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KEY WORDS: North Atlantic; biology; slope; rise; chemistry; geology; benthos; trace metals; hydrocarbons; sediment; grain size; survey; epifauna; infauna; hydrography; gas chromatography; spectroscopy; abundance; diversity; multivariate statistics; colonization; photographs; recovery; Atlantic Region.

BACKGROUND: Operations associated with oil exploration and production in the U.S. North Atlantic region represent a broad spectrum of potential impacts to marine ecosystems. Adverse effects to biological communities on the continental slope and rise cannot be quantitatively assessed without first establishing an adequate background data base (i.e., baseline) which characterizes these communities prior to any resource-related activity. The baseline studies of submarine canyons and non-canyon areas herein documented pre-perturbation environments prior to possible man-made changes. This report represented results of a two-year field study funded by the U.S. Department of the Interior, Minerals Management Service.

OBJECTIVES: (1) To characterize biological, geological, and chemical properties of the benthic environment, at various depths, within potential oil and gas development areas on the U.S. North Atlantic continental slope and rise; (2) To monitor potential changes in these properties, determining the natural extent of spatial and temporal variations; and (3) To estimate recovery rates of deep-sea benthic communities following perturbation.

DESCRIPTION: Fourteen stations near the U.S./Canadian border to south of Rhode Island (41°N Lat, 66°W Long to 39°N Lat, 70°W Long) were established along four across-slope transects situated east to west. Water depths ranged from 225-2,155 m. Stations were sampled six times during a two-year period (i.e., November 1984 to July 1986). Temporal and spatial variations in epifaunal and infaunal communities were studied using a variety of methods, including camera transects, crab traps, bottom trawls, and box corers. Data were interpreted using various statistical analyses (i.e., cluster, ordination, rarefaction curves, Shannon-Wiener diversity index, and others). Sediment textures and chemistry were examined from box core samples. Infaunal recolonization rates were measured from trays deployed for 7- or 14-month periods. Hydrocasts of Niskin bottles were employed to determine water quality at representative sites. Trace metals and hydrocarbons were examined in two species: the common brittle star Ophiomusium lymani and red crab Geryon quinquidens, the latter being of commercial importance.

SIGNIFICANT CONCLUSIONS: Continental slope and rise fauna of the U.S. North Atlantic region were characterized by a highly diverse, but poorly known communities of epifaunal and infaunal organisms. Faunal community structure was affected by water depth, sediment texture, currents, and east-west gradients. Upper slopes had greatest infaunal densities but mid-slopes were most diverse. Epifaunal diversity and densities were highest along the easternmost transect. Recolonization rates were very low, suggesting that perturbations would be long-lasting.

STUDY RESULTS: The overall infaunal diversity of the U.S. North Atlantic continental slope and rise region was high. A total of 1,019 species were collected from 191 box core samples, with >50% (i.e., 531 species) of the fauna being previously undescribed. Annelids dominated, accounting for 45% (i.e., 435 species) of the total infauna. Important polychaete families included Spionidae, Ampharetidae, Paraonidae, Cirratulidae, and Dorvilleidae. The polychaete Aurospio dibranchiata was a dominant at deep stations (2,100 m). Arthropods represented 23% of the total fauna by abundance, with important orders being Isopoda, Amphipoda, Tanaidacea, and Cumacea. Molluscs, represented primarily by classes Bivalvia, Gastropoda, Aplacophora, and Scaphopoda, accounted for 15% (by abundance) of all infaunal species collected. The aplacophoran mollusc Prochaetoderma yongei was a co-dominant with the sipunculan Aspidosiphon zinni at mid-slope stations (i.e., 1,220-1,350 m water depths).

Infauna changed along depth and sediment texture gradients. Upper slope sites between 225 and 550 m, where sediments were course and currents were presumably high, exhibited the most distinct communities. Upper slope infauna were dominated by polychaetes and exhibited the highest infaunal densities encountered (i.e., mean >19,000 individuals/m^2). Mid-slope stations, located at water depths between 1,200 and 1,350 m, showed high infaunal diversity characterized by an abundance of large-bodied sipunculans and aplacophoran molluscs. The mid-slope was characterized by fine sediments containing high levels of organics and nitrogen. Lower slope sites (i.e., at 2,100 m) revealed an infauna dominated by small polychaetes; sediments were fine to medium-course.

Epifauna varied along depth and east-west gradients. Diversity was nearly twice as high (i.e., 83 species) at the easternmost station as compared to the westernmost site, where 42 species were noted. Densities peaked on lower slopes (water depths: 1,800-2,000 m) at both east and west transects (7 and 5 organisms/m^2), respectively). Secondary peaks in species diversity were noted in the eastern portions of the study area at 1,100 m (>5 organisms/m^2), and in the western portion at 550 m (5 organisms/m^2)]. Along the east-west gradient, mid-slope variance was highest, there being no difference among deepest stations. Comparisons along depth gradients showed that changes in community structure were most pronounced along mid-slopes. Important upper slope taxa included hard corals Dasmomilia lymani and Flabellum alabastrum, and the polychaete quill worm Hyalinoecia artifex; the most common fishes were rat-tails (Nezumia spp.). Mid-slopes along the U.S./Canadian border were dominated by three octocorals, Acanella arbuscula, Anthomastus agassizii, and Eunepthya florida; the most common fishes were deep-sea eels (Synaphobranchus spp.). However, along the mid-slope western transect, these species were replaced by several fish species and the red crab Geryon quinquidens. Lower slopes were dominated by the brittle star Ophiomusium lymani, cerianthid anemones, the sea urchin Echinus affinis, and the sea pen Distichoptilum gracile; most common fish was the rat-tail Coryphaenoides carapinus.

Significant differences in upper slope canyon versus non-canyon biota at 550 m were probably related to higher currents in the canyon. Only minor differences were seen in mid-slope gully versus non-gully biota (water depth: 1,200 m). Although there were minor time-related differences in the infaunal community, the epifauna was temporally stable. Experiments to measure rate of recolonization of defaunated sediments over 7- and 14-month periods showed that rates were very low and were in agreement with previous studies.

Chemical analyses of sediments showed that mid-slope sediments were fine grained and in comparison to deeper stations, had higher percentages of total hydrocarbons (i.e., 14-22 µg/g dry weight). Low levels of hydrocarbons were found in the brittle star Ophiomusium lymani (30-55 µg/g wet weight) and in the red crab Geryon quinquidens (6-12 µg/g wet weight). However, aluminum and iron content was high in

the brittle star, probably due to ingested sediments; copper content in the crab was high due to normal concentrations in its blood.

STUDY PRODUCT(S): Maciolek, N., J. F. Grassle, B. Hecker, B. Brown, J. A. Blake, P. D. Boehm, R. Petrecca, S. Duffy, E. Baptiste, and R. E. Ruff. 1987. Study of Biological Processes on the U.S. North Atlantic Slope and Rise. Vol. 1, Executive Summary; Vol. 2, Final Report. A final report by Battelle Ocean Sciences, Woods Hole Oceanographic Institution, and Lamont-Doherty Geological Observatory of Columbia University for the U. S. Department of the Interior, Minerals Management Service Atlantic OCS Region, Vienna, VA. Vol. 1 - NTIS No. PB88-196522; Vol. 2 - NTIS No. PB88-196514/AS. MMS Report 86-0051. Contract No. 14-12-0001-30064. ix + 41 pp. (Vol. 1); 362 pp. + app. (Vol. 2).

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