within 45 days of receipt of the request as to whether or not it will proceed to the next step- preparation of an area identification and publication of a Request for Information and Interest (RFII) in the Federal Register to solicit public comment. The RFII is usually held open for 60 to 90 days, after which a decision to proceed to the next step – preparation of an environmental impact statement (EIS) - is made. At this time, the Director has the option of establishing a State-Federal task force to provide liaison with the affected states(s) and support the EIS work. A Notice of Intent to prepare the EIS is also issued, which has a 30-day comment period. Scoping meeting(s) are held to gather public comments and information and a Proposed Action and Alternatives Memo (PAMM) is prepared that lists alternative actions to the proposed leasing. The next step is obtaining consistency with the affected state's coastal zone management plan under the Coastal Zone Management Act (CZMA). The state(s) have 90 days to respond, after which a Proposed Leasing Notice (PLN) is published with a 60-day comment period. After review of the PLN comments, a lease sale decision document is prepared with a summary of comments and a list of the alternatives. After approval to proceed, a Final Leasing Notice is published 30 days prior to the date of the lease sale. The sale is then held and the sealed bids are reviewed for fair market value and are either accepted or rejected.

Noncompetitive Leasing

The noncompetitive leasing process is much simpler and faster than that for competitive leasing. Upon receipt of a written request from a Federal, state, or local government agency, MMS makes a determination as to whether the request qualifies for a noncompetitive lease and sends a letter of response. If the request is approved, a review of existing NEPA documents is made; if additional NEPA work is needed, an MMS team is assembled to prepare the needed report(s), or review reports prepared by the requesting agency. Information is obtained from the requestor on the specific sand borrow area, volume of sand needed, and length of the project. A timetable is also prepared listing all remaining steps and estimated dates for completion. Essential fish habitat, endangered species, and archeological reviews are completed, and comments are crafted, if necessary, into terms and stipulations. After completion of all NEPA work, terms and stipulations are attached to the lease document. If the requesting agency is Federal, a Memorandum of Agreement (MOA) is prepared and the terms and stipulations are attached. It is then reviewed by the Solicitor, and signed by MMS and the other agency. In the case of a non-Federal requestor, a negotiated lease is prepared with terms and stipulations attached. It is then reviewed by the Solicitor, and signed by MMS and the requestor. PL 103-426 (see Appendix A) requires that letters be sent to the U. S. Senate and House of Representatives after the lease is signed.

Table 1 shows the steps involved in the noncompetitive leasing process.

THE NEPA PROCESS

Regardless of whether the MMS is considering a noncompetitive negotiated agreement to use OCS sand for beach nourishment/restoration or a competitive sale for offshore material, the Bureau must ensure that any such actions will not have significant impacts on the quality of the human environment.

The National Environmental Policy Act (NEPA) (42 U.S.C. 4321-4347) is the Nation's charter for protection of the environment. The NEPA provides an interdisciplinary framework for federal agencies to prevent environmental damage, and contains "action-forcing" procedures to ensure that federal agency decision-makers take environmental factors into account.(42 U.S.C. 4321; C.F.R, 1500.1.) The implementing regulations of the Council on Environmental Quality (CEQ) (40 CFR 1500-1508) outline the guidelines by which Federal agencies conduct their environmental analyses (see appendix F). Environmental factors are taken into account through a process of environmental analysis that assesses the impacts of a proposed project on the human environment. The NEPA defines the "human environment" to be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment (C.F.R. 1508.14). Impacts include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect or cumulative. Impacts may also include those resulting from actions which may have both beneficial and detrimental impacts, even if the agency believes that the effect will be beneficial (40 CFR 1508.8).

As part of ensuring environmentally sound and acceptable decisions for marine mineral operations, the MMS prepares, as required by NEPA, an Environmental Assessmentor an Environmental Impact Statement to determine any possible environmental consequences of OCS marine mineral development. An EA is a concise public document in which the Federal agency briefly provides sufficient evidence and analysis for determining whether to prepare an EIS or make a "finding of no significant environmental impact" (FONSI). An EIS is a detailed document that thoroughly analyzes the proposed action. It is prepared when the Federal agency determines, either through its own judgment or through an EA, that the proposed action will have significant environmental impacts that require examination in further detail. The EIS process is much more involved than the EA process and includes public scoping and outside review of both draft and final EIS's as illustrated in Figure 1.

In general, the NEPA documents contain a description of the proposed scenario/project for recovery and transport of the resource material from the identified borrow or lease areas, along with a discussion of any possible alternatives to the proposed action. The analysis also evaluates the potential environmental impacts of each alternative examined and identifies mitigating measures to avoid or lessen possible impacts. These measures are usually attached to the lease as stipulations.

Appendix K shows the Table of Contents for a typical MMS EA prepared to evaluate the impacts associated with a requested negotiated lease agreement.

NEPA Process for Non-Federal, Non-competitive Agreements

The environmental review process for non-Federal non-competitive agreements, Federal non-competitive agreements, and competitive hard mineral leases can be vastly different. Each process, while similar, has its distinct trigger actions which can causes changes in the environmental review process. Figure 2 illustrates the environmental review process conducted for a non-federal entity requesting a negotiated agreement.

Typically, the MMS receives and reviews the request for a negotiated agreement and prepares an EA to determine if significant impacts may occur that would require preparation of an EIS. If the EA determines that the proposed action would not result in any significant effects, a FONSI is prepared. The FONSI generally states that the effects of the proposed action have been evaluated in an EA, briefly gives the reasons why the proposal will not have significant effects, and states that the preparation of an EIS is not required. The FONSI includes a description of any additional mitigating measures not in the original proposal which will be required to reduce significant effects to an insignificant level.

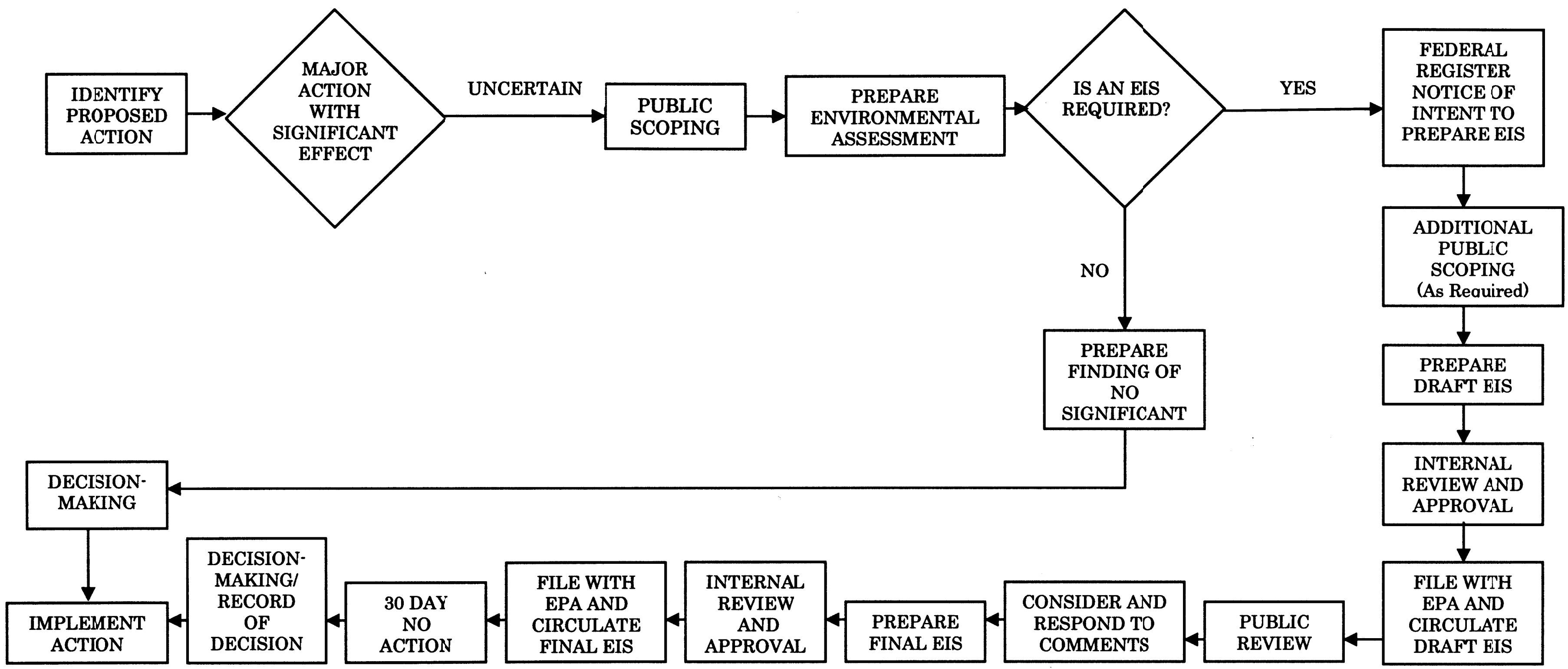
If the MMS determines that an EIS is needed, either a project-specific or, if feasible, a programmatic EIS must be prepared. In some cases however, an EA may be prepared in lieu of an EIS if a previous NEPA analysis which adequately covers the potential impacts in the same area or is considered tierable under NEPA regulation (1502.20;

Table 1. Noncompetitive Leasing Steps/Responsibilities

LEASING STEPS	MMS OFFICE	OUTSIDE AGENCY
Receive/evaluate request for sand	MMS Leasing Division-Sand and Gravel Program	
Determine if request qualifies	MMS Leasing Division-Sand and Gravel Program	
Obtain specific information about proposed project from requestor	MMS Leasing Division-Sand and Gravel Program	
If Federal Agency is involved, initiate and prepare Memorandum of Agreement	MMS Leasing Division-Sand and Gravel Program, Solicitor	Other Federal Agency
Evaluate/initiate/ complete NEPA process	MMS Leasing Division-Sand and Gravel Program, MMS Environmental Division	Other Federal agencies including USACE, FWS, NOAA Fisheries
Determine if stipulations, specific lease conditions required	MMS Leasing Division-Sand and Gravel Program, MMS Environmental Division	
Prepare draft lease, make revisions as necessary	MMS Leasing Division-Sand and Gravel Program, Solicitor	
Prepare final lease for signatures	MMS Leasing Division-Sand and Gravel Program, ADOMM, MMS Director	
Send signed lease to requestor with notice to proceed	MMS Leasing Division-Sand and Gravel Program	
Send letters of notification to Congress	MMS Leasing Division-Sand and Gravel Program, ADOMM, MMS Director	

Approximate time for completion: 4 to 6 months
Average Frequency of requests: 2-3 per year
Approximate Number of MMS people involved:8-10

Figure 1. NEPA Environmental Review Process: An Overview.



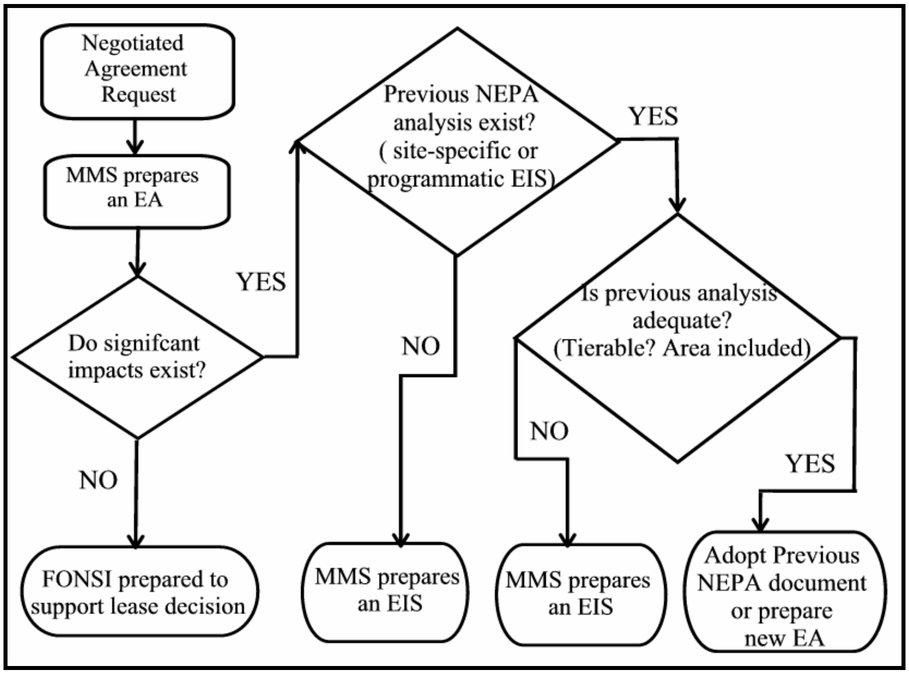


Figure 2. NEPA Process for Negotiated Agreements for OCS sand by Non-Federal Agencies

1502.21) has been completed.

NEPA Process for Federal, Non-competitive Agreements

To date, the MMS has entered into several negotiated noncompetitive agreements for the use of OCS sand to restore or renourish coastal beaches. In some of those instances, the ACOE, or another Federal or State agency is the entity requesting the use of OCS sand. In these instances, the MMS is usually notified by the requesting Federal agency prior to initiation of the NEPA process. When this occurs, the MMS requests cooperating agency status and prepares sections of the EIS or EA pertaining exclusively to the offshore borrow area. The MMS also cooperates on other required consultations (i.e. EFH, Section 7, and Coastal Zone Consistency) during the NEPA review process as well. In some cases, the outside Federal agency has already prepared the NEPA analysis before notifying MMS of their request. In these instances, the MMS undertakes a detailed review of the NEPA document to determine its adequacy for supporting a negotiated agreement. If the outside agency's document is an EIS, found to be adequate, the NEPA regulations allow the MMS to adopt the document. The MMS will then place a notice in the Federal Register outlining the MMS position.

The NEPA regulations concerning adoption do not extend to EA's; therefore, the MMS must prepare its own EA to support the potential agreement despite the fact that the EA may be adequate. This does not, however, preclude the MMS from using information or analysis prepared in the EA. When an MMS review of a Federal agency's EIS or EA indicates that the analysis is not sufficient, then the MMS will send a detailed review letter outlining the inadequacies and detailing the revisions that should be made. If the document is an EIS and is revised accordingly, the MMS would adopt the document as outlined above. If the revised EA is adequate, the MMS will prepare a short and concise EA to support the agreement. If the revised document, whether it is an EIS or an EA, fails to be sufficient, then the MMS prepares a detailed EA correcting the defined deficiencies. Figure 3 depicts the NEPA review process for other Federal agencies requesting a non-competitive lease.

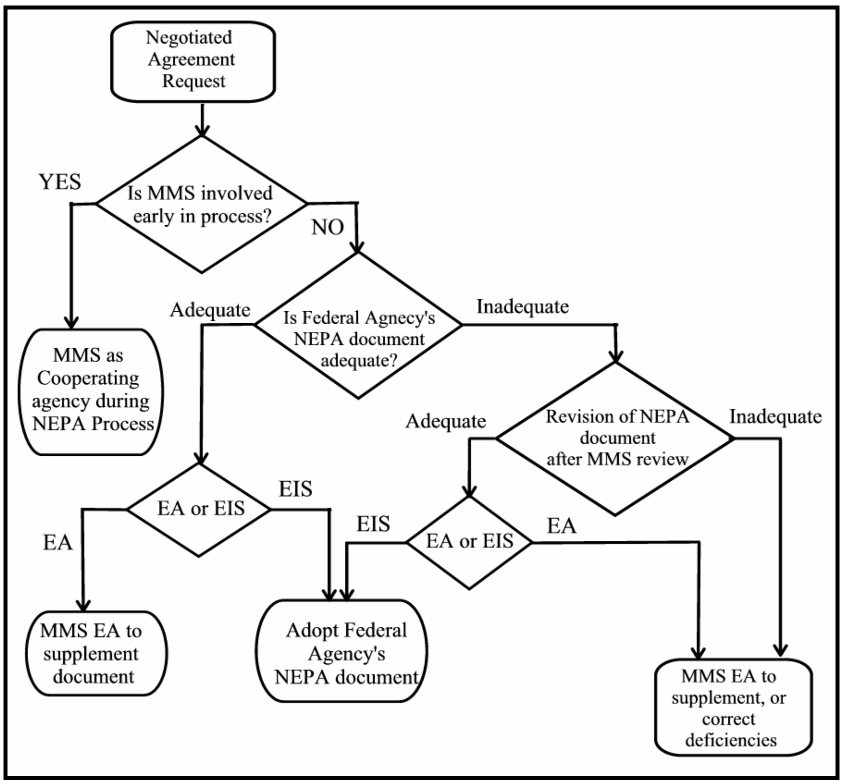


Figure 3. NEPA Process for Negotiated Agreements for OCS Sand by Federal Agencies.

NEPA Process for Competitive Lease Sales

To date there have been no competitive lease sales finalized by MMS for the use of OCS minerals. However, there have been inquires from private entities concerning the lease of OCS resources for use as construction material. Inquires and potential requests are expected in the future. Figure 4 shows the MMS NEPA review process for holding a Federal OCS competitive lease sale. If the proposed sale is to be held in a new area for which a previous EIS has not been completed, then an EIS would be prepared. Should an EIS or other NEPA document exist, the MMS must determine its adequacy in light of the new decisions and alternatives to be considered, if it covers the area being considered for lease, or if it is tierable. If an EIS exists, but new environmental information is available such that it would significantly affect the decision, then a new EIS would be prepared. If an existing EIS or NEPA material serves to support any new decisions, then the previous document would be adopted or an EA would be prepared to supplement or support the previous analysis.

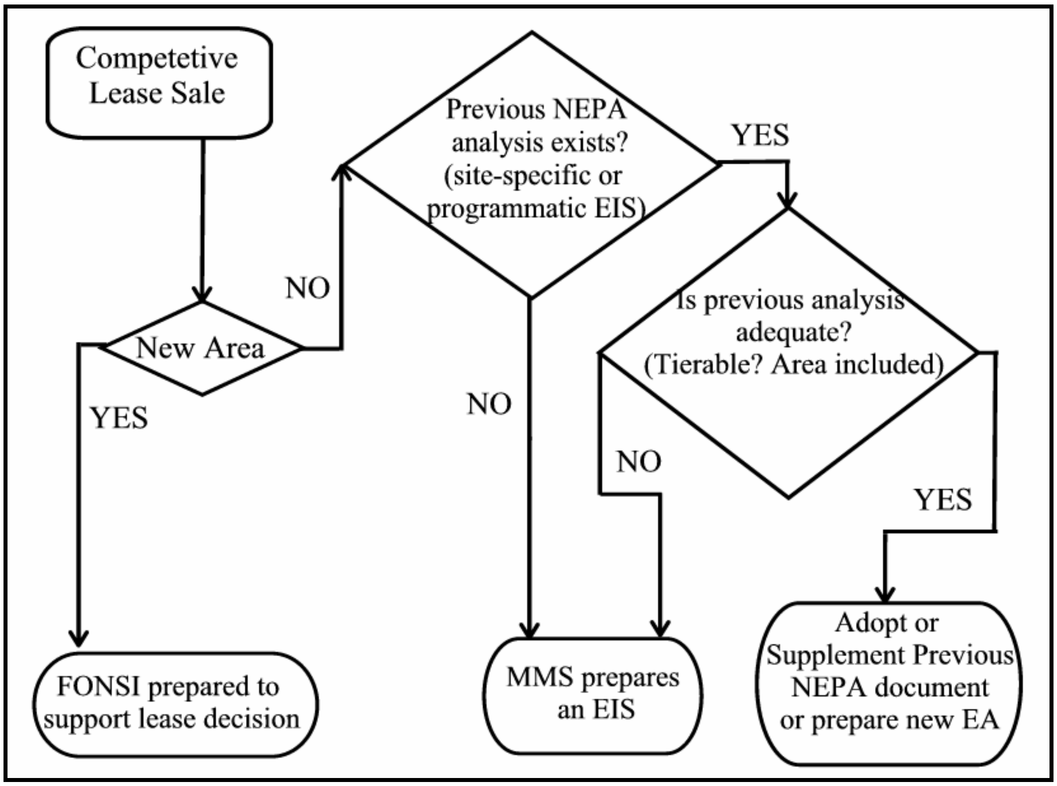


Figure 4. NEPA Process for Competitive Hard Mineral Lease Sale.

COORDINATION WITH OTHER FEDERAL AGENCIES

U.S. Army Corps of Engineers

A Memorandum of Agreement between MMS and the U.S. Army Corps of Engineers (ACOE) was signed in 1999, in which the two agencies agreed to exchange information and to work jointly on environmental analyses of proposed sand borrow areas. Since the agreement was signed, MMS has worked closely with the New York, Philadelphia, Baltimore, Norfolk, Charleston, and Jacksonville District offices, including participating as a cooperating agency on preparation of EIS's, development of statements of work for environmental studies, and participation on technical proposal evaluations for such studies.

U.S. Fish and Wildlife Service

Federal agencies must request that the U. S. Fish and Wildlife Service (FWS) or NOAA Fisheries, as appropriate, furnish information as to whether any listed species or designated critical habitat are in a proposed project area. Should any listed or proposed species or designated critical habitat be identified within a proposed project area, the MMS or lead Federal agency for the project prepares a biological assessment to determine if the proposed project may affect the species or their habitat. Typically, areas to be avoided or other mitigation measures are considered within the assessment. If the biological assessment indicates that the proposed project may affect a listed species or critical habit, the MMS or lead agency must request a formal consultation with FWS/ NOAA Fisheries. If the assessment determines that the proposed project is not likely to adversely affect listed species or critical habitat, then the MMS or lead agency on the project normally requests an informal consultation with the FWS to receive their written concurrence of "no adverse affect."

Once MMS or the lead agency requests a formal consultation with FWS/NOAA Fisheries, the Services must formulate a biological opinion as to whether the project will jeopardize the continued existence of a listed species or adversely modify critical habitat. Should a jeopardy determination be made, the FWS/NOAA Fisheries will include reasonable and prudent alternatives, if any, to the proposed project that would avoid jeopardy. In addition, the FWS/NOAA Fisheries may also suggest discretionary conservation recommendations to assist the MMS or lead agency in reducing or eliminating the impacts of the proposed project.

In those cases where the FWS/NOAA Fisheries conclude that the proposed project and the resulting anticipated incidental take will not violate the ESA, the Services will provide an incidental take statement with the biological opinion. The incidental take statement will provide the amount of anticipated incidental take with reasonable and prudent measures, necessary and appropriate, to minimize such take. The Services will also specify terms and conditions to implement the reasonable and prudent alternatives. As with other required consultations, the MMS has found historically that early coordination and interagency cooperation results in project plans that minimize impacts and avoid delays.

The consultation process, in many instances, results in mitigating measures incorporated into the project design or through lease stipulations.

Appendix E contains the Federal regulation pertaining to consultation requirements of the Endangered Species Act.

NOAA Fisheries

Pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation Act, all Federal agencies are required to consult with NOAA Fisheries on all actions, or proposed actions, permitted, funded or undertaken by the agency, that may adversely affect essential fish habitat (EFH).

For the purposes of clarification, the following terms are defined:

- "EFH" means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity;

- "Adversely affect" means any impact which reduces the quality and/or quantity of EFH.

Adverse effects may include direct (e.g., contamination, physical disruption), indirect (e.g. loss of prey), site-specific or habitat-wide impacts, including individual, cumulative or synergistic consequences of actions (50 CFR 600.810). When an EFH consultation is completed, it generally consists of:

- notification to NOAA Fisheries of a Federal action that may adversely affect EFH;

- an EFH assessment provided to NOAA Fisheries, preferably incorporated into the NEPA process;

- EFH conservation recommendations provided by NOAA Fisheries to the MMS; and

- MMS's response to NOAA Fisheries' EFH conservation recommendations.

The trigger for an EFH consultation is a Federal action agency's determination that an action or proposed action, funded, authorized or undertaken by that agency may adversely affect EFH. Historically, the MMS has always made a determination of "may adversely affect EFH" when authorizing beach nourishment or coastal restoration projects. In almost all cases, the MMS makes every effort to discuss EFH concerns with NOAA Fisheries, other cooperating agencies, and academia before entering into a formal consultation with NOAA Fisheries and during the development of the EFH assessment. Whenever possible the MMS uses existing interagency procedures established under NEPA (e.g. environmental assessments and environmental impact statements) and other environmental mandates to fulfill its EFH assessment responsibilities in order to streamline the consultation process. However, in some cases the MMS has used stand alone EFH assessment documents to fulfill its consultation responsibilities. Early coordination efforts have resulted in the early identification of appropriate conservation measures that help MMS minimize environmental impacts and avoid project delays. As with the FWS consultation process, coordination with NOAA Fisheries often results in conservation measures incorporated into the project design or through lease stipulations.

Appendix E contains the Federal regulation pertaining to essential fish habitat consultations.

PERTINENT LAWS AND PROCEDURES

Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) establishes a moratorium on the taking and importation of marine mammals and marine mammal products, with exceptions for scientific research, allowable incidental taking, exemptions for subsistence activities by Alaskan natives and hardship exemptions (16 U.S.C. 1371).

During preparation of a NEPA document (Environmental Assessment (EA) or EIS), as part of early coordination and interaction with the USFWS and NOAA Fisheries, the MMS partakes in the discussion of potential impacts to any species covered by the MMPA. The USFWS usually provides their comments in the form of a letter or as part of the Fish and Wildlife Coordination Act Report (FWCA 16 U.S.C. 662). NOAA Fisheries provides its comments in letter form as well. The concerns and/or recommendation of either agency must be addressed by the MMS. All practicable efforts are made to avoid the taking of a marine mammal. If the taking of a marine mammal is unavoidable, then the responsible agency will be contacted to begin the process of obtaining a permit for any take. It usually takes a minimum of a year to obtain a permit, if no additional studies are necessary. This lengthy time period is necessary because the issuance of a permit must be in the form of a regulation that appears in the Federal Register and must be coordinated with the Marine Mammals Commission, Committee of Scientific Advisor on Marine Mammals, and the public.

Appendix J contains the complete text of the Marine Mammal Protection Act of 1973.

National Historic Preservation Act

The National Historic Preservation Act (NHPA) establishes preservation as a national policy and directs the Federal government to provide leadership in preserving, restoring and maintaining the historic and cultural environment of the Nation. Preservation is defined as the protection, rehabilitation, restoration, and reconstruction of districts, sites, buildings, structures, and objects significant in American history, architecture, archeology, or engineering. The Act authorizes the Secretary of the Interior to expand and maintain a national register of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology and culture, referred to as the National Register.

The 1980 amendments established guidelines for nationally significant properties, curation of artifacts, and data documentation of historic properties, and preservation of Federally owned historic sites; required designation of a Preservation Officer in each Federal Agency; authorized the inclusion of historic preservation costs in project planning costs; and, authorized the withholding of sensitive data on historic properties when necessary. Federal agencies are directed to maintain historic properties in ways that consider the preservation of historic, archeological, architectural, and cultural values. Federal historic preservation programs shall insure that the preservation of properties not under the jurisdiction or control of agencies, but subject to be potentially affected by agency actions, are given full consideration in planning.

Federal agencies having direct or indirect jurisdiction over a proposed Federal or federally assisted undertaking shall take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register. Federal agencies shall afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on each undertaking (Section 106 (16 U.S.C. 470f). In addition, federal agencies shall assume responsibility for the preservation of historic properties that are owned or controlled by the agencies. They also shall establish a program to locate, inventory and nominate all properties under the agency's ownership or control that are eligible for inclusion on the National Register (Section 110(16 U.S.C. 470h-2)).

The MMS must be able to document compliance with the Act by including relevant coordination or consultation correspondence, study results, agency views and comments, and, if required, mitigation plans in MMS project reports and NEPA documents. The Act requires Federal agencies to develop and implement professional qualification standards for Federal employees and contractors.

Section 106, Review Process, directs Federal agencies, with direct or indirect jurisdiction over proposed Federal or Federally assisted undertakings, to take into account effects on historic properties, in accordance with regulations issued by the Advisory Council on Historic Preservation, and in consultation with the Council and the State Historic Preservation Officer.

Section 110 requires Federal agencies to assume responsibility for the preservation of historic properties owned or controlled by them and requires them to locate, inventory, and nominate all properties that qualify for the National Register. Agencies shall exercise caution to assure that significant properties are not inadvertently transferred, sold, demolished, substantially altered, or allowed to deteriorate.

Appendix I contains the complete text of the National Historic Preservation Act.

Coastal Zone Consistency

Congress enacted the Coastal Zone Management Act (CZMA) to protect the coastal environment from growing demands associated with residential, recreational, commercial, and industrial uses. The CZMA provisions help States develop coastal management programs (Programs) to manage and balance these competing uses. Section 307 of the CZMA gives States with Federally-approved programs the right to review for consistency any Federal activities and Federal licenses and permits that affect land and water use and natural resources of the coastal zone.

States can review sand and gravel lease issuances for Federal consistency. The MMS describes how the lease issuance is consistent "to the maximum extent practicable" with the Program's enforceable policies in a "consistency determination" (CD). Ninety days before MMS issues the leases, we send a copy of our CD to each affected State for Federal consistency review. The State must concur with or object to the consistency determination within a designated time period. If the State concurs, MMS can issue the leases. If the State objects, it must describe the inconsistency and any alternative measures that would allow the lease issuance to be consistent to the maximum extent practicable with the Program's enforceable policies. Generally, MMS tries to resolve any differences with the State; however, CZMA allows the Agency to proceed with issuing the leases notwithstanding any unresolved disagreements and provided that we describe in writing the legal impediments to full consistency or find our lease sale activity fully consistent with the enforceable policies. As well, the State and MMS can ask NOAA for mediation to work out any differences.

MMS ADVISORY COMMITTEES

Minerals Management Advisory Board

The Minerals Management Advisory Board (MMAB) advises the Secretary of the Interior, the Director of the MMS, and other officers of the Department of the Interior on issues related to leasing, exploration, development, and protection of the OCS, and royalty management of Federal and Indian leases and agreements for oil, natural gas, coal, and other solid minerals. The MMAB is composed of three Committees:

- The OCS Policy Committee

- The OCS Scientific Committee

- The Royalty Policy Committee

Although all three committees have potential responsibilities for offshore sand and gravel, only the first two committees are currently involved in OCS sand and gravel issues.

<u>The OCS Policy Committee's Hard Minerals Subcommittee</u>

The OCS Policy Committee formed a Hard Minerals Subcommittee in 1994 to provide advice and guidance on marine mineral issues and policy, particularly those concerning sand and gravel. The subcommittee consists of 5 members and a chairman. The specific responsibilities of the subcommittee are to:

- Provide support for the Secretary to implement recommendations of the OCS Policy Committee embodied in the Sand, Gravel, and Shell Resources Report of 1993.

- Provide support for legislation that would authorize the Secretary to negotiate agreements for leasing, extraction, and use of OCS hard minerals for private and public projects and for stand-alone legislation for exploration and leasing of all OCS hard minerals.

- Help develop policy and procedures for managing OCS hard mineral resources in consultation with Congress, coastal states, and private industry.

- Provide advice on demonstration projects, public outreach and education programs, environmental studies, and other activities related to OCS hard minerals.

The subcommittee is currently composed of:

- Larry Schmidt, Chairman (New Jersey) (to retire shortly)
- Donald Oltz (Alabama)
- Robert Jordan (Delaware)
- Lisa Edgar (Florida)
- John Wiltshire (Hawaii)
- George Banino (marine mining industry)

The OCS Scientific Committee

The purpose of the OCS Scientific Committee of the Minerals Management Advisory Board is to advise the Director of the MMS on the feasibility, appropriateness, and scientific value of the MMS OCS Environmental Studies Program (ESP). The ESP's main function is to obtain environmental information through research to support the decision process at all stages of the offshore minerals leasing program. This program operates under the following guidelines:

- To provide information on the status of the environment upon which the prediction of impacts of OCS minerals development may be based;

- To provide information on the ways and extent that OCS development can potentially impact the human, marine, biological, and coastal resources and areas;

- To ensure that information already available or being collected under the program is in a form that can be used in the decisionmaking process associated with a specific leasing action, or with the longer-term OCS minerals management responsibilities; and

- To provide a basis for future monitoring of OCS operations, including assessments of short-term impacts attributable to the OCS oil and gas and minerals programs.

The Committee reviews the relevance of proposed studies and of data being produced by the program and may recommend changes in the program's scope, direction, and emphasis.

This Committee consists of 10-15 members appointed by the Secretary for 2-year terms. Members may be appointed to serve two additional 2-year terms. They are appointed to the Committee based on their scientific competence, reputation within their particular fields of expertise, and ability to evaluate important elements of the OCS Environmental Studies Program. An active effort is made to balance membership with respect to technical skills and geographic representation. The Committee elects a Chair and Vice Chair from its members every 2 years. The Chief, Environmental Division, MMS, serves as the Executive Secretary for the Committee.

Recently, the OCS Scientific Committee established a Sand and Gravel Subcommittee to provide recommendations relative to environmental studies for offshore hard minerals. The present make-up of the subcommittee is as follows:

- Robert Diaz, Biologist, Chairman
- Charles Marek, Industry Representative
- James Coleman, Physical Processes Expert
- Duane Gill, Socioeconomist

IDENTIFICATION OF INFORMATION NEEDS

MMS RESOURCE STUDIES: STATE/FEDERAL COOPERATIVE EFFORTS TO LOCATE OCS SAND AND GRAVEL

The MMS began a cooperative sand evaluation program with a number of states on the east and Gulf coasts in 1992. The program was started in response to requests by the states to begin looking at the OCS for future sand supplies for beach nourishment. The states were concerned that, after the 20 or more years of using sand from state waters, the supplies were becoming depleted. The concept of the cooperative program was that MMS and the state would work jointly to explore and evaluate sand deposits in areas near beaches with the greatest need for renourishment. The MMS supplies part of the funds, with the state providing the rest. Oversight of the program is carried out by task forces established with each cooperating state. The task forces consist of members from MMS, the affected state agencies, and other Federal agencies as required. In addition to gaining valuable information about the sand resources and needs of the participating states, the program has enabled MMS to build close relationships with officials from those states.

To date, MMS has established cooperative agreements with 10 states: New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Florida, Alabama, Louisiana, and Texas (Figure 5). The first 6 as listed, were initiated in 1992. Texas and Alabama followed in 1993 and Florida and Louisiana began the next year. The sequence of activities of the cooperative projects is first making a thorough assessment of beach sand needs for the next 15-20 years, prioritizing the beaches in greatest need, gathering geological and geophysical information offshore of the highest-priority beaches and determining if sufficient volumes of suitable sand are available. Environmental studies are then initiated, including benthic biological surveys and computer-generated wave modeling for most of the best sand sites to determine impacts to the benthos and coastline if the sand is removed. Some of the states with short coastlines, like Delaware, have surveyed their portions of the OCS out to 10 miles, while others like Florida, with lengthy coastlines, will require more time to complete their assessments.

The MMS has contributed about $5,000,000 to the cooperative program, with the states matching that amount, mostly as in-kind contributions. Thus, the average outlay to each state has been around $50,000 per year. Several of the sand deposits identified and evaluated by the cooperative program have already been used for beach nourishment projects, including Great Gull Bank offshore Maryland (for Assateague Island projects), Sandbridge Shoal offshore Virginia (for Virginia Beach and Dam Neck Naval Base projects), and Canaveral Shoals offshore Florida (for Indialantic, Melbourne Beach, and Patrick Air Force Base projects.

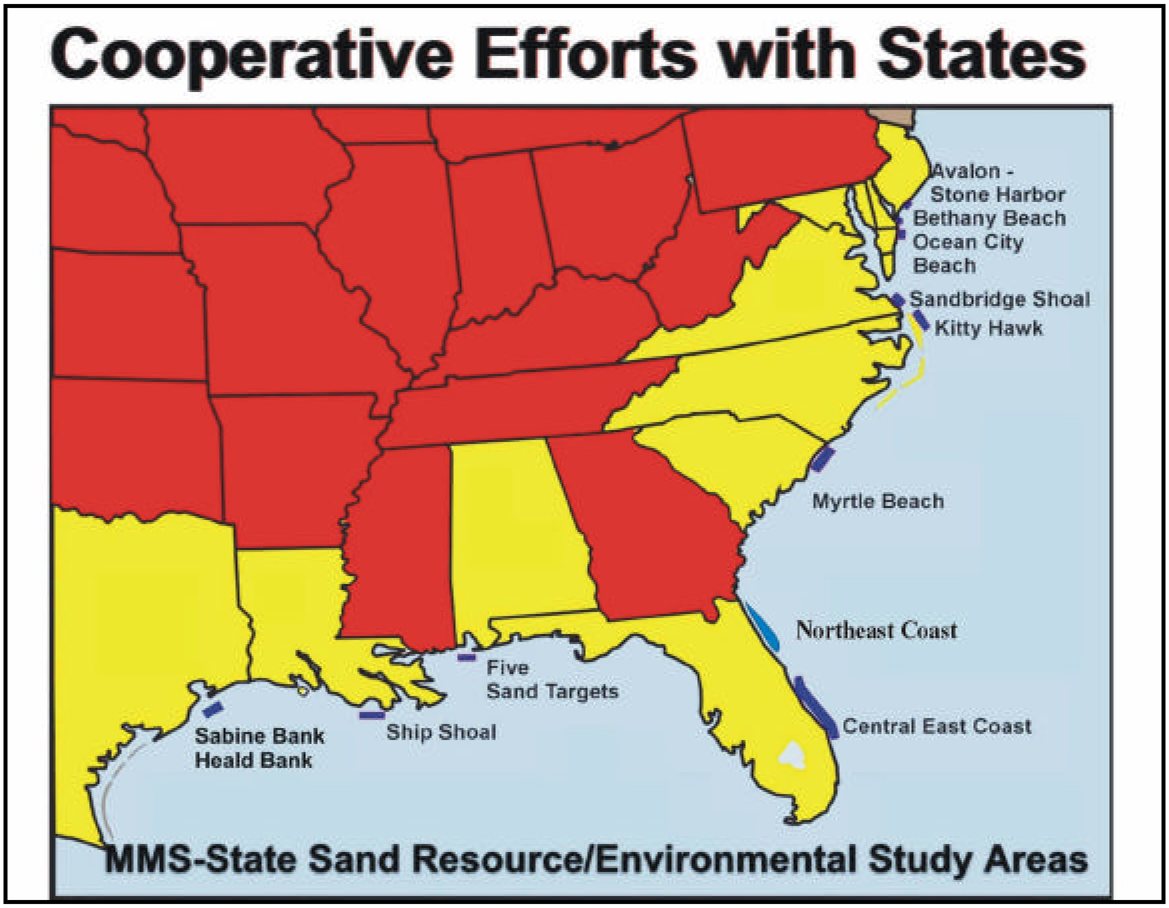


Figure 5. Location of MMS State-Federal Sand Investigations.

THE DREDGING PROCESS AND ASSOCIATED/RESULTANT IMPACTS

The following discussion represents a summary of open-ocean dredging processes and the potential impacts which may occur to various facets of the marine, coastal, and socioeconomic environments. This information is pertinent in that these factors drive the direction of the MMS studies program relative to the conduct of sand and gravel environmental studies.

A complete description of the dredging process and the potential impacts that may occur during a typical offshore operation, both for sand for beach nourishment and coastal restoration and for coarse material for use as construction aggregate can be found in Louis Berger Group, Inc. 1999. Hitchcock et al. 1998 also describes in detail the various types of dredges associated with offshore aggregate mining operations. The following references also contain detailed overviews of potential offshore dredging impacts:

- Blake et al.1996

- Hammer et al. 1993
- Research Planning, Inc. 2001a.

The Dredging Process

Dredge Types and Operating Characteristics

Dredges are grouped into two main classes: mechanically operated and hydraulically operated. With respect to a site-specific project, each type of dredge has its advantages and disadvantages. Offshore sand mining for beach nourishment projects employ the hydraulic type almost exclusively.

The types of dredges likely to be used in obtaining offshore sand for beach nourishment projects are cutterhead (Figure 6) and hopper dredges (Figure 7). Together with other factors (including practicality and costs), the distance from borrow site to beach determines the dredging and sand transport method to be used. Two methods of transport are commonly used: (1) a hydraulic cutter suction dredge pumps the material as a fluidized mass (slurry) through a pipeline from the borrow site to the beach, or (2) a hopper dredge, equipped with two dredgeheads and a hopper transports the collected sand when the hopper is full to the shore for unloading via an offshore pumpout shoreline connection, and subsequent placement on the beach.

Generally, if the borrow area is less than 5-6 km from the beach, then cutter suction and pipeline are used. If the distance is greater than 5-6 km, a hopper dredge is employed. Pipeline deployment over greater distances is possible, but is dependent upon the prevailing sea conditions at the site. A cutter suction dredge is more productive than a large hopper dredge because the latter cannot approach close to the beach with the prevailing water depths.

Most modern, high capacity dredges are of the hydraulic type employing suction produced by high speed centrifugal pumps to excavate the sediment and dispose of it, either through a pipeline or to a storage hopper. Material dislodged from the ocean floor by the suction is suspended in water in the form of a slurry and then passed through the centrifugal pump and discharge pipeline to the nourishment or disposal site.

Hydraulic dredges have very high production rates when the materials to be dredged are relatively soft and contain a high ratio of water. The cutter-suction dredge is the most widely used dredge in the industry. It is equipped with a rotating cutter which surrounds the intake end of the suction pipe. It can efficiently excavate all types of compacted sediments such as dense sands, gravel, clay and soft rock. The cutter-suction dredge is primarily used in beach nourishment projects and navigation/ channel

Figure 6. Cutterhead Suction Dredge.

Figure 7. Trailing Suction Hopper Dredge.

dredging.

The rotating cutterhead is usually an open basket with hardened teeth or cutting edges, somewhat like an over-sized dentist's drill. Figure 8 illustrates different types of cutterheads. The end of the suction pipe is normally located within the basket. In standard practice, the dredge is swung back and forth in an arc pivoted from a large post or spud attached to the stern. The cutterhead cuts downward a short distance with each swing. Because the cutterhead rotates in one direction only, the bite is much stronger on one swing than the other.

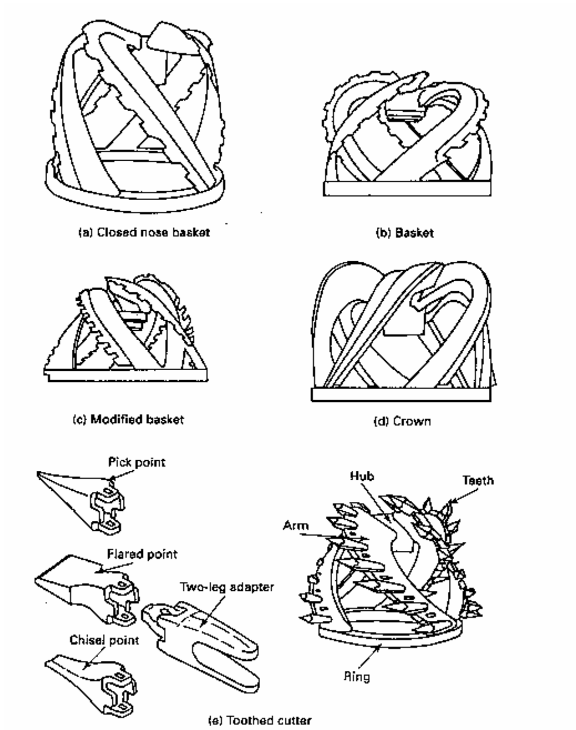


Figure 8. Types of Rotating Cutterheads.

Suction dredges circulate large quantities of slurry that, during most beach nourishment projects, is pumped ashore by pipeline along with the sand. As such, there may be a significant discharge of water containing fine particulate materials at the end point. Treatment of the decanted solids is normally unnecessary for beach nourishment activities. Around 90 to 95% of the excavated sand reaches the beach via the pipeline discharge.

Trailer Suction Hopper (TSH) dredges are self-propelled ships suitable for operations in an ocean environment and capable of mining sand and loading a self-contained hopper while the ship is underway. Most TSH dredges are twin screw and have bow thrusters which provide a high degree of maneuverability. Loading takes place as the ship moves ahead at a speed of 2-3 knots. Unloading can be by bottom discharge (bottom doors or split hull), pump discharge, or discharge by mechanical means (dragging, grab, etc.). The TSH dredges, while mainly used offshore for aggregate mining, are frequently employed on beach nourishment projects, especially where the distance of the borrow area to the shore is a factor. Hopper dredges are also used for mining offshore deposits of coarse sand and gravel for use as construction aggregate. A typical hopper dredge has a capacity of 3,060 m^3 with two drag-heads, each of 746 kW, and pump-out power of 3,282 kW. The dredge operates 24 hours a day; the typical cycle time is around 5 hours, excluding lost time due to repairs and maintenance. Time lost due to repairs may amount to as much as 3 hours daily. The disadvantage is that although the dredging rate is about 1,988 m^3/hour (higher than that of the cutter suction dredge) only about 20% of the hopper dredge's available working time is devoted to excavating.

A suction hopper dredge uses a pump to draw a slurry of bottom water and sediment through the dredgehead into a riser or pipe leading to the mining vessel. Figure 9 shows a typical dredgehead for a large, ocean-going hopper dredge.

Figure 9. Dredge Head on a Trailing Suction Hopper Dredge.

As the sediment accumulates in the hopper, much of the water decants overboard. As its name implies, the TSH dredge mines while in motion, creating numerous shallow trenches commonly about 1 m wide and 0.3 m deep as the dragheads traverse over the seabed. The dredge uses one of several dragheads, each of which is equipped with a coarse-grid steel framework positioned across the opening of the suction head to prevent large rocks from entering the suction pipe.

Once the hopper is full, the dredge travels to the pump-out mooring located not less than 2,500 feet seaward of the mean low water line. The borrow material is then pumped via a submerged pipeline directly onto the beach. Approximately 96% of the excavated sand is discharged onto the beach from the transfer pipeline.

Effluent Discharge at Sea

For beach nourishment dredging using either type of dredge, there is virtually no solids effluent discharged at sea, and resuspended materials are localized to the vicinity of the excavation tool.

Typical Depth of Cut

An examination of pre- and post-dredging bathymetric survey maps for several OCS beach nourishment dredging projects indicates that the average total depth of cut for a 1,000,000 to 2,000,000 cubic yard excavation within a borrow area was 2- m. However, there have been limited zones for some projects where the final excavation depth has been as much as 3-m to 5-m or slightly more. Construction solicitations and specifications documents, as well as MMS stipulations for negotiated leases generally have provisions that limit the dredge cuts in borrow areas to specific depths below the seafloor and limit side-slope ratios to 1:2 or less.

Emplacement on the Beach/Determining the Suitability of an Offshore Sand Source as Beach Nourishment Material

Excavated material comes ashore through a pipeline where bulldozers and graders distribute and smooth out the material. Generally, 2 - 4 bulldozers and an equal number of graders are required. Work normally proceeds in segments of approximately 500 feet in length.

A beach renourishment procedure involves the construction of a "toe dyke" or "bund" by bulldozing existing sand to the outer, seaward limit of the future beach outline. The base of the bund is below sea level and the top protrudes 1 to 2 m above. The bund serves to protect sand placed in the fill area behind it from immediate erosion by the surf. Requirements for efficient renourishment of the beach are a fill area >30.5 m wide and a sufficient depth of fill, the preferred build-up being to 3.7 m above sea level.

To determine suitability of a specific sand source for beach nourishment, the mean grain size of the source material should be close to or slightly larger than that occurring at the in-situ or target beach. The term "beach quality" sand commonly infers a significant or a high degree of similarity between the sediment textural parameters of the sand source (shoal or deposit) and the sand target (coastal beach). However, estimates of beach quality are often considered by assessing an "overfill factor". The "overfill factor" concept and determination methodology were developed to describe a measure of the amount of source material that would be required to be placed on a target beach to compensate for the losses that occur from natural winnowing processes along the shoreface. The overfill factor represents the number of cubic meters (m^3) of material required to create one cubic meter (1 m^3) of in-situ beach when the beach is in a condition compatible with the native material. Overfill factors are expressed as a ratio of a unit volume of natural or in-situ beach to a volume of source material required; the factor is commonly listed as the unit of fill volume required.

Summary of Potential Impacts Associated With Offshore Dredging on the Federal OCS

This summary describes the potential effects of open-ocean dredging operations. Navigational and channel dredging impacts are not considered.

Geologic setting plays a multiple and long-reaching role in any project to dredge offshore sand for beach nourishment. Existing geological conditions place practical constraints on the implementation of the action, and the action itself will have numerous impacts on existing geologic processes and conditions. These impacts, in turn, have a potential to affect biological and physical processes onshore and offshore.

The siting of the dredging operation is controlled by existing geological conditions, i.e., the location of the geomorphic features and geologic structures with available and suitable sand reserves. The geologic conditions at a chosen borrow site will place constraints on the methodologies used to recover sand. The chosen methods, in turn, will impose method-specific environmental impacts and affect the cost of recovery.

Changes in Bathymetry

Dredging for sand has the potential to change the existing bathymetry at the borrow site. Dredging at a shoal may result in the total removal of a topographic feature. If the dredging operation is not engineered properly, a bathymetric depression or pit may result. If select areas of a shoal are dredged (e.g., the crest), there may be an increase in the depth of the water column over these areas. Dredging of a relatively flat sand sheet would leave a pit or trench. Dredging to remove subsurface channel sands may also leave a pit on the seafloor. Each of these changes could affect current patterns at the site. Maa et al., 2001 suggest that changes in existing current strengths and directions will, in turn, alter depositional patterns.

Although unlikely to occur in Federal waters, in shallow, coastal, nearshore environments, studies have indicated that water movement in a pit may be reduced and lead to the development of anoxic conditions. Diminished current velocities over a pit may promote the deposition of fine sediments. If the sediment supply is not sufficient to fill up the pit with either sand or fines, it will persist. On the other hand, changes in currents may result in the scour of pits and the removal of fine sediments. Changes in the topography of an area may also result in deleterious effects to fish populations which, in many cases, are tied to specific habitats and bottom areas (Cutter and Diaz, 2000; Diaz et al., 2003, in-press).

Altered Bottom Substrate

The bottom substrate at and near a borrow site may be modified in several ways. As discussed above, a change in the hydrologic regime as a consequence of altered bathymetry may result in the deposition of fine sediments where there had been a shifting sand sheet environment.

Existing substrate characteristics may also be changed by the exposure of underlying sedimentary units. The removal of surficial or subsurface sand units may expose underlying material that has different textural and compositional properties than the existing surface substrate. The most drastic change would be from sand to mud.

The bottom substrate at a distance from the borrow site may also be modified by the deposition of sediments in benthic and surface plumes generated by dredging activities. Sediments contained within plumes produced from the disturbance and resuspension of bottom sediments, and from discharges of the dredging vessel and equipment, will settle out from the water column and be deposited at a distance from the dredge site. The resedimentation of resuspended sediments may result in a layer of sediment that differs from the existing substrate. A change in bottom substrate from the original may result in the repopulation of a dredged area by different benthic infaunal species than the pre-dredging resident community (Newell et al. 2001).

Turbidity (Water Quality)

The primary water quality impact during sand dredging operations is increased turbidity (i.e., water with elevated suspended sediment concentrations) (Hitchcock et al., 1998). Factors that affect the turbidity levels include the following variables:

- characteristics of the dredged material (e.g., size distribution);

- nature of the dredging operation (i.e., dredge type and size, relationship between the cutter and the magnitude of hydraulic suction, type of draghead, the magnitude of hydraulic suction and the speed of the vessel); and

- waves and currents at the location of the dredging operation.

The dispersion of turbid water during dredging throughout the area is referred to as a turbidity plume. The plume is generally a temporary impact governed by factors such as sediment concentration, size distribution and shape. Different dredges generate turbidity during different processes. The TSH dredges trigger a small plume at the seabed from the draghead ("benthic plume") and a larger surface plume from the discharge of overspill of water with suspended sediment from the hopper (i.e., pumping past overflow of the hopper). The overspill occurs during "economic loading" of the hopper with consolidated sediment. Economic loading entails pumping dredged material into the hopper until all the material overflows.

Exposure of marine organisms to turbidity can result in clogging of feeding and respiration structures. Uptake of turbid waters by fish cause an overproduction of mucus over their gill filaments which can result in suffocation. Fish encountering reduced oxygen levels will leave the area. Sessile marine organisms such as some shellfish species, sponges and tubeworms will be unable to flee the area and may be smothered.

Non-biological impacts of turbidity may include reduced aesthetic appeal of a coastal area if the adjacent surface waters are clouded by a sediment plume. Archeological sites may be damaged by dredging or covered by sedimentation (New Jersey Council of Diving Clubs, 1997). Hydrodynamic and mechanical interaction of the draghead with the seabed will 'throw' finer grained sediment into suspension around the draghead from where it can be transported before settling out, potentially resulting in the burial of shipwrecks or prehistoric sites.

Impacts on Marine Mammals

Potential direct impacts to marine mammals include: disturbance to benthic and aquatic habitats; disturbance to the prey base; interference with filter feeding; noise disruption; and potential collisions between equipment or transport vessels and marine mammals. Certain types of impacts, such as vessel collisions are more likely to affect certain species which have surface feeding or resting habits, such as the right and humpback whales. Similarly, marine mammals that are slow swimmers may have difficulty avoiding a fast moving vessel.

Noise, a byproduct of dredging operations, can directly affect marine mammals by altering normal behavior patterns. Researchers have suggested that most marine mammals become habituated to low level background noise, such as ship traffic and offshore petroleum activities. However, some animals show abrupt responses to sudden disturbances (Hammer et al. 1993). Noise associated with dredging operations may have a greater effect on species that are more sensitive to low-frequency sound than on species with different optimum hearing ranges.

Dredging for sand can affect the ability of marine mammals to obtain food in several ways. Dredging operations can cause the animals to avoid particular feeding areas due to noise or vibrations. Turbidity plumes caused by offshore dredging can affect species of concern and their prey in a variety of ways. Decreased feeding success and prey availability may occur in areas of increased activity-related turbidity. Decreased visibility can affect foraging ability by those species that use sight as a primary means to locate prey. Particulate matter may have deleterious effects on filter feeders and gilled organisms, although mobile, free swimming biota, such as pelagic fish, can avoid turbid areas. In that, dredge plumes have been noted many miles downstream of an active dredge operation, these effects could be experienced outside the immediate vicinity of the dredging activity (Hitchcock et al. 2002).

Operations using hopper dredges tend to be discontinuous and associated plumes would be dispersed over a larger area. However, because the concentration of the suspended particles in the plume diminish rapidly with time and distance from the source, the effects on fauna further away from the activity are reduced. In general, the effects of turbidity on phytoplankton or pelagic fish and invertebrates (due to gill irritation and reduction of light levels for visual feeders) are considered small (see literature in Hammer et al. 1993).

Within the water column, the effects of particulates on drifting biotic communities are considered negligible because of the limited area affected and the typically short exposure time (Louis Berger Group, Inc. 1999). A suction hopper dredge usually operates for three to four hours during a 14 hour period, with the remaining time spent in transit or unloading sand. This discontinuous method of offshore dredging under most conditions allows suspended sediments to dilute, dissipate and settle.

Impacts on Benthic Biological Resources

The primary ecological impact of dredging sand borrow areas is the complete removal of the existing benthic community through entrainment into the dredge. Mortality of the benthic infauna and epifauna will occur as they pass through the dredge pump (Hobbs, 2002). In addition, excessive siltation and increased turbidity associated with offshore dredging and nourishment processes can result in impacts to marine organisms. Siltation and burial of benthic organisms and reef/hard bottom habitat is an issue of concern, and the increase in turbidity affects both filter-feeding organisms and fishes. Larval and juvenile fish, in particular, are especially sensitive to dredging-induced turbidity, as their gills may become clogged or abraded by floating particulates. The feeding ability of "visually dependent" larval and juvenile fishes may be decreased due to a reduction in available light.

Organisms living in the sediments being dredged from Federal OCS sites may be removed and/or destroyed. The borrow areas being dredged are generally recolonized by adult organisms from adjacent areas or by recruitment of larval and juvenile organisms from the surrounding area. The rate at which a borrow area recovers and the degree to which the community returns to its original density and species composition is dependent upon the duration and timing of the dredging, sediment composition of the borrow area, the hydrodynamics of the borrow pit and surrounding area, the degree of sedimentation that occurs following dredging, and the type of dredging equipment used to remove the sediment (Newell et al. 1998; Newell et al. 2001; Hitchcock et al. 2002). The physical characteristics of the site can be changed by dredging. The borrow area may fill in with a different type of sediment (e.g. silt vs. clay) or the currents through the area are altered by the change in topography. This could influence recolonization rates as well as community composition. If the changes in the physical environment are significant some species native to the area may be unable to recolonize that location.

Impacts on Fishes

Potential impacts to juvenile and adult fish include direct burial and gill clogging or abrasion. Only the less motile species of fish, or those which feed exclusively on non-motile prey, are expected to be impacted by dredging efforts (Van Dolah, 1992). Most other species will leave an area while dredging occurs, significantly decreasing their abundance and diversity for the short term, and will return to the borrow area shortly after dredging is completed. Available food sources (i.e., benthic invertebrates) could be significantly depleted during dredging and may affect the foraging success of bottom feeding fish. Depending on the recovery rate of the benthic communities in the dredged area, this may have short-term or long-term effects on fish distributions in a specific area. Changes in benthic topography could also remove physical characteristics necessary as habitat for some fish.

Impacts on Commercial and Recreational Fisheries

The impacts that an offshore dredging operation may have on resident commercial and recreational fisheries will vary to a large extent on the intensity of the operation and its duration. The degree of impact on a fishery is in direct correlation with the effects on the biodiversity, biomass, population density, and the extent of dredging based on method, intensity, and dredge duration at one particular site. Wainwright et al (1992), in a study of benthic marcoinvertebrates in a coastal, nearshore area noted that dredging projects have the potential for negative impacts on key fishery resources and possibly the fishing industry itself. These effects have been an issue of environmental significance for decades, yet little research has been undertaken relative to impacts of actual operations on fish populations or food sources.

A dredge operation may temporarily result in spatial exclusion of the area surrounding the dredging activity or temporary suspension of commercial and/or recreational fishery activities. Commercially or recreationally targeted fish species may also temporarily flee an area while dredge activities are being conducted (Oakwood Environmental,1998).

Impacts on Archaeological Resources

In some Federal OCS areas submerged archaeological properties may be present. These properties could consist of drowned prehistoric or historic terrestrial sites or historic shipwrecks. Some of these sites are considered significant under criteria established for the National Register of Historic Places, others are not. Significant archaeological resources need to be identified, assessed, and protected under the requirement of the National Historic Preservation Act.

Regardless of whether shipwrecks are historic in nature, they often are focal points for certain fish and are now considered potential EFH by NMFS, especially if these structures are the only hard habitat for miles around. In many cases, as noted by diving groups at public meetings and in comments received in response to various Federal Register public notices, these structures support recreational fisheries worth many millions of dollars. Various fisheries plans for specific fish species specifically mention shipwrecks as key habitat for particular species. Shipwreck sites are also used extensively by sport divers, recreational fishermen, and commercial fishermen.

Offshore dredging and beach nourishment activities have been known to result in the burial of wrecks by as much as 10 feet of sand and recovery is unlikely given the replenishment schedules and reuse of many borrow areas over a period of time. Environmental groups in New Jersey have cited some of the replenishment projects in the State as having severely damaged fisheries habitat in New Jersey. Wrecks have also been impacted directly by dredges. In 1997 a dredge that had been contracted by the Army Corps of Engineers to recover sand for the massive Sandy Hook to Manasquan Inlet, New Jersey Sand Replenishment Project destroyed a shipwreck in Belmar Borrow Area Six. In this case, the dredge actually sucked or lifted parts of the shipwreck out of the water and deposited it on the beach, as reported in several newspapers (New Jersey Council of Diving Clubs, 1997).

In addition, there an incident was reported to MMS by a concerned citizen during the public comment phase for a possible Federal OCS competitive sale for coarse sand and gravel off the coast of New Jersey whereby a prehistoric site was dredged up off Sandy Hook, New Jersey and re-deposited on the beach (the so-called “Corcione Site”). There are also cases along the Atlantic seaboard where early colonial sites have been submerged during a sea level rise in the 17th century, so the potential that historic properties could be adversely affected does exist. When the sandy alluvial fill material within offshore Pleistocene/Holocene river channels is the target of dredging activities, there is a high potential for impact to inundated prehistoric sites.

Air Quality Impacts and Considerations

Air quality impacts associated with dredging operations occur as a result of the operation of the dredge pumps, the pump-out equipment, the dredge propulsion engines, tugs and barges, and heavy equipment utilized on the beach. This equipment may emit various air pollutants in the offshore area and at the beach over an extended period of time. The type of dredging activities and equipment used that induce air emissions vary by the dredging methods. The two typical methods used in the U. S., trailing suction hopper and hydraulic cutter-suction dredges both tend to emit critical air emissions in the form of nitrogen oxides (NO_x), with smaller amounts of SO_2, VOC, CO and PM.

When a hopper dredge is used, air emissions result from the diesel engines used for the operation of the pumps during the dredging, propulsion as the dredge moves from the excavation site to the discharge site, and the pump-out at the pipeline near the beach. In addition, the emissions resulting from the operation of tugboats and barges for relocating the mooring buoys, from auxiliary power and engine idle, and on shore pollutants generated by those bulldozers and trucks engaged in beach filling and grading operations need to be considered as well.

When a cutter-suction dredge is used, the dredge stays around the excavation site and the excavated material is transported directly to the beach as a slurry in a pipeline. While the emission characteristics are similar to those emissions associated with a hopper dredge, over water air emissions generally occur at a farther distance from shore.

Section 176(c) of the Clean Air Act, as amended in 1990, requires federally-sponsored or approved projects to have a conformity determination undertaken, which is defined as conformity to a State Implementation Plan's purpose of eliminating or reducing the severity and number of violations of the National Ambient Air Quality Standards and achieving expeditious attainment of those standards, as indicated in the U.S. Environmental Protection Agency developed "Determining Conformity of General Federal Actions to State or Federal Implementation Plans; Final Rule" (40 CFR Parts 6, 51 and 93). In the final rule, the emission thresholds are established and any project resulting in emissions exceeding the thresholds have to follow all procedures and guidelines described in this rule for conformity determination. For a project site within a severe non-attainment area, the threshold is 25 tons/year for NO_x and VOC. For a project site located at a moderate or marginal non-attainment area within an Ozone

Transport Region, the threshold is 100 tons/year for NO_x and 50 tons/year for VOC. The emission thresholds for the most critical project pollutant NO_x varies by area.

SUMMARY OF MMS SAND AND GRAVEL ENVIRONMENTAL STUDIES CONDUCTED/ONGOING TO DATE

Federal Outer Continental Shelf (OCS) sand and gravel resources must be wisely managed to ensure that environmental damage to the marine and coastal environments is minimized, mitigated, or does not occur. The MMS has focused on integrating the collected resource data provided through the State/Federal cooperative efforts with environmental information to not only identify suitable OCS sand deposits, but also to provide needed environmental information to make decisions regarding the use of Federal sand for future beach nourishment activities.

Since 1992, MMS has spent over $8 million for marine mineral environmental studies. Site-specific, interdisciplinary studies have been conducted in identified sand borrow areas to provide basic information on the biological character of resident benthic communities, as well as the evaluation of potential dredging effects on the local wave and current regime.

The primary purpose of MMS-funded site-specific biological studies has been to address biological concerns raised by the potential for adverse environmental impacts on marine life as a consequence of dredging sand on the OCS. In order to develop an understanding of the baseline benthic ecological conditions at offshore borrow sites prior to any dredging activity, the MMS has funded numerous site-specific, field-oriented studies. These studies have entailed the compilation and synthesis of existing oceanographic literature and available data sets which exist within identified offshore borrow areas, as well as biological field sampling surveys.

The biological field sampling surveys have involved the collection of traditional benthic grab samples, sediment profile camera images, fish trawls, and video sled footage. As a result of these efforts, the MMS has been able to characterize and evaluate present benthic and pelagic communities within offshore borrow sites and address the possible effects of offshore sand dredging, including interpretations as to the potential rate and success of recolonization following cessation of dredging. In addition, the studies present a time schedule of environmental windows that best protects benthic and pelagic species from adverse environmental effects.

Prior to any dredging activity, the potential for adverse changes in the local wave and current patterns created by alterations in the local bathymetry must be assessed. Increased wave action after dredging offshore shoal areas has been noted, in certain coastal areas of the U.S., to result in localized changes in erosional patterns and longshore coastal transport. A proper and thorough assessment must take into account the local current regime and the historical wind and wave climate.

The MMS has funded numerical wave modeling studies to examine the potential for alteration in the local wave field following dredging and the excavation of sand within identified borrow sites. The modeling also explores the potential for increased wave action after dredging and any resultant adverse localized changes in erosional patterns and longshore coastal transport which might result in significant losses of beach sand after renourishment. These efforts have enabled MMS-funded researchers to further explore the potential for changes in local sediment transport rates, as well as the cumulative physical effects of multiple dredging events.

Recognizing that the environmental effects of dredging operations in many instances are similar for all areas, generic-type studies have also been initiated to examine the effects of particular types of dredging operations on various aspects of the physical, chemical, and biological environments, and to develop or recommend appropriate mitigation, laboratory modeling, or monitoring techniques to alleviate or prevent adverse environmental impacts.

Since the Federal OCS also represents a future source of coarse sand and gravel for use as construction aggregate, MMS has also funded work in the United Kingdom to assess the potential for environmental damage associated with offshore aggregate mining in the event that such an endeavor is proposed for the U.S. OCS. These efforts have focused upon the extent and potential impacts associated with the surface and benthic plumes generated during the aggregate operation and the possible effects of these plumes on benthic organisms residing in the vicinity of the dredging operation.

The studies information is used by MMS analysts to evaluate the effects of specific proposed dredging operations, as required under current environmental laws and legislation. The results are also incorporated, as appropriate, in lease requirements and stipulations for the dredging of OCS sand.

Table 2 lists completed and ongoing MMS sand and gravel environmental studies as of the end of February 2003. Table 3 lists the peer-reviewed journal articles which have been published or are in the process of being published. Appendix C contains technical summaries for many of the completed efforts.

Table 2. Summary of Marine Minerals Environmental Studies (as of February 28, 2003).

Study Title	
COMPLETED STUDIES	
Marine Mining Literature Search Study	OCS Study MMS 93-0006
Marine Mining Mitigation and Technology Study	OCS Study MMS 95-0003
Marine Mining Placer Mining Test	No report submitted
West Florida Shelf Benthic Repopulation Study	OCS Study MMS 95-0005
Wave Climate Modeling and Evaluation Relative to Sand Mining on Ship Shoal, Offshore LA, for Coastal and Barrier Islands Restoration	OCS Study MMS 96-0059
Synthesis of Hard Mineral Resources on the Florida Panhandle Shelf	Final report submitted Sept. 1998
Environmental Surveys of OCS Sand Resources off Virginia	OCS Study MMS 97-0025
Investigation of Benthic and Surface Plumes Associated With Marine Aggregate Dredging Activities	OCS Study MMS 99-0029
Environmental Surveys of OCS Sand Resources Offshore Alabama	OCS Study MMS 99-0052
Development of Criteria to Evaluate Wave Refraction Models	OCS Study MMS 99-0046
Environmental Survey of Potential Sand Resource Sites Offshore Maryland and Delaware	OCS Study MMS 2000-055
Environmental Surveys of OCS Sand Resources Offshore New Jersey	OCS Study MMS 2000-052
Wave Climate and Bottom Boundary Layer Dynamics with Implications for Offshore Sand Mining and Barrier Island Replenishment, South-Central Louisiana	OCS Study MMS 2000-053
Study of the Cumulative Effects of Marine Aggregate Dredging	Final report submitted Sept. 1999
Design of a Monitoring Protocol/Plan for Environmentally Sound Management and Development of Federal Offshore Sand Borrow Areas Along the United States East and Gulf of Mexico Coasts	OCS Study MMS 2001-089
A Numerical Modeling Examination of the Cumulative Physical Effects of Offshore Sand Dredging for Beach Nourishment	OCS Study MMS 2001-098
Integrated Study of the Biological and Physical Effects of Marine Aggregate Dredging on the Seabed	OCS Study MMS 2000-054
Table continued on next page	

Table 2 continued

ONGOING STUDIES	
Collection of Environmental Data Within Sand Resource Areas Offshore North Carolina and the Environmental Implications of Sand Removal for Coastal and Beach Restoration	Applied Coastal Research and Engineering
Environmental Surveys of Potential Borrow Areas on the East Florida Shelf and the Environmental Implications of Sand Removal for Coastal and Beach Restoration	Continental Shelf Associates
Environmental Surveys of Potential Borrow Areas Offshore Northern New Jersey and Southern New York and the Environmental Implications of Sand Removal for Coastal and Beach Restoration	Applied Coastal Research and Engineering
Model Development or Modification for Analysis of Benthic and Surface Plume Generation and Extent During Offshore Dredging Operations	Baird Engineering
Winter Waterbird Survey of Offshore Shoals From Northern New Jersey to the Virginia/North Carolina Border	U. S. Fish and Wildlife Service
Field Testing of a Physical/ Biological Monitoring Methodology for Offshore Dredging and Mining Operations	Virginia Institute of Marine Science
Environmental Investigation of the Use of Shoals Offshore Delaware and Maryland by Mobile Benthos and Finfish Species	Versar
Worldwide Analysis of Shipwreck Damage Caused by Offshore Dredging: Recommendations for Pre-operational surveys/mitigation During Dredging to Avoid Adverse Impacts	Research Planning, Inc.
Wave-Bottom Interaction and Bottom Boundary Layer Dynamics in Evaluating Sand Mining atbine Bank for Coastal Restoration, Southwest Louisiana (GOM LSU CMI) (Final report due May 2005)	Louisiana State University
Focused Analysis/Review of Benthic Assemblages on Ridge and Shoal Features of the U.S. East and Gulf of Mexico Coasts	USGS-Biological Resources Division
Investigation of Finfish Assemblages and Benthic Habitats Within Potential Borrow Areas in Federal Waters Offshore Southeastern Texas and Southwestern Louisiana	USGS-Biological Resources Division
FISCAL YEAR 2004 STUDIES IN PROCUREMENT	
Review of Existing and Emerging Environmentally-Friendly Offshore Dredging Technologies	
Analysis of Potential Biological and Physical Dredging Impacts on Offshore Ridge and Shoal Features/Engineering Alternatives and Options to Avoid Adverse Environmental Impacts	

Table 3. Peer Reviewed Publications resulting from MMS Marine Minerals Environmental Studies
Hobbs, C.H., III. 2002. An Investigation of Potential consequences of marine mining in shallow water: an example from mid-Atlantic coast of the United States. *Journal of Coastal Research* 18(1):94-101.
Maa, P.– Y. Maa, C.H. Hobbs, III, and Hardaway, S.C. Jr. 2001. A criterion for determining the impact on shorelines caused by altering wave transformation. *Journal of Coastal Research*, 17(1):107-113.
Maa, J.P.– Y and C.H. Hobbs, III, 1999. Physical impact of waves on adjacent coasts resulting from dredging at Sandbridge Shoal, Virginia. *Journal of Coastal Research*, 14(2):525-536.
Newell, R.C., L.J. Seiderder, N.M Simpson, and J.E. Robinson. 2001. Animal: sediment relationships n costal deposits of the eastern English Channel. Impacts of Marine Aggregate Dredging on Benthic Biological Resources in Coastal Deposits. Journal of the Marine Biological Association of the United Kingdom, 81:1-9.
Newell, R.C., L.J. Seiderder, N.M Simpson, and D.R. Hitchcock. 1998. The Impact of Dredging works in Coastal Waters: a review of the sensitivity to disturbance and subsequent recovery of biological resources on the seabed. Oceanography and Marine Biology, 36:127-178.
Pepper, D.A., Stone, G.W., Wang, P. 2000. A Preliminary Assessment of Wave, Current, and Sediment Interaction on the Louisiana Shoreface Adjacent to the Isles Dernieres. *Estuaries* (in press).
Stone, G.W. and McBride, R.A. 1998. Louisiana barrier Islands and their Importance in Wetland Protection: Forecasting Shoreline Change and Subsequent Response of Wave Climate." *Journal of Coastal Research*, 14(3):900-916.
Stone, G. W., Xu, J.P. and Zhang, X.P.1995. Estimation of the Wave Field During Hurricane Andrew and Morphological Impacts along the Louisiana Coast, *in* Impacts of Hurricane Andrew on the Coastal Zones of Florida and Louisiana: August 22-26, 1992. G. W. Stone and C. W. Finkle(eds.). *Journal of Coastal Research, Special Issue.* 21:234-253.
In Press
Byrnes, M.R., R.M. Hammer, T.D. Thibaut. Potential Physical and biological effects of sand mining off New Jersey. *Journal of Coastal Research*, *Special Issue*.
2002. Byrnes, M.R., R.M. Hammer, T.D. Thibaut. Potential Physical and biological effects of sand mining off Alabama. *Journal of Coastal Research*, *Special Issue*.
Diaz, R.J. et al. In press. The importance of physical and biogenic structure to juvenile fishes on the shallow inner continental shelf.
Diaz, Robert, J.P. Maa, and C.H. Hobbs, III. Possible Impacts of Sand Mining Offshore of Maryland and Delaware: Part 2 – on biological aspects. *Journal of Coastal Research.*
Hayes, Miles and Rob Narin. Paper on offshore Ridge and Shoal Features. *Journal of Coastal Research*, *Special Issue*.
Hitchcock, D.R., and Steve Bell. Physical Impacts of Marine Aggregate Dredging on seabed resources in costal deposits. *Journal of Coastal Research*, *Special Issue*
Kelley, S., J. Ramsey, and M. Byrnes. Numerical Modeling Examination of the Cumulative Effects of Offshore Sand Dredging for Beach Nourishment. *Journal of Coastal Research, Special Issue.*
Table continued on next page

Table 3 continued
Maa, J.P., C.H. Hobbs, III., S.C. Kim, and E. Wie. Possible Impacts by Cumulative Sand Mining Offshore of Maryland and Delaware: Part 1 – on physical oceanographic processes. *Journal of Coastal Research, Special Issue*
Maa, J.P.-Y., Hsu, T.-W., Tsai, C.-H., and W, J, Juang, Comparison of wave refraction and diffraction models. *Journal of Coastal Research, Special Issue.*
Michel, J. Regional Management Strategies for Federal offshore Borrow Areas, U.S. East and Gulf of Mexico Coasts. *Journal of Coastal Research*, *Special Issue*.
Nairn, R., J.A. Johnson, D. Hardin, and J. Michel. Development and design of a biological and physical monitoring program for the evaluation of long-term impacts to the marine environment from offshore sand dredging operations in the united states outer continental shelf. *Journal of Coastal Research*, *Special Issue*.
Newell, R.C., L.J. Seiderder, N.M Simpson, and J.E. Robinson. Impacts of Marine Aggregate Dredging on Benthic Biological Resources in Coastal Deposits. *Journal of Coastal Research*, *Special Issue*.
Stone, G.W., D.A. Pepper, J. Xu and X. Zhang. Ship Shoal as a prospective borrow site for barrier island restoration, coastal south-central Louisiana, USA: Numerical wave modeling and field measurements of hydrodynamics and sediment transport. *Journal of Coastal Research*.
Vittor, B.A., T.D. Thibaut, R.M. Hammer, and D.B. Snyder. 2001. Temporal and Spatial Factors Influencing Infauna, Epifauna, and Demersal Fishes Associated with Sand Resource Areas of the Inner Continental Shelf Offshore Alabama. *Gulf of Mexico Science, in press.*

SAND AND GRAVEL ENVIRONMENTAL RESEARCH COMPONENTS

Research Considerations: General/NEPA

Relative to the NEPA process, research is used to assess what may happen from a particular action. Therefore, research must be tailored to meet the needs of possible development prospects. It is then applied to decisions made at the policy level. Studies information is extrapolated and applied to the proposed action. Thus, studies are not specific to a policy, but they are conceptually oriented towards possible effects.

Research Considerations with Respect to the Location of Sand Borrow Areas

The use of Federal OCS sand as a source of beach renourishment/coastal Restoration material will continue into the foreseeable future, especially given the growing scarcity of material in State waters and the adverse environmental impacts associated with the continuous removal of Nearshore sand material. Federal sand will serve as a primary and emergency source of material for beach nourishment and coastal restoration coastal restoration offshore all of the Atlantic states from New Jersey to Florida (with the exception of Georgia), as well as the Gulf of Mexico States of Alabama, Louisiana and Texas. Table 4 shows anticipated near-term requests for Federal sand from several coastal states. Potential borrow sites are being investigated and evaluated through the MMS/State partnerships offshore New Jersey, Long Island, New York, Virginia, the east and west coasts of Florida, the west coast of Louisiana, southern North Carolina, and offshore Texas. These efforts will continue to generate the need for environmental information.

Currently, the States of Virginia and North Carolina, in cooperation with the MMS, and the U.S. Army Corps of Engineers are identifying new OCS sources of material for beach and coastal restoration offshore southeastern Virginia (False Cape area) and the Bogue Banks area of southern North Carolina. Requests from the State and local jurisdictions to use these sites are expected within the next 3 to 5 years.

An area of intense focus is the southwestern Louisiana/southeastern Texas coast which which is undergoing severe erosion. In the early 1990's, the Texas Bureau of Economic Geology and the MMS completed cooperative projects that delineated the Heald and Sabine Banks in Federal waters offshore of Galveston and the Bolivar Peninsula as extensive resources containing beach-quality sand. Furthermore, several coastal sites in the vicinity of Galveston Island have been identified as areas of severe coastal erosion. The need for new sand resources for these areas is nearing the critical stage as sources in State waters are not available. In FY 2000, the MMS and the State of Texas agreed to reactivate and reinvigorate the cooperative agreement. Support is

Table 4. Anticipated/Possible Conveyances of Federal Sand in the Near-Term (within the next 1 to 5 years).

STATE	LOCALITY	CUBIC YARDS WHICH MIGHT BE CONVEYED
LOUISIANA	Ship Shoal for LA Barrier Island projects (Barataria Basin projects/Whiskey Island west flank project)	20,000,0000 – 30,000,0000
LOUISIANA/TEXAS	Holly Beach, LA/Texas Beaches (from Sabine Bank)	4,000,000 – 6,000,000
LOUISIANA	Houma levee project (Ship Shoal)	10,000,000
VIRGINIA	Virginia Beach resort strip	?
VIRGINIA	Dam Neck Naval Facility	1,000,000-2,000,000
NEW JERSEY	Corsons Inlet	1,200,000
NEW JERSEY	Harvey Cedars	7,400,000
NEW JERSEY	Avalon-Stone Harbor	?
NEW JERSEY	Monmouth-Sea Bright	?
NEW JERSEY	Brigantine Beach	?
NEW JERSEY	Manasquan-Barnegat Inlet	?
NORTH CAROLINA	Dare County	?
FLORIDA	East Coast (Jacksonville and counties south)/West Coast (Fort Myers area)	?

strong for coastal beach restoration, hurricane protection projects, and the activities of the cooperative. Support is evident from communication with the Governor, the media, and local citizen groups.

The State of Louisiana has plans to investigate potential sand sources along the southwestern coast of the State. Sabine Bank was examined as a potential source of sand for a beach nourishment project at Holly Beach, Louisiana, initiated in June 2002. A shallower borrow site was selected for the project even though a large amount of fine silt and clay overburden needed to be removed before the actual borrow material could be accessed. The present cost of dredging and transporting sand from Sabine Bank, which lies approximately 16 miles offshore, also played a factor in the final decision. Nonetheless, Sabine Bank is considered a primary target for use by both Louisiana and Texas in the future, particularly as dredging costs decrease year by year.

In Fiscal Year 2003, the MMS, in cooperation with the Florida Geological Survey (FGS), began research in a virtually unexplored area to evaluate potential offshore sand resources for beach restoration along portions of Florida's northeast coast. This includes the offshore area along Nassau, Duval, St. Johns, Flagler and Volusia Counties. More than 30 percent of the 148 shoreline miles in this study area is classified as critical eroding. The primary focus is on the area extending from 3 to 8 miles offshore. Year one of this investigation will encompass the coastal and offshore portions of Nassau and Duval Counties to further understand processes affecting the study area to be characterized. Florida's eastern coastline is in a state of constant change. Natural forces impacting this coastline include waves, wind, and a probable rise in sea level. These forces are especially active in the winter months when nor'easters (wind coming in from the northeast) may sit offshore for days at a time. Together with high tides, this results in severe beach erosion. Florida has been, and will continue to be, a major user of Federal sand. In 1995, the MMS negotiated a non-competitive lease with the City of Jacksonville to obtain the use of 1.24 million cubic yards of Federal sand to nourish seven miles of beach from Atlantic Beach to Jacksonville Beach. The probable use of material from the sites which will be identified as a result of the present MMS/FGS effort require that the MMS undertake a biological characterization/numerical wave modeling effort similar to that already accomplished for other OCS areas in the Atlantic and Gulf of Mexico.

Resources on the southeast coast of Florida off Dade County are also rapidly being depleted. Finding alternate sand sources is a crucial challenge for beach experts. With the scarcity of sand in coastal Atlantic waters in the south Florida area, sand investigations in the central part of the State to locate compatible sand for such areas as Miami Beach are currently taking place. At a national beach conference held in Biloxi, Mississippi in January 2002, a Dade County official indicated that there is only 500,000 cubic yards of sand left in state waters that can be used for future Dade County beach nourishment projects. New advances in dredging technology and dredge capacity are allowing for the transport of sand over greater distances than are economically possible now.

In addition, many of the communities along the southwest Florida coast, such as Fort Myers and Naples are in critical need of sand for beach nourishment. The economy of these areas largely depends on the beach habitat and tourist industries. It is likely that geological and geophysical data and information will be collected in the future off the southwestern coast of Florida off Sarasota, Charlotte, Lee, and Collier Counties in order to identify potential sources of beach quality sand in Federal waters.

Research Considerations: Operational/Logistical

When considering the character and intent of MMS studies to assist in the Agency's evaluation of impacts associated with dredging on the Federal OCS, one must take into account the differences between the offshore oil and gas program and the sand and gravel program. Previous sections of this plan have described the sand and gravel negotiated agreement and competitive leasing processes, the State-Federal cooperative program in which geological and geophysical information is collected to assess the potential offshore coastal states as a source of sand borrow material, and the dredging process and technologies available for the removal of offshore material.

OCS sand and gravel operations tend to be very focused, site-intensive operations. Requests to MMS are for specific volumes of material in a well-defined area (See Appendix B for a sample negotiated sand lease). The MMS receives requests for negotiated agreements throughout the year, without a set schedule. In many cases, the Agency has a clear indication of where a borrow site for a planned project will occur. In other cases, the MMS will receive requests for use of offshore areas for which the Agency had no prior notice or knowledge. This situation is in sharp contrast to the oil and gas program which operates on a planned 5-year schedule in which a large area is put up for bid. Exactly where the eventual operation will be and to what scale is virtually unknown. Impacts are generally considered and evaluated in the NEPA document on a broad scale. Systems, both biological and physical, are considered normally on a regional level.

In light of the fact that requests for negotiated agreements for Federal OCS sand are so well defined (including the scenario for resource development, i.e., type of dredge, depth of cut, etc.), MMS analysts can readily use site-specific biological and physical information to estimate the impacts associated with a specific operation and incorporate this evaluation into the operational stipulations. These defined factors have resulted in a comprehensive set of objectives for the collection of biological and physical information and conduct of studies within areas identified through the MMS cooperative efforts as potential borrow sites. (through our State-Federal cooperative program or through coordination with other Agencies such as the ACOE). As much as possible, ACOE borrow areas are also accommodated within the studies.

In instances where there may be little or no site-specific environmental information available, generic studies which provide information relevant to all OCS sand and gravel operations and management can prove invaluable in assisting the MMS analysts during the required NEPA assessment. These studies examine the effects of particular types of dredging operations (beach nourishment and construction aggregate activities) on various aspects of the physical, chemical, and biological environments, and/or develop/recommend appropriate mitigation, laboratory modeling, or monitoring techniques to alleviate or prevent adverse environmental impacts in areas where limited biological/physical information is available prior to initiation of a lease or negotiated agreement.

Research Considerations: Borrow Site/Environmental

The primary target to-date during the MMS/State Federal OCS sand investigations have been the submerged shoals located offshore within the ridge and swale areas along the Atlantic and Gulf of Mexico coasts. Some of these shoals have already been dredged and many are being considered as long-term sources of material for beach replenishment efforts. MMS expects this trend to continue into the foreseeable future.

Many of the anticipated environmental research areas outlined below relative to the MMS sand and gravel program deal with the assumed long-term use of submerged shoals on the Federal OCS and the effects of dredging within the ridge and swale features. A recently completed biological/physical monitoring protocols study raised several questions relative to the continued use of submerged shoals as sand borrow areas (Research Planning, Inc. 2001a):

- Are there procedures to dredge within ridge and shoal areas that would minimize ecological impacts and/or speed recovery, such as dredging completely one specific shoal or ridge and leave adjacent features untouched vs. dredging a small amount of sand from each shoal or ridge feature, or dredging in strips leaving undisturbed areas that act as local sources of recruitment and allow recruitment from older life stages?

- Are there gaps in baseline data, both biological and geomorphological, at each candidate OCS dredging site? Although some site characterization data have been gathered at some locations, the data and information are such that they will not suffice for establishing an accurate “before impact” data set.

- What is the use and role of sand ridges and shoals as potential "essential fish habitat" by migrating or resident fish? Many researchers suggest that these topographic features perform some critical function in supporting fish stocks, either during migration or as habitat for spawning/juvenile fish. However, there are limited data to confirm or disprove this belief.

- Are there benthic biological differences that run longitudinally along the ridge and shoal features that may affect the proposed sampling design and require further stratification?

- Can the relationship of carbon- and nitrogen-stable isotopes and trophic level improve the scientific knowledge of how the alteration of organic matter and benthic invertebrate communities affect the population of bottom feeding fish in an anthropogenically disturbed and recovering area of the ocean?

- Is there a preferred manner to remove sand from a shoal/ridge feature to maximize its use and maintain the integrity of the feature? For example, there are currently concerns that certain dredging practices result in the accumulation of fine-grained sediments in the borrow areas, making the site unsuitable for re-use. Also, there are questions about where on ridges it is best to dredge to speed recovery and reduce long-term impacts.

Physical Research

The use of Federal OCS sand as a source of renourishment/restoration material will continue, especially given the growing scarcity of material in state waters and the adverse environmental impacts associated with the continual removal of nearshore sand material. Dredging significant amounts of sand within the offshore area, particularly within the ridge and shoal areas which are the primary borrow site targets, may result in wave field alterations or changes in the sediment load and transport properties within the nearshore zone.

The specific targeting of submerged shoals located in Federal waters offshore the East and Gulf of Mexico coasts as a continuous source of sand for planned and emergency projects raises potential cumulative impact issues. Many of these shoals have already been dredged and are being considered as a long-term source of material for beach replenishment efforts. However, these features often play a role in mitigating the local wave climate, especially during intense storm events. Many of these submerged features are known or suspected to play a role in mitigating the resident wave field, whether on a day-to-day basis, or during extreme storm events. For example, physical field studies have indicated that Ship Shoal, offshore Louisiana and Sabine Bank, offshore the southwestern Louisiana coast, play important roles in determining wave refraction patterns during fair-weather conditions, and mitigates the wave field during storms in this area (Stone and Xu,1996; Underwood et al., 1999). On the west coast of Florida, the physical impacts of dredging on the local wave climate could be especially significant given the shallow water depths likely to be encountered at potential borrow sites and the frequency of severe storms which traverse this part of the Gulf of Mexico.

Numerical wave modeling has been an invaluable tool in examining the potential effects of dredging on offshore shoals. In some cases, modeling indicates that long-term excavation of shoals in some areas can result in a deleterious wave climate and sediment transport regime, particularly during storm events. Wave modeling and sediment transport potential computations performed to assess the significance of impacts that would result from dredging sand at proposed sites offshore the central eastern coast of Florida determined that extractions on the order of six to nine million cubic yards from within sites offshore St. Lucie Inlet, could have significant potential impacts on the adjacent shoreline. Therefore, these sites may need to be redesigned so that their impacts fall within acceptable limits, most likely by limiting the maximum depth of excavation at the sites (Kelly et al. 2003). A similar situation exists for the complex of ridges and troughs that extend southeast and offshore from Cape Canaveral which cause significant increase in wave heights as waves propagate over this area. Model results indicate that the potential for negative impact to the physical regime exists in this area from cumulative, large-scale dredging (Kelly et al. 2001). This necessitates the continued investigation of the potential physical effects of offshore dredging in the site-specific areas where potential borrow sites have been identified.

Information that can be used to effectively evaluate the effects of dredging on the local wave climate/sediment transport regime in many site-specific areas is presently lacking. In light of these concerns, the MMS sand and gravel program must continue to develop study efforts to:

- Examine the potential for alteration in the local wave field following dredging and the excavation of sand from within identified sand borrow sites.

- Explore the potential for increased wave action after dredging within identified borrow sites and any resultant adverse localized changes in erosional patterns and longshore coastal transport which could result in significant losses of beach sand after renourishment.

- Examine the potential for changes in local sediment transport rates as a result of altering the resident bathymetry.

- Examine the cumulative physical effects of multiple dredging events within the identified borrow sites.

Particularly imperative is the continued evaluation, through numerical modeling and field data collection, of the long-term effects of offshore dredging within the ridge and swale features on the Federal OCS. This information can ultimately be used to suggest engineering options and mitigation measures that can be implemented to avoid potential deleterious impacts, while allowing for the selective removal of the needed volumes of sand for nearby beach projects.

As noted by Hayes and Nairn in Research Planning, Inc. (2001a), offshore sand ridges will continue to form in the future providing there is enough sand available for ridge formation. Ridge formation continues at the present time, as evidenced by the presence of numerous shoreface-attached ridges off Alabama and the Mid-Atlantic Bight. Also, numerous studies have shown that wave-generated currents and storm-generated flows impact the ridges several times a year. But this must be a very long-term process and may not mitigate the loss of a ridge resulting from dredging activities. An important issue is how fast are the ridges moving, which is an indirect way to infer how quickly they will be re-created. One of the primary concerns regarding the impact of dredging offshore shoals is whether the removal of sand from the shoal will somehow disrupt the process that maintains the shape of the shoals. For example, if convergence of waves over the crest is a contributing factor to maintaining the shape of the shoals, there may be a limit where reduction in the crest height of the shoal would suppress this process. The concern would be that the shoal might deflate or unravel, losing its form with time. At this time the state-of-the-art in modeling these processes is probably insufficient to confidently assess the impact. Therefore, research must be conducted to track changes in the shape of the shoal, ridge, and swale features.

Biological Research

The use of Federal sand for planned beach nourishment projects necessitates the continued investigation of the potential biological effects of offshore dredging in site-specific areas. In particular, MMS recognizes that currently available information is lacking and insufficient to fully understand the benthic ecology of offshore ridge and shoal features, the most likely targets for sand use into the foreseeable future. Due to the large geographic extent of the OCS and the numerous influences which affect its environment, these features represent diverse, active physical systems with differing and unique biological communities that make it difficult to generalize potential impacts.

In past cases in which state and local jurisdictions have initiated requests for sand in ridge and shoal areas and where MMS has not conducted site-specific studies, the MMS has had to rely on limited information to prepare an environmental assessment of the proposed project. The MMS has used whatever information exists that has been previously compiled and synthesized to evaluate the resident biology and potential impacts from a dredging operation. These compilations at best provide a regional context for use within the environmental analysis; site-specific studies are needed to validate this information and provide more detail as to the local biology, both infaunal and epifaunal.

In anticipation of the continued use of Federal sand for beach nourishment projects, as well as the need for detailed information to assess the biological impacts of dredging to the greatest extent possible in identified borrow areas, the MMS sand and gravel program plans to pursue ESP funds to:

- Compile and synthesize existing oceanographic literature and data sets in site-specific areas to develop an understanding of the baseline benthic ecological conditions on and around potential borrow sites.

- Conduct biological field data collection efforts to supplement those existing resources.

- Analyze the biological field data in conjunction with existing literature to characterize and evaluate the present infauna, epifauna, demersal fishes and sediment grain size in proposed borrow areas.

- Address the potential effects of offshore sand dredging on benthic communities including an analysis of the potential rate and success of recolonization following cessation of dredging.

- Develop time schedules of environmental windows in site-specific areas that best protect marine wildlife, benthic and pelagic species from adverse environmental effects.

- Examine the cumulative effects of multiple dredge events within identified borrow sites through post dredging surveys and long-term monitoring of benthic and pelagic species.

The program must continue to build a foundation of information and conduct scientific investigations in site-specific areas, not only building on the research of others, but paving the way and negotiating new areas of study relevant to the evaluation of potential offshore dredging operations on the marine environment. The continued, long-term use of sand shoals on the Federal OCS, for example, presents issues relative to possible negative impacts to fisheries.

The same shoals that are targeted as potential sand resources for coastal restoration or beach nourishment tend to be focal points for both recreational and commercial fisheries. The potential effects to fisheries from sand dredging are controversial, having been identified in some cases as limited due to fish being wide foraging, migratory, or spending only a small portion of their life cycle in the area. In addition, areas that are identified as potential sources are large in geographic extent, extending for miles in some cases and the proposed borrow areas are small in comparison; therefore, the lost of altered habitat area, overall, would seem to be minimal. On the other hand, these shoals are speculated to be nursery grounds, important foraging habitat, and migratory corridors for some species, serving as an orientation feature or landmark during migration.

In the report "Development and Design of Biological and Physical Monitoring Protocols to Evaluate the Long-term Impact of Offshore Dredging Operations on the Marine Environment", the authors note that, excluding the potential effects of lost essential habitat as a result of dredging, the greatest potential effect to the fish community utilizing a dredge borrow area is an alteration in trophic energy transfer from the benthic community to the fish populations. If the amount of energy being transferred to the fish population from the benthic community is less than what is naturally being provided by the area before dredging, then the potential long-term and cumulative ecological impacts of sand dredging may be greater than predicted to date (Research Planning, Inc., 2001a).

Cutter and Diaz (2000) and Cutter and Diaz (2003, in-press), upon completion of an MMS-funded environmental evaluation of shoals offshore Maryland and Delaware noted that a sand mining scenario that removed the top meter of sand from Fenwick Shoal would disturb approximately 7.7 km^2 with the potential acute impact on noncommercial sessile species being the loss of about 150 x 10^6 individuals representing 300 kg of wet weight biomass that could have functioned as trophic support to fishes. In addition, mobile species would be displaced and have to search for replacement habitat. To minimize impacts and promote recolonization of mined areas, the authors suggest that the total removal of substrate should be avoided. Small areas within borrow sites should be left to serve as refuge patches that would promote recolonization and serve as habitat for mobile species.

Newell et al. (2002) undertook a survey of benthic macrofauna in the vicinity of a coastal marine aggregate dredging site off the south coast of the United Kingdom in 1999.The object of the survey was to determine the impact of marine aggregate dredging on community composition, the extent of impact outside the boundaries of the dredge site, and the rate of recolonization and recovery of the fauna following cessation of dredging. For some types of dredging, a suppression of species variety, population density and biomass, as well as differences in species composition compared with the surrounding deposits was noted. These types of impacts could ultimately have an effect on resident fish populations.

The current scientific literature contains little information on how fisheries utilize these shoal features. Altering the physical characteristics of the ridge and swale areas (e.g., grain size, bathymetry, etc.) could result in deleterious effects on various fish species. Activities that adversely influence these uses, through disturbances in migration patterns, trophic energy exchange, and changes in substrate, water quality, or acoustic parameters can directly result in a decrease of both recreational and commercial fisheries. With the passing of legislation such as the Magnuson-Stevens Act, agencies such as the MMS are mandated to consider the effects of offshore activities such as dredge operations on fisheries.

In May 2002, MMS awarded a contract to Versar, Inc. to conduct a field effort to examine how fisheries and other mobile species u tilize the shoals offshore Maryland and Delaware (Figure 10). The objectives of the study and the questions which are being addressed are as follows:

Do shoals located on the mid-Atlantic seafloor:

- serve as orientation features for finfish and mobile epi-benthos to orient to during migrations or other population movements?
- serve as a staging ground for various species of finfish and mobile epi-benthos during migrations or other population movements?
- provide needed physical habitat structure for a variety of marine species?
- serve to maintain physical habitat diversity by contributing to maintenance of adjacent lows and seafloor flats?

The first field cruise took place 16 – 10 September, 2002. Based on geologic information received from the Maryland Geological Survey and the MMS, as well as fisheries information from commercial fishermen, track lines were developed for a benthic video sled survey. One hundred and twelve (112) linear km of data were collected from within four identified sand borrow sites and five reference, control areas. Figure 11 shows the type of habitat data being collected during this effort. Following the sled survey, trawling gear was used to gather information on fish populations in the area.

This study will serve to provide valuable information as to how various fish species utilize portions of the ridge and swale environment and might potentially indicate areas which should be avoided during planned dredging activities. Further information will be required that builds upon the results of the finfish study to examine any potential data gaps and to procure a more refined understanding of how specific offshore shoals are utilized by fisheries. A similar effort is currently being conducted for MMS by the

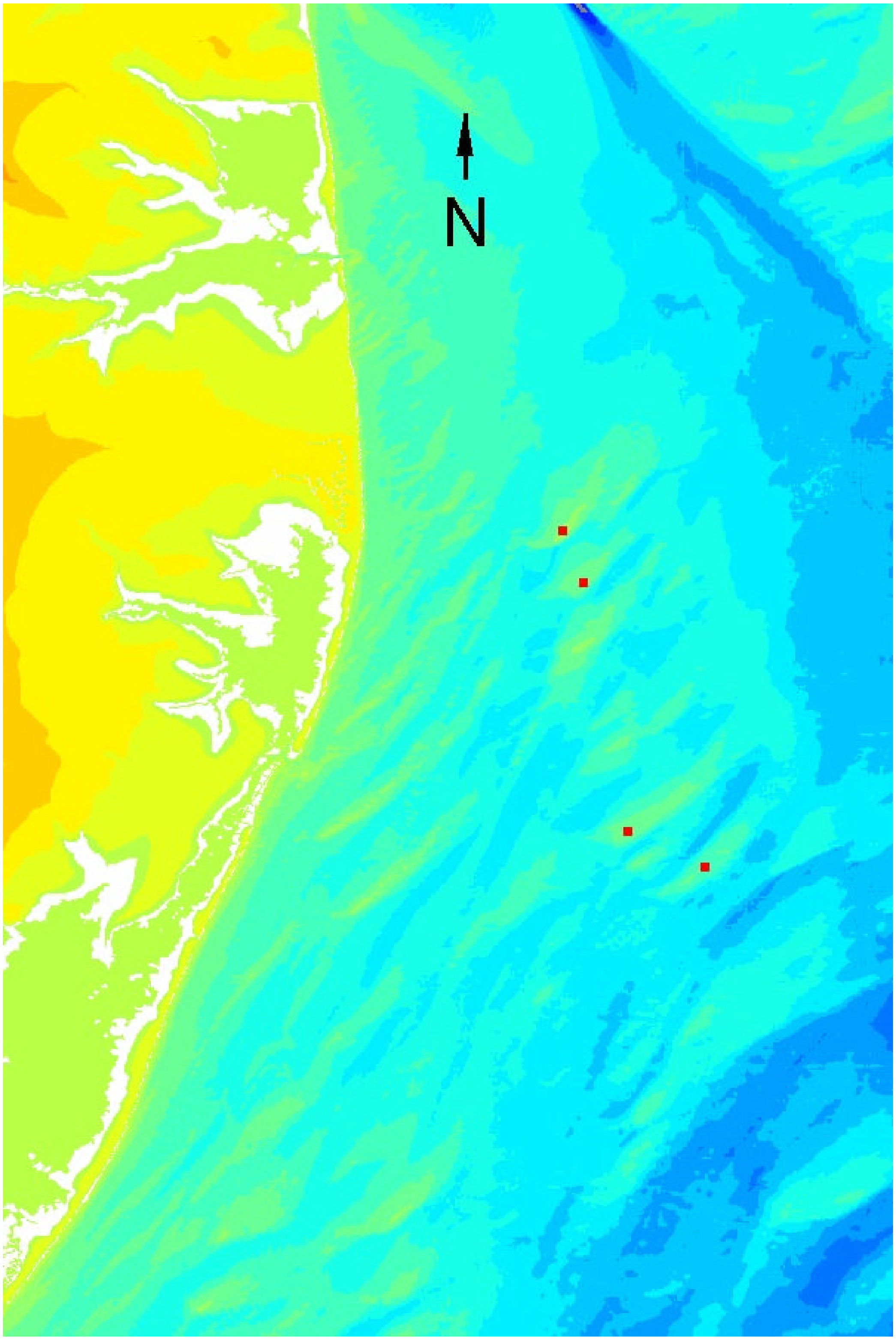


Figure 10. Location of Four Sand Borrow Areas Offshore Maryland/Delaware Where an MMS Finfish Habitat Study is Being Conducted

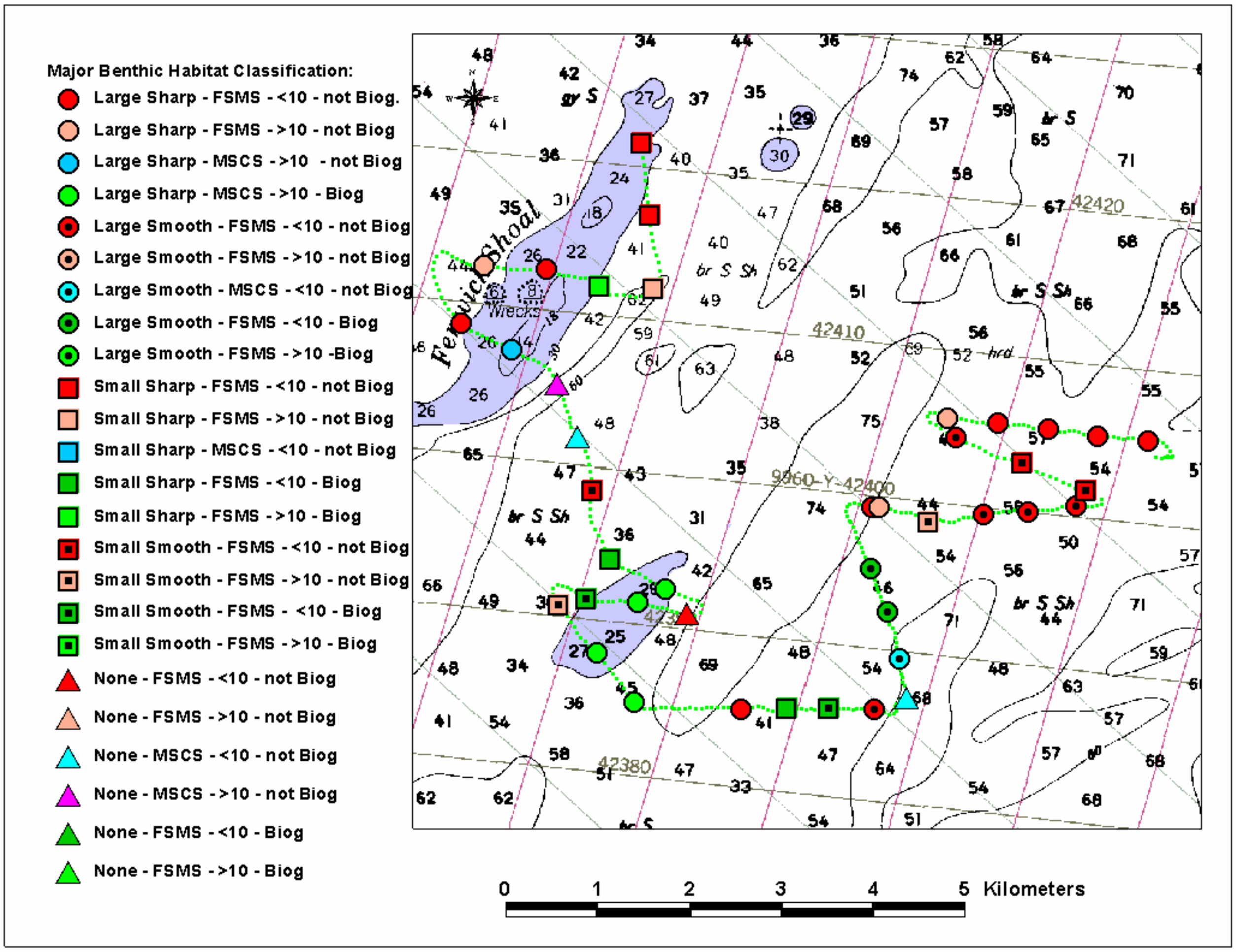


Figure 11. Map showing type of data being collected during the MMS-funded fish habitat study offshore Maryland and Delaware (Diaz and Nestlerode, 2003).

U.S.G.S.-Biological Resources Division on Sabine and Heald Banks offshore Texas and southwestern Louisiana; these areas are important fishery areas for such species as red snapper. The impacts of dredging on fish habitats in these potential sand borrow sites must be investigated before allowing the large-scale removal of material.

Studies have also pointed out relationships between the topography of the submerged shoals, sediment grain size composition, and some of the biological parameters characterizing the benthic and nekton communities. Research Planning, Inc. (2001a), during development of biological and physical monitoring protocols, noted that the offshore ridge and shoal features represent very diverse and active physical systems with differing habitat conditions located throughout each feature.

Hayes and Nairn (2003, in-press) document several different types of physical environments in and around the ridge and shoal areas and point out that these characteristics appear to provide a unique assembly of micro-habitats around the shoals. The benthic communities and fish populations associated with each of these habitats are very different, as indicated by Cutter et al., 2001 offshore Maryland and Delaware. The disappearance or bathymetric alteration of a shoal feature could haveserious consequences on these habitats and, in turn, on resident community structures.

Despite the prevalence of the ridge and swale features along the east coast of the United States, little is documented about the ecological relationships of these features and their associated biological communities. Hayes and Nairn (2003, in-press), during an evaluation of the evolution and nature of the submerged shoal features, note that a literature review conducted into the ecological utilization of ridge and shoal features by fish species indicated that little is known or has been published on the subject.

Several authors (Louis Berger Group, 1999; Hammer et al., 1993; Oakwood Environmental, 1998) speculate about the importance of offshore ridge and shoal features to fisheries migrations and as important habitat for fisheries growth and development. However, literature reviews have failed to obtain any scientific evidence to support these relationships. Continued research is necessary to further define the nature of the biological communities which inhabit the ridge and swale areas if negative impacts from dredging operations are to be avoided or mitigated.

Socioeconomic Research

Costs and Benefits of Beach Nourishment Activities/Impact on Local Economies and Populations

The costs and benefits of beach nourishment and coastal restoration, and the impacts on the local economies and populations are examined and determined by the ACOE, the State, and the local communities before the MMS receives a request negotiates for access to Federal sand for site-specific projects.

During the study of the feasibility of a beach or coastal project, the ACOE develops a plan which maximizes net national economic development (NED) benefits. An essential element of this plan is the formulation of a benefit-cost ratio (BCR). Under current budget policies, the ACOE will not recommend the construction of any project whose benefits do not exceed its costs. Costs are determined by the outlays required to provide initial project construction and periodic renourishment over the life of the project. Benefits are those which increase the economic value of the national output of goods and services (Engineer Policy 1165-2-1). For projects funded entirely by State and local governments, these entities do their own cost/benefit/tourism analyses prior to nourishment.

Because the social costs and benefits are analyzed and considered well in advance of MMS activities, the Agency is not planning on pursuing environmental studies to address these issues. Included in this plan, as Appendix I is the chapter on the social costs and benefits of beach nourishment activities from the National Research Council's book, *Beach Nourishment and Protection* (National Research Council, 1995). This material explains in detail the types of cost and benefit analyses undertaken with regards to beach nourishment projects and activities.

Offshore resources that may be impacted by dredging activities that fall within the socioeconomic regime are shipwrecks and prehistoric artifacts, and commercial and recreational fisheries. The MMS has a regulatory responsibility to ensure the integrity of these resources (see discussion on the National Historic Preservation Act earlier in this document).

Archaeological Resources

In September 2002, MMS awarded a contract to Research Planning, Inc. (RPI) to review current practices and procedures for the protection of submerged prehistoric and historic sites and shipwrecks during offshore dredging operations, and to provide a plan and proposed specifications by which the MMS can ensure that significant drowned prehistoric and historic sites and shipwrecks that exist within potential Federal OCS sand borrow areas or aggregate areas are not adversely impacted by offshore dredging operations. This study entails:

- A worldwide search of the existing literature base relative to submerged prehistoric or historic site and shipwreck damage or disturbance resulting from offshore dredging operations.

- A technological and engineering review of current dredging practices and procedures for the various types of dredges used in beach nourishment and construction aggregate dredging.

- A worldwide review of current practices and procedures to mitigate against adverse impacts to submerged prehistoric or historic sites, known shipwrecks, and possible shipwreck sites during offshore dredging operations.

- A review and analysis of the current MMS specifications for archaeological surveys in advance of offshore dredging operations proposed for the Federal waters.

- A review of current MMS procedures for protecting submerged prehistoric or historic sites, known shipwrecks, and possible shipwreck sites during offshore operations.

Using the information gathered, RPI will:

- determine whether or not the existing MMS archaeological survey specifications are adequate to pre-operationally locate and determine the possible existence of submerged prehistoric or historic sites and shipwrecks and protect these resources given the scale of a typical beach or aggregate dredging operation. RPI will provide recommendations for changes in specifications if warranted and provide proposed specifications for such.

- assess the current methods for evaluating the potential for, and/or, identifying prehistoric sites within buried river channels and suggest strategies to mitigate impacts from dredging.

- determine if the buffer zones and avoidance criteria currently applied in regards to avoiding physical interactions with submerged prehistoric or historic sites and shipwrecks or potential shipwreck sites is adequate to protect the resource given the scale of a typical beach or aggregate dredging operation. RPI will provide recommendations for changes in the avoidance criteria and/or buffer zones if warranted and provide proposed specifications for such.

As dredging technologies evolve and change, and as remote sensing equipment becomes more refined and efficient, it may become necessary to further review the standards applied by MMS for archaeological surveys prior to operations and the buffer zones and allowances applied to protect resources.

Commercial and Recreational Fisheries

One of the primary uses of the OCS is fishing. Sand shoals that are desirable as potential sand borrow areas for beach nourishment frequently are also focal points for various fisheries, both commercial and recreational. Areas identified as potential sources of offshore construction aggregate are also, in many cases, important commercial or recreational fishery zones. As the MMS sand and gravel program expands in scope, the necessity of managing offshore resources to support and sustain these multiple types of use is increasing.

Due to the fact that there are large variations in fisheries at any given location, the physical settings in which dredging might occur, and the kinds of gear and methods used for fishing, meta-analysis is needed to aid the prediction of impacts and how those impacts may be mitigated. In addition, it is important to know how effective past mitigation measures have been in order to apply the most effective measures in projects regulated by MMS.

Mitigation

MMS must continue to evaluate, through numerical modeling and field data collection, the long-term biological and physical effects of offshore dredging within the ridge and swale features on the Federal OCS which have been identified as potential sand borrow areas. This information can be used to suggest engineering options and mitigation measures that can be implemented to avoid potential deleterious impacts, while allowing for the selective removal of the needed volumes of sand for nearby beach projects. A study by the National Academy of Sciences (National Research Council, 1995) points out that, until there is a better understanding of the ecological consequences of offshore dredging, particularly long-term, the most prudent action which regulatory authorities can take is to design and engineer projects so that alterations in the physical conditions and biological resources of a borrow site are minimized or are short term relative to the planned frequency of renourishment.

In addition, the MMS must investigate the new advances in offshore dredging technology which are leading to less destructive offshore operations. Researchers are actively increasing the knowledge base relative to the physical processes involved in dredging procedures. Physical and mathematical modeling of these processes with the aim to be able to predict their behavior and thus be able to control these processes in order to reduce the negative environmental aspects associated with the offshore removal of surficial sand is ongoing. This research also allows the dredge masters to know exactly where and what they are dredging and to more effectively be able to control the depth of cut.

New environmentally-friendly engineering technologies currently being used overseas are being contemplated for use in U.S. waters. One such example is the Punaise (Dutch for thumbtack). The Punaise is a remotely operated, watertight submerged dredge that resides on the seafloor, pumps sediment without impact to navigation, and is not affected by storms. Because it is located on the seafloor, it is very tolerant of adverse surface wave action, which allows it to operate in all types of weather and sea state conditions. The Punaise is connected to a shore station by an umbilical, which supplies not only power and communication, but also serves as the discharge line through which the dredged slurry is pumped. The entire dredging process, including sinking and floating (i.e., filling and emptying ballast tanks), is controlled from the shore station. The Punaise can operate for long periods with relatively low labor costs. Maximum flexibility in sediment removal is attained through repositioning the Punaise at the dredging site from time to time with the help of a tug. The Punaise operates under the principle of deep dredging (i.e., putting the dredge pump as close to the sediment intake as possible). In so doing, the Punaise always requires an embedded support that must extend below the suction intake for vertical stability during dredging. Previous work in The Netherlands has proven the technology to be an effective system to dredge and pump material for traditional beach nourishment projects. The Punaise is especially adept at working in storm conditions at relatively low costs and is not restricted by the Jones Act for operations in the United States.

In order to effectively manage the development of sand resources in an environmentally sensitive manner, the MMS must have intimate knowledge of the most current dredging technologies available for use.

Monitoring, Including Development and Field Testing of Monitoring Protocols

To date, coastal erosion management projects utilizing Federal OCS sand resources have been examined on a case-by-case, project-specific basis. These resources must be managed on a long-term, large scale, system-wide basis to ensure that environmental damage will not occur as a result of continual and prolonged use. The long-term effects of dredging in the identified sand borrow areas is not well understood. Sand sources that are to be used repeatedly may require biological and physical monitoring to ensure that unacceptable impacts to the marine and coastal environments do not occur.

The National Academy's Committee on Beach Nourishment and Protection (National Research Council, 1995) pointed out that the long-term physical alterations resulting from the dredging of sand borrow sites in marine habitats have not been well documented. The borrow areas are often surveyed immediately after dredging to obtain estimates of the volume of material removed, but subsequent monitoring of bottom bathymetry and sediment composition has rarely been accomplished. Data on the refilling rates of borrow areas are especially lacking. The Committee points out that this has significant environmental implications because long-term renourishment programs may require the use of several borrow areas that will be altered both physically and biologically for extended periods.

The physical effects of offshore borrow areas on surrounding habitats have not generally been evaluated. Creation of a borrow pit or excessive dredging of a bathymetric feature that has some controlling influence on the local wave and current regime may affect the stability of nearshore features or reduce sediment transport to areas down-current of the borrow site. Wave energy and the stability of the beach may also be affected if the borrow site lies within the depth of closure.

Likewise, long-term dredging may adversely affect the biological characteristics of an area. Removal of benthic assemblages which inhabit the surficial sediments may indirectly affect other species that use the benthos as a food source. Recovery of benthic organisms within continually dredged areas has rarely been studied over a long-term basis and certainly not in areas which have or are expected to experience repeated dredging events. Newell et al (2202) found that, in some areas where aggregate dredging had occurred over a long time period, benthic populations had been severely reduced and were unlikely to ever recover fully.

The evaluation of long-term dredging effects may be particularly important in unique habitats such as the ridge and swale features which appear to support varying types of organisms. Monitoring must be conducted to resolve whether or not these areas return to the physical and biological conditions that existed before dredging and, if so, how long it takes. The National Academy study pointed out that monitoring is particularly needed in regions where there has been little, if any, physical or biological monitoring of borrow areas used for beach nourishment projects.

Development of Monitoring Protocols

Research Planning, Inc. (2001a) completed a study for MMS in October 2001, the objectives of which were to:

- Develop field monitoring systems to evaluate the physical and biological impacts of using Federal offshore borrow areas on a long-term basis;

- Examine the feasibility, appropriateness, and desirability of putting these monitoring systems into place and identification of the need for collection of supplemental biological data or physical modeling information in the Federal borrow areas; and

- Identify the need for and collection of any additional geological/geophysical data to define available sand supplies for planned projects within the study areas.

The study consisted of a comprehensive literature review to clearly identify the geophysical processes and biological ecosystems that would be affected by OCS sand mining for beach nourishment and habitat protection. The investigators developed a series of broad scientific questions around which the monitoring program was designed. Following the completion of an extensive literature review, the project team identified those ecological resources (physical and biological) that would have the greatest potential for being affected by offshore sand mining, both directly and indirectly. Impacts occurring from a one-time dredging event at a given location as well as repeated dredging of an area over some time period were included.

Based on the literature review, it was determined that, from a purely physical perspective, the only change of consequence is the potential impact of dredging on shoreline change. All other physical changes and impacts caused by dredging were determined to be important only if they result in a biological impact, either directly or indirectly. Thus, four physical monitoring and modeling protocols were developed to address these issues:

- Bathymetric and Substrate Surveys
- Sediment Sampling and Analysis
- Wave Monitoring and Modeling
- Shoreline Monitoring and Modeling

For marine biota, the biological communities and associated habitats that were determined as most likely affected by OCS sand dredging were soft substrate benthic communities; nekton; and marine mammals and wildlife. Studies of the recovery of soft substrate benthic communities following dredging have indicated that communities of comparable total abundance and diversity can be expected to re-colonize at dredge sites within several years. However, even though these re-colonized communities may be similar in terms of total abundance and species diversity, their taxonomic composition, in terms of dominant species and species abundance, is often very different from pre- to post-dredging. The RPI report concluded that the ecological utilization of ridge/shoal features by fish species as critical habitat for spawning, overwintering, or foraging area is relatively unknown, and should be addressed. However, the greatest potential effect to the fish community utilizing a dredge borrow area is an alteration in trophic energy transfer from the benthos to the fish population. For marine mammals and other marine wildlife such as sea turtles and birds, of the identified direct and indirect impacts, the greatest potential for serious effect is associated with direct collision with the dredge vessel or entrainment in the suction dredge. Thus, two biological monitoring protocols were developed to address these issues:

- Benthic communities and their trophic relationships to fish
- Marine mammal and wildlife interactions during dredging

In April 2002, MMS initiated a cooperative agreement with the Virginia Institute of Marine Science to field test the monitoring protocols on Sandbridge Shoal, offshore Virginia. Field work commenced in June 2002 with the collection of benthic biological samples; study results are expected in May/June 2004. The field test results will be used to modify/adjust/tailor the protocols suggested by RPI (2001a) during any future monitoring programs put in place during offshore dredging operations.

NATIONAL OFFICE INVOLVEMENT

The MMS Sand and Gravel Unit within the Leasing Division at the Headquarters (HQ) level provides policy direction and guidance for the development of marine mineral resources on the Federal OCS. MMS staff assigned to the program and their disciplines are:

- Renee Orr, Chief, MMS Leasing Division
- Barry Drucker, Physical Scientist/Environmental Coordinator
- Roger Amato, Physical Scientist/Geologist
- John Rowland, Physical Scientist/Geologist
- Tony Giordano, Geologist
- Will Waskes, Marine Biologist

The Sand and Gravel Unit focuses on collecting geologic and environmental information, developed through partnerships with coastal States and other Federal Agencies, to identify sand deposits in Federal waters suitable for beach nourishment and wetlands protection projects. The section is responsible for developing environmental studies, for the coordination of NEPA documents to evaluate proposed offshore dredging projects, and for the negotiation and development of various lease documents and agreements. Information collected in conjunction with these efforts assists the MMS in making future decisions relative to the possible use of offshore and gravel deposits, whether it be for beach nourishment/coastal restoration use, or for use as construction aggregate. When appropriate, the HQ Sand and Gravel Unit coordinates and utilizes the services of other MMS-HQ staff and regional personnel. This may include other Leasing Division staff, HQ Environmental Assessment and Environmental Sciences staff, and environmental staff from the MMS regional offices.

REGIONAL OFFICE INVOLVEMENT

The MMS Regional Offices assist the HQ sand and gravel staff during various phases and tasks associated with the sand and gravel program. This includes: review of negotiated agreements in-progress, providing information on obtaining prospecting permits or pipeline/archaeological survey requirements to prospective lessees, preparation/review of NEPA documents, review of Statements of Work for sand and gravel environmental studies; participation on technical proposal evaluation committees for environmental studies, and serving as Contract Inspectors for on-going environmental studies. The MMS Gulf of Mexico Region in New Orleans has a permanently established Sand Team to keep abreast of on-going sand and gravel activities along the Atlantic and Gulf of Mexico coasts and to assist the HQ office when regional expertise is necessary.

SUMMARY/CONCLUSIONS/RESEARCH INITIATIVES

This document provides information as to the regulations and procedures which the MMS operates under with respect to the offshore sand and gravel program. As the steward of all seabed and submerged mineral resources on the Federal OCS, the MMS Sand and Gravel Program works cooperatively with coastal states and other Federal Agencies to collect geological and geophysical data and information to locate potential sources of clean sand for use in beach nourishment/coastal restoration projects. Coastal states negotiate leases with the MMS for access to Federal sand for public works projects; Federal Agencies who wish to use these resources sign Memorandum of Agreements with MMS. The MMS will also oversee the leasing process for competitive sales for OCS sand and gravel should a private entity seek to harvest these resources for use as construction aggregate in the future.

As the regulatory agency that oversees the use of sand and gravel resources on the OCS, MMS has the responsibility to ensure that offshore dredging operations are conducted in a safe and environmentally sound manner. In regards to this environmental mandate, MMS prepares required NEPA documents to evaluate proposed dredging projects or reviews/coordinates with other State/Federal entities on the preparation of such documents. The MMS Sand and Gravel Program develops and oversees environmental studies to provide information to assist in the assessment of environmental impacts associated with the development of identified sand borrow areas. Research is tailored, as best as possible, to meet the needs of possible development prospects and the MMS environmental assessment staff. It is applied to decisions made at the policy level and is often incorporated as stipulations in negotiated leases and other lease documents.

Beginning in 1991, MMS Environmental Studies Program funds have been used to initiate environmental studies to support the MMS Sand and Gravel Program. This has included the conduct of literature review, generic studies, and site-specific physical and biological efforts. This information has been used to assist in the preparation and/or review of NEPA documents and subsequently support the issuance of lease documents for access to Federal sand resources.

The MMS is concerned principally with open-ocean dredging operations and associated possible impacts of such, as opposed to navigational and channel dredging activities. Navigational and channel dredging operations are conducted in more spatially constricted or close-to-shore areas (and in some cases, highly polluted areas) and the impacts of such activities are, and may be, entirely different. Where appropriate, impact studies associated with dredging for navigational or channel-widening/deepening situations are considered to the extent that they can applied.

The search for new offshore sand borrow sites and the use of Federal sand and gravel resources for beach nourishment and coastal restoration efforts will continue and is likely to increase in the future as nearshore/coastal resources become depleted or can no longer be used due to environmental or other restrictions. This prospect, plus the realization that Federal sand borrow sites already used will continue to be used for many years to come necessitates that the MMS Sand and Gravel Program continue to pursue the procurement and conduct of environmental studies as follows:

1. Continue to develop and procure site-specific physical and biological studies in potential sand borrow areas identified through the ongoing cooperative MMS/State Sand and Gravel Task Forces. Wherever and whenever possible, these studies should accommodate and encompass areas identified by the U. S. Army Corps of Engineers. Physical efforts should include, using state-of-the-art numerical wave modeling, an assessment of the potential impacts of a one-time dredging event and several dredging events (cumulative assessment) at the identified sites on the local wave/current/sediment transport regime.

2. Compile and synthesize existing oceanographic literature and data sets in site-specific areas to develop an understanding of the baseline benthic ecological conditions on and around potential borrow sites. The biological effort should include the conduct of field efforts to collect information on infauna, epifauna, demersal fishes, and sediment grain size to complement any existing, pertinent information in the area. The studies should use this information to address the potential effects of offshore sand dredging on benthic communities and offer conclusions relative to the potential rate and success of post-dredging benthic repopulation. The final report for these studies will be used to assist MMS decisionmakers in preparing/reviewing required NEPA documents and will also be used to formulate possible lease stipulations for negotiated leases when appropriate.

3. Develop field study efforts to evaluate the long-term physical and biological effects of cumulative dredging events at sand borrow sites which are expected to serve as long-term sources of material for beach nourishment and coastal restoration efforts. At the present time, the offshore submerged sand shoals are the likely sand targets for many years to come. These areas, many consisting of a ridge and swale system, may represent a unique habitat encompassing varying types of infauna and epifauna depending on location within the system.
   In addition, although numerical wave modeling is an invaluable, relatively inexpensive tool for assessing the potential effects of dredging on the local wave and current regime, some degree of physical field data collection is necessary to fully evaluate the ongoing and long-term effects of dredging on the physical environment within the ridge and swale systems. These studies should use the data and information collected to suggest mitigation to alleviate or avoid adverse

environmental effects from dredging efforts.

4. A regulatory mandate exists to assess the potential for adverse impact of proposed dredging activities on essential fish habitat. However, at the present time, much of the available information on fish habitat is sketchy at best and very general; detailed information that can be used by the MMS and NMFS to fully and correctly assess the potential effects of a proposed, site-specific dredging project is lacking. Therefore, MMS must pursue field studies to collect relevant data and information on fish species vs. habitat and location within identified sand borrow sites. These studies should encompass an assessment of the potential impacts of a typical one-time and successive dredging events on the resident fish populations. This is especially important given that many of the submerged shoal areas which are being targeted as potential sand borrow sites are also valuable commercial and recreational fishery resources. These studies should be used to mitigate any potential impacts of a proposed operation, whether through area avoidance, lease stipulations, or engineering modifications.

5. Physical and biological monitoring may be warranted in areas where dredging is likely to continue on a long-term, consistent basis. RPI (2001a) developed recommended monitoring protocols, which are currently being field tested at Sandbridge Shoal, offshore Virginia via a cooperative agreement with the Virginia Institute of Marine Science. Sandbridge Shoal represents an excellent area in which to test the protocols in that:

   1. It represents an area that is being used as a long-term source of sand borrow material for three entities (Sandbridge Beach, U.S. Naval facility at Dam Neck, and the Virginia Beach resort strip), and

   2. The existing physical and biological database is well suited to serving as a baseline for the ensuing field data collection efforts.

   Upon completion of the field testing and the submission of study results and recommendations from VIMS, MMS should have a monitoring approach that can be implemented if warranted.

   The Agency is pursuing a Regional Management strategy which will involve the integration and cooperation of all Federal, State, and local players with an interest in using sand borrow sites off their coasts on a long-term basis. It may be possible to pursue funds from these entities and develop a "pool" of money which can be used to implement monitoring, providing that is beneficial to all the concerned parties. A report completed in 2001 for the MMS evaluates the regional management concept (Research Planning, Inc., 2001b). The concept is being tested first in the State of Louisiana where a Louisiana Sand Management Working Group has been established.

6. If MMS is to successfully fulfill its environmental mandate with respect to the sand and gravel program, MMS staff must, at all times, be intimately familiar with the current state-of-the-art technologies with respect to offshore dredging. New, less destructive dredging technologies are being developed, much of it overseas, to mitigate against adverse impacts to the physical and biological marine environments. The Sand and Gravel Program will pursue engineering review studies to assess these technologies and their applicability to U.S. operations. These studies will include an assessment of engineering and mitigative equipment and strategies.

7. The MMS Sand and Gravel Program will continue to pursue study efforts to assess and improve agency requirements relative to offshore surveys and survey requirements for the protection of such resources as historic and prehistoric archaeological sites. Many of the present MMS requirements were developed for the oil and gas program and are not readily adaptable to the needs of the sand and gravel program.

8. The MMS Sand and Gravel Program must establish a background that can facilitate assessing the environmental impacts of beach nourishment activities on commercial and recreational fisheries. Research into dredging impacts, conflicts with the fishing industry, and mitigation techniques has been accomplished mainly in Europe; this is a large database and body of knowledge that can be used to avoid impacts here in the U. S. A study to gather and assimilate the current literature base and other material from private, academic, and governmental sources by qualified fisheries scientists and various marine experts would hopefully provide the MMS with a comprehensive list of detailed mitigation measures that can be applied to avoid adverse impacts to fisheries that may be present in sand resource areas, regardless of geographic location.

9. The MMS must explore the use of environmental windows and the application of studies information in establishing such windows for proposed dredging operations within the agency's jurisdiction. Environmental windows are periods in which the adverse impacts associated with dredging can be reduced below critical thresholds. For example, seasonal restrictions can be applied, and dredging activities prohibited, when the perceived increase in potential harm to aquatic resources is above critical thresholds. Windows are an intuitively simple means of reducing risk to biological resources from stressors generated during dredging activities, including entrainment of fish eggs and larvae, resuspension of buried contaminated sediments, habitat loss, and collisions with marine

mammals. The use of windows as a management tool, however, can have significant cost implications. For example, windows can prolong completion of dredging projects, delay project deadlines, and increase risk to dredging personnel by shifting dredging to periods of potentially inclement weather and sea states.

10. MMS has successfully undertaken studies and leveraged funds to evaluate the environmental effects associated with offshore aggregate mining operations. These studies have taken place in the United Kingdom where an active offshore mining industry is present; several U. K. dredging companies, industry groups, and government agencies have contributed funds, equipment, and technical personnel to these efforts. Two reports have been delivered which report the results of the U. K. efforts (Hitchcock et al.1998; Hitchcock et al. 2002). Further study efforts will be pursued if offshore aggregate operations appear imminent in the U.S. in the future.

11. MMS must pursue study efforts within potential sand borrow areas in Federal waters that are not associated with offshore shoals. Significant quantities of sand suitable for beach nourishment have been found within Federal waters in sheet sands on the inner continental shelf off the Delmarva coast and within buried channel deposits offshore Louisiana. Sheet sand deposits tend to be highly variable in thickness, areal extent and grain size. Such characteristics can make sheets sands difficult to dredge. Paleochannel deposits may be limited in size, and are usually buried under a significant thickness of overlying sediment. These types of deposits have very different resident biological communities than the shoal-type deposits and may be impacted quite differently during a typical dredging operation. In addition, the taking of the deposits could leave a sizable depression in the seafloor which could result in adverse changes in the local wave climate and sediment transport regime. These factors and the biological and physical impacts associated with the use of these deposits must be thoroughly investigated before negotiating leases for planned beach nourishment projects.

12. The MMS Sand and Gravel Program will continue to pursue the publication of environmental study results in peer-reviewed scientific journals. In 2003, the *Journal of Coastal Research* will publish a special issue containing twelve papers reporting the results of MMS-funded sand and gravel environmental study efforts.

13. Since the social costs and benefits and the impacts of site-specific beach nourishment projects and activities on local populations, economies and such factors as tourism are analyzed and considered well in advance of MMS activities, whether by the ACOE, or by a State or local government, the MMS will not

pursue environmental studies to address these issues.

14. No air quality impact studies are planned. These impacts are, and will continue to be evaluated on a project-specific basis, as each individual project has its own emission characteristics; emission estimates have to be made for each particular project in order to determine whether or not a conformity analysis/determination is needed. Air emissions for the offshore and onshore phases of a dredging operation can be predicted using estimated power requirements, fuel consumption, length of time for various operations, and the emission factors obtained from the Environmental Protection Agency's *Compilation of Air Pollutant Emissions Factors, AP-42* and other updated documents. Emissions can be calculated for each phase of dredge vessel operation: dredging, transiting between borrow site and nearshore mooring site and return, and pumping out to the beach.

BIBLIOGRAPHY AND RERERENCES USED

Blake, N.J., L.J. Doyle, and J.J. Culter. 1996. Impacts and direct effects of sand dredging for beach renourishment on the benthic organisms and geology of the west Florida shelf. U. S. DOI. MMS OCS Report 95-0005. 109 p.

Center for Cold Ocean Resources Engineering. 1996. Marine mining technologies and mitigation techniques: a detailed analysis with respect to the mining of specific offshore mineral commodities. U. S. DOI. MMS OCS Report 95-0003. 250 p.

Cruickshank, M.J. 1987. Marine mining on the outer continental shelf: environmental effects overview. U. S. DOI. MMS OCS Report 87-0035. 66 p.

Cutter, G. R., and R. J. Diaz, 2000. Benthic habitat mapping and resource evaluation of potential sand mining areas, 1998 – 1999. In: Cutter, G.R., Jr., R.J. Diaz, J.A. Musick, J. Olney, D. Bilkovic, J. P.-Y. Maa, S. Kim, C. S. Hardaway, D. Milligan, R. Brindley, and C. H. Hobbs. 2000. Environmental survey of potential resource sites offshore Maryland and Delaware. U. S. DOI. MMS OCS Study 2000-055.

Cutter, G. R., Diaz, R. J. Hobbs, C. H. 2003. In-press. Benthic habitats and biological resources off the Virginia coast 1996 and 1997.

Cutter, G.R., Jr., R.J. Diaz, J.A. Musick, J. Olney, D. Bilkovic, J. P.-Y. Maa, S. Kim, C. S. Hardaway, D. Milligan, R. Brindley, and C. H. Hobbs. 2000. Environmental survey of potential resource sites offshore Maryland and Delaware. U. S. DOI. MMS OCS Study 2000-055. 514 p.

Diaz, R. J., Cutter, G. R., and Able, K. W. 2003. In-press. Relationship between benthic habitat and juvenile fishes on the shallow inner continental shelf.

Diaz, R. J. and J. Nestlerode. 2003. Quick-look classification of benthic habitats at potential sand mining areas in the Fenwick Shoal region. Interim report submitted to Versar in support of MMS Maryland/Delaware finfish habitat study. 11pp.

Giordano, A.C. 1999. Guidelines for obtaining minerals other than oil, gas, and sulphur on the Outer Continental Shelf. U. S. DOI. MMS OCS Report 99-0070.

Hammer, R.M., B.J. Balcom, M.J. Cruickshank, and C.L. Morgan. 1993. Synthesis and analysis of existing information regarding environmental effects of marine mining. U. S. DOI. MMS OCS Study 93-0006. 392 p.

Hayes, M. O. and R. B. Nairn. 2003, in press. Natural maintenance of sand ridges and linear shoals on the U. S. Gulf and Atlantic continental shelves and the potential impacts of dredging.

Hitchcock, D. R , R. C. Newell, and L. J. Seiderer. 1998. Marine aggregate mining benthic and surface plume study. U. S. DOI. MMS OCS Study MMS 99-0029, 168pp.

Hitchcock, D. R , R. C. Newell, and L. J. Seiderer. 2002. Integrated report on the impact of marine aggregate dredging on physical and biological resources of the seabed. U. S. DOI. MMS OCS Study MMS 2000-054, 241p.

Hobbs, C. H. 2002. An investigation of potential consequences of marine mining in shallow water: an example from the mid-Atlantic coast of the United States. *Journal of Coastal Research* 18 (1): 94-101.

Kelley, S. W., Ramsey, J. S., and Byrnes, M. R. 2001. Numerical modeling evaluation of the cumulative physical effects of offshore sand dredging for beach nourishment. U. S. DOI. MMS OCS Study 2001-098, 95p.

Louis Berger Group, Inc. 1999. Use of Federal offshore sand resources for beach and coastal restoration in New Jersey, Maryland, Delaware, and Virginia. U. S. DOI. MMS OCS Report 99-0036.

Maa, J.P.-Y., Hobbs, C. H. and Hardaway, C. S., JR. 2001. A criterion for determining the impact on shorelines caused by altering wave transformation. *Journal of Coastal Research*. 17(1):107-113.

National Research Council. 1995. *Beach Nourishment and Protection*. Prepared by the Committee on Beach Nourishment and Protection and the Marine Board's Commission on Engineering and Technical Systems. National Academy Press. Washington, D.C. 334p.

Newell, R. C., Seiderer, L. J., and Robinson, J. E. 2001. Animal: Sediment relationships in coastal deposits of the eastern English Channel. *J. Marine Biology Association of the United Kingdom.* 81:1-9.

Newell, R. C., Seiderer, L. J., and Hitchcock, D. R. 1998. The impact of dredging works in coastal waters: a review of the sensitivity to disturbance and subsequent recovery of biological resources on the seabed. Oceanography and Marine Biology: an Annual Review. 36:127-178.

New Jersey Council of Diving Clubs. 1997. Letter to MMS from Jack Fullmer, President of the NJCDC.

Oakwood Environmental Ltd. 1998. Strategic cumulative effects of marine aggregates dredging (SCEMAD). U.S. DOI. Final report to the Minerals Management Service, Washington, D.C., under contract No. 1435-01-98-CT-30894.

OCS Policy Committee. 1993. U. S. Outer Continental Shelf sand and gravel resources: programs, issues, and recommendations. Minerals Management Service, Final Report of the OCS Policy Committee's Subcommittee on OCS Sand and Gravel Resources.

Research Planning, Inc. 2001a. Development and design of biological and physical monitoring protocols to evaluate the long-term impacts of offshore dredging operations on the marine environment. U. S. DOI. MMS OCS Study 2001-089. 116 p.

Research Planning, Inc. 2001b. Examination of regional management strategies for Federal offshore borrow areas along the United States east and Gulf coasts. U. S. DOI. MMS OCS Study 2001-090. 19 p. plus appendices.

Stone, G. W. and Xu, J. P. 1996. Wave climate modeling and evaluation relative to sand mining on Ship Shoal, offshore Louisiana, for barrier island restoration. U. S. DOI. MMS OCS Study 96-0059. 170 p.

Stone, G. W. 2000.Wave climate and bottom boundary layer dynamics with implications for offshore sand mining and barrier island replenishment in south-central Louisiana. U. S. DOI. MMS OCS Study 2000-053. 90 p.

Van Dolah, R.F. 1992. A physical and biological monitoring study of the Hilton Head beach nourishment project. Marine Resources Research Institute, Charleston, SC. 159 p.

Underwood, S. A., Chen, R., Stone, G. W., Zhang, X. P., Byrnes, M. R., and McBride, R. A. 1999. Beach response to a segmented breakwater system, southwest Louisiana, USA. *Proc. Coastal Sediments '99*, 2042-2056.

Wainwright, T.C., Armstrong, D.A., Dinnel, P.A., Orensanz, J.M., and McGraw, K.A. 1992. Predicting effects of dredging on a crab population: An equivalent adult loss approach, *Fisheries Bulletin* 90:171-182.