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**STUDY TITLE**: Gulf of Mexico Offshore Monitoring Experiment (GOOMEX), Phase I: Sublethal Response to Contaminant Exposure

**REPORT TITLE**: Gulf of Mexico Offshore Monitoring Experiment (GOOMEX), Phase I: Sublethal Response to Contaminant Exposure, Final Report

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KEY WORDS: Offshore oil and gas production, oil platforms, sublethal chronic effects, detoxification responses, community structure analysis, histopathology, pore water toxicity, reproductive effort, contaminant analyses, hydrocarbons, and trace metals

**BACKGROUND**: The most significant unanswered questions related to environmental impacts of offshore oil and gas development and production are those concerning chronic, low-level stresses on ecosystems that result from discharges, spills, leaks, and disruptions caused by long-term development of energy resources. A mandate to conduct studies to predict, assess, and manage the effects of Outer Continental Shelf (OCS) oil and gas development activities on the marine environment is provided to the MMS under the OCS Lands Act Amendments.

**OBJECTIVES**: (1) To document any fundamental detoxification responses in the resident fauna of long-term OCS production sites, which have resulted from exposure to

contaminants associated with OCS activities; and (2) To document the impacts of any contaminant exposure at the organism, population, or community level.

**DESCRIPTION**: The "Gulf of Mexico Offshore Operations Monitoring Experiment (GOOMEX)" is a three-phase study to test and evaluate a range of biological, biochemical, and chemical methodologies to detect and assess chronic sublethal effects of offshore oil and gas production. Study results will be used to formulate and recommend techniques for monitoring offshore activities to assess the importance of the associated environmental changes. A closely coordinated series of investigations is being used to test for biological impacts in the vicinity of long duration activities associated with oil and gas exploration and production. A chronic impact is defined as an effect on the biota that is caused by exposure to the long-term accumulation of chemicals in the environment. Study components are linked by a common design and analytical approach. The basic program included four field activities over a two year period. The sampling was designed to detect nearfield impacts and contaminant gradients extending out from each site. The study evaluated five test sites and narrowed the long-term study to the three most appropriate sites: MU-A85, MAI-686, and HI-389. The sampling design included a radial pattern with stations at 30-50, 100, 200, 500, and 3000 m distance. The radial design employed a dose-response model to test the hypothesis that biological, chemical and biochemical variations are due to platform derived contaminants. Study components included contaminant (trace metals and hydrocarbons) analysis in sediments, pore waters, and biological tissues; assemblage analysis of benthic meiofauna, infauna, and epifauna; assessment of community health based on life history and reproduction studies; and the induction of detoxification responses.

**SIGNIFICANT CONCLUSIONS**: The biological patterns around platforms are the result of the complex interactions of variations in sediment grain size, organic matter enrichments, and toxic response to contaminant exposure. Contaminant levels associated with these three study sites only exceed levels thought to produce deleterious biological effects at a few stations close to the platform. In general the levels of contamination were low. While further study is needed, the results of GOOMEX Phase I suggest that benthic environments around platforms were disturbed as a result of the presence of the platform and discharges derived from exploration and production activities. Observed shifts in populations and other sublethal effects can only be more fully understood based on directed studies in the field and the laboratory.

**STUDY RESULTS**: Several important observations have come from Phase I of the GOOMEX project. First, we found sediments under platforms were highly enriched in sand and the texture o sediment is strongly correlated with distance from the platform. Visual examination and chemical analysis showed that the sand was primarily related to disposal of cuttings during drilling activities. Hydrocarbons and metals are common contaminants near platforms. As a direct result of the disposal of drill mud and cuttings, contaminants were restricted to sediments close to the platforms (100's of meters). Polycyclic aromatic hydrocarbon (PAH) levels in sediments were well below levels known to be associated with toxic biological effects (<4,000 ppb) and no significant

enhancement of bioaccumulation of hydrocarbons was observed in megafaunal invertebrates or fish near platforms. Two of the three study sites (HI-A389 and MU-A85) exhibited strong gradients in the concentrations of barium, silver, cadmium, mercury, lead, antimony and zinc in sediments. Still, no significant enhancement in bioaccumulation of metals in invertebrates or fish in close proximity of platforms was observed. A comparison with contaminant levels in continental-shelf organisms suggested that metal levels in invertebrate tissues are higher in general at the study sites.

Meiofaunal communities in sediments provided sensitive indications of stress and exposure including decreased abundances for some species. This pattern is consistent with previous studies showing the sensitivity of some species to toxic chemicals. As a consequence of a differential response to toxin exposure, the ratio of the resistant of the sensitive meiofaunal species (i.e., nematode/harpacticoid) provided a good indicator of changes in community structure.

For macroinfauna, some species were enhanced while others were depressed in abundance near platforms confirming a shirt in community structure near the platforms. Some species of macroinfauna (i.e., ploychaetes) were enhanced within 100-meter of the platforms. In contrast, a reduction in some species of meiofauna was observed. Enhancements in the abundance of macroinfauna are attributable to an increase in just a few species. Reductions in abundance are consistent with a toxic response while increases in abundance are consistent with the increased food (carbon; i.e., ploychaetes/amphipods).

Few effects were detectable in invertebrates that lived primarily on top of the sediments. Each platform appeared to affect these animals in unique ways and there did not appear to be an over-riding influence on patterns attributable to the presence of the platform. Histopathological evaluations of fish found no contaminant-related liver lesions.

When exposed to chemical contaminants many organisms have systems to eliminate damaging toxicants. No increase in the activity of these protective systems was apparent when comparing results between near and far stations. This suggests little or no increased exposure was being experienced by bottom dwelling animals near platforms.

Another method of assessing the potential for toxic effects is to expose test organisms to the suspected contaminants in the laboratory and monitor for indications of deleterious effects. Utilizing several test organisms, a detrimental effect was observed when the organisms were exposed to sedimentary interstitial waters collected within 100 m of HI-A389. Laboratory induced toxic effects and high concentrations of trace metals in sediments seemed to correlate providing circumstantial evidence of cause and effect.

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