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STUDY TITLE: University Research Initiative on the Effects of Offshore Petroleum Development in the Gulf of Mexico

REPORT TITLE: Influence of Hypoxia on the Interpretation of Effects of Petroleum Production Activities

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KEY WORDS: Produced waters, discharges, effluents, hydrocarbons, trace metals, radionuclides, benthos, hydrography, hypoxia, anoxia, fate and effects, Louisiana, oxygen depletion

BACKGROUND: Natural variation in space and time has been one of the greatest problems encountered in assessments of effects of petroleum production activities in a field setting. In the extensively developed oil and gas production areas of the northern Gulf of Mexico, a major confounding effect is seasonally intense and widespread hypoxic (dissolved ¡2 < 2 mg/l) bottom waters. Several investigations of the impacts of oil and gas development in the coastal and offshore regions of Louisiana have been complicated by the effects of hypoxia on the benthos. Based on prior investigations and concerns related to confounding effects on impacts studies, we hypothesized that the effects of offshore petroleum development in the form of a production platform discharge could be identified on the Louisiana continental shelf and placed in the context of natural, temporal variability as caused by hypoxic bottom waters.

OBJECTIVES: As a result of previous investigations of the fate and effects of produced water discharges and the persistence of severe hypoxia/anoxia on the Louisiana

continental shelf in summer, we hypothesized that differences in the benthic fauna could be identified as a gradient in distance from the production platform, that these differences will be consistent across time, and that the relative importance of environmental variables that affect benthic community variability can be identified.

DESCRIPTION: Two production platforms and one non-production platform were studied to determine if the effects of offshore petroleum development in the form of a produced water discharge could be identified on the Louisiana continental shelf and placed in the context of natural, temporal variability as caused by hypoxic bottom waters. Study sites were two platforms in the South Timbalier block area in 20 m water depth, 3 km apart, one production (ST53A) and one non-production (ST53B); and a production platform in the West Delta block area (WD32E) in 20 m water depth, 74 km from ST53B. The reference site for WD32E was an open water station in West Delta Block 33. A fourth platform (production, ST52C) was dropped from the study design in July 1990. A reconnaissance cruise was conducted in April 1990, and field studies were conducted mid-month in June through October 1990. Standard benthic community studies accompanied by detailed hydrographic measurements and chemical contaminant analyses were conducted.

SIGNIFICANT CONCLUSIONS: There were some indications of gradients in benthic community parameters at the two production platforms, but these gradients were not always consistent in time, nor consistent with distance from the platform, nor significant. However, there were no clear environmental signals at any of the platforms with distance from the platform. There were indications that hydrocarbon composition and concentrations at the two production platforms were different from the non-production platform. Multiple regression analysis identified oxygen concentration, bottom water temperature and salinity, and sediments as important environmental factors that explained the variation in benthic community parameters of species richness and abundance. Production discharge hydrocarbon concentrations were not significant in any of the models, but there were no clear environmental signals related to these contaminants at any of the study sites.

STUDY RESULTS: The 1990 season of hypoxia at ST53A and ST53B was severe, in that hypoxia occurred early and persistently in the spring, hypoxia was severe in the summer, long periods of anoxia were documented, and the generation of hydrogen sulfide in bottom waters was recorded often. The oxygen record for WD32E showed incursions in and out of hypoxic conditions, with no extremely low levels for prolonged periods. The grain size distributions were considerably different between the South Timbalier area (primarily silty sands) and the West Delta area (primarily silts). The degree of variability among stations within a single study site was high, and not always consistent with time.

The range of hydrocarbon concentrations was greatest at WD32E, and there were obvious indicators of petrogenic origin hydrocarbons at selected stations during some months. In a few instances at WD32E, analyte concentrations and summed PAH concentrations approached or exceeded the threshold level where negative impacts on

benthic infauna have been shown previously. Hydrocarbon concentrations, in general, however, were low for most study sites (even where sediments were silty) and were characterized as weathered petrogenic or biogenic in nature. In general, there were no consistent spatial or temporal trends in hydrocarbon chemistry at the three study sites.

There were significant and dramatic decreases in summer and fall in species richness and abundance of organisms at ST53A and ST53B (severe hypoxia), but a more gradual decline in benthic populations at WD32E (ephemeral hypoxia). The benthic communities at ST53A and ST53B were similar to each other with regard to taxonomic composition and changes in dominance of species through time; these communities were distinct from those of WD32E Differences in the benthic communities could be attributed to sediment characteristics and oxygen environments.

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