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STUDY TITLE: Georges Bank Monitoring Program: Benthic Infauna.

REPORT TITLE: Georges Bank Benthic Infauna Monitoring Program: Final Report for the Third Year of Sampling. Vol. 1, Final Executive Summary; Vol. 2, Final Report; Vol. 3, Appendices.

CONTRACT NUMBER(S): BLM: CT2-07; MMS: 14-12-0001-29192.

SPONSORING OCS REGION: Atlantic.

APPLICABLE PLANNING AREA(S): North Atlantic.

FISCAL YEAR(S) OF PROJECT FUNDING: 1982; 1983; 1984.

COMPLETION DATE OF REPORT: April 1985.

COST(S): FY 1982: $2,158,359; FY 1983: $1,007,127; FY 1984: $832,530; CUMULATIVE PROJECT COST: $3,998,016.

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KEY WORDS: North Atlantic; fates and effects; infauna; epifauna; benthos; sediment; grain size; benthic photographs; seasonality; community; exploratory drilling; drilling discharges; monitoring; survey; trophic dynamics; life history; multivariate statistics; Georges Bank; Oceanographer Canyon; Lydonia Canyon; Atlantic Region.

BACKGROUND: The Georges Bank is one of the most productive commercial fishery areas in the world. In addition, the underlying geologic structures of the Georges Bank region are of the type that may contain substantial reservoirs of petroleum and/or natural gas. It was recognized that potential conflicts may arise between commercial fishing interests and the petroleum industry in the utilization of the varied natural resources of the Georges Bank environment. Because of these concerns, a Biological Task Force (BTF) for Lease Sale 42, which encompassed Georges Bank, was established. One purpose of the BTF was to design environmental studies and monitoring programs to detect the possible early warning signs of environmental deterioration on Georges Bank. The Georges Bank Benthic Infauna Monitoring Program, one portion of a multidisciplinary monitoring program recommended by the BTF, was implemented to meet these goals. This report provided the results of the third year of benthic sampling on Georges Bank.

OBJECTIVES: (1) To link the fate of discharges (i.e., primarily drilling fluids and cuttings) from oil and gas exploratory operations in the Lease Sale 42 area to effects on benthic species and communities; (2) To determine the quantities, the physical characteristics, and the chemical composition of materials discharged during drilling operations; (3) To estimate where discharged materials accumulate and in what concentrations; (4) To measure the existing background levels of contaminants in the sediments and biota and what levels above background can be detected with existing technology; and (5) To determine whether benthic populations change at selected regions on Georges Bank during various stages of oil and gas activity and to relate these changes to pollutant levels associated with discharges.

DESCRIPTION: A total of twelve cruises were made to the study area over a period from July 1981 to June 1984. The study program included intensive sampling of soft bottom benthic communities collected near, upcurrent, and downcurrent of drilling rigs, analysis of bottom photographs for epifauna and microtopography, dredge and trawl collections, and total organic carbon and sediment grain-size analyses. Sampling station locations were established to determine both near-rig and regional

environments impacts. Collections of six replicate infaunal samples at each of 46 stations were made on a seasonal basis. A 0.04 m^2 modified Van Veen grab sampler was used to collect infaunal samples which were live sieved through nested 500- and 300-μm screens. Subsamples of the infaunal grab samples were taken for CHN and grain size analyses. Three replicate 0.1-m^2 Van Veen samples of undisturbed bottom sediment were also collected at each station for chemistry analysis. Twenty-nine of the 46 total stations were located in a tight radial array around an exploratory drilling rig positioned at a water depth of 80 m in Block 312. A second group of three stations was located in proximity to a second exploratory drilling site positioned at a water depth of 140 m in Block 410 to determine near-field impacts; stations were located from 200 to 2,000 m up and down current from the drilling rig in Block 410. Remaining stations were positioned over a broad expanse of the Bank and within areas of potential drilling mud deposition, including stations at the head of Lydonia and Oceanographer Canyons. In the laboratory, each benthic sample was resieved through nested 500- and 300-μm screens, transferred to 70% alcohol, and stained with rose bengal. Biological specimens within each sample were then sorted to into basic taxonomic groups and identified to the lowest possible taxon. Wet biomass was variably determined separately for each species (i.e., wet weights were determined for all species from all samples collected during the first eight cruises; wet weights were taken from only a portion of the samples collected during the last four cruises). Statistical techniques included agglomerative clustering, similarity analysis by the Normalized Expected Species Shared (NESS) and Bray-Curtis techniques, and Shannon-Wiener diversity calculations. Hurlburt's modification of the rarefaction method was used to predict the number of species in a random sample without replacement. If available, six frames from each station per cruise were analyzed for microtopographic features and densities of visible epifauna. Additional aspects of the program, implemented following the first year effort, included a detailed life history analysis of 23 dominant benthic species, and a study linking fish feeding with benthic production. Life history parameters were determined for a suite of 19 polychaete, three amphipod, and one echinoderm species. For each species, size-class frequency distributions were calculated. Yellowtail flounder (Limanda ferruginea) were collected for gut content analysis as part of the benthic feeding component. Length frequency measurements were made on polychaetes and amphipods contained within the stomachs of collected fish, then compared to similar measurements made on benthic infauna.

SIGNIFICANT CONCLUSIONS: Little heterogeneity was found in the benthic communities of Georges Bank, based on an analysis of stations with good replication data. A strong relationship between faunal composition and sediment type and depth was indicated by cluster analysis. Little seasonal variation was observed although cluster and correspondence analyses suggested some annual differences. A large portion of the variation in the abundance of several amphipod species could be explained by recruitment and mortality. However, patterns in the density of polychaete species were more difficult to explain. Dominance remained fairly constant at each station over the three-year period. Biomass varied over time and space, and a significant increase was observed at some stations between the first and second years. Depth-related patterns of microtopography were revealed by bottom photographs, and confirmed the patchy distribution of the sand dollar, Echinarachnius parma. Sediment grain size and total organic carbon were correlated with sandy sediments having values below 0.20%. Predominantly silt-clay sediments had markedly higher values. Although eight wells had been drilled in the study area, no biological impacts which could be attributed to drilling activities were detected at any station. This was true also for the site-specific array in Block 312 and the three stations in Block 410.

STUDY RESULTS: Biological patterns in benthic infauna were similar throughout the three years of the monitoring program. There was little seasonal change in the numbers of species and benthic community structure at any station. Benthic composition was homogeneous at stations at or deeper than 100 m, and it was possible to resolve subtle differences between years. Replicate samples from any of the regional stations were more similar to each other than to replicates from other stations. Distinct communities were found at each station. Annual and spatial variations in biomass were observed among stations. During the first and second years of the program, there was a significant increase in biomass at some stations. Clams (ocean quahog, Arctica islandica) and sand dollars (Echinarachnius parma) dominated the biomass when they were present. When clams and sand dollars were not present, polychaetes and

arthropods dominated. Altogether, 372 species of polychaetes were identified and accounted for 38.8% of all taxa. Arthropods made up 19.7% of the identified taxa, with amphipods being the largest group. Molluscs accounted for 15% of the identified species. Overall levels of wet-weight biomass were similar to estimates from other studies. Mean ash-free dry weight biomass for all cruises varied from 1.38 to 23.86 g/m^2. Bottom photographs found well-defined ripples to be present most of the year on the 60-m contour. Along the 70- to 80-m depth contour, seasonal differences in ripple patterns were noted. Little rippling of sediments was observed at 100 m. The bottom photographs also corroborated the patchy distribution of E. parma as suggested by the grab sample analyses. In Block 312, where drilling took place from December 1981 until June 1982, there was no statistical correlation between benthic infaunal community parameters and an increase in barium concentrations in surface sediments or percent silt-clay in sediments. There was, however, a high correlation between community parameters and percent fine sand. This was particularly evident at two stations west of the drilling site where species composition was different from other stations in the area. These two stations also had higher proportions of fine sand. The results indicated that the discharges of drilling fluids and cuttings did not have a measurable impact on the benthic fauna. Similarly, fluctuations in the numbers of individuals per grab sample were attributed to seasonal patterns. There was no indication that a small accumulation of petroleum hydrocarbons (<0.5 ppm) in the sediments had a measurable effect on the infauna. These results were also true for Block 410, where no measurable impact was detected after analysis of 12 seasonal samples collected from the drilling site. Variations in abundance for three amphipod species and one echinoderm species could be explained on the basis of recruitment, mortality, and adult migration. Polychaete variability was more difficult to interpret where four species were found to reproduce year-round; eleven species showed reproductive activity during all or part of an extended period; and two species reproduced during the winter-spring period. Demersal fish were found to consume a significant fraction of the annual production of benthic amphipods on Georges Bank, documenting the importance of benthic infauna in supporting the commercial fishery. Yellowtail flounder fed primarily on macrobenthic species although the dominant prey species varied seasonally and between species. The flounder appeared able to adapt to changes in the abundance of their preferred prey species. Medium to fine sand predominated in the sediments of the Bank. Finer size classes increased with depth, along a regional gradient from northeast to southwest, on seasonal and two- to three-year time scales. Increases in fine sediments over time may be due to biological processes and/or an analytical artifact (e.g., successive sampling along a local gradient). Drill cuttings were observed at the drill sites in Blocks 312 and 410. The concentration of barium in the upper 2 cm of sediment increased by a factor of 5.7 in Block 410 between pre- and post-drilling samples. In Block 312, the largest increase was 4.7 fold within 200 m of the drilling site. Total organic carbon and sediment grain size were related. In sandy areas, organic carbon values were <0.20%. Finer, predominantly silt-clay sediments which were indicative of net depositional areas, had markedly higher percentages of organic carbon. Carbon content also tended to increase with depth. Previous studies had suggested that benthic macrofaunal communities may be important in maintaining bottom sediment stability during a storm. The present study found little effect from such storms on the benthic macrofauna. Despite the erosion of sediments and the disappearance of the surface biological mat, benthic populations did not show a sharp decline during the 1980-1982 winter periods. Eleven stations sampled during this study had been previously monitored during a 1977-1978 benchmark study on Georges Bank. The dominant species from the 1977-1978 samples generally agreed with the dominant species from the present study. However, average density of individuals was higher in the current monitoring program samples, even when only individuals retained on the 0.5-mm screen were compared.

STUDY PRODUCT(S): Maciolek-Blake, N., J. F. Grassle, and J. M. Neff (eds.). 1985. Georges Bank Benthic Infauna Monitoring Program: Final Report for the Third Year of Sampling. Vol. 1, Final Executive Summary; Vol. 2, Final Report; Vol. 3, Appendices. A final report by Battelle New England Marine Research Laboratory and Woods Hole Oceanographic Institution for the U.S. Department of the Interior, Minerals Management Service Atlantic OCS Region, Vienna, VA. Vol. 1 - NTIS No. PB89-220701; Vol. 2 - NTIS No. PB89-220719; Vol. 3 - NTIS No. PB89-220727. Contract No. 14-12-0001-29192. vii + 38 pp. (Vol. 1); xix + 333 pp. (Vol. 2); iii + 240 pp. (Vol. 3).

ACCESS NUMBER: **29192.3**

The entire set of final reports for Years 1 through 3 is available in NTIS No. PB89-220693.

A reference biological specimen collection and benthic photographs are maintained by Battelle New England Marine Research Laboratory, Duxbury, Massachusetts.

*P.I.'s affiliation may be different than that listed for Project Manager(s).