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STUDY TITLE: Deepwater Program: Gulf of Mexico Deepwater Information Resources Data Search and Literature Synthesis

REPORT TITLE: Deepwater Gulf of Mexico Environmental and Socioeconomic Data Search and Literature Synthesis, Volume I: Narrative Report and Volume II: Annotated Bibliography

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BACKGROUND: Recent years have seen a great increase in oil and gas industry interest in the deepwater Gulf of Mexico. Deepwater development poses a number of environmental, socioeconomic, and technological issues. A "Deepwater Workshop" was held by the Minerals Management Service (MMS) in 1997. Workshop participants identified synthesis of existing environmental and socioeconomic data as an important priority. This synthesis report addresses the need for a comprehensive search and integration of environmental and socioeconomic data for the deepwater Gulf of Mexico.

OBJECTIVES: The goal of this program was to gather environmental and socioeconomic information related to the deepwater environment, in order to describe the ecosystem; understand the environmental processes that drive the system; and

understand potential sensitivities to oil and gas operations. Specific objectives were to develop (1) a computer-searchable annotated bibliography incorporating literature, relevant data, and ongoing research pertaining to geological, physical, chemical, and biological processes of the study area, social and economic data and literature, and deepwater technology; and (2) a synthesis report that describes the deepwater Gulf ecosystem, dominant environmental processes, biologically sensitive pathways, and socioeconomic activities in the area.

DESCRIPTION: This report focuses on the deepwater Gulf of Mexico, defined as extending from a depth of 305 m (1,000 ft) to the border of the U.S. Exclusive Economic Zone. Conventional and innovative technologies used to explore and develop hydrocarbon resources in the deepwater Gulf of Mexico are described. The physical environment is described, including geology and physical and chemical oceanography. Biological communities of the water column and benthic environments are discussed, including chemosynthetic communities associated with hydrocarbon seeps. Fish communities and fisheries potentially affected by deepwater operations are described. Socioeconomic effects of oil and gas industry operations in the Gulf of Mexico are summarized. A synthesis chapter draws together information to contrast deepwater operations and deepwater environments with their shallow water counterparts. A computer-searchable annotated bibliography was also produced.

SIGNIFICANT CONCLUSIONS: Deepwater operations differ from their shelf counterparts in several significant ways. These differences pose technical, environmental, and socioeconomic challenges, most of which are being addressed by ongoing and planned industry and MMS studies. The deepwater environment also differs from the better-known shelf environment in ways that could affect the nature of environmental and socioeconomic impacts. Areas of significant data gaps include geohazards, energetic currents, benthic processes, and linkages between the benthic and water column environments.

STUDY RESULTS: Differences between deepwater operations and their shelf counterparts include higher production rates, which may affect spill probabilities and spill sizes; a shift from primarily bottom-founded structures (fixed platforms and compliant towers) to floating production systems (tension leg platforms, spars, semisubmersibles), and subsea production systems; a lower density of structures and reduced need for explosive platform removals; increased use of synthetic based drilling fluids; increased use of subsea wells tied to a floating production system; a need for longer, heavier pipelines to connect to existing infrastructure; problems keeping flowlines open due to formation of waxes and hydrates in cold temperatures; and use of floating production storage and offloading facilities (FPSOs) for transportation. These differences pose technical and environmental challenges, most of which are being addressed by ongoing and planned industry and MMS studies.

The engineering and geological constraints on the continental slope off Texas and Louisiana related to hydrocarbon recovery will require both novel geological and geophysical surveys and engineering methods. Significant seafloor engineering

problems in deep water include slope instabilities, both short-term (slump) and long-term (creep); pipeline spanning problems; mass transport from unknown causes; and unusual stiffness and strength conditions.

Physical oceanographic characteristics of the deepwater Gulf may be of concern to the MMS from three perspectives: (1) facilities design; (2) pollutant transport; and (3) biological consequences, such as intensified primary and secondary production associated with cyclonic eddies and confluence zones between Loop Current eddies. Five classes of energetic currents in the deepwater Gulf of Mexico are of potential concern from a facilities design perspective. Oceanographic research has shown that the continental slope is characterized by a complex array of cyclonic and anticyclonic eddies of varying time and length scales. These features have substantial impacts on nutrient concentrations, plankton and micronekton communities, and cetacean distribution

Chemically, the deep Gulf is buffered from the direct influence of coastal waters and processes, as reflected in low levels of anthropogenic contaminants in the water column. However, oceanographic mechanisms can transport low-salinity, nutrient-rich waters across the shelf and into the deepwater environment. Secondary movement of materials downslope is an important process as well. The benthic environment is mostly unaffected by anthropogenic impacts. Widespread natural seepage of oil, gas, and brines in near-surface sediments creates an unusual "natural background" of hydrocarbons, which is important when attempting to detect impacts of oil and gas activities.

Standing stocks and productivity of plankton are low in the deepwater Gulf of Mexico. However, "hot spots" in primary production occur when/where nutrient availability is locally enhanced. Those deepwater "hot spots" that are temporally persistent (even if spatially variable) have higher stocks of zooplankton and micronekton. The occurrence of "hot spots" in the deepwater Gulf of Mexico is relevant not only to plankton, but to fisheries and apex predators like marine mammals. The presence of sizeable populations of apex predators in the deepwater Gulf of Mexico implies a reliable supply of lower trophic level prey resources and suggests that underlying physical processes allow "oases" of biological productivity to develop in the mostly oligotrophic deepwater environment. When/where they occur over deepwater in the Gulf, anticyclonic and cyclonic hydrographic features play an important role in determining biogeographic patterns of and controlling secondary productivity.

Current deepwater fishing practices in the northern Gulf of Mexico include trapping for golden crab, trawling for royal red shrimp, bottom longlining for groupers and tilefishes, and surface longlining for sharks and tunas. Of these gear types, the pelagic longline presents the greatest possibility for interactions or space-use conflicts with the oil and gas industry. Another concern is the potential for interference with migratory routes due to attraction of epipelagic fishes (e.g., tunas, dolphin, billfishes, and jacks) to surface structures and mooring lines. Because of the highly migratory nature of many epipelagic species, these effects could extend to the regional scale (hundreds of

kilometers). In addition, eggs and larvae of many epipelagic and mesopelagic fishes are commonly found in the surface waters of the deepwater Gulf, where they could be exposed to contaminants discharged from surface facilities. The potential for impacts could be higher where eggs and larvae are concentrated, as may occur in association with certain oceanographic features.

In contrast with the continental shelf, the deepwater environment is inhabited by a relatively rich assemblage of up to 28 cetacean species. The assemblage includes resident population(s) of endangered sperm whales and several “cryptic” species (beaked whales, dwarf and pygmy sperm whales) whose habits are poorly known due to their avoidance of aircraft and ships. Therefore, many more cetacean species may come in contact with routine oil and gas operations in deepwater. Conversely, most historical sea turtle sightings have been recorded on the continental shelf. Historically, deepwater sea turtle sightings have consisted primarily of adult leatherbacks, with few loggerheads and Kemp’s ridleys (to the shelf edge only). Deep waters of the Gulf may also serve as developmental habitat for hatchling and juvenile sea turtles of the five Atlantic species, and may be used by all species as a transitory habitat. The presence and persistence of mesoscale oceanographic features strongly influences the distributions of protected species. Knowledge of these mesoscale features, as well as the ability to detect and track them through remote sensing, may provide a tool for mitigating some impacts of oil and gas operations in the deepwater Gulf.

Most benthic studies have been descriptive, focusing on abundance, biomass, species composition, and zonation. While oceanographic mesoscale features are known to strongly affect water column primary and secondary productivity (“hot spots”), this understanding has not been extended to the benthos. It is reasonable to suspect that where water column “hot spots” persist spatially, benthic enrichment may occur. The implications for the deepwater benthos are just beginning to be investigated. Also, compared with the continental shelf, the northern Gulf of Mexico continental slope offers complex and rugged morphology including numerous submarine canyons and salt structures. Due to the water depth, true reef communities such as those seen on the shelf will not be present. However, there are some physiographic features whose benthic communities are practically unknown, including the Sigsbee and Campeche Escarpments. As additional information is obtained, new communities and resources may be encountered, and the MMS will need to evaluate their need for protection from oil and gas operations.

Chemosynthetic communities are a distinctive and widespread feature of the deepwater environment. The amount of seafloor influenced by seepage is quite small compared to the extent of the subbottom hydrocarbon system, and industry engineers generally strive to avoid the unstable substrate at seeps. In addition, the MMS requires site-specific surveys for proposed bottom disturbing activities in water depths greater than 400 m to evaluate the potential for chemosynthetic communities. When such areas are identified, they are subsequently protected from physical disturbance from anchors, pipelines, chains, and templates. Current interest lies in improving the capacity to predict where seep communities will occur and in understanding processes

ACCESS NUMBER: 30916

that contribute to either stability or change in this environment so that anthropogenic changes could be distinguished from natural processes.

STUDY PRODUCT(S): Continental Shelf Associates, Inc. 2000. Deepwater Gulf of Mexico Environmental and Socioeconomic Data Search and Literature Synthesis. Volume I: Narrative Report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2000-049. 354 pp.

Continental Shelf Associates, Inc. 2000. Deepwater Gulf of Mexico Environmental and Socioeconomic Data Search and Literature Synthesis. Volume II: Annotated Bibliography. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2000-050. 298 pp.

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