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STUDY TITLE: Ecological Investigations of Petroleum Production Platforms in the Central Gulf of Mexico

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BACKGROUND: The Outer Continental Shelf (OCS) Environmental Studies Program of the Bureau of Land Management (BLM) was designed to provide information to assess the environmental impact of OCS oil and gas production activities. Because the northwestern Gulf of Mexico supports the greatest amount of these activities of any region of the United States, identification of possible long-term environmental impacts within this region was anticipated. As past BLM studies had shown baseline conditions in prospective lease areas, a study of the physical, chemical, and biological features of the Louisiana OCS was designed to provide a better understanding of the fates and effects of previous development discharges. This knowledge would subsequently be available to better monitor drilling activities on the OCS. With this goal in mind, a

multidisciplinary study of the impacts of petroleum production platforms in the central Gulf of Mexico was initiated.

OBJECTIVES: (1) To determine the distribution and concentration of petroleum hydrocarbons, selected trace metals, and drilling-related substances in surficial sediments and tissues of important benthic and demersal species; (2) to examine the microbial hydrocarbon degradation and nutrient cycling processes and related nutrient chemistry in surficial sediment; (3) to compare benthic communities, with emphasis on selected "indicators," in the immediate vicinity of platforms with those at control sites; (4) to examine the distribution and persistence with depth in sediments of petroleum hydrocarbons, selected trace metals, and drilling-related substances; and (5) to investigate the biofouling communities and artificial reef effect associated with selected platforms representing a variety of production types and durations.

DESCRIPTION: Twenty-four sites located from 5 to 115 km (3 to 73 mi) from shore and extending from the west shore of the Mississippi Delta (89°32'W long) to a line south of Marsh Island (91°44'W long) were studied for long-term cumulative effects of petroleum production. Four primary study platforms and four control sites were visited in May 1978, August/September 1978, and January 1979. Sixteen secondary platforms were sampled August/September 1978. At the four primary platforms, sampling stations were located along the four points of the compass at 100-, 500-, 1,000-, and 2,000-m distances. Secondary platforms were sampled only on a north transect.

Investigations at each site included collection of hydrographic data, analyses of sediment cores for grain size, hydrocarbons, and trace metals, and the study of marine life (attached fouling growth and fishes) associated with the platforms and the surrounding seafloor. A total of 560 8.0-cm^2 cores for meiofauna, 840 0.09-m^2 Smith-McIntyre grabs for macroinfauna, and 40 9.0-m otter trawls for macroepifauna and demersal fishes were collected in the three cruises. Additional data were collected by angling, scuba diving, and underwater television. Analyses of samples from selected stations included sediment clay mineralogical analysis for determination of barite and lead-210 (Pb^{210}) dating with metals and hydrocarbon analysis of sediments to chronologically order contaminants. Hydrocarbon concentrations in the water column, sediments, and organisms were determined using gas chromatography (GC) and confirmation of types were conducted using GC/mass spectrography. Atomic absorption spectrophotometry (AA) was used to determine concentrations of cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), nickel (Ni), lead (Pb), and zinc (Zn) in sediments and selected biological samples. Barium (Ba) and vanadium (V) were determined by neutron activation analysis.

SIGNIFICANT CONCLUSIONS: Analyses revealed increased levels of low molecular weight hydrocarbons in water, increased levels of high molecular weight hydrocarbons in sediments near platforms, and minor accumulations of hydrocarbons in platform-associated organisms. There was little evidence for trace metal contamination in sediments of the study area, but several metals (Ba, Cr, Cu, Pb, Zn) were elevated in sediments collected within 100 m of platforms. Microbial activity was determined to be highly variable, exhibiting no adverse effects to low oil concentrations. Overall, total

organic carbon, hydrocarbon, and trace metal concentrations did not result in ecologically-significant effects on benthic populations.

STUDY RESULTS: Hydrographic data indicated a region heavily influenced by runoff from the Mississippi River. During spring and summer, stratification and reduced dissolved oxygen concentrations in regions up to 45 km (28 mi) offshore and in water depths up to 27 m result in death or emigration of much of the bottom fauna. Observations following tropical storm "Debra" (August 1978) suggested that storms may mix bottom sediments and help to restore healthy bottom water conditions where summer stratification and oxygen depletion occur.

Sediments were generally dominated by terrigenous silts and clays with coarser sand only present in residual sand bars or near shore. Clay mineralogy of sediment samples collected greater than 500 m from production platforms revealed no evidence of Ba or sodium montmorillonite (drilling fluid minerals), suggesting that long-term accumulation of drilling material from sediments was not possible. Pb^{210} analysis showed large variations, and no indication of increasing age with depth.

Analysis of hydrocarbon samples showed: (1) elevated levels of low molecular weight hydrocarbons in the water columm; (2) sediment total organic carbon levels within the normal range of other Gulf of Mexico areas; (3) evidence of long-term high molecular weight hydrocarbon contamination in sediments over the entire study area with increased contamination near some platforms; and (4) little accumulation of hydrocarbons evident within the animal tissue of those organisms studied near platforms. No biological effects were identified even though the study area is the recipient of a considerable amount of industrial chemicals from various sources.

Due to high natural variability and the low numbers of individuals collected, the data for trace metals in organisms were of limited value. Surficial sediment trace metal concentrations did not show strong evidence of contamination from the platforms, though within 100 m of some platforms elevated levels of some metals (Ba, Cr, Cu, Pb, and Zn) were observed. All levels were determined to be below that of public concern and no evidence of bioaccumulation was observed.

Microbiology studies showed: (1) microbial counts of high variability, though trends toward increasing activity appeared with movement eastward toward the Mississippi River; (2) many environmental factors potentially influenced the oil degrading potential of sediments and the resulting variability prevented predictions from the existing data base; (3) no adverse effect of low levels of oil on any reasonably active microbial process; and (4) variability of inorganic nutrient levels in sediments between sites precluded identification of trends. Histopathology investigations showed highest numbers of tissue abnormalities within fishes closely associated with platforms (spadefish and sheepshead). Conclusions were difficult to draw due to high variability in the data and lack of fish collection from control sites.

Reviews of the extensive statistical evaluation of the benthic population data (1,029 taxa) and of the interrelations with all biotic and abiotic factors were given. The major

conclusions drawn from the benthic population data were: (1) the physical environment (governed predominantly by the Mississippi River) was a major influence to population levels; (2) in general, total organic carbon, hydrocarbons, and trace metal concentrations did not have ecologically significant effects, even though total hydrocarbon amounts at six sites and average sediment trace metal concentrations were greater than previously reported as detrimental to benthic populations; and (3) tropical storms, hypoxic bottom conditions, and chronic contamination from the Mississippi River cause serious effects that mask any platform related effects.

Survey of biofouling and fishes associated with platforms resulted in the classification of platform habitats offshore Louisiana into three zones by depth and faunal characteristics. Coastal platforms (shore to 7-m bottom contour) were dominated by barnacles and shorefishes. Offshore platforms (37 to 64 m) supported bivalves and shorefishes and some Caribbean fauna, while the Blue Water Zone Platforms (>64 m) were dominated by Caribbean fauna. Results documented that offshore platforms provide otherwise severely limited hard substrate which concentrates epibiota and fishes. Evidence of detrimental effects of produced water discharges on platform macroepibiota was reported.

STUDY PRODUCTS: Bedinger, C. A., Jr. 1981. Ecological Investigations of Petroleum Production Platforms in the Central Gulf of Mexico. A final report by Southwest Research Institute for the U.S. Department of the Interior, Bureau of Land Management Gulf of Mexico OCS Office, New Orleans, LA. Vol. Ia - NTIS No. PB82-167784; Vol. Ib - NTIS No. PB82-167792; Vol. Ic - NTIS No. PB82-167800; Vol. Id - NTIS No. PB82-167818; Vol. II - NTIS No. PB82-167826; Vol. III - NTIS No. PB82-167834; Set - NTIS No. PB82-167776. Contract No. AA551-CT8-17. 1,782 pp.