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STUDY TITLE: Gulf of Mexico Offshore Monitoring Experiment (GOOMEX), Phase I: Sublethal Response to Contaminant Exposure**Error! Bookmark not defined.**

REPORT TITLE: Gulf of Mexico Offshore Operations Monitoring Experiment Phase I: Sublethal Responses to Contaminant Exposure, Interim Report: Year 1

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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, 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 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 Outer Continental Shelf (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 includes four field activities over a two year period. The sampling is 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 includes a radial pattern with stations at 30-50, 100, 200, 500, and 3000 m distance. The radial design employs a dose-response model to test the contaminants. Study components include contaminant analysis in sediments, pore waters, and biological tissues (trace metals and hydrocarbons); assemblage analysis of benthic meiofauna, infauna, and epifauna; assessment of community health based on life history and reproduction studies; and the inducible of detoxification responses.

SIGNIFICANT CONCLUSIONS: This interim report serves as a progress report and preliminary evaluation of the data produced to date. At this time the data is incomplete and no final conclusions have been drawn. An assessment of the partial results is provided in the Study Results section.

STUDY RESULTS: Hydrocarbons were elevated in sediments close to the platform and rapidly decreased to background levels within 100-200 m of the platform. HI-A389 and MU-A85 had strong gradients in hydrocarbon contaminants whereas MAI-686 exhibited a weak and variable gradient due to the low concentration measured and the erosional setting at the site. Data on tissue contaminant levels is too limited to draw conclusions at this point. However, polynuclear aromatic hydrocarbon (PAH) concentrations in fish livers were significantly higher hear the HI-A389 platform than at the far station. Significant trends are beginning to appear in the data however a larger number of analyses will be needed to confirm the significance of these preliminary indications. Two of the three study sites (HI-A389) and MU-A85) showed strong elemental gradients (Ba, Ag, Cd, Hg, Pb, Sb, Zn) with highly significant negative correlations with distance and positive correlations with Ba. Based on only two samplings of Ba trend at the third site (MAI-686) is apparent but not significant and fewer elements show a significant correlation with Ba (Cd, Hg, Pb, Zn). Several of the correlate metals (cu, Hg, Sb) appear to be constituents of the barite ore used in drilling mud while for other (Cd, Pb, Zn) non-drilling mud, rig-related sources appear to be

important. Good correlations were observed between the pore water bioassay results and solid phase (bulk) metal levels.

Harpacticoids copepods are the best meiofaunal indicator of platform affects. Harpacticoid abundance and diversity declines in sediments near the platforms. Preliminary evidence indicates that there may be a meiofauna reproductive potential under platforms as well. The reproductive effort of invertebrate populations appear to respond to the presence of a platform resulting in variations in size class distributions, percent gravid females, stage of reproductive development, and prevalence of diseases and parasites. An immunological probe to estimate reproductive effort is in the calibration and purification stage, and inoculation experiments are awaiting analysis. Histopathological evaluations have been performed on the livers and spleens of fish form Cruises 1 and 2. No contaminant related liver lesions were observed in any of the tissues. Parasitic infections were the most common abnormalities, with microsporidians being the most prevalent. Two other prevalent lesions included inflammatory foci and granulomatous inflammation.

Detoxification enzyme assays in invertebrates were shown to be ineffective (low activity, little induction) and invertebrate exposure studies focus on *in vitro* assays of contaminants accumulated in invertebrate tissues. There was an excellent correlation between aryl hydrocarbon hydroxylase (AHH) and ethoxyresorufin-O-deethlase (ERODL) activity for most fish species, which confirms that these two assays measure the same effect (i.e., P4501A induction). Based on the data form the first two cruises, differences in fish EROD and AHH at near- and far-field activity were minimal. A sea urchin embryological development test displayed significant toxicity to sediment pore waters at four of the five platforms sampled during the first cruise. Significant toxicity was observed at 14 of 125 stations, mostly within 150 meters of a platform. Preliminary analysis of Cruise 1 data indicates a link between toxicity and sediment trace metal concentrations especially zinc.

New techniques are being developed including meiofauna genetic diversity, an immunological probe to estimate reproductive effort in invertebrates, utilization of more appropriate (i.e., indigenous species) organisms for bioassays, and evaluation of various *in vitro* toxicological assays presently utilized in mammalian systems.

STUDY PRODUCTS: Kennicutt, M.C., II, ed. 1994. Gulf of Mexico Offshore Operations Monitoring Experiments, Phase I: Sublethal Responses to Contaminant Exposure, Interim Report: Year 1. OCS Study MMS 94-0005. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, Louisiana. 333pp.

Carr, R.S. and D.C. Chapman. 1993 Toxicity of sediment pore water associated with offshore oil and gas platforms in the Gulf of Mexico. Paper to be presented at eh 14th Annual Meeting of the Society of Environmental Toxicology and Chemistry, Houston, Texas. November 14-18.

McDonald, S., T.r. Narashimhan, K. Connor, K. Willett, S. Safe, and M.C. Kennicutt II. 1994. CYP1A1 Induction in Marine Fish Species from the Gulf of Mexico. Society of Toxicology 1994 Annual Meeting, abstract.

Roscigno, P.F. and M.C. Kennicutt II. 1993. Marine Ecosystems: Assessing the Impacts of Chronic Contamination from Offshore Platforms. Marine Technology Society Journal. 27:66-71.

Field Operation Handbook: A guide to appropriate, accurate, and complete sampling in support of GOOMEX. 1993. Gulf of Mexico Offshore Operations Monitoring Experiment. Phase I: Sublethal Responses to Contaminant Exposure.

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