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Workshop on Environmental Research Needs in Support of Potential Virginia Offshore Oil and Gas Activities

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Workshop on Environmental Research Needs in Support of Potential Virginia Offshore Oil and Gas Activities
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ABOUT THE COVER
The graphic on the cover depicts that location of the potential lease sale area off the coast of Virginia within the Mid-Atlantic outer continental shelf planning area, which extends from Delaware to North Carolina.
# Workshop on Environmental Research Needs in Support of Potential Virginia Offshore Oil and Gas Activities

List of Figures ............................................................................................................................. iv

List of Tables ............................................................................................................................... v

Appendices .................................................................................................................................. v

Executive Summary ...................................................................................................................... 1

Overview ....................................................................................................................................... 1

Workshop Objectives and Format ................................................................................................ 2

Virginia OCS Description ............................................................................................................. 3

## Environmental Resources

Endangered and Protected Species ............................................................................................. 4

  Summary of Discussion Points .................................................................................................. 4

  Knowledge Gaps for Endangered and Protected Species ...................................................... 7

Pelagic and Demersal Fish and Fisheries ................................................................................... 8

  Summary of Discussion Points .................................................................................................. 8

  Knowledge Gaps for Fish and Fisheries .................................................................................. 9

Benthic and Biological Issues ..................................................................................................... 10

  Summary of Discussion Points ................................................................................................ 10

  Knowledge Gaps for Benthos and Biology ............................................................................. 12

Physical and Geological Oceanography .................................................................................... 12

  Summary of Discussion Points ............................................................................................... 12

  Knowledge Gaps for Physical and Geological Oceanography ............................................ 13

Social and Economic Issues ......................................................................................................... 15

  Summary of Discussion Points ............................................................................................... 15

  Knowledge Gaps for Social and Economic Issues ............................................................... 17

Workshop Recommendations ...................................................................................................... 18

  Physical and Geological Oceanography ............................................................................... 18

  Fish and Fisheries .................................................................................................................. 19

  Benthos and Biology ............................................................................................................... 20

  Endangered and Protected Species ....................................................................................... 22

  Socioeconomics .................................................................................................................... 23

  General Recommendations: ................................................................................................. 24

References .................................................................................................................................... 25
List of Figures

Figure 1. Federal outer continental shelf planning areas.
Figure 2. General location of proposed Mid-Atlantic Area Lease Sale 220 off the coast of Virginia. Status of leases and other lease sales for the 2007-2011 period are also shown.
Figure 3. Mid-Atlantic OCS planning area showing protraction areas and wells drilled from previous lease sales.
Figure 4. Detailed location of Virginia OCS lease sale area within the Mid-Atlantic OCS planning area.
Figure 5. Details of Lease Sale 220 area off the coast of Virginia.
Figure 6. National Geophysical Data Center map encompassing much of the Virginia OCS lease sale area, Norfolk and Washington canyons are the prominent features, from: http://ngdc.noaa.gov/mgg/coastal/grddas02/grdden02.htm
Figure 7. Survey effort for marine mammals and sea turtles in the Atlantic waters off of Virginia. Effort is given in kilometers of appropriately surveyed trackline mile per square kilometer of ocean (color code at bottom of image). The light blue shading around the lease site is a 20 mile buffer zone (see text of workshop report).
Figure 8. Sightings of Turtles (Green, Leatherback, Loggerhead, Kemp’s Ridley, and Unidentified) in the Atlantic waters off of Virginia and around the proposed lease site.
Figure 9. Sightings of North Atlantic Right, Humpback, and Sperm whales in the Atlantic waters off of Virginia and around the proposed lease site.
Figure 10. Sightings of Blue, Fin, Minke, Sei, and unidentified Balaenoptera and Rorqual whales in the Atlantic waters off of Virginia and around the proposed lease site.
Figure 11. Sightings of dolphins and pilot whales in the Atlantic waters off of Virginia and around the proposed lease site.
Figure 12. Sightings of beaked whales in the Atlantic waters off of Virginia and around the proposed lease site.
Figure 13. Oil spill cleanup after the Exxon Valdez (NOAA Photo).
Figure 14. Shipping traffic density during two months in Hampton Roads, VA. Data courtesy Mark Swingle.
Figure 15. Ambient noise levels from 0 to 1000hz in the Bay of Fundy right whale habitat are shown on the right. The intensity of noise from ships passing through the region (7 times) during a single 24 hour period is shown in color (red is loud, blue is quiet). For reference, a right whale upcall is shown at left in black and white, with scale matched to the ambient noise spectrogram. Note the frequency overlap between the call and the shipping noise. Images and data courtesy Chris Clark and Susan Parks.
Figure 16. Ambient noise levels in a relatively pristine marine environment (left top) and in a highly urbanized one (right top). The lower graphs show that in the quiet ocean, finback whales provide the dominant low frequency noise, while in the urban one, finback sounds are completely masked by the ambient noise levels from human activities. Images and data courtesy Chris Clark.
**List of Tables**

Table 1. Lease sale history of the Atlantic OCS Planning Area, see Figure 2 for area boundaries. Data summarize and rounded from: [http://www.gomr.mms.gov/homepg/offshore/atlocs/atleas.html#ATLOCSSALE](http://www.gomr.mms.gov/homepg/offshore/atlocs/atleas.html#ATLOCSSALE)

Table 2. Summary of the number Mid-Atlantic reports by major category. See Appendix C for details.

Table 3. Summary of physical and geological data needs for the Virginia OCS lease sale area.

Table 4. Summary of endangered and protected species concerns for the Virginia OCS lease sale area.

**Appendices**

Appendix A. List of Atlantic BLM and MMS studies

Appendix B. Workshop Agenda

Appendix C. Workshop Attendees

Appendix D. Workshop PowerPoint presentations
Executive Summary
The Minerals Management Service (MMS) has the responsibility for leasing and overseeing oil and gas development on the outer continental shelf. This oversight includes ensuring exploration and production are done in an environmentally responsible manner. In planning for a potential lease sale in the Mid-Atlantic outer continental shelf (OCS) Area offshore Virginia, MMS sponsored a workshop on the environmental research needs in support of potential Virginia offshore oil and gas activities 3 and 4 December 2008, in Williamsburg, Virginia. The focus of the workshop was to assess the existing scientific knowledgebase along the Virginia Coast and the information gaps that need to be addressed should a lease sale for oil and gas activities be held for the Virginia outer continental shelf. This report summarizes the outcome of the workshop.

The first lease sales in the Mid-Atlantic region in the 1970s and 1980s lead to a series of environmental studies to collect baseline data on physical and biological conditions. These studies ranged from the Canadian border to Florida. Several were close to or included parts of the Virginia OCS within the planned lease sale. The principle recommendation from all breakout groups was to assess existing data in a thorough and systematic manner. This effort would include all MMS sponsored studies, other Federal and State agency reports and databases, and the peer-reviewed literature. This data assessment needs synthesize all disciplines. The exception may be socioeconomic, where there is little in the way of existing data to synthesis. New studies that focus on socioeconomics or monitoring could be started, but directed studies need to be informed by the results of the existing data synthesis.

Given the complexity of the OCS and developing management strategies that focus on ecosystem based views of living and mineral resources, a cross-disciplinary effort between biology, fisheries, and physical studies is needed. It will be essential that synthesis efforts incorporate water column and bottom processes data. Geohazards also need to be integrated with the living resources data. Special attention needs to be given to the possibility of chemosynthetic organisms within the Virginia OCS lease sale area.

MMS should develop a comprehensive and integrative plan to assess the cumulative impacts of multiple energy uses on the OCS and adjacent ocean areas. MMS should work with other relevant agencies, states and stakeholders to develop consistent standards to assess the geographic extent of potential impacts and the consequent range of requisite studies.

Overview
The MMS, a bureau within the Department of the Interior, sponsored a workshop on the environmental research needs in support of potential Virginia offshore oil and gas activities 3 and 4 December 2008, in Williamsburg, Virginia. The focus of the workshop was to assess the existing scientific knowledgebase along the Virginia Coast and the information gaps that need to
be addressed should a lease sale for oil and gas activities be held for the Virginia outer continental shelf. This report summarizes the outcome of the workshop.

The MMS has the responsibility for leasing and overseeing oil and gas development on the outer continental shelf (OCS). The OCS comprises the portion of the submerged seabed adjacent to all US coasts whose mineral estate is subject to Federal jurisdiction (Figure 1, MMS 2006). In addition, MMS’s oversight includes ensuring exploration and production are conducted in an environmentally responsible manner.

The MMS is planning for a potential lease sale in the Mid-Atlantic OCS Area offshore Virginia (Figure 2). The Mid-Atlantic Planning Area, which extends from Delaware to North Carolina (Figure 3), encompasses approximately 112.83 million acres and has had the most lease sales (5), the largest number of leases awarded (238), and the most wells drilled (32 exploratory, 2 COST) (Table 1). The offshore Virginia lease sale (designated number 220) is scheduled for 2011 under the current OCS leasing Program 2007-2012 and will cover about 2.9 million acres starting 50 miles offshore Virginia (Figures 3, 4, and 5, http://www.mms.gov/5-year/). The Gulf of Mexico (GOM) MMS region will be responsible for administering the Atlantic OCS area. The GOM region is the largest and manages more than 7,000 active leases covering more than 39 million offshore acres, with over 3,850 producing and 200 drilling facilities for some 160 qualified operators.

The Atlantic OCS area is divided into four planning areas along the Atlantic seaboard: the North Atlantic, Mid-Atlantic, South Atlantic, and the Straits of Florida (Figure 2). Between 1976 and 1983, nine oil and gas lease sales were held for the Atlantic OCS planning area. Straits of Florida was transferred from the Gulf of Mexico OCS Planning Area to the Atlantic OCS Planning Area in 1985 and has had only one lease sale (Lease Sale #5) in 1959 that resulted in three exploratory wells (Table 1). A total of 433 blocks were leased in all the Atlantic OCS lease sales and 49 exploratory wells and 5 COST wells were drilled. Within the Mid-Atlantic Planning Area 32 exploratory wells and two COST wells were drilled (Table 1, Figure 3). On November 17, 2000, the interests in the last remaining 8 natural gas and oil leases active in the Federal waters offshore North Carolina were relinquished by Conoco, Shell Offshore and OYX USA. The last oil and gas lease sale within the Atlantic Region occurred in 1983. On November 17, 2000, the interests in the last remaining eight natural gas and oil leases active in the Federal waters offshore North Carolina were relinquished. There are now no oil and gas leases in existence off the Atlantic Coast.

**Workshop Objectives and Format**

The objectives of the workshop on environmental research needs in support of potential Virginia OCS oil and gas activities were to:

- Review the status of the environmental and socioeconomic information for Virginia’s inner and outer continental shelf.
- Develop recommendations for a coordinated plan of environmental and socioeconomic research need prior to oil and gas activities.
- Explore for the potential of coordinated interdisciplinary and interagency research programs.
Emphasis at the workshop was directed toward assessing what is known and unknown within the area. The workshop format included presentations and breakout groups. Oral presentations by local and regional scientific experts in the areas of physical oceanography, fish and fisheries, marine mammals, socioeconomics and other relevant science topics of concern covered existing data and major environmental concerns. After the plenary presentations, attendees formed into disciplinary breakout groups and focused on identifying the key issues of concern should oil and gas activities occur off the coast of Virginia, and the important scientific information gaps that need to be addressed. The agenda for the workshop is in Appendix A and a list of attendees in Appendix B. Copies of the oral presentations are in Appendix C.

The first of four breakout sessions was spent on discussing what is known and brainstorming where information gaps exist. Topics and gaps were discussed and framed in terms of being able to address key issues for future studies. The second session was spent prioritizing the ideas and studies. The third session was spent expanding on the one or two substantive ideas from each disciplinary group to provide background for potential studies, and information about what each study would be about and how it would be executed. The fourth session was spent preparing a brief summary that was presented to the entire workshop by the disciplinary facilitators. Emphasis was placed on MMS environmental information needs in planning for oil and gas activities on the Virginia OCS.

**Virginia OCS Description**

Studies conducted in the Atlantic OCS Region (Figures 1 and 2) from 1974 to 1995 have resulted in over 450 published reports. Of these about 200 reports related to the Mid-Atlantic OCS Area (Figure 2, Appendix D). Information on these studies and reports can be obtained from the MMS, Environmental Studies Program Information System (ESPIS):

https://www.gomr.mms.gov/homepg/espis/espismaster.asp?appid=1

The majority of the Mid-Atlantic studies were baseline or benchmark studies, with many being the first systematic scientific studies of the inner and outer continental shelf along this area of the US Atlantic coast. Many were large-scale, multidisciplinary investigations designed to characterize the nature, abundance, and diversity of biological communities, the physical characteristics of the seafloor and overlying water column, and concentrations of certain trace metals and hydrocarbons in the water, sediments, and endangered species prior to OCS oil and gas activity (Table 2).

**Environmental Resources**

Each of the disciplinary breakout groups reviewed what is known, identify gaps in our knowledge, and discussed datasets, reports and published works. Topics focused on being manageable and able to address issues in future environmental studies.

The main considerations that the breakout groups were asked to consider fell into two categories:

- Short term to support the upcoming lease sale.
- Long-term, to meet future needs should oil and gas development occur.

Possible funding partners identified as having an interest in the OCS included the following Federal agencies: National Science Foundation (NSF), Office of Naval Research (ONR), National Aeronautics and Space Administration (NASA), National Oceanographic Partnership
Program (NOPP), United States Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA).

**Endangered and Protected Species**
Facilitator: Scott D. Kraus

The endangered and protected species group addressed the data gaps and issues pertaining to marine mammals, sea turtles, and sea birds in the waters of and around the potential Virginia OCS lease sale area.

**Summary of Discussion Points**
Although there has been a substantial amount of survey effort, only a limited amount of it has occurred in the lease sale area (Figure 7). Survey effort is particularly low in the offshore portions. Most of the region-wide survey effort dates from the late 1970’s and early 1980’s, for example the Cetacean and Turtle Assessment Program (CeTAP). Subsequent surveys have been focused on areas of specific interest (i.e., Navy training ranges), and have not covered the entire region. The CeTAP surveys collected data on marine mammals and sea turtles (http://gcmd.nasa.gov/records/GCMD_seamap284.html) and most subsequent surveys have done the same. Some NMFS surveys were focused only on sea turtles. No surveys for pelagic birds have been conducted in the region, and data on their distribution and abundance is anecdotal. Most of this survey effort is also aerial. Both the effort data and sighting maps presented are cumulative maps of all data collected from 1979 to 2005. Data was not analyzed for seasonality, which would be required to evaluate the seasonal use patterns of this region by different species.

**Sightings Data**
The marine mammal and sea turtle data shows a high use of Atlantic waters of Virginia by multiple species of sea turtles and cetaceans (Figures 8 to 12). The maps show all documented sightings, but they have not been corrected for survey effort, so they do not represent an unbiased view of distribution. The lack of survey effort in most of the offshore region, and in specific areas inshore, means that sightings data shown here is biased according to where people looked.

Sea turtle data was not separated by species, partly because species identifications from aircraft are difficult or impossible (except for leatherbacks). Figure 8 shows that sea turtles are found wherever surveys have been conducted. Sightings are reduced offshore, probably due to a lack of survey effort. All sea turtles are classified as endangered under the Endangered Species Act.

As a general rule, right whales have been sighted in coastal waters (with a few exceptions at the shelf break), humpbacks have been seen on the shelf from shore to the shelf break, and sperm whale sightings are almost entirely found near the shelf break and in deeper waters (Figure 9). All of these generalizations are weakened by the lack of consistent survey effort throughout the region. Although the seasonality of humpback and sperm whales is not well known here, right whales probably occur from early-November to the end of April, as Virginia is a migratory path for right whales going to and from the winter calving ground off the southern U.S. Atlantic coast. All three of these species are classified as endangered under the Endangered Species Act, and right whales can be considered at risk of extinction due to human activities (Caswell et al., 1999; Fujiwara and Caswell, 2001).
Sightings of the balaenopterid whales are shown in Figure 10. With the exception of minke whales, all species are listed as endangered under the Endangered Species Act. Although all species of balaenopterids are included in this map, blue and sei whales are relatively rare in the region. Finback whales are fairly common, and are usually seen along the outer shelf and shelf break, with occasional sightings further offshore. Like the other species, these generalizations are weakened by the lack of consistent survey effort throughout the region. The seasonal distribution patterns for these species is not well known, although records include sightings from the region throughout the year.

All dolphins, porpoises, and pilot whales are protected under the Marine Mammal Protection Act, but none are listed under the Endangered Species Act. The coastal assemblage in this region is composed primarily of the coastal bottlenosed dolphin (Tursiops spp), (Figure 11). The near shelf edge assemblage is dominated by pilot whales (Globicephala spp), striped, spotted, and spinner dolphins (Stenella spp.), Risso's dolphins (Grampus griseus), and common dolphins (Delphinus delphis). Like all cetaceans in this region, seasonal distribution and abundance patterns are not well known due to the lack of consistent survey effort throughout the region. Nevertheless, records include dolphin and pilot whale sightings throughout the year.

All beaked whales are protected under the Marine Mammal Protection Act, but none are listed under the Endangered Species Act. All beaked whales are primarily deep-water species and their distribution is off the shelf edge in this region (Figure 12). Beaked whales are long divers (up to two hours) so they are frequently missed by surveys. Also, because they occur in the offshore portion of this region where survey effort is sparsest, information on seasonal distribution and abundance patterns is completely lacking.

Potential Environmental Issues
We classified the consequences of drilling activities into three categories relative to their potential to affect individual animals, localized groups of individuals, and stocks or populations. Three areas of concern included the discharges accidentally or chronically released during the course of drilling activities, increases in vessel traffic associated with both exploration and rig maintenance, and production activities, and underwater noise associated with seismic exploration, drill rig operations, and from associated vessels.

Discharges
The stereotypical concern of the American public with regard to offshore drilling is the catastrophic large-scale oil spill typified by 1989 Exxon Valdez disaster off the coast of Alaska (Figure 13). However, extensive advances in drilling technology and a lot of historical data from the Gulf of Mexico suggests that the probability of an oil spill from drilling operations is extremely low. There are other drilling related discharges, which require consideration, including drilling muds, rig waste, and air pollution. The direct consequences of these on marine mammals, sea turtles, and seabirds are likely to be low, with potential effects limited to a few individuals or local groups.

This is not to say that the probability of damage is non-existent. As Geraci and St. Aubin (1990) have pointed out, “When oil is drawn from the seabed or transported along oceanic routes, some
inevitably escapes.” However, for marine mammals, those at highest risk are fur-bearing animals (pinnipeds, polar bears, and sea otters). Only pinnipeds occur in this part of the Atlantic, and they are rarely found in the region. Manatees occasionally travel this far north, but tend to be coastal and rare, and are therefore unlikely to be at risk from discharges or spills. For cetaceans the data suggests that cutaneous exposure to oil, inhalation, and ingestion, have minor and/or temporary consequences (Geraci, 1990). With regard to the potential for baleen fouling, perhaps the most worrisome of the potential oil spill threats for large whales, the evidence indicates that these species have the potential to clear 95% of all oil within 24 hours of exposure. The final concern, the ingestion of the toxic chemicals associated with oil spills remains in need of further study, although preliminary information indicates some metabolic and de-toxifying capabilities in cetaceans (Geraci, 1990).

**Vessel Traffic**

Many scientific studies have been done to assess the role of speed in ship kills of large whales, and five studies have specifically evaluated this for right whales. Various studies (Vanderlaan and Taggart 2007, Pace and Silber 2005, Laist et al. 2001, Kite-Powell et al. 2007, Vanderlaan et al. 2008) used different analytical approaches, but all reached the same conclusion that vessel speed plays a role in the level of severity of a strike. In addition, Knowlton et al. (1998) concluded that in none of their simulations did a slower moving ship increase the risk of collision. A slower ship has lower hydrodynamic forces and is thus safer for a whale trying to take avoidance action. The cumulative results of these multiple studies are conclusive – no matter which technique is applied, increased shipping speed carries increased risk of death and serious injury to all large whales. The entrance to Chesapeake Bay is one of the busiest shipping areas along the East Coast, serving several commercial ports and military facilities (Figure 14). This high level of shipping crosses the migratory routes of right whales and probably humpbacks. All species of baleen whales have been reported killed by ships (Jensen and Silber 2004, Laist et al. 2001), and finbacks, humpbacks, and right whales are most frequently reported. Existing data suggests that vessel traffic out of the Chesapeake Bay area has been responsible for at least five right whale mortalities in the last 15 years (Knowlton and Brown, 2007).

Vessel traffic associated with the lease site will be dependent upon the oil and gas activities (seismic, drilling, maintenance, and production) and how the site is eventually developed if oil or gas is found and transported. Nevertheless, all vessels over 65 feet in length will be subject to seasonal speed restrictions implemented by NOAA on December 9, 2008. Under 50 CFR Part 224, NMFS established regulations to implement speed restrictions of no more than 10 knots to reduce the likelihood of deaths and serious injuries to endangered North Atlantic right whales that result from collisions with ships.

**Noise**

Cetaceans live in an environment that at best has visibility of 200 ft, and in most ocean regions far less. They have therefore evolved into highly acoustic animals, using sound to find food, communicate, and in some cases to navigate. As human activities in the ocean have increased, noise from commercial and recreational vessels, sonars, seismic exploration, dredging, and construction have all increased dramatically. A large portion of this noise comes from vessel engines and propellers, and those sounds occupy the low frequencies used by most large whales. Acousticians have estimated that the chance of two whales hearing each other today has been
reduced to 10% of what it was 100 years ago (Parks and Clark, 2007) due to the masking of communication sounds by the ambient ocean noise created by multiple industrial activities (see Figure 15).

Oil and gas development within the lease site will involve seismic exploration (loud, broadband low frequency pulses), hazards surveys sonar (mid-to high frequency pulses), drilling (low frequency broadband noise), and vessel traffic (loud broad spectrum sounds, frequency dependent upon the ship size). While some military sonars have been shown to cause deaths in beaked whales (by mechanisms that are still being studied), within the activities related to oil and gas development, only seismic exploration has the sound source levels that are capable of inflicting serious damage to cetaceans if suddenly exposed.

Although there is no uncertainty that these noises are cumulatively affecting the ocean environment for cetaceans, there is some uncertainty about both the behavioral responses of cetaceans to many of these sounds and the population consequences of those sounds (National Research Council, 2005). Almost all animals within a broad region will be exposed to the sounds of seismic exploration. Human technology can detect seismic exploration across ocean basins, and there is ample reason to believe that many whale species can do as well or better. The subsequent activities are more likely to affect local groups of animals, although large shipping (if that proves to be the mode of transport) can create sounds audible from over 100 miles away. The cumulative impacts from all of these activities are adding to the ambient noise levels in the ocean and are steadily eroding marine mammal’s abilities to communicate (See Figure 16). At some point this acoustic smog (Clark et al., 2007) will start to affect the abilities of whales to find food and mates. When that happens (and that point may be near), human noise pollution in the oceans will have significant, long-lasting, population level consequences on the survival of some marine mammals. Because the bulk of human industrial sounds in the oceans are low frequency, it is likely that the large baleen whales will be those that will be affected first.

Noise mitigation is possible, and there may be some seasonal restrictions that would minimize impacts on highly endangered species such as right whales. However, because of the potential for large-scale widespread impacts, underwater noise should be the primary consideration in environmental mitigation strategies around any leased sites in this region.

**Knowledge Gaps for Endangered and Protected Species**

Data gaps have been identified throughout the previous sections and are summarized in Table 4.

Care needs to be taken in synthesis of existing data as the quality and original sources of data need to be assessed. Thus caution is needed in using previous data synthesis efforts as there may be redundancy in the unpublished and gray data. Age of existing data could be an issue for mammals and turtles, as much of it is 20 to 30 years old.

A comprehensive data inventory and synthesis from original sources for marine mammals, sea turtles, coastal and marine birds (pelagic & onshore) is needed. Included in this would be published peer-reviewed literature and various gray literature sources such as MMS reports (Appendix D), NMFS turtle surveys and stock assessment reports, and Navy surveys. Unpublished data held by States, universities-theses and dissertations, and NGOs also needs to
be included, for example, the Nature Conservancy, Virginia DEQ, National Marine Sanctuary proposal for Norfolk Canyon, Right Whale Consortium, UNCW, and Virginia Aquarium humpback data, VIMS sea turtle data. Finally, on-going studies that are yielding data of interest and not yet published should be included. Metadata file associated with these studies needs to look at season, geographic extent, etc.

Seasonal and annual data are needed that include:

- Passive acoustics for broad sounds to get all animals. For lifetime of the project.
- Residents vs. migrants, sperm whales may be residents and fin whales migrants.
- Joint industry program on noise needs to be integrated into other programs.
- Controlled experiment with sonic tags. To see how animals behave when seismic work starts.

**Pelagic and Demersal Fish and Fisheries**
Facilitators: Ken Able and Rich Brill

There are several databases and many reports and publications that are relevant for assessing fish and fisheries in the proposed Virginia OCS lease sale area. These sources need to be reviewed and summarized. Efforts to summarize and synthesize these existing sources should be divided into two broad categories: short-term and long-term assessments. For example, fish migration patterns could be analyzed in the short-term with relevant existing National Marine Fisheries Service (NMFS) data. Information available in the NMFS database includes fish species and abundance, physical habitat mapping, seasonality, and vessel trip reports that include gear type, effort, etc. To meet future needs, should oil and gas development occur, longer-term studies of the fish situation at the shelf break, slope, and canyons would be needed as the data density declines further offshore at the shelf break and abyssal plain.

**Summary of Discussion Points**

Synthesis of existing data should be the primary task. A number of fish and fisheries databases include at least part of the Virginia lease sale area. New surveys for canyons and upper slope habitats may be needed as these areas have not received as much sampling effort. The long-term nature of several datasets needs to be explored for patterns in fish populations. This would include examining many of the peer reviewed articles on fish and fisheries of the region. Published syntheses that used these databases, or are currently being conducted, have looked at fish migration and population dynamics, oilrig attraction, acoustic ecology, larval abundance, fisheries timing, location, effort, and landings. For example, the shelf wide Northeast Fisheries Science Center Oceanography Branch (NEFSC) EcoMon plankton survey (http://www.nefsc.noaa.gov/epd/ocean/MainPage/shelfwide.html) conducts six, shelf-wide plankton surveys per year and the ichthyoplankton data from more recent surveys (1999-present) are currently being added to NEFSC databases. Other examples relevant to specific areas of the Virginia area would be NMFS zooplankton database and the Norfolk Canyon shark database of the National Shark Research Consortium and Shark Research Program at the Virginia Institute of Marine Science (http://www.flmnh.ufl.edu/fish/sharks/nsrc/vims.htm). Particular attention needs to be given to analysis of toxic effects and hydrocarbon databases. This will address risks from drilling and also from spills.
A portion of the existing information contained in these databases may be outdated and will need to be updated with new focused studies. For example, how will climate change species distributions? Care will need to be taken in comparing fisheries information to ensure that techniques are comparable. Assessment of how differences in gear affect broad regional summaries may need to be done. An assessment of how relevant data collected from the other MMS regions, particularly the Gulf of Mexico for fish and fisheries impacts from oil and gas development needs to be conducted.

Specific factors that need to be considered for fishes include population dynamics of various life stages. More data are needed on larval stages and spatial scales of egg distributions. Synthesis of existing data with some additional seasonal sampling linked with physical transport models will be required (cross linked with physical oceanography section). Temporal scales from short-term to long-term patterns in fish abundance need to be assessed relative to the spatial scales of oil and gas development sites (for example, platform or pipeline) to larger scale effects (for example, circulation patterns). Impacts of seismic surveys on fishes must be specifically assessed, as most of the data on sound effects relates to marine mammals (see Endangered and Protected Species section). For fishes, what are the physiological effects from air guns, for example and are there other impacts that might affect fisheries?

Particular attention needs to be given to species that may be most affected by oil and gas development, such as demersal fishes (excludes highly migratory pelagics), shellfish populations (crab, shrimp, scallops, etc.), highly localized species, and sharks. All of these groups include both commercially or recreationally important species.

**Knowledge Gaps for Fish and Fisheries**

Currently there is little to no data on existing body burdens for oil and gas development related pollutants. This information is needed for key indicator species and should be monitored for both population and individual loads. Indicator species would include localized noncommercial species and commercial species (such as, tilefishes, mussels, lobsters, and red crabs).

Some habitats within the Virginia lease sale area with limited information will require baseline studies, such as Norfolk and Washington Canyons. The ecosystems of canyons tends to be spatially diverse and complex and difficult to study, thus there is little know about the Middle Atlantic canyons. Similar focused studies would be needed for upper-slope (depth > 200 m) habitats.

When and where fisheries occur will be a key factor to determine relative to the timing of seismic surveys and considerations for fishery windows similar to those used to minimize environmental disruption from other activities. Little is known about the acoustic ecology of fishes and what the impacts of sound production from seismic surveys are. Dock surveys for various aspects of recreational and commercial fisheries would be needed to establish baseline data on total value of the Virginia region and as a point for assessing change in fisheries shifts (cross linked with Socioeconomics section).

Larval stages will have the most sensitivity to drilling muds and fluids. An assessment of data from the Gulf of Mexico region is needed to determine transferability of knowledge. Is Gulf of
Mexico, Pacific, and Alaska Regions information on fish attraction to oil and gas structures applicable in Mid-Atlantic Area? Do oil and gas structures result in more fishes or simply attract existing fishes and do these structures act as vectors for invasive species?

Larval stages are also subject to oceanographic processes and interactions with major topographic features. How all these processes and factors influence larval transport needs to be determined. In particular, how the Gulf Stream interacts with other coastal circulations to affect larval transport of both regionally spawning fishes and invertebrates, as well as extra-regional larvae transported into the Virginia area.

**Benthic and Biological Issues**

Facilitator: Linda Schaffner

Little nonfisheries benthic and biological data are available for the Virginia OCS lease sale area. This area likely represents a “Transition Zone” between the influences of a colder temperature regime to the north (cold pool) and warmer Gulf Stream dominated North Carolina and Cape Hatteras shelf region to the south. It is well known that bathymetric and latitudinal gradients are important sources of variation over the OCS. The position of the Virginia OCS lease sale area within the broader region means it is subject to significant temperature variations at the shelf break and slope. Canyons intruding into the shelf area and other topographic features along the shelf-edge further increase the variation among shelf habitats. The deep-sea regions in the east of the Virginia OCS lease sale area are likely more constant and typical of other deep-sea regions.

**Summary of Discussion Points**

The proposed lease area is small with the width of the western edge about 50-75 miles and tapers to a point to the east at a depth of 3000 m. The area also contains two canyons beyond the shelf break. The canyons represent unique habitat within the region and should be carefully evaluated and monitored for impacts from oil and gas activities. As with the other disciplines, the further offshore one goes the less information there is. In general, there have been a limited number of benthic and biological studies in the Virginia OCS lease sale area. Benthic information from the area is limited. There are a number of studies that have been conducted near or in part of the Virginia OCS lease sale area such as the BLM-OCS mid-Atlantic studies from the 1970-80s with data on the shallower shelf (Boesch et al., 1977 and Appendix D), MMS Manteo-Cape Hatteras study to the south (Blake and Diaz, 1994), general faunal surveys on the shelf and slope (Wigley and Theroux, 1981, Maciolek et al., 1987), and various NOAA reports.

Fauna changes occur at Cape Hatteras and further south for the continental shelf. Changes in the fauna at slope depths also occur between Virginia and Hatteras. There is a large change in topography of the shelf and slope between Virginia and North Carolina. The Virginia OCS is not comparable with shelf fauna further to the north either. The Virginia OCS is more influenced by the warm Gulf Stream water and northern OCS by cold water pools. The outer shelf and shelf break are not well studied and poorly characterized. The Nature Conservancy has attempted to identify benthic habitat by developing a GIS mapping database, which includes USGS grab samples from the 1960s used to classify bottom habitats.
Key habitat or bottom types that need to be identified and inventoried include dispersed hard bottom such as clay, rocky shale or shelly outcrops; low and high topographic areas on the outer shelf and slope; and hard bottoms overlain with soft sediments. Habitat types with particularly low or high productivity need to be identified including what is below soft sediment veneers. An important component of locating and determining the aerial extent of various habitat types is detailed bathymetry. Currently NOAA’s National Geophysical Data Center (NGDC) has much of shelf area mapped at very coarse scales (see Figure 6 and http://ngdc.noaa.gov/mgg/coastal/grddas02/grdden02.htm for examples). The data that supports the NGDC maps needs to be assessed to determine the actual resolution and accuracy of the published maps.

Any effort directed to new studies needs to be focused in areas of expected oil and gas activity and concentrate on the most important habitats. Inshore of the proposed sale area is a broader region that will need to be assessed for benthic resources. This broader region can be divided into five segments for the purposes of benthic biology:

- Outer continental shelf from 3 to 50 miles offshore is about 40% of the total region.
- Shelf break about 20%.
- Slope about 10%.
- Canyon area is <2%.
- Deep-sea at eastern tip is about 30%

Synthesis of existing data from other deep-sea areas should show the deep-sea is broadly homogeneous along the Atlantic coast and that the deep-sea portion of the proposed sale area should be given low priority for new sampling. Canyons will require special attention as they tend to support high diversity of large epifaunal species related to the spatial and vertical extent of hard bottom. Sampling design would need to consider the limited area that canyons occupy and adjust effort to insure the canyons are adequately sampled. There is a need to describe canyon ecosystems in order to determine their uniqueness and sensitivity to oil and gas activities, as they may be high priority areas for protection.

Synthesis of existing data in the peer-reviewed and gray literature should be a primary task undertaken. This needs to include the large number of environmental studies and report supported by MMS (Appendix D). Before any synthesis takes place, MMS should develop scenarios as to how the existing data synthesis will be used. This will help to focus the effort on identification of data needs for future assessments. A workshop format with ecologists to discuss what is known, and how to prioritize and synthesize data is recommended. The flow of tasks would be for MMS to first develop scenarios for data needs and to identify who needs to be part of a synthesis team to attend a workshop. At a minimum, at least one experienced benthic ecologist for each major area segment would be needed (OCS, slope, and deep-sea). In addition, ecologists for benthic-pelagic coupling and physical oceanographers for physical-biological coupling would be needed. Second, the references and data should be compiled and synthesized by scientists who would present the findings at the workshop. The product from this workshop would be written as a peer-reviewed manuscript(s), which would be used to develop management tools for the area relative to oil and gas development.
There is a possibility that at the shelf break, rock outcrops and scarps may be present with unique community types. For example from New Jersey to North Carolina there are some deep reef-building organisms, and *Lophelia* spp. (deep water coral) may be present. Tile fish are present on hard substrate and clay bottoms. Geologically, ridge and swale topography is a prominent feature of the shelf in this area with sand waves as high as 10 m and wavelength of 10’s of meters. These features are known to shape benthic community structure and can be seen at 50 m resolution.

**Knowledge Gaps for Benthos and Biology**

One of the larger unknown questions is what are the latitudinal gradients along bathymetric contours and how does the Virginia OCS lease sale area compare to the rest of the OCS along the Atlantic coast? A first step to address this question would be mapping of benthic habitats to identify the extent and diversity of habitats that are present. This would include the use of broad scale multibeam and swath mapping for classifying sediment type and determining general patterns and distributions of habitat types. This effort would be combined with intermediate scale side scan sonar and Autonomous Underwater Vehicle (AUV) mapping to provide higher resolution of selected areas. Remote ground-truthing would be needed to identify high-priority areas and sentinel sites, e.g. for hard-bottom, high productivity swales. The focus of the ground-truthing effort would be on the outer shelf/shelf break area and use a diversity of approaches. Included would be AUV and sled video (long distances; collect data at regular intervals) methods. Point sampling with cameras and box-cores would be required for collection of sediments and fauna. At a minimum, the baseline sampling would be used to determine details of biotic communities including diversity, abundance and biomass. The sampling would also need to determine if the Virginia OCS is similar to the OCS to the north and south. Interpretation of benthic data would also rely on physical factors that regulate communities and species distributions such as differences in temperature or sediment supply (cross-linked with Physical and Geological section).

**Physical and Geological Oceanography**

Facilitator: Larry Atkinson

**Summary of Discussion Points**

There is a need to balance long- and short-term studies to accommodate the data required prior to the lease sale date. Prior to any lease sale, there needs to be an evaluation of data gaps. For geological issues, factors that need to be assessed included the extent of methane hydrates and bottom resuspension within the Virginia OCS region. Of particular relevance to the shelf topography are the extensive ridge and swale sand wave features. From a physical oceanographic perspective, how physical parameters associated with the Gulf Stream, and other broad regional circulation patterns, will influence and effect exploration needs to be understood. Other factors to assess would be the extent of offshore disposal of military waste (since World War I) as these sites would have to be located and identified as hazardous. Of particular importance would be to understand how the two canyons (Washington and Norfolk Canyons) and deep currents interact with other shelf processes. In addition, proposals for any pipeline route running from offshore to onshore need to be considered in light of the above physical and geological factors. Research and databases developed for alternative energy studies may be of benefit to oil and gas development and vice-versa.
Existing Mid-Atlantic MMS studies and data, plus those other agencies and peer-reviewed literature, should be synthesized in such a way that they inform and facilitate the design of additional studies. We recommend the literature review and analyses of existing data be organized around priority topics (for example, deep water boundary currents, permanent moorings; Rossby waves associated with Gulf Stream meanders and eddies). Consideration needs to be given for interests of other agencies who may wish to partner with MMS. For example, would the Commonwealth of Virginia or the Navy have any interest or resources? Also, are there deep current studies of the Gulf Stream or other Navy data that can be “unclassified?”

For oil spill risk analysis, current and wind information are needed, is there sufficient data now or do we need more to properly map spills? Modeling is underway, and sea surface height anomaly, drifters, and circulation information are needed. This could be a high priority data gap.

Synopsis of physical oceanography projects supported by other agencies and MMS (ESPIS website: https://www.gomr.mms.gov/homepg/espis/espismaster.asp?appid=1 and example peer-reviewed citations):
- SYNOP project off Cape Hatteras, Office of Naval Research (ONR) program - echo sounder study, look at variability of Gulf Stream and modeling, deeper water (Savidge and Bane, 1999).
- Study of physical processes in Mid-Atlantic Slope and Rise (MASAR) (Appendix D).
- Frontal eddy dynamics (FREDY) study off NC, current meters, drifters, cross-shelf transport. Was prior to Manteo project (Glenn and Ebbesmeyer, 1994; Appendix D).
- Data Assimilation and Model Evaluation Experiment (DAME´E), ONR program for ocean modeling Gulf Stream and then entire North Atlantic (Chassignet et al., 2000).
- Shelf Edge Exchange Processes (SEEP), DOE program (Biscaye, 1994).
- Dumpsite 106 studies for entire Atlantic Margin (Fry and Butman, 1991).
- Ship “Oleander” – profiles from New York to Bermuda weekly time series (Rossby et al., 2005).
- NOAA Coast Watch – Satellite remote sensing data source (http://coastwatch.noaa.gov/).
- MARCOOS (NOAA), coastal ocean, data sets and time series, gliders and codar data (http://www.marcoos.us/).

From the 1970s to today the questions addressed by these studies haven’t changed but the technology has. Satellite data is clearly an advancement and should be key to understanding physical and biological processes on the OCS.

Knowledge Gaps for Physical and Geological Oceanography
The presence of Norfolk and Washington Canyons within the Virginia OCS complicate the physical and geological setting. How these canyons interact with local currents, general regional flows, and storms will be key to understanding sediment transport dynamics and resuspension. For example there is limited understanding of the effect of internal tides/waves and their
propagation/evolution on mixing and currents at the shelf break and canyon heads. Issues that need to be resolved with regard to deep near-bottom currents included their strength and variability and how turbidity is affected (background levels vs. what operations create). Seasonal variability in cross-shelf transport processes is also an important issue. In particular, how is the Benthic Boundary Layer (BBL) affected by hurricanes vs. Nor’easters, and “normal” events vs. larger-scale anomalies? The magnitude and frequency of events within the four defined environments (outer continental shelf, shelf break/slope, abyssal plain, and canyons) relative to bottom considerations, geological characterizations, and geohazards need to be viewed in a holistic way. This includes long-term cycles such as North Atlantic Oscillation (NAO) and other inter-annual variability effects. For many of these issues, satellite data will be a key asset. Nearshore processes, such as coastal currents, fronts and freshwater plums from Chesapeake and Delaware Bays, will also need to be assessed as they will play a large role in spill trajectories and movement of surface water layers.

Models and studies relevant to transport of potential spills and what they might encounter and disturb, both environmental (microbes, blue crab larvae, fish spawning, etc.) and human impacts, needs to be cross-referenced to biological and fisheries concerns. Key areas for acquiring data for these models would include wind and other meteorological data in high resolution in time and space, and surface currents. All models need to be validated with recent observations.

Ridge and swale topography is a prominent feature of Virginia OCS and how these topographic features interact with and influence transport and biological processes needs to be considered. For example, can ridge and swale topography change pollution transport, and what are the seasonal and storm induced movement implications and concerns for burying pipelines? This will be key to determining the appropriate depth of burial for pipelines to keep them below what could be exposed by movement of these features. Factors relative to the infringement of pipelines on the coastal environment and upland also need to be considered.

Geographic Information System (GIS) linked databases need to be developed to improve visualization and data dissemination. GIS could also be the primary means of interfacing the science with management decisions. Geological and geophysical data models are needed for a few locations (2-6 sites/scenarios informed by observations – at least one model for the shelf, slope and abyssal plain) to cover the variability of the shelf/slope environments. These models would inform drilling locations and establish a range of possible scenarios. Datasets needed to combine into the GIS based models would include:

- Bathymetry – A good example would be CARUMBA (Central Atlantic Region US Margin Basin Analysis: Central & North Atlantic; USA and Canadian Margin basins) a project to collect existing bathymetry data and put them into GIS format.
- Grain size – spatial variability of sand vs. mud – scale of observations cross-shelf distribution.
- Chemical/toxins – sediments and pore water.
- Sediment/fauna interactions.
- Drilling technology.
- Thermal distribution related to above
Ideas were prioritized for three issues (oil spills, geohazards, and site specific impacts) and four environments of interest (shelf, slope, abyssal plain, and canyons), as summarized in Table 3. One study recommendation would be to set up a range of stations that exemplify two to six site types (including at least one per environment of interest) expected to occur within the lease area that explain the spectrum of sediment transport and bottom characterization. From these stations a range of scenarios can be tested. The variables to measure include, but not limited to, are: currents, sediment transport, and various other geological and physical oceanographic considerations relevant to drilling locations.

**Social and Economic Issues**

Facilitators: Diane Austin and Doug Lipton

There are a few socioeconomic studies along the Atlantic coast that pertain to oil and gas activities (Appendix D). Most socioeconomic studies that have been conducted are concentrated in the Gulf of Mexico and Alaska OCS regions.

**Summary of Discussion Points**

The lack of information on the socioeconomic issues resulted in the breakout session focusing on key questions that would need to be addressed. The format of the discussion was therefore based on these questions rather than identification of existing information and future information needs.

Will data gaps in social and economic issues have a bearing on permit process? Three-year permit process will provide opportunity to fill data gaps of concern to MMS.

Without a pipeline terminating in Virginia, what is the potential economic positive for Virginia? Currently there is no lease-sharing revenue agreement with Virginia. What are the implications for not having a lease-sharing agreement to oil and gas development in the region? Leasing has almost always been an issue in Virginia from the first lease sales in the 1970s (Table 1). Virginia Beach wanted to restrict development to natural gas (not oil) due to tourist industry issues. What will be the regional impacts on Virginia employment and the net effect on Virginia due to oil and gas related infrastructure?

Experience from the Gulf of Mexico region with increased traffic to bring in supplies to support oil and gas industries may be useful for decision-making in Virginia.

What are the interactions of oil and gas, alternative energy development, and other activities? For example, would it be possible to develop a multiuse framework with other industries, such as offshore aquaculture. What are reasonable development scenarios comparing and contrasting the different energy sources? Incorporation of offshore wind studies and other energy development project might be a way of accommodating multiple users. There is a need to consider the cumulative impacts of all offshore activities.

What are the economies of scope and most efficient use of resources on the OCS? There is a need to examine various options from no development to combinations of technologies. Possible interactions with military activity in the Virginia Capes area must be considered. Past and
current research on this needs to be summarized for possible hazards from military use, both environmental and economic impacts.

What are the impacts of potential energy development on education, academic research, training, and development? Is there potential for new growth and centers of excellence? What are the effects of creating such centers that might draw people from beyond Virginia?

How will potential offshore energy development affect existing relationships among local jurisdictions (Dillon’s Rule, Payne 2003)? How would tourism be affected by a new energy industry? Are there revenue-sharing models for localities and multi-state levels? Case studies should be developed for key areas. Decision support models that would aid local/state planners need to be identified. Consideration to impacts of growth and development from oil and gas activities on the land use and value need to be assessed along with watershed issues, and indirect effects on Chesapeake Bay and coastal waters.

The potential impacts on port traffic and expansion of the Hampton Roads facilities needs to be accessed. How much port capacity do we have in local ports and can the additional vessel tie-ups be accommodated? What is the existing relevant labor force and what demographic implications will immigration of new workers bring? What is the existing transportation infrastructure and what are the potential impacts on that infrastructure of offshore development at each phase of that development? What are the environmental consequences of transportation expansion?

Consequences to individuals and communities need to be considered. For example, what is the existing housing infrastructure and what are the potential impacts on that infrastructure of offshore development at each phase of that development? What are the potential impacts of decommissioning on the communities, workers, institutions, etc? What does the public think? Need independent surveys, risk perception study of coastal residents. A risk perception study prior to and following a revenue sharing model is needed. Need to define what questions are important for such surveys. What will be the impacts of offshore development on the price of natural gas regionally and nationally? What are the consumer benefits?

Environmental concerns that have economic impacts (cross linked with Biology and Fisheries sections) would include the monetary value of potential ecosystem services impacts. What is the potential for spatial interactions and conflict with commercial and recreational fishing? What are the potential impacts of the possible importation of invasive species?

Linking models of regional economy to appropriate environmental questions and watershed models is needed and would include spatial dimensions, coupled with land use. Hampton Roads Planning District has models that could be utilized in a case study. Fiscal effects should be addressed through a regional model. What are the state level fiscal benefits of the program? What are the benefits other than revenue? Differences in the spatial distribution of the program may affect State level fiscal benefits, the net impact on the State depends on where growth occurs. State level effects should be addressed first, then regional effects. What will the employment benefits be? Need for a baseline economic analysis with sufficient spatial granularity.
Knowledge Gaps for Social and Economic Issues

What are the onshore socio-economic effects of reasonable estimates of offshore energy development for scenarios of no development, offshore oil and gas, offshore wind or other alternative energy sources, and both offshore oil and gas and wind? Issues of highest priority include potential impacts on transportation infrastructure, ports, housing, and commercial and recreational fishing.

A risk perception study at two scales is needed with a case study of Hampton Roads and a broader regional study that would include residents from Cape May to Cape Hatters. Where oil and gas development will be based will be key to planning these studies. Will it be Hampton Roads, or will constraints and costs move it to other areas? Where onshore development is likely to occur in response to offshore development will need to be determined ahead of time to avoid expending effort in the wrong areas. The regional economic model should dovetail with what local planning districts are doing as much as possible. Costs and constraints of infrastructure development should be incorporated into the model. Information on land use changes is also a high priority.

What are the threats/benefits to local economies (tourism, recreation, way of life, and fisheries) from onshore development, oil spills, increased ship traffic, and social structure and occupational shifts? Regional models should assess threats/benefits to local economies as well as consideration of existing state policies and interstate relationships. We identified three overarching themes that should apply to any socio-economic study:

- Consider oil and gas in context of other offshore energy development.
- Consider onshore infrastructure impacts.
- Consider cumulative, long-term impacts.

We identified four study topics that included:

Fiscal effects of offshore development - Regional economic models should dovetail with what local planning districts are doing. Costs and constraints of infrastructure development should be incorporated into the models. Link models of regional economy to appropriate environmental questions and watershed models, couple with land use. Hampton Roads Planning District has models that could be utilized in a case study. Experience from development in Gulf of Mexico may provide data and examples that apply to Virginia decision-making.

Spatial distribution of onshore development in response to offshore activities - Where is onshore development likely to occur in response to offshore development? What are the impacts of growth and development on the land itself relative to watershed issues, and what are the indirect effects on Chesapeake Bay and coastal waters? How would the industry impact port traffic and expansion of the Hampton Roads port? What is the existing transportation infrastructure and what are the potential impacts on that infrastructure of offshore development at each phase of that development? What are the environmental consequences of transportation expansion? What is the existing housing infrastructure and what are the potential impacts on that infrastructure of offshore development at each phase of that development?
Public perceptions of risks and benefits of offshore development - Include residents from Cape May to Cape Hatters. There is a need for risk perception study prior to and following a revenue sharing model. Need to define what questions are important for such surveys.

Threats/Benefits to local communities - What are the impacts of potential energy development on education, academic research, training, and development? What is the existing relevant labor force and what demographic implications will immigration of new workers bring? What is the potential for spatial interactions with commercial and recreational fishing?

Other issues to consider would include the possible interactions with military activity in the Virginia Capes area, potential impacts of decommissioning on the communities, workers, and institutions. What will be the impacts of offshore development on the price of natural gas?

**Workshop Recommendations**

**Physical and Geological Oceanography**

Synthesis, mining, and reanalysis of existing data and databases are needed in order to understand the current state of knowledge regarding physical and geological processes within the Virginia OCS lease sale area. The synthesis and interpretation would be central to planning new environmental studies.

For the entire water column, transport processes, temperature, salinity, and density (with seasonal considerations) need to be characterized with specific consideration for:

- Coastal fronts and estuarine interactions.
- Cross and along shelf processes (cold pools, upwelling/downwelling, storm events, tides).
- Shelf break processes, including seasonal stratification issues, Ekman transport, eddies and Gulf Stream, internal tides, and wind waves.
- Up and down canyon flows and forcing factors.
- Upper and lower layer interactions over the slope for the Deep Western Boundary Current (DWBC), topographic Rossby Waves (TRW), and Gulf Stream meanders and eddies.
- Climate trends including North Atlantic Oscillations (NAO).

For geologic and bottom processes, physical properties and distributions of sediment types on the shelf, slope, rise, and canyon need to be characterized with specific consideration for:

- Cross and along shelf transport.
- Sediment resuspension and dynamics.
- Bottom Boundary Layer (BBL), effects of stratification and instability.
- Slope and canyon wall stability and failure history.
- Acoustic bottom mapping with multibeam and sidescan.
- Methane seeps, gas hydrates, shallow gas deposits, and other geohazards.
- Paleochannels, shallow flow zones, past transport pathways (high resolution shallow seismic).
- Basin floor fan evolution.
Multi-disciplinary synthesis of physical oceanography and biological data to identify areas of high productivity or essential habitat. Integration of data and concerns from other disciplines is necessary with specific consideration for:

- Coastal fronts and channels relative to marine mammal feeding, migration, and gathering areas.
- Ridge and swale topography influence on physical and biological processes.
- Shelf break winter and summer processes.
- Canyon head.
- Slope sea and eddy

Studies that will require new observations and modeling:

- Deep current energy – trapped waves and possible sites of energy intensification, current-Rossby/topographic wave interactions.
- Canyons – unusual currents, upslope/downslope flow, warm ring interaction affecting cross isobath transport.
- Sediment dynamics studies – specifically on the slope and fan.
- Detailed survey of geohazards - methane venting, shallow gas.
- Mapping of seeps with interdisciplinary considerations (chemo-synthetic organisms, etc).

**Fish and Fisheries**

Synthesis, mining, and reanalysis of existing data and databases are needed in order to understand the current state of knowledge regarding fish and fisheries within the Virginia OCS lease sale area. The synthesis and interpretation would be central to planning new environmental studies. For fish and fisheries, the key elements of this synthesis need to specifically consider seasonal distributions of historical and extant finfish and shellfish fisheries. Distributions and reproduction of fishes and shellfishes in the Mid-Atlantic Bight from Cape Lookout to Cape Cod and from the shoreline to abyssal plain needs to be considered. Extant databases include those managed by NMFS, Mid-Atlantic Fishery Management Council, state agencies, and The Nature Conservancy. In particular, Essential Fish Habitat (EFH) characterization including managed species, prey species, and their habitat need to be included.

Environmental studies and knowledge from the Gulf of Mexico, Pacific, Alaska, and other oil and gas producing areas, for example Nova Scotia or North Sea, needs to be evaluated for possible application to impacts of oil and gas exploration and drilling and transport of and on the Virginia coast.

There are broad areas of overlap between fish and fisheries and other disciplines data needs:

- Passive acoustics as sampling methods and cumulative impact of sound pollution on fishes (Endangered and Protected Species).
- Linking oceanography and biology with bottom and water column currents, and temperature (physical and geological).
- Habitat mapping (Benthic and Biological).
- Trophic interactions with birds, marine mammals, benthic and pelagic fishes, and invertebrates (Biological, Endangered Species).
- Space-use conflicts with port-space and fishing areas (Socioeconomic).
- Techniques for visualizing and managing information (all disciplines).
Studies are needed to address knowledge gaps in the finfish and shellfish fauna and fisheries especially for the upper slope and canyon habitats. In particular there is a need to characterization EFH within the Virginia OCS lease sale area for managed species and their prey species, and to determine baseline contaminant loading in key commercial species, such as scallops, tilefish, red crabs, and goosefish. The potential for drilling infrastructure (e.g., pipeline, platform) to facilitate invasive species and adjacent fauna to establish residency also needs to be evaluated.

Rationale for and focus of these studies would be to assess changing environmental conditions and management strategies, and their effects on fishing techniques and target populations. Fish and fisheries need to be viewed in an ecological framework that includes both ecological processes and climate change factors. This approach would best inform MMS for EFH and other consultations. Baseline data to evaluate potential impacts over time must be collected prior to any oil and gas activities.

**Benthos and Biology**

Synthesis, mining, and reanalysis of existing data and databases are needed in order to understand the current state of knowledge regarding biological conditions within the Virginia OCS lease sale area. The synthesis and interpretation would be central to planning new environmental studies. Before any synthesis takes place, MMS should develop scenarios as to how the synthesis will be used. Formation of a synthesis team of interdisciplinary scientists with information exchanged in a workshop format is recommended.

The synthesis team would review and synthesize existing reports and data. MMS would first provide scenarios to the team as guidance with team members working with existing data in advance of meeting. Areas of focus would include:

- Spatial and temporal distributions - effects of bottom type, temperature regimes (latitudinally, bathymetric regimes).
- Potential impacts and effects - lessons learned from other regions and stressors.
- Information could be used to develop management tools.
- Products would be directed to peer-reviewed literature

Rationale for this approach is to examine the diverse sources of information as early as possible to provide focus for future investigations and better understanding of environmental risks. This effort could lead to the development of a database management approach that is based on GIS tools which will be essential for visualizing and conveying information to agencies and the public.

Studies are needed to address knowledge gaps in the biological and benthic processes especially to identify the location and extent of key high priority or unique habitats, such as those associated with high productivity (swales) or high biodiversity (hard bottom). Sampling effort would be stratified based on biotic zonation and areas of likely exploration impacts and with consideration of any pipeline pathway. Broad scale bathymetric mapping would be necessary for stratifying the area (coarse maps may already be available). Detailed mapping of select high priority habitats using acoustic, video, and photographic techniques will be needed. Ground-truthing and baseline data for megafauna, macrofauna, and other biogenic features need to be
collected prior to the start of oil and gas activities. The products should be primarily directed at the peer-reviewed literature and development of management tools such as GIS databases.

Following guidelines used in the Gulf of Mexico Region, unique biological communities should be protected areas for drilling. Consideration of buffer zones is needed to lessen the influence of development activities. In addition, improvements in oil development technology have reduced the footprint of impacts, therefore data synthesis efforts as well as new studies need to be informed by more recent environmental studies and technologies.

There is little data available for the Virginia OCS lease sale area for benthic resources. This area likely represents a “transition zone” between major biogeographic provinces and thus may contain unique faunal associations. It is situated in an area of significant topographic complexity in the transition from shelf to deep slope, which likely influences the area’s biology.

**Outline for a Benthic Study**

A benthic mapping effort would be key to planning any new environmental studies of the bottom. Approximate distribution of effort in each of three major habitat areas would be:

- **Shelf break (~50%)**
- **Outer shelf (~25%)**
- **Slope (~25%)**

Canyons would be included in the sampling for the shelf break as this is where canyon heads are located.

Study metrics would include indicator species such as sea scallops, which can be surveyed photographically, amphipods, and echinoderms. A metric would need to be developed for offshore and deep-sea habitats specific to oil and gas activities similar to other coastal indices used in assessing benthic habitat conditions (for example see Weisburg et al., 1997 or Diaz et al., 2004). Metrics reflect critical importance of macrobenthos in assessing conditions of biodiversity, structure and sensitivity at the community level, and would function as indicators of sensitivity to environmental change at individual species and major taxa group levels.

Abundance and biomass reflect the productivity regime and level of disturbance and would be measured as biomass per individual and depth distribution of biomass.

An assessment would need to be made to determine if full community studies versus selected components would be required. As species diversity is high in deep water and slope areas, diversity metrics will be important in assessing benthic conditions including habitat stability and degree of disturbance. Various methods for measuring deep-sea diversity should be explored.

Meiofauna and microbes would have a lower priority as they are small and more difficult to work with. But genomics may provide methods to make studies practical as baseline measurements. These groups could provide evidence of significant disturbance.

Details of the study plan would include a stratified/random approach with directed sampling of key habitats. Acoustic mapping/backscatter analysis would be needed to identify hard bottom and other OCS features such as sand ridges. For specific habitats (topographic lows, canyons,
hard bottom) rapid assessment technique (sled, video) would be used to characterize, but sediment samples would still be needed to adequately characterize habitats.

The deep-sea region is a small fraction of the Virginia OCS lease sale area and would require only a few samples. Data from surrounding deep areas will likely be able to characterize the Virginia OCS lease sale area as the deep-sea has the least likelihood of spatial variability and is relatively a small area. Visual surveys (video/photographic) would be used to quantify megafauna (echinoderms, anemone, crustacean, fish), biogenic structures to characterize function of community, and physical characteristics of the bottom would provide crude estimates of fluxes (turbidity, suspended particles). Visual surveys would also be used as ground truthing for multibeam and would require good geo-position data.

**Endangered and Protected Species**

There may be a significant amount of un-synthesized extant and developing data that could provide a foundation from which to develop preliminary assessments and research work plans for the region. It is important that these data sources be synthesized, mined, and reanalyzed in order to understand the current state of knowledge regarding endangered and protected species within the Virginia OCS lease sale area. A data inventory and synthesis would be developed for marine mammals, sea turtles, and coastal and marine birds (pelagic and onshore). Included would be on-going studies that are yielding data of interest (not yet published). Metadata files associated with studies need to be analyzed to look at season, geographic extent, etc. All products should be in a GIS database management system for data visualization and integration of all data streams.

New scientific surveys would be needed that are a combination of methods including:

- **Shipboard** - separate protocols for marine mammals, seabirds, and sea turtles, adaptive sampling with line transect approach.
- **Aerial** - restricted to sea turtles and marine mammals, high definition photography as a possibility for birds.
- **Passive acoustics** - broad spectrum (in terms of frequency sensitivity) pop-ups or equivalent, capable of detecting whales, dolphins and specifically beaked whales.
- **Platforms of opportunity** - train and place professional observers on whale watches, shelf-edge fishing charters, seismic vessels, rig service vessels, and other opportunities.

Studies would have to be multi-year to examine temporal trends and seasonal differences. All seasons and at least three years within the lease triangle plus a buffer area that would extend to shore would be required. Data would need to be collected pre-, during-, and post-seismic and -drilling activity. Methods to assess residency in sperm whales, humpbacks, beaked whales, right whales, selected dolphin species, and sea turtles using photoidentification, tagging specifically for turtles, and genetics need to be implemented.

Rationale for initiation of new surveys is that most sightings and distribution data is 20-30 years old, and may not be relevant to contemporary patterns. In addition, there is little or no survey effort beyond 50 miles, i.e., most of the lease site. There is an urgent need to identify the seasonal distribution and abundance patterns of most endangered and protected species in the lease region before activities are started.
A passive acoustic buoy array should be setup and maintained for the life of the project. In the first year, a baseline would be established with continued monitoring after seismic begins for at least two years. Baseline data on frequency of occurrence of different species and communication signals would also be collected. Species-specific hearing ranges and seasonality of species of concern would be documented to evaluate mitigation options with regard to seasonality of presence and activities for right, humpback, sperm and beaked whales, and sea turtles. Part of the data synthesis would integrate results from the Joint Industry Program (JIP) and determine what activity produces 180-200Db noise. Behavioral responses to seismic noise needs to be documented for the species of interest mentioned above. For the entire Mid-Atlantic Planning Area, there is an opportunity to conduct a study comparing responses of naïve animals in this area with data from Gulf of Mexico Region mammal studies.

Rationale for these studies is that effects of noise from seismic and operational activities on marine mammals and seas turtle have only been studied in a few species. Because of the multi-species assemblage that occupies the lease sale area, careful monitoring and planning will be required to mitigate negative impacts on a broad array of endangered species. Species of particular concern include right whales, humpbacks, beaked whales, finback whales, and sperm whales. Data on sea turtle responses to these sounds is sparse as well. A multi-pronged approach is recommended as described above.

There is significant overlap between endangered species and physical oceanographic data needs. A study that integrates the oceanography of the region with the presence of endangered species and other key resource species should be considered. In other areas, researchers have been developing such methods to predict the likelihood of a particular species present based upon seasonal oceanographic conditions.

Finally, we wanted to acknowledge that in spite of our focus on the lease sale area and the waters between the area and the Virginia coast, there is the potential for larger scale impacts. Those broader impacts are certain to involve noise production related to seismic activity, and however small the potential for oil spills may be, should one occur, it’s effects will probably extend outside of the Virginia region.

**Socioeconomics**

In regard to socioeconomics, it is important that realistic scenarios for what will happen within the Virginia OCS lease sale area be developed. Overall, there is little data to assess specific or broader impacts on the economy and communities of the region. States and local planners need to know what will happen to their communities relative to oil and gas activities. What is the distribution of impacts within region expected to be? Is there a need to consider a synergistic view with other activities like wind power, navy actives?

Studies are needed to develop socioeconomic models to assess public perceptions of risk and benefits, developing a baseline of opinions now which tracks into the future. Three overarching themes that should apply to any socioeconomic study include:

- Consider oil and gas in context of other offshore energy development.
- Consider onshore infrastructure impacts.
• Consider cumulative, long-term impacts.

Recommended socioeconomic studies include:
• Fiscal effects of offshore development.
• Spatial distribution of onshore development in response to offshore activities.
• Public perceptions of risks and benefits of offshore development.
• Threats and benefits to local communities.

**General Recommendations:**

The principle recommendation from all breakout groups was to assess existing data in a thorough and systematic manner. The exception was socioeconomic, where there is little in the way of existing data to synthesis. This data assessment needs to incorporate all disciplines. New studies that focus on monitoring could be started immediately, but directed studies need to be informed by the results of the existing data synthesis.

A cross-disciplinary effort between biology, fisheries, and physical studies is needed. It will be essential that synthesis efforts incorporate water column and bottom processes data. Evidence for slope failure, methane seeps and other geohazards also needs to be integrated with the living resources data. Special attention needs to be given to the possibility of chemosynthetic organisms within the Virginia OCS lease sale area.

Given the complexities of OCS ecosystem, MMS should develop a comprehensive and integrative plan to assess the cumulative impacts of multiple energy uses on the OCS and adjacent ocean areas. MMS should work with other relevant agencies, states and stakeholders to develop consistent standards to assess the geographic extent of potential impacts and the consequent range of requisite studies. In particular, MMS should work with NMFS to identify issues with non-energy uses of the OCS such as offshore aquaculture.
References


Figure 1. Federal outer continental shelf planning areas.
Figure 2. General location of proposed Mid-Atlantic Area Lease Sale 220 off the coast of Virginia. Status of leases and other lease sales for the 2007-2011 period are also shown.
Figure 3. Mid-Atlantic OCS planning area showing protraction areas and wells drilled from previous lease sales.
Figure 4. Detailed location of Virginia OCS lease sale area within the Mid-Atlantic OCS planning area.

Figure 5. Details of Lease Sale 220 area off the coast of Virginia.
Figure 6. National Geophysical Data Center map encompassing much of the Virginia OCS lease sale area, Norfolk and Washington canyons are the prominent features, from: http://ngdc.noaa.gov/mgg/coastal/grddas02/grdden02.htm
Figure 7. Survey effort for marine mammals and sea turtles in the Atlantic waters off of Virginia. Effort is given in kilometers of appropriately surveyed track line mile per square kilometer of ocean (color code at bottom of image). The light blue shading around the lease site is a 20 mile buffer zone (see text of workshop report).
Figure 8. Sightings of Turtles (Green, Leatherback, Loggerhead, Kemp’s Ridley, and Unidentified) in the Atlantic waters off of Virginia and around the proposed lease site.

Figure 9. Sightings of North Atlantic Right, Humpback, and Sperm whales in the Atlantic waters off of Virginia and around the proposed lease site.
Figure 10.  Sightings of Blue, Fin, Minke, Sei, and unidentified Balaenoptera and Rorqual whales in the Atlantic waters off of Virginia and around the proposed lease site.

Figure 11.  Sightings of dolphins and pilot whales in the Atlantic waters off of Virginia and around the proposed lease site.
Figure 12. Sightings of beaked whales in the Atlantic waters off of Virginia and around the proposed lease site.

Figure 13. Oil spill cleanup after the Exxon Valdez (NOAA Photo)
Figure 14. Shipping traffic density during two months in Hampton Roads, VA. Data courtesy Mark Swingle.
Figure 15. Ambient noise levels from 0 to 1000hz in the Bay of Fundy right whale habitat are shown on the right. The intensity of noise from ships passing through the region (7 times) during a single 24 hour period is shown in color (red is loud, blue is quiet). For reference, a right whale upcall is shown at left in black and white, with scale matched to the ambient noise spectrogram. Note the frequency overlap between the call and the shipping noise. Images and data courtesy Chris Clark and Susan Parks.
Figure 16. Ambient noise levels in a relatively pristine marine environment (left top) and in a highly urbanized one (right top). The lower graphs show that in the quiet ocean, finback whales provide the dominant low frequency noise, while in the urban one, finback sounds are completely masked by the ambient noise levels from human activities. Images and data courtesy Chris Clark.
Table 1. Lease sale history of the Atlantic OCS Planning Area, see Figure 2 for area boundaries. Data summarize and rounded from:
http://www.gomr.mms.gov/homepg/offshore/atlocs/atlleas.html#ATLOCSSALE

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Table 2. Summary of the number Mid-Atlantic reports by major category. See Appendix C for details.

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<td>Onshore Impacts and Industry Information</td>
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Table 3. Summary of physical and geological data needs for the Virginia OCS lease sale area.

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<td><strong>Shelf</strong></td>
<td>Water column information (X- and L-margin, current velocities, surface dynamics, currents) Characterize transport processes to and away from coast (with seasonal considerations), fronts. Spill trajectories Deep current characterization MAB</td>
<td>Ridge and swale BBL Sediment transport, accumulation rates Sediment properties</td>
<td>Mass movement (creep) Earthquakes/seismic activity, faulting Methane venting Shallow gas pockets Unexploded ordnance and archeological sites Disposal areas Cables Mapping Paleo channels/delta</td>
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<td>Water column information (X- and L-margin, current velocities) Characterize transport processes to and away from coast (seasonal; fronts, turbidity currents) Spill trajectories Gulf Stream and eddy processes/interactions and scales Deep current characterization</td>
<td>Sediment transport, accumulation rates Sediment properties</td>
<td>Mass movement (slope failures) Earthquakes/seismic activity, faulting Methane venting Hydrates Unexploded ordnance and archeological sites Cables Mapping Paleo channels/delta</td>
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<tr>
<td><strong>Rise (Deep)</strong></td>
<td>Water column information (X- and L-margin, current velocities) Characterize transport processes to and away from coast (seasonal) Spill trajectories Gulf Stream and Eddy processes/interactions and scales Deep current characterization DWBC location?</td>
<td>Sediment transport Turbidity currents, accumulation rates Sediment properties</td>
<td>Mass movement Slope failures Earthquakes/seismic activity, faulting Unexploded ordnance and archeological sites Cables Methane venting Hydrates Unexploded ordnance</td>
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<td><strong>Canyon</strong></td>
<td>Flow anomalies relative to regional currents Disturbances Flux of material Characterize transport processes (turbidity currents) Trapped/focused current energy?</td>
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<td>Mass movement (slope failures)</td>
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Table 4. Summary of endangered and protected species concerns for the Virginia OCS lease sale area.

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<td>Distribution and abundance</td>
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<td>Distribution and abundance</td>
<td>Light&lt;br&gt;Distribution and abundance</td>
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Appendix A.

List of Atlantic BLM and MMS studies
Information and Data Summaries

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Socioeconomics

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<td>A Study of the Socio-Economic Factors Relating to the Outer Continental Shelf of the Mid-Atlantic Coast, Book II, Volumes IV and V</td>
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<td>08550-CT3-11</td>
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<td>A Study of the Socio-Economic Factors Relating to the Outer Continental Shelf of the Mid-Atlantic Coast, Book III, Volumes VI, VII, VIII and IX</td>
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<td>08550-CT5-51</td>
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<td>Travel Economic Impact Model, Volume I: Final Economic Analysis Methodology</td>
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<td>Coastal North Carolina Socioeconomic Study, Volume V: Socioeconomic Monitoring Design and Methodology</td>
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**Onshore Impacts and Industry Information**

- ENV76-22611: 1978-10 Methodology for Assessing Onshore Impacts for Outer Continental Shelf Oil and Gas Development, Volume II: Methodology
- ENV76-22611: 1978-11 Methodology for Assessing Onshore Impacts for Outer Continental Shelf Oil and Gas Development, Volume III: Baltimore Canyon Test Case
- ENV76-22611: 1980-5 Methodology for Assessing Onshore Impacts for Outer Continental Shelf Oil and Gas Development, Volume I: Executive Summary
- N/A: 1982-35 Deepwater Technology: Exploration, Production, and Blowout Prevention - Technical Paper 82-01
- AA851-CT2-41/29199: 1983-13 Study of Alternative Modes for Transporting OCS-Produced Oil and Natural Gas
- 14-12-0001-29063: 1983-15 Drilling Discharges in the Marine Environment
- 14-12-0001-29195: 1983-30 Identification and Assessment of Impacts Associated with the Construction and Operation of Submarine Pipelines on the Mid-Atlantic Outer Continental Shelf - Final Report
- 14-12-0001-29195: 1983-5 Indentification and Assessment of Impacts Associated with the Construction and Operation of Submarine Pipelines on the Mid-Atlantic Outer Continental Shelf
- 14-35-0001-30588: 93-0005 Synthesis and Analysis of Existing Information Regarding Environmental Effects of Marine Mining, Executive Summary

**Oil Spill Fates and Effects**

- 08550-CT4-B: 1976-11 A Gas Chromatographic-Mass Spectrometric-Computer Analysis of Hydrocarbons Associated with Sediment, Benthic Fauna and Zooplankton (Mid-Atlantic)
- Open File 76-451: 1976-5 An Oil Spill Risk Analysis for the Mid-Atlantic Outer Continental Shelf Lease Area
- AA550-CT8-1: 1976-8 Sources, Effects and Sinks of Hydrocarbons in the Aquatic Environment
- AA550-CT6-45: 1977-1 A Summary and Analysis of Environmental Information on the Continental Shelf from the Bay of Fundy to Cape Hatteras - Volume I, Book I
- AA550-CT8-1: 1978-6 Design for a Simplified Regional Impact Methodology Using Rims and Seas
- Water-Resources Investigations 78-56: 1978-9 An Oil Spill Risk Analysis for the Mid-Atlantic (Proposed Sale 49) Outer Continental Shelf Lease Area
- N/A: 1981-29 Papers on Oil Spreading Dynamics - On A Classical Treatment of a Static Contact Angle Problem
- N/A: 1989-7 Oil Spill Risk Assessment Task Force Report
- N/A: 1989-8 Drilling and Production Discharges and Oil Spills in the Marine Environment
- 14-35-0001-30500: 91-0043 Estimating the Environmental Costs of OCS Oil and Gas Development and Marine Oil Spills: A General Purpose Model: Overview and Summary
- 14-35-0001-30500: 91-0043 Estimating the Environmental Costs of OCS Oil and Gas Development and Marine Oil Spills: A General Purpose Model, Economic Analysis of Environment Costs
- 14-35-0001-30500: 91-0043 Estimating the Environmental Costs of OCS Oil and Gas Development and Marine Oil Spills: A General Purpose Model, Model Methodology, Documentation and Sample Outputs

**Marine Mammals and Turtles**

- AA551-CT8-48: 1979-34 Summary of CETAP'S Data Collection Effort, Second and Third Quarter
- AA551-CT8-48: 1979-42 Cetacean and Turtle Assessment Program Report for the Fourth Quarter
- N/A: 1982-16 Possible Effects of Noise From Offshore Oil and Gas Drilling Activities on Marine Mammals; A Survey of the Literature (Technical Report 776)
- 14-12-0001-29169: 1984-15 Study of the Effects of Oil on Marine Mammals, Sixth Interim Report
- 14-12-0001-29169/CT9-29: 1985-19 Expanded Studies of the Effects of Oil on Cetaceans, Final Report, Part I
- 14-12-0001-29169/CT9-29: 1985-20 Cutaneous Response to Plastic and Metallic Implants of Potential use for Marking Cetaceans, Final Report, Part II
- PE-OOGV1: 1990-6 Underwater Blast Effects from Explosive Severance of Offshore Platform Legs and Well Conductors
- 14-12-0001-30673: 1990-8 Marine Mammals and Noise, Final Manuscript

- 13269: 1991-1 Southeast Atlantic Right Whale Behavior and Whale/Boat Interactions Using Coordinated Airship Overflights
- 14-12-0001-30663: 86-0070 Study of the Effects of Oil on Marine Turtles, Final Report, Volume I: Executive Summary
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<td>Development of Satellite-Linked Methods of Large Cetacean Tagging and Tracking In OCS Lease Areas, Final Report</td>
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**Marine and Coastal Birds**

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**Benthic Biology**

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<td>Experimental Colonization of Crude Oil Contaminated Sediments by Benthos on the Middle Atlantic Continental Shelf</td>
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<td>AA551-CT9-5</td>
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<td>Crude Oil Effects to Developmental Stages of the American Lobster, Technical Report</td>
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<td>Effects of a Natural Disturbance on a Continental Shelf Live Bottom Community off North Carolina</td>
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<td>The Distribution and Abundance of Ichthyooplankton in the Middle Atlantic Bight as Determined from Coastal Surveys and Site-Specific Studies, 1965-1976</td>
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<td>An Oil Spill - Fishery Interaction Model Development &amp; Applications</td>
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<td>04-8-M01-149 &amp; 79 AA-D-00102</td>
<td>1981-3</td>
<td>Small-Scale Commercial Fishing in Southern New England (WH01-81-72)</td>
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<td>Assessment of Space and Use Conflicts Between the Fishing and Oil Industries, Volume I: Interactions Between Fishing Gear and Oil Structures</td>
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<td>Summarization and Interpretation of Historical Physical Oceanographic and Meteorological Information for the Mid-Atlantic Region, Final Report</td>
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<td>Measurement of Gulf Stream and Wind Induced Shelf Circulation in the South Atlantic Bight</td>
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<td>A Numerical Model of the Shelf Circulation in the Middle Atlantic Bight Driven by Tides, Transient Storms and the Offshore, Large-Scale Circulation: Formulation of Proper Open Boundary Conditions (Report Number 73)</td>
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<td>A Description of a Three-Dimensional Coastal Ocean Circulation Model</td>
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<td>Effects of Wind and Gulf Stream Events on the Currents off the Coast of North Carolina as it relates to Oil Spill Risk Potential</td>
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<td>MASAR Special Cruise Report for the Deployment of Two Mooring in Lease Block 510 off Cape Hatteras (Nov 1-5, 1985)</td>
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<td>Mid-Atlantic Slope and Rise Physical Oceanography Study (MASAR/POS) Semi-Annual Report No. 2</td>
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<td>A Physical Oceanographic Field Program Offshore North Carolina -- Current Meter, Surface Wind and Water Level Data Products</td>
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<td>A Physical Oceanographic Field Program Offshore North Carolina -- Special Event-Near Shore Experiment</td>
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<td>The Physical Oceanography of the U.S. Atlantic and Eastern Gulf of Mexico, Final Report</td>
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<td>Preliminary Textural and Mineralogical Analyses of Cretaceous and Holocene Sediments from the Northern New Jersey Coastal Plain, Final Technical Report, Year 8</td>
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Appendix B.

Workshop Agenda
Workshop on Environmental Research Needs in Support of Potential Virginia Offshore Oil and Gas Activities

December 3-4, 2008
Williamsburg Woodlands Conference Center
Woodlands Hotel and Suites
105 Visitors Center Drive
Williamsburg, Virginia

Wednesday, December 3

7:45-8:30 a.m.  Breakfast (Continental breakfast provided) and Registration

8:25-8:30 a.m.  Opening Remarks, Robert Diaz, VIMS

**Historical Perspective**

8:30-8:40 a.m.  History of MMS activities along the Atlantic Coast, Jim Cimato, Branch Chief Environmental Studies Program, MMS

8:40-9:00 a.m.  Activities associated with oil and gas development, Kent Satterlee, Shell Exploration and Production Company

**Environmental Resources**

9:00-9:20 a.m.  Physical oceanography of the Virginian Sea, Larry Atkinson, Old Dominion University

9:20-9:40 a.m.  Pelagic fishes, Rich Brill, NOAA

9:40-10:00 a.m.  Demersal fishes, Ken Able, Rutgers University

10:00-10:40 a.m.  Break

10:40-11:00 a.m.  Benthos, Linda Schaffner, VIMS

11:00-11:20 a.m.  Protected and endangered species, Scott Kraus, New England Aquarium

11:20-11:40 a.m.  Economic issues, Doug Lipton, University of Maryland

11:40-12:00  Social issues, Diane Austin, University of Arizona

12:00-1:00 p.m.  Lunch (Box lunch provided, Maple Room)
**Workshop Breakout Sessions**

1:00-1:05 p.m. Workshop directions, Diaz
1:05-3:00 p.m.
- Room A, Social/Economic Issues, Lipton/Austin
- Room B, Fish/Fisheries Issues, Able/Brill
- Room C, Benthic Issues, Schaffner
- Room D, Geological/Physical Oceanographic Issues, Atkinson
- Room E, Endangered Species Issues, Kraus

3:00-3:30 p.m. **Break**

3:30-4:20 p.m. Continuation of breakout groups.

4:20-4:30 p.m. Breakout group facilitators meet.

5:00-7:00 p.m. **Social with cash bar (Oak Room)**

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**Thursday, December 4**

**Continuation of Working Groups**

7:45-8:30 a.m. Breakfast (Continental breakfast provided) and Registration

8:30-10:00 a.m.
- Room A, Social/Economic Issues, Lipton/Austin
- Room B, Fish/Fisheries Issues, Able/Brill
- Room C, Benthic Issues, Schaffner
- Room D, Geological/Physical Oceanographic Issues, Atkinson
- Room E, Endangered Species Issues, Kraus

10:00-10:30 a.m. **Break**

10:30-12:00 p.m. Continuation of breakout groups.

12:00-1:00 p.m. **Lunch (Box lunch provided, Maple Room)**

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**Breakout Group Summaries**

1:00-2:30 a.m.
- Social/Economic Issues, Lipton/Austin
- Fish/Fisheries/Endangered Species Issues, Able/Brill
- Benthic Issues, Schaffner
- Geological/Physical Oceanographic Issues, Atkinson
- Endangered Species Issues, Kraus

2:30-3:00 p.m. **Final Discussion and Closing Comments**

3:00-3:30 p.m. **Stakeholder Concerns**
Appendix C.

Workshop Attendees
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<td><a href="mailto:kimberly.skrupky@mms.gov">kimberly.skrupky@mms.gov</a></td>
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</table>
Appendix D.

Workshop PowerPoint presentations

1 Cimato History

2 Kent Oil&Gas

3 Atkinson Physical

4 Brill Fisheries

5 Able Fish

6 Schaffner Benthos

7 Kraus Protected Species

8 Lipton Economics

9 Austin Social
History of MMS Activities along the Atlantic Coast

James M. Cimato
Chief, Environmental Sciences Branch
December 2008
MMS Mission

To manage the energy and mineral resources on the OCS in an environmentally sound and safe manner and to timely collect, verify, and distribute mineral revenues from Federal and Indian lands.
Lease Activity

- Ten oil and gas lease sales between 1976 and 1983
- 410 leases, last 8 leases relinquished in 2000
- Only one Virginia lease, no drilling
Environmental Studies Program

Mission

To provide the information needed to predict, assess, and manage impacts from offshore energy and marine mineral exploration, development, and production activities on human, marine, and coastal environments.
Environmental Studies Program Yearly Expenditures by Region

Fiscal Year

Dollars (Millions)

Alaska  Atlantic  G.O.M.  Pacific  National  Totals
Environmental Studies Program

- Over 120 separate studies funded in the Atlantic Region
- Spans the years from 1974 to 1998
- Over 70 summary documents and workshop proceedings
Environmental Studies Program

- Characterization of biological resources
- Observation and modeling of ocean currents
- Fates and effects of impact producing agents (oil, muds, noise, emissions)
- Social, economic and cultural impacts
- Oil spill risk assessment
Research Planning

- **What is known -- gap analysis:**
  - Gather & Synthesize existing literature
  - Workshops with scientists & stakeholders

- **Identify the issues of concern**
  - Discharges (oil, muds, emissions)
  - Noise
  - Habitat Disruption
  - Space-use conflicts
  - Effects on Social Systems
Determining Priorities

- Mission relevance
- Technically feasible
- Scientific merit
- Timing
- Applicability
- Affordable
Program Quality

- Information Needs Reviewed Internally/Externally
- NAS Reviews
- OCS Scientific Committee
- External Participation on Proposal Reviews
- Scientific/Quality Review Boards
- Peer Reviewed Literature
Partnership

- National Oceanographic Partnership Program (NOPP)
- National Oceanic and Atmospheric Administration (NOAA)
- United States Geological Survey (USGS)
- Coastal Marine Institutes – LSU and UAF
MMS Environmental Studies:

Ongoing Studies:

Completed Reports:
https://www.gomr.mms.gov/homepg/espis/espisfront.asp

MMS Technology: www.mms.gov/tarphome

International Committee on Regulatory Research and Development: www.icrard.org
Environmental Studies Program
Marine Minerals

- Sand: over 40 studies completed or in progress
- 30 million yd$^3$; 23 sites
- 5 states; 125 miles of coastline
MMS Workshop - Environmental Research Needs in Support of Potential Virginia Offshore Oil and Gas Activities

Activities Associated with Offshore Oil & Gas Development

December 3-4, 2008
Disclaimer statement

This presentation contains forward-looking statements concerning the financial condition, results of operations and businesses of Royal Dutch Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management’s current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Royal Dutch Shell to market risks and statements expressing management’s expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as “anticipate”, “believe”, “could”, “estimate”, “expect”, “intend”, “may”, “plan”, “objectives”, “outlook”, “probably”, “project”, “will”, “seek”, “target”, “risks”, “goals”, “should” and similar terms and phrases. There are a number of factors that could affect the future operations of Royal Dutch Shell and could cause those results to differ materially from those expressed in the forward-looking statements included in this Report, including (without limitation): (a) price fluctuations in crude oil and natural gas; (b) changes in demand for the Group’s products; (c) currency fluctuations; (d) drilling and production results; (e) reserve estimates; (f) loss of market and industry competition; (g) environmental and physical risks; (h) risks associated with the identification of suitable potential acquisition properties and targets, and successful negotiation and completion of such transactions; (i) the risk of doing business in developing countries and countries subject to international sanctions; (j) legislative, fiscal and regulatory developments including potential litigation and regulatory effects arising from recategorisation of reserves; (k) economic and financial market conditions in various countries and regions; (l) political risks, project delay or advancement, approvals and cost estimates; and (m) changes in trading conditions. All forward-looking statements contained in this presentation are expressly qualified in their entirety by the cautionary statements contained or referred to in this section. Readers should not place undue reliance on forward-looking statements. Each forward-looking statement speaks only as of the date of this presentation, May 4, 2006. Neither Royal Dutch Shell nor any of its subsidiaries undertake any obligation to publicly update or revise any forward-looking statement as a result of new information, future events or other information. In light of these risks, results could differ materially from those stated, implied or inferred from the forward-looking statements contained in this document.

The United States Securities and Exchange Commission (SEC) permits oil and gas companies, in their filings with the SEC, to disclose only proved reserves that a company has demonstrated by actual production or conclusive formation tests to be economically and legally producible under existing economic and operating conditions. We use certain terms in this presentation, such as “oil in place” that the SEC’s guidelines strictly prohibit us from including in filings with the SEC. U.S. Investors are urged to consider closely the disclosure in our Form 20-F, File No 1-32575 and disclosure in our Forms 6-K file No, 1-32575, available on the SEC website www.sec.gov. You can also obtain these forms from the SEC by calling 1-800-SEC-0330.
Offshore Activities Summary

- Seismic acquisition
- Lease sale
- Exploratory drilling and seismic surveys
- Shallow hazard survey
- Environmental and engineering baseline surveys
- Delineation and development drilling
- Platform/Pipeline Installation
- Shore base facility construction
- Production operations
- Decommissioning
OCS Regulatory Approval & Environmental Review Processes

**Pre Lease**
- Solicit Comments
- 30-day Comment Period
- Draft Proposed Program Published
- 30-day Comment Period
- Proposed Program Draft EIS Published
- 90-day Comment Period
- Proposed Final Program
- Final EIS
- 60-day Period with Congress
- 5-Year Program Announced

**2. Planning for Specific Sale**
- Call for Information Published
- 30-day Comment Period
- Sale Area Identification
- Draft EIS Distributed
- 45-60 day Comment Period
- Final EIS Published
- CZM review begins
- +/- 30-day Comment Period
- +/- 3-month Period
- Proposed Notice of Sale
- 30-day Period
- Lease Sale
- Leases Issued

**3. Exploration Plan (EP) Approval**
- EP/EIA Submitted
- Environmental Assessment
- 30-day Period
- CZM Review Starts
- 3-month Period
- Exploration Plan Approved
- Exploration Drilling Starts

**Post Lease**

**4a. Development and Coordination Document (DOCD) Approval**
- DOCD/EIA submitted
- Environmental Assessment
- 30-day Period
- CZM Review Starts
- 3-month Period
- DOCD Approved
- Facility Permits Approved
- Development Drilling Starts

**4b. Development and Production Plan (DPP) Approval**
- DPP submitted
- CZM Review Starts
- 3-month Period
- Draft EIS Published
- 90-day Comment Period
- Final EIS Published
- DPP Approved
- Production Well Application

* An additional 3-month period can be requested by the affected state. ** DPP used outside of Gulf of Mexico current planning areas.

EIA = Environmental Impact Analysis
Seismic Surveying

- Seismic surveys provide detailed information about subsurface formations.
- A special air gun is used to produce sound that is reflected from the rock layers.
- Detectors pick up the sound reflections.
- The arrival times of each reflection indicate the depth of the rock layers, which is used to produce a cross section view of the subsurface.
Hydrocarbon Traps

- Earth forces create *folding* that results in *anticlinal* traps.
- Hydrocarbons migrate into a porous and permeable layer where they are trapped by an impervious layer.
- A *fault* is a fracture or break in rock layers created by movements in the earth.
- A *fault trap* has an impervious layer that moves opposite a porous and permeable layer, which traps the hydrocarbons.
Baltimore Canyon Trough Seismic Stratigraphy

NORTHWEST

SEA LEVEL

OCS-A 0046
COST B-2

COST B-3

0337
0317

TWO-WAY TRAVEL TIME (SEC)

0.0

2.0

4.0

6.0

30 KM

UKI
UKII
UKIII
LKI
LKII
LKI

CENOZOIC

JII
JO

JIII

DU

JIV

J

DUC

SEA FLOOR

?
Baltimore Canyon Trough
Jurassic Platform

Shell
OCS-A 0097

Tenneco
OCS-A 0131

Shell
OCS-A 0336
Shell
OCS-A 0337

Two-Way Travel Time

0.0

3.0

6.0

SW
Baltimore Canyon Trough
Jurassic Carbonate Platform

SOI et al.
OCS-A 0336

SOI et al.
OCS-A 0337

SOI et al.
OCS-A 0317

Maastrichtian (UKI)
Barremian (LKII)
Aptian (LKla)
Berriasian (LKIII)

organic build-up
m. Kimmeridgian (J0)

SEA FLOOR

AGGRADED SHELF - EDGE CARBONATES

REEF

MIXED SILICICLASTIC AND CARBONATE FOREREEF

pinnacle reef

0 2 4 6 8 10 s. mi.
0 2 4 6 8 10 km.

SUBSEA DEPTH (feet)
-2000 -4000 -6000 -8000 -10000 -12000 -14000 -16000 -18000 -20000 -22000

SUBSEA DEPTH (meters)
-6000 -4000 -2000
Exploratory Drilling

One DP Semi-sub Drilling Rig for Noble Drilling

(Scheduled Delivery in 2008)
Noble Clyde Boudreaux

- Water Depth: 10,000 Feet
- Variable Load: 7,000 ST
- Drilling Depth: 35,000 Feet
- Mud Capacity: 10,085 bbls
- Mud System: 7,500 Psi
- Delivered: June 2007
State-of-the-art technology is used to determine the best surface locations to drill
Industry Deepwater Milestones

EPW Developments - a long history of pushing the boundaries in Deepwater
Shell in the Gulf of Mexico

Deepwater Platforms
Non-Operated
Shelf Platforms
Developments

Deepwater Platforms
Non-Operated
Shelf Platforms
Developments

Mars
Ram Powell
Deimos
Brutus
Ursa
Marlin
Na Kika

Auger
Perdido
Enchilada
WC-565
BZ A19
NPI-975

Holstein

Existing/New Material Oil
Major JV Partners: Shell, Chevron, BP
Key Features

- Deepest spar at 7817 ft (2382m); 6 slot well bay
- Deepest subsea production at Tobago 9627 ft (2934m)
- 34 wells (22 DVA subsea, 12 remote subsea)
- All production commingled, gas and liquid separated and pumped subsea
- 100k bopd, 200 mmscf/d and 80k bwipd topsides processing
- Light-weight, “single lift” topsides; enhanced safety systems; 150 man quarters
- Oil (77 miles) and gas (107 miles) export pipelines; deepest producing pipeline cut and tie-in (5000 ft)
Subsea Layout under the Spar

- Subsea Boosting System
- Manifold
- Subsea Wells
- Flowline Sled
Offshore Pipelay Operations

Figure 11.1 S-lay Configuration.

Semi-sub S-lay barge—LB 200

Figure 11.4 J-lay configuration.

Technip’s DP vertical reel vessel Deep Blue (J-lay)
Platform Wastes/Discharges are regulated by MMS, EPA, and USCG
WATER DISCHARGE PERMITS

Prohibits discharge w/o permit

CWA 1972

Restore and maintain the chemical, physical, and biological integrity of the Nation’s water (Sect. 101(a))

EPA

Regulations

Technology-based Effluent Guidelines
  • BPT
  • BAT
  • BCT

New Source Performance Standards (NSPS)

EPA States

NPDES Permit
  • Water Quality Standards
    • Human health
    • Environment
NPDES Permit "Cook Book"
Platform Discharges

- **Produced Water**
  - Oil & Grease...42 mg/l daily max / 29 mg/l mo. avg.
  - Toxicity...no effects at edge of mixing zone

- **Drilling Fluids**
  - No free oil...by static sheen test
  - Toxicity...LC50 >30,000 ppm
  - Mercury and Cadmium...1 mg/kg / 3 mg/kg in Barite

- **Workover, Treatment, and Completion Fluids**
  - Oil & Grease...42 mg/l daily max / 29 mg/l mo. avg.
  - No free oil...by static sheen
Platform Discharges

- Sanitary waste...residual chlorine 1 mg/l min.
- Domestic waste...no floating solids
- Misc. discharges...no free oil by visual observation
- Misc. discharges chemically treated
  - No free oil by visual observation
  - Toxicity...no effects at edge of mixing zone
Platform Discharges

- Synthetic based drilling fluid (olefin/ester)
  - No discharge of whole fluids
  - Stock base fluid limits
    - Poly-nuclear Aromatic Hydrocarbons (PAH)
    - Sediment toxicity
    - Biodegradation Rate
  - Discharge limits
    - Formation oil by RPE/GCMS
    - Sediment toxicity
    - Retained fluids on cuttings $\leq 6.9\%$ or implement BMP
East Coast Refineries

Total Refining Capacity = 1.5 MBPD

East Coast Refineries
- Sunoco Inc. R&M Refinery
  3144 Passyunk Ave., Pennsylvania, PA (335,000 barrels per day)
- Sunoco Eagle Point Refinery
  Us Highway 130 South & Highway 295, Westville, NJ (145,000 barrels per day)
- Sunoco Marcus Hook Refinery
  100 Green St., Marcus Hook, PA (178,000 barrels per day)
- ConocoPhillips Trainer Refinery
  4101 Post Rd., Trainer, PA (185,000 barrels per day)
- ConocoPhillips Bayway Refinery
  1400 South Park Ave., Linden, NJ (238,000 barrels per day)
- Citgo Asphalt Refining Co.
  4 Paradise Rd., Paulsboro, NJ (32,000 barrels per day)
- Valero Refining Co.
  800 Billingsport Rd., Paulsboro, NJ (160,000 barrels per day)
- Premcor Refining Group, Inc.
  Wrangle Hill Rd., Delaware City, DE (182,200 barrels per day)
- Western Refining Yorktown Inc.
  2201 Goodwin Neck Rd., Grafton, VA (63,650 barrels per day)
Major U.S. Natural Gas Transportation Corridors, 2008

Legend
- Interstate Pipelines
- Intrastate Pipelines

Source: Energy Information Administration, Office of Oil and Gas, Natural Gas Division, GasTran Gas Transportation Information System.

The EIA has determined that the informational map displays here do not raise security concerns, based on the application of the Federal Geographic Data Committee’s Guidelines for Providing Appropriate Access to Geospatial Data in Response to Security Concerns.
Physical oceanography of the southern Mid-Atlantic Bight

Larry Atkinson (ODU) with help from Drs. Jose Blanco (ODU), Alan Blumberg (Stevens), Leo Oey (Princeton), Josh Kohut (Rutgers),
Area is outside most coastal processes and extends well into the deep sea.
Coastal Current

Lease Block

Gulf Stream

Eddies

Slope Sea

SSH (m) & (u,v)@k=0; on 2004/12/23

12/3/08

MMS Workshop - Virigina -
Atkinson
Movie of Sea Surface Temperature

Blue - cold
Red - Warm
Big blue arrows - wind

By Leo Oey
Sea surface height
Strong currents at big
Changes in color
Note Gulf Stream,
Coastal currents,
Eddies/rings.

See migration of
Eddies in Slope Sea.
Occurrence of wave dominant period and height by month (1990-2007) – Buoy 44014

12/3/08

MMS Workshop - Virginia - Atkinson
## Extreme events – Wind

50 m height wind speed (m/s) at 25, 50 and 100 years return period
Buoy 44014 - 15 yrs of data

<table>
<thead>
<tr>
<th></th>
<th>Wind speed</th>
<th>Gust</th>
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<tbody>
<tr>
<td>Um</td>
<td>19.7</td>
<td>24.9</td>
</tr>
<tr>
<td>Ur(25)</td>
<td>36.2</td>
<td>46.2</td>
</tr>
<tr>
<td>Ur(50)</td>
<td>38.4</td>
<td>49.1</td>
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<tr>
<td>Ur(100)</td>
<td>40.64</td>
<td>51.95</td>
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**ws** = hourly wind speed (eight-minute average on each hour)

**gust**= Peak 5 second gust speed (m/s) measured during eight-minute on each hour

**Um** : Mean value of maximum monthly wind speeds (m/s)

**Ur(r)** : Wind speed (m/s) with r year return period (r=25, 50 and 100 years)
Extreme events – Waves

Wave Heights predictions (m) from grouped data - (1990 - 2007) Buoy 44014

Peak Over Threshold (POT) model
Weimbull distribution
dt=14.9 yr

<table>
<thead>
<tr>
<th>Return Period (yr)</th>
<th>20</th>
<th>50</th>
<th>100</th>
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<td>POT, Z=4 (m), (\lambda)=20, (288 storms)</td>
<td>8.0</td>
<td>8.6</td>
<td>9.1</td>
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<tr>
<td>POT, Z=6 (m), (\lambda)=6, (2.7 storms)</td>
<td>8.8</td>
<td>9.6</td>
<td>10.3</td>
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</tbody>
</table>

Ht (m) for 95% interval for return period T (year)
Maximum current = 116 cm/s

12/3/08

MMS Workshop - Virigina - Atkinson
An example of transport processes

From “Lagrangian flow patterns north of Cape Hatteras using near-surface drifters” by Glen Gawarkiewicz *, Christopher A. Linder
Drifter tracks show two modes of movement from outer shelf to Gulf Stream

From Gawarkiewicz
2 special cases: Movement in the SAB and Recirculation into the outer shelf and back out

From Gawarkiewicz
Lessons from Literature

• Several modes of transport in the area of interest.
• They can be observed and modeled.
Ocean Observing Assets

• NDBC Buoys
• Satellite: winds, altimetry (SSH), surface temperature (SST), ocean color.
• Coastal: NOAA COOPS systems
• MARCOOS: coastal currents with high frequency radar, glider runs and assimilating models.
MARCOOOS High Frequency Radar Current coverage of area

Map every two hours. Data going to CG search and rescue.
Operational Modeling

• NOAA Real-Time Ocean Forecast System (Atlantic)
• NOAA/NOS - Operational Forecast System (NOS plans to expand OFS grids offshore in the future)
• Navy Coastal Ocean Model (NCOM)
Comments/Thoughts

• Will MMS do studies in this area similar to those they did off Cape Hatteras for the Manteo blocks decades ago?
• Activity in the Virginia block will affect coastal waters off North Carolina and Maryland and not so much the Virginia coast.
• Do we plan for MAB wide impact studies?
• Regional associations (MACOORA) now exist and can be part of the solution.
Environmental Research Needs in Support of Potential Virginia Offshore Oil and Gas Activities

Pelagic Fishes

Richard W. Brill,
National Marine Fisheries Service,
Northeast Fisheries Science Center
& Virginia Institute of Marine Science

Photo: Kerstin Fritsches,
University of Queensland
NORTHERN BLUEFIN TUNA

*Thunnus thynnus*

MIGRATIONS OF NORTHERN BLUEFIN TUNA DETERMINED FROM RELEASES AND RECAPTURES OF TAGGED FISH.

MIGRATIONS OF SOUTHERN BLUEFIN TUNA DETERMINED FROM RELEASES AND RECAPTURES OF TAGGED FISH.

Yellow areas: Spawning areas of northern bluefin tuna.

Orange areas: Spawning area of southern bluefin tuna.

Geographic distribution and migrations of two species of bluefin tuna. Both the northern bluefin tuna and the southern bluefin tuna make extensive migrations. Although these species are distributed world-wide, like the albacore tuna, they return to restricted areas to spawn.

**TUNA AND BILLFISH—fish without a country**

James Joseph | Witold Klawe | Pat Murphy

*Paintings by: George Mattson*

INTER-AMERICAN TROPICAL TUNA COMMISSION
YELLOWFIN TUNA

Thunnus albacares

- AREAS WHERE YELLOWFIN TUNA ARE CAUGHT WITH LONGLINE GEAR.

- SPAWNING AREAS.
White marlin

GEOGRAPHIC DISTRIBUTION OF STRIPED MARLIN.

GEOGRAPHIC DISTRIBUTION OF WHITE MARLIN.

SPAWNING AREA OF STRIPED MARLIN

SPAWNING AREA OF WHITE MARLIN
Adult bluefin tuna use Virginia – North Carolina inshore areas as winter feeding grounds.
Juvenile bluefin tuna migrate north in the summer along the continental shelf.
Best guess…

Of the large pelagic fishes, bluefin tuna are the most likely to be impacted by the proposed offshore oil & gas development.
Five specific environmental variables matter:

1. temperature
2. oxygen
3. salinity
4. substrate (bottom type, places of refuge, etc.)
5. effective prey abundance.
5. Effective prey abundance

(A) number of prey

(B) prey availability

prey availability is a function of:

(a) visual environment

(b) olfactory environment

(c) auditory environment
For large pelagic fishes, three specific environmental variables matter:

1. temperature
2. oxygen (concentration & partial pressure)
3. salinity
4. substrate (bottom type, places of refuge, etc.)
5. effective prey abundance
Impacts to Marine Fisheries Habitat from Nonfishing Activities in the Northeastern United States

Offshore oil exploration -- probable impacts on pelagic fishes:

1. temperature

2. oxygen

3. salinity

4. substrate (bottom type, places of refuge, etc.)

5. effective prey abundance
   (A) number of prey
   (B) prey availability
      (a) visual environment
      (b) olfactory environment
      (c) auditory environment
Effective prey abundance -- (A) number of prey

1. Disruption of entire pelagic communities (i.e., phytoplankton → zooplankton → tuna prey base) due to oil slicks from spills or wellhead blowouts

2. Alteration of bottom habitat from vessel anchoring, platform or artificial island construction, pipeline laying, dredging, etc.

3. Prey dispersal due to noise from drilling activities, construction, etc.

Bluefin tuna feed on sand eels

Vertical movement patterns of juvenile bluefin tuna off Virginia
Effective prey abundance -- (B) prey availability

(a) visual environment
(b) olfactory environment
(c) auditory environment

Increases in suspended particles (reduce light penetration)

Contaminant discharge, spills, or wellhead blowouts (effect olfactory environment and olfactory function)

Noise (disrupt ability to locate prey, cause hearing impairment)
However...

Specific movement patterns and distributions are **highly variable** and show multi-year, decadal, and longer cycles correlated with oceanographic cycles (e.g., North Atlantic Oscillation).

... **equivocal** whether the areas off Virginia impacted by proposed oil and gas development are “critical”
Annual migrations, diving behavior, and thermal biology of Atlantic bluefin tuna, *Thunnus thynnus*, on their Gulf of Mexico breeding grounds.

Steven L. H. Teo · Andre Bouetany · Heidi Dewar · Michael J. W. Stokesbury · Kevin C. Weng · Shana Bremmer · Andrew C. Setz · Charles J. Farwell · Eric D. Prince · Barbara A. Block

Could oil and gas development be problematic for fishers?
U.S. domestic longline vessel.

Equivocal for commercial fishing

highly mobile fleet pursuing highly mobile fishes
Not equivocal for recreational fishing because of very limited mobility of the fleet, and “popularity” of bluefin tuna.
…not equivocal for recreational fishing industry
problematic for policy makers…

People of affluence and influence
(in proximity to Washington DC)
Summary

Potential Impacts of Virginia Offshore Oil and Gas Activities:

Equivocal for pelagic fishes (even bluefin tuna)

Equivocal for commercial fishers (longline)

Not Equivocal for recreational fishing industry
Light-based geolocation, accurate to:

± 1 to 2° in latitude

± 0.5° in longitude
Long-term fluctuations in the eastern Atlantic and Mediterranean bluefin tuna population

Christelle Ravier and Jean-Marc Fromentin


**Eastern Atlantic and Mediterranean bluefin tuna populations**

Figure 8. Synthetic series (thin line) computed as mean of the standardized values of the different time-series. The trend (bold line), estimated by Eigen Vector Filtering (see the text), constitutes an index of long-term fluctuations in abundance.
Adult bluefin tuna used Virginia – North Carolina & New England inshore areas as winter feeding grounds.
BENTHIC FISH/FISHERIES ISSUES

Kenneth W. Able
Marine field Station
Institute of Marine and Coastal Sciences
Rutgers University
Figure 1. Middle Atlantic Bight study area with important localities mentioned in the text.
ECOLOGICAL SETTINGS

• Continental shelf waters strongly influenced by seasonal variation in temperatures
• Outer continental shelf margin influenced by submarine canyons and Gulf Stream
• Fish fauna is highly migratory
• Larval supply has multiple sources
• Diverse assemblages of fishes
Figure 6. Composite distribution of age 1+ juvenile and adult and YOY *Alosa pseudoharengus* during seasonal cruises of the National Marine Fisheries Service groundfish survey. Details of sampling effort and geographical landmarks indicated in Fig. 1.
Figure 15. Composite distribution of age 1+ and YOY *Centropristis striata* during seasonal cruises of the National Marine Fisheries Service groundfish survey. Details of sampling effort and geographical landmarks indicated in Fig. 1.
Figure 9. Composite distribution of age 1+ and YOY *Anchoa mitchilli* during seasonal cruises of the National Marine Fisheries Service groundfish survey. Details of sampling effort and geographical landmarks indicated in Fig. 1.
Figure 19. Composite distribution of age 1+ and YOY *Cynoscion regalis* during seasonal cruises of the National Marine Fisheries Service groundfish survey. Details of sampling effort and geographical landmarks indicated in Fig. 1.
Figure 14. Composite distribution of age 1+ and YOY *Morone saxatilis* during seasonal cruises of the National Marine Fisheries Service groundfish survey. Details of sampling effort and geographical landmarks indicated in Fig. 1.
INFORMATION GAPS

• Response of fishes to oil and gas platforms
• Response of fishes to seasonal variability in thermal regimes
• Responses variability due to climate change
Workshop on Environmental Research Needs in Support of Potential Virginia Offshore Oil and Gas Activities

~ Benthos ~

Linda C. Schaffner, Professor
Department of Biological Sciences
Virginia Institute of Marine Science
linda@vims.edu

December 3, 2008
Outline

• MMS Offshore Program Area
• The benthos - a few fundamentals
• Benthic habitats, including Essential Fish Habitat (EFH), Habitats of Particular Concern (HAPC), commercial species and more...
• Potential effects of exploration, drilling and normal operations on benthic ecosystems
• Potential effects of oil spills on benthic ecosystems
• Breakout sessions
Virginia Offshore Program Area as presented by MMS

- Outer continental shelf to deep sea
- Region includes Norfolk and Washington Canyons
- Potential effects of onshore activities and pipelines across the shelf and into nearshore areas must also be considered
Outline

• MMS Offshore Program Area
• The benthos - a few fundamentals
  • Benthic habitats, including Essential Fish Habitat (EFH), Habitats of Particular Concern (HAPC), commercial species and more…
  • Potential effects of exploration, drilling and normal operations on benthic ecosystems
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The Benthic Effect

- The term benthos is used for habitats, organisms, and the processes they modulate in, on, or very near the bottom.
- The benthic organisms regulate or modify most physical, chemical, geological and biological processes in shallow waters and becomes more dependent on pelagic processes as depth increases.
The benthos serves as the “memory of the ecosystem”

- Materials reaching bottom are mostly decomposed, but some remain as part of a permanent record.
- Benthic organisms “sample and integrate” events
- As a result, sediments and resident benthic organisms are among the most common monitoring tools used to detect environmental degradation

(figure from Pearson and Rosenberg 1978)
The benthos provides key ecosystem functions

- Benthic organisms have major effects on nutrient cycling, carbon transformations and pollutant fate, especially on shelf and in nearshore regions
- Secondary production by benthic organisms provides essential links to higher trophic levels
Outline

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Benthic Habitats - some examples, not a comprehensive review

- General trends across the shelf/upper slope from VIMS BLM study in late 1970s (mostly off NJ, one transect in Virginia)
  - Physical environment
  - Hydrocarbons, metals, bacteria
  - Benthic assemblages

- Habitats of Particular Concern (HAPC)
- “Priority Areas” identified by NRDC
- Commercial species - e.g. scallop
- Nearshore areas potentially impacted by onshore activities and pipelines
Cross Shelf - Physical Environment

ridge and swale topography

<table>
<thead>
<tr>
<th>near shore</th>
<th>inner shelf</th>
<th>central shelf</th>
<th>outer shelf</th>
<th>shelf break</th>
<th>continental slope</th>
<th>deep sea</th>
</tr>
</thead>
</table>

Temperature constancy
-0.5 - 30°
-0.5 - 17°
4 - 16°
8 - 11°
11 - 12°
4°

Sediment grain size
Fine sand
Coarse-medium sand
Sediment grain size
Muddy fine sand
Mud

Silt and clay
< 10 %
> 50 %

Sediment mobility
nearly constant
frequent
seasonal
occasional
quiescent

Modified from VIMS (1979)
Cross Shelf - Sediment Associated Metals, Hydrocarbons, Bacteria

Modified from VIMS (1979)
Shelf - Benthic Assemblages

Foraminifera - Density

Meiobenthos - copepod/nematode ratio

Macrobenothos - Density

Macrobenthos - Species Richness

Modified from VIMS (1979)
Ridge - Swale Topography

Sediment grain size
- Ridge: med-coarse sand
- Flank: muddy fine sand
- Swale: muddy fine sand

Silt and clay
- Ridge: 0%
- Flank: 0 - 2%
- Swale: 3 - 6%

Sediment mobility
- Ridge: frequent
- Flank: seasonal
- Swale: severe storms

Important biogenic processes
- Ridge: physically controlled
- Flank: bioturbation
- Swale: bioturbation and biodeposition

Macrobenthos
- density, biomass and species richness

Modified from VIMS (1979)
Submarine Canyons

- Fifteen canyons in the North Atlantic were recognized by the New England Fisheries Management Council in June 2007 as Essential Fish Habitat (EFH) and “Habitat Areas of Particular Concern” (HAPC)
- These include Washington and Norfolk canyons, which are in the Virginia Offshore Program Area
- In addition to fishing issues, some canyons were selected because of the unique biological communities found there --- for example, deep-water corals, sponges and sea fans --- and because many of these complex structures are vulnerable to disturbance.


Commercial species: Sea Scallop

- Geographic range: In the Northwest Atlantic Ocean, from Newfoundland to North Carolina
- Habitat: Adult scallops form dense aggregations called "beds" on the ocean floor. Commercially valuable scallop beds are usually found at depths between 59 and 360 feet.
- Life span: Up to 20 years
- Other species to consider? Surf clam?

“Priority Ocean Areas”

• Specialized habitat areas identified by experts for attributes:
  – High biodiversity
  – High abundance
  – Migration pathways
  – Nursery or spawning areas
  – Endangered or threatened species
  – Fisheries

• Virginia - priority areas include:
  – Submarine canyons
  – A 35-kilometer corridor (extending from shore) of nearshore waters, encompassing many subareas of importance.
  – The continental shelf/slope break area, from the 100-meter to the 400-meter isobath

Nearshore areas

- Highly productive
- Diversity of habitat types
- Often serve as nursery areas
- Foraging areas for adult fish, crabs, birds
- All are relatively sensitive to disturbance
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Potential Effects in Space and Time

• Potential for adverse effects with all activities:
  – Exploration - effects likely to be temporary and localized
  – Drilling and Construction - localized to widespread, short to long-term
  – Normal Operations - relatively localized?, long-term
  – Influenced by engineering and advanced technologies

• Influenced by level of activity
  – Accidental release of oil (should drilling for oil occur)
  – Potential for wide-spread and long-term effects
  – Heavily influenced by nature, which can not be controlled
Effects of Drilling and Normal Operations on Benthic Habitats, Organisms and Processes

• From drilling activities:
  – direct disruption of benthic habitats (e.g. production activities, deposition of drill cuttings)
  – toxicity due to drilling muds - OBM, SBM, WBM
  – long term, cumulative impacts on biodiversity and benthic productivity depending on level of activities

• From development of new infrastructure (e.g. onshore processing and pipelines):
  – direct disruption of benthic habitats (e.g. nursery areas, migration corridors, SAV, wetlands, oysters)
  – indirect effects via changes in water quality and watershed impacts that change physical environment (e.g. runoff)
  – long term and cumulative impacts on biodiversity and benthic productivity depending on level of activities
Effects of Oil Spills

• Emerging perspective - effects can be pervasive and long-lasting
• Chronic effects at all levels, including communities and ecosystems

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Breakout Sessions

• Session 1 - Review existing information and begin identify key datasets, reports, published works. Identify information gaps.

• Session 2 - What key areas of research are needed? Why?

• Session 3 - Develop one or two substantive ideas. The group will be asked to provide background for the potential study, objectives and approach. How would MMS use the information? Aspects such as feasibility, opportunities for partnering with other agencies, etc., should also be addressed.

• Session 4 - Draft a summary presentation.
“I don’t know why I don’t care about the bottom of the ocean, but I don’t.”
Protected and Endangered Species

Scott D. Kraus, PhD  New England Aquarium

- Marine Mammals: Vessel Traffic (collisions)
- Sea Turtles: Noise (Exploration, operations, vessels)
-  
  Water and Air Pollution (oil and gas emissions)
Figure 5. Sightings of Turtles (Green, Leatherback, Loggerhead, Kemp’s Ridley, and Unidentified) in and around the proposed lease site.
Figure 1. Sightings of North Atlantic Right, Humpback, and Sperm whales in and around the proposed lease site for oil and gas exploration.
Figure 2. Sightings of Blue, Fin, Minke, Sei, and unidentified Balaenoptera and Rorqual whales in and around the proposed lease site for oil and gas exploration.
Figure 3. Sightings of Dolphins (Spotted, Whitesided, Bottlenose, Common, Bottlenose, Risso’s, Spotted, Striped, and unidentified) and Pilot Whales in and around the proposed lease site for oil and gas exploration.
Figure 4. Sightings of Beaked, Cuvier’s, Sowerby’s, and Unidentified Beaked whales in and around the proposed lease site.
The Problem of Right Whales vs Ships

Co-occurrence: Right whale habitat in the western North Atlantic is nearly a perfect overlap with high-density shipping areas.
Ambient Noise: One Day in the Bay of Fundy

A Contact Call – How Right Whales Say “What’s Up”

Sounds from a Courtship Group Focal Female
Video not available, cannot find 'vids:tscc' decompressor.
24-Hour Comparison

Sea of Cortez, Mex. - Rural

Singing Fin Whales

Ligurian Sea, Med. - Urban

Singing Fin Whales – there but not to be heard
A blue whale’s acoustic space - 50 yrs ago
A blue whale’s acoustic space - Now
Data, Maps, and Images Courtesy of:

Bob Kenney: Univ. of Rhode Island and the Right Whale Consortium

Mark Swingle: VIMS

Chris Clark: Cornell University, Lab of Ornithology

Kerry Lagueux, New England Aquarium

NOAA Fisheries (Alaska)
Acoustic Ecology Scenes: lost in the smog of human noise

© Chris Clark
The Economics of Environmental Impacts From Oil & Gas Development Off the Coast of Virginia

Doug Lipton
Department of Agricultural & Resource Economics
University of Maryland College Park
December 3-4, 2008
Williamsburg, VA
OVERVIEW

ECONOMIC PERSPECTIVE ON:
○ WHAT RESOURCES?
○ HOW ARE THEY VALUED?
○ WHAT’S CHANGED FROM EARLIER STUDIES?
### COMMERCIAL FISH LANDINGS

<table>
<thead>
<tr>
<th></th>
<th>0-3 MILES</th>
<th>3-200 MILES</th>
<th>TOTAL</th>
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<tbody>
<tr>
<td>POUNDS</td>
<td>497 million</td>
<td>103 million</td>
<td>600 million</td>
</tr>
<tr>
<td>DOLLARS</td>
<td>$155 million</td>
<td>$108 million</td>
<td>$264 million</td>
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</table>

- Menhaden make up 72% of the landings by weight
- Sea Scallops and Blue Crab make up 25% Each, or 50% of the Total Landed Value
WHAT’S CHANGED – COMMERCIAL FISHING

OLD
○ FISHING DISPLACEMENT MODELS BASED ON ENGINEERED APPROACH

NEW
○ RANDOM UTILITY MODELS - MODEL FISHING LOCATION CHOICE OF INDIVIDUAL FISHERMEN ON A TRIP BY TRIP BASIS
  ▪ LOG BOOKS
  ▪ VESSEL MONITORING SYSTEMS
AQUACULTURE

- SHELLFISH – PRIVATE PROPERTY

- OFFSHORE CAGES – POTENTIAL
  - U.S. Pilots
    - New England
    - Puerto Rico
    - Hawaii
  - Korea Commercial Scale
    - Highly Profitable rock bream production
FOR HIRE BOAT TRIPS – 2007

<table>
<thead>
<tr>
<th>INSHORE</th>
<th>&lt; 3 MILES</th>
<th>&gt; 3 MILES</th>
<th>UNKNOWN</th>
<th>TOTAL</th>
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<tbody>
<tr>
<td>TRIPS</td>
<td>280,452</td>
<td>49,700</td>
<td>284,615</td>
<td>2,793</td>
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• HOW WILL COSTS AND RETURNS FOR FOR HIRE BUSINESSES CHANGE?

• HOW WILL THE NET BENEFITS TO FISHERS ON FOR HIRE TRIPS CHANGE?
PRIVATE BOAT & SHORE FISHING TRIPS – 2007

<table>
<thead>
<tr>
<th>INSHORE</th>
<th>&lt; 3 MILES</th>
<th>&gt; 3 MILES</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRIPS</td>
<td>7,195,198</td>
<td>5,806,081</td>
<td>807,892</td>
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</table>

• SPENDING BY INDIVIDUALS FOR 13.8 MILLION TRIPS PER YEAR HAS SIGNIFICANT IMPACT ON REGIONAL ECONOMY. CHANGE?

• HOW WILL NET BENEFITS TO THESE FISHERMEN CHANGE WITH CHANGES IN FISHING OPPORTUNITY AND QUALITY?
WHAT’S CHANGED – RECREATIONAL FISHING

- MODELING
  - RANDOM UTILITY MODELS
  - STATED PREFERENCE SURVEYS
  - REASONABLE TIME SERIES OF DATA

- ABILITY TO VALUE
  - TRIPS
  - CHANGE IN CATCH RATES ON A TRIP
  - LOCATIONS

- BENEFITS TRANSFER
ENDANGERED, THREATENED & CHARISMATIC SPECIES

- NON-CONSUMPTIVE VALUE
  - WHALE-WATCHING
  - BIRD WATCHING

- EXISTENCE VALUE
  - WILLINGNESS-TO-PAY FOR CHANGE IN THE STATUS
WHAT’S CHANGED – EXISTENCE & NON-CONSUMPTIVE VALUE

- STATED PREFERENCE SURVEYS
- CONJOINT ANALYSIS
BEACHES

- U.S. RESIDENTS PARTICIPATING IN VISITS TO BEACHES ADJACENT TO STUDY AREA
  9,301,380

- NUMBER OF BEACH DAYS
  78,258,000

SOURCE: NATIONAL SURVEY ON RECREATION & THE ENVIRONMENT (2000); LEEWORTHY (2001)
WHAT’S CHANGED – BEACH VALUATION

- RANDOM UTILITY MODELS & SURVEYS IN SOME PLACES – e.g., FLORIDA, CALIFORNIA

- NOT MUCH RESEARCH IN MID-ATLANTIC
WATERFRONT

- TYPES
  - HOMES
  - BUSINESSES

- VIEWSHEDS
WHAT’S CHANGED – WATERFRONT VALUATION

- HEDONIC ANALYSIS
  - WATERFRONT
  - WATERVIEW
  - WATER QUALITY
CONCLUSIONS

- HUGE IMPROVEMENT IN VALUATION METHODOLOGIES OVER THE PAST 20 YEARS

- DATA SPOTTY – GOOD IN SOME PLACES (RECREATIONAL FISHING), POOR IN OTHERS

- FEW EXAMPLES OF REGION-WIDE ECONOMIC ASSESSMENTS
Workshop on Environmental Research Needs in Support of Potential Virginia Offshore Oil and Gas Activities: Social Issues

Diane Austin
Bureau of Applied Research in Anthropology
University of Arizona
December 3, 2008
Social Impact Assessment: Historical Context

- Co-occurrence of NEPA, 1970s energy crisis, & expansion of federal OCS leasing program
- National Academy of Science energy-related research plan and BLM-MMS research agenda: examine project technologies & resource demands related to construction, operations, and accidents
- Atlantic Region coastal areas: urbanized, heterogeneous, and complex; OCS development to require new infrastructure and a workforce; goal to characterize the infrastructure and estimate labor demand
BLM/MMS Studies of Mid-Atlantic Region

- A Study of the Socio-Economic Factors Relating to the Outer Continental Shelf of the Mid-Atlantic Coast - 1974
- An Oil Spill Risk Analysis for the Mid-Atlantic Outer Continental Shelf Lease Area - 1976
- Methodology for Assessing Onshore Impacts for Outer Continental Shelf Oil and Gas Development – 1978, 1980
- Design for a Simplified Regional Impact Methodology Using Rims and Seas – 1978
- Assessment of Space and Use Conflicts Between the Fishing and Oil Industries – 1981
- Assessing the Impact of Oil Spills on a Commercial Fishery – 1981
- Impacts of Oil and Gas Exploration, Development, and Production on the Atlantic Continental Shelf - 1991
Sample Findings of Prior Studies
As a result of the absence of any offshore activity along the east coast, there is a **dearth of direct supportive capability** anywhere in the region of study.

Since the region is a major importer of crude, and the magnitude of a find is unlikely to alter this fact, the **impact of offshore crude availability is not expected to differ at the shoreline** point of delivery over that associated with [current bulk carrier] operations.

However, it is possible that a different bulk carrier philosophy could prevail that would substantially alter the net impact (offshore port plus OCS development) on the region.
An Oil Spill Risk Analysis for the Mid-Atlantic Outer Continental Shelf Lease Area

Smith, Slack, and Davis - 1976

- In summary, the final product of trajectory model runs consisted of a large number of possible oil spill trajectories or pathways... These trajectories represent only hypothetical pathways for the transport of oil slicks...

- Unless additional refinery capacity is developed to handle increased quantities of crude oil, production from Mid-Atlantic fields would tend to merely replace existing sources currently carried by tankers to Mid-Atlantic terminals. Thus some oil spill risk exists independent of decisions on leasing and development of the area.
Assessment of Space and Use Conflicts Between the Fishing and Oil Industries

Centaur, 1981

• Labor: (1) there may exist **direct competition for labor** between the OCS oil support vessel (supply boats, crew boats, utility boats, tug boats) and fishing industries and (2) there may exist **indirect competition for labor** between the onshore OCS oil support and fishing industries
• Port space, and
• Other areas of impacts including fuel and repair facilities, equipment, supplies, and financing
Impacts of Oil and Gas Exploration, Development, and Production on the Atlantic Continental Shelf

A.T. Kearney, 1991

- Develop and demonstrate a model to identify onshore *economic* impacts of offshore activity

- MMS-Defined Coastal MSAs
  - Jaws City County -- York County
  - Chesapeake City -- Hampton City
  - Newport News City -- Norfolk City
  - Portsmouth City -- Suffolk City
  - Virginia Beach City
Impacts of Oil and Gas Exploration, Development, and Production on the Atlantic Continental Shelf

Use of VA ports as supply bases:
- Hampton Roads - likely
- Norfolk - likely
- Portsmouth - possible
- Chesapeake – possible

Repair Yards
- Limited Repairs
  - Accomack --Northampton
  - York -- James City
  - Surry -- Isle of Wight
  - Hampton -- Virginia Beach
  - Chesapeake -- Suffolk
- Major Repairs
  - Newport News
  - Norfolk
- Repairs Available
  - Portsmouth
Active GOM Leases October 2001

Active leases issued
- Prior to 1999
- In 1999 & 2000
- In 2001
Expanding the Study of Socioeconomic Impacts

- Stakeholders Issues in the Eastern Gulf of Mexico - 1999
- Effect of the Oil and Gas Industry on Commuting and Migration Patterns in Louisiana: 1960-1990 – 2002
- Social and Economic Impacts of OCS Activities on Individuals and Families: Volume 2: Case Studies of Morgan City and New Iberia, Louisiana - 2002
- Environmental Justice Considerations in Lafourche Parish, Louisiana – 2003
- Labor Migration and the Deepwater Oil Industry – 2005
- Examination of the Development of Liquefied Natural Gas on the Gulf of Mexico - 2008
onshore

offshore

**Rig**
- company man
- toolpusher
- driller
- crane operator
- derrickman
- rigger
- derrickman
- roughneck
- roustabout
- shaker
- mud engineer
- wireline operator
- fishing tool operator
- snubber
- completion specialist
- rig mechanic
- electrician
- welder
- galleyhand
- medic
- linen hand
- cook

**Fabrication**
- engineer
- draftsman
- crane operator
- welder
- fitter
- tacker/helper

**Trucking Company**
- dispatcher
- owner/operator
- driver

**Diving/ Underwater Construction Company**
- divers
- ROV//AUV technicians
- diver-tenders
- tenders

**Offshore Vessel Company**
- port captain
- captain
- mate
- engineer
- deckhand

**Platform**
- foreman/field supervisor
- lead operator
- second level operator
- first level operator
- roustabout

**Other Platform Positions**
- electrician
- mechanic
- instrumentation technician
- computer technician

**Other Rig Positions**
- medic
- linen hand
- cook
Sources of Impacts on Workers/Families

- danger
- cycles
- OCS
- overall economic picture
- work schedules
- satisfaction
- economic rewards
- non-OCS opportunities
- industry restructuring
- societal expectations
Sources of Impacts on Communities

- education & training
- healthcare
- housing
- demographic & social change
- local, state, federal government policies
- overall economic picture
- local perceptions & practices
- emergency social services
- OCS
- healthcare

COMMUNITY HEALTH CENTER CASE LOADS OF UNINSURED PATIENTS VIS-A-VIS OIL INDUSTRY CYCLES

- Workers in search of jobs, and their families
- Laid-off workers and their families
- Uninsured workers and their families

OIL INDUSTRY ACTIVITY LEVEL

COMMUNITY HEALTH CENTER CASE LOADS OF UNINSURED PATIENTS
Topics for Possible Consideration

- Perceived Risk
- Composition of Labor Force (local to international) and Labor Migration
- Impacts on Livelihoods
- Environmental Justice
- Cumulative Impacts
- And more…
“By opening the public comment period for drafting an environmental impact statement (EIS) on offshore drilling, the Interior Department has now taken the first concrete action in Washington since Bush and Congress lifted certain bans on offshore drilling in the Outer Continental Shelf. … Needless to say, not everyone is pleased with the late-term move from the Bush administration…”
Social Impacts Occur and Must be Studied at Multiple Levels

- Local
- Regional
- National
- International

Individuals Organize Themselves in Communities

- Geographic
- Virtual
- Professional
- And more…
Working with Communities

• Initial scoping visits to identify issues and interested communities
• Ethnographic study
• Data synthesis and analysis
• Follow up focus group visits
• Final report with copies to communities
Sample Methods for Studying Social Impacts on Communities

- Semi-Structured Interviews
- Focus Groups
- Surveys
- Oral History Interviews
- News/Media Analysis
The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the Offshore Energy and Minerals Management Program administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS Minerals Revenue Management meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.