SOUTH ATLANTIC OCS
BENCHMARK PROGRAM
1977 REPORT

VOLUME 1
EXECUTIVE SUMMARY

RETURN TO:

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VOLUME 1
EXECUTIVE SUMMARY

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EXECUTIVE SUMMARY

The fabric and nature of modern society is rooted in the intensive use of energy resources; foremost among these is petroleum. Easily accessible domestic petroleum deposits have long since been exploited and, although significant reserves still exist, their recovery has become increasingly difficult. As a result, U.S. petroleum demands have been satisfied through importation of formerly inexpensive foreign oil. In recent years, our petroleum use has greatly exceeded domestic production and our growing dependence upon unreliable external sources has decreased the strength of the U.S. dollar and increased balance-of-payment disparities. Now, impending energy shortages emphasize the need for increased domestic production.

In the face of the current economic climate and energy demands, the Continental Shelf areas of the United States have emerged as a major potential source of petroleum. The Outer Continental Shelf (OCS) Lands Act of 1953 charged the Secretary of the Interior with managing the economic development of those Continental Shelf lands beyond the area of state jurisdiction. This responsibility was expanded by the National Environmental Policy Act (NEPA) of 1969, which specified that exploration for and exploitation of shelf resources must be accomplished in a manner that will preserve the integrity of the environment. Pursuant to these goals, the Bureau of Land Management (BLM), an agency of the Department of the Interior, established the Outer Continental Shelf Environmental Studies Program (OCSESP). The program was originally designed to include four phases that would provide the information upon which management decisions facilitating development of shelf resources and protecting the environment could be based:

- Review and summary of present information as a basis for further decisions and study designs
- Multidisciplinary baseline studies of predevelopment characterization of the environment
- Special studies designed to answer specific questions
- Environmental monitoring to detect changes as a result of the development and exploitation of the Outer Continental Shelf region.

In November 1976, BLM contracted with Texas Instruments Incorporated (TI) to perform the South Atlantic Outer Continental Shelf Benchmark Program (SABP) during 1977 as part of the environmental studies planned for that area. The SABP study area was in the Georgia Bight off the coasts of North Carolina, South Carolina, Georgia, and northern Florida between Cape Fear, North Carolina, and Cape Canaveral, Florida (Figure 1.1).

The first-year goals of the SABP were to:

- Initiate seasonal studies to determine the concentration ranges of high molecular weight (HMW) hydrocarbons and selected trace metals in the sediments preceding oil and gas development
- Initiate seasonal studies to determine the existing ranges of HMW hydrocarbons and trace metal concentrations in selected benthic macrofaunal species preceding oil and gas development
Figure 1.1. SABP Study Area and Sampling Stations
Initiate quantitative seasonal studies of benthic infaunal (>500-µm) communities, meiofaunal (62- to 500-µm) communities, and foraminiferal populations to determine the natural ranges of selected parameters.

Initiate histological studies to determine the tissue condition of selected benthic macrofaunal species preceding oil and gas development.

Describe seasonal variations in the concentrations of HMW hydrocarbons and selected trace metals in the water column.

Enumerate heterotrophic and hydrocarbon-oxidizing microorganisms; identify dominant microbial species in the surface microlayer film, near-surface water, and sediments and evaluate the oil-degrading potential of these organisms; and examine the relationship between oil concentration and the ratio of hydrocarbon-oxidizing microbes to aerobic heterotrophic microbes.

Collect samples and perform analyses in support of benchmark data interpretation and collect samples and data in support of the South Atlantic study programs conducted by the U.S. Geological Survey (USGS) and the physical oceanography contractor (Science Applications, Inc.).

Data in support of these goals were collected during four seasonal oceanographic cruises in the study area and subsequent laboratory analyses. The results of these efforts provide a benchmark for the South Atlantic/Georgia Bight region which is summarized in the following pages.

On the basis of hydrographic, sedimentary, and biological characteristics, the Continental Shelf region of the Georgia Bight was broadly divisible into a narrow inshore region, a broad midshelf region, and the outer-shelf/upper-slope region. A special habitat type, the hard bottom, occurred where rock outcrops are exposed in the mid- and outer-shelf areas.

The nearshore area of the shelf, which receives the continental organic and inorganic nutrient outfall, is a relatively narrow band (≤20 km) shoreward from a pronounced and relatively stable density demarcation. The great majority of runoff materials appeared to be retained in this nearshore zone, resulting in relatively high silt/clay fractions in the sediments and nutrient conditions favorable to biological activity. Beyond the density demarcation, the midshelf region (most extensive of the three habitat zones) was characterized by general nutrient impoverishment and a coarse, well-sorted sand substrate that was subjected to considerable scouring and sediment transport. The outer-shelf/upper-slope zone was beyond the major effects of scouring because of its greater depth, and the silt/clay content of its sediments was intermediate between the nearshore and midshelf regions. It showed the effects of periodic enrichment by the intrusion of deep, nutrient-laden Gulf Stream waters. While distinctly related on the basis of general characteristics, the stations sampled in the outer-shelf/upper-slope zone showed much less similarity to each other than did the stations in the nearshore and midshelf zones.

Biological community structure in the Georgia Bight was keyed to the hydrographic and sedimentary conditions of the shelf. Zooplankton density observed over the South Atlantic OCS area was intermediate between that reported for the shelf and slope zones in other geographic areas; abundance peaked during the summer. Copepods dominated plankton samples taken in
both the 202-µm and 505-µm nets (59% and 35% of total numbers, respectively); *Parvocalanus* and *Undinula* dominated the fine- and coarse-meshed net samples, respectively. Chaetognaths, ostracods, decapods, gastropods, and urochordates were also important constituents of the plankton collectively representing 39% of total numbers in the 202-µm nets and 62% of the catch in the 505-µm nets. As measured by the Shannon-Weaver diversity index, the study area was one of high species diversity, particularly during summer.

There was no evidence of higher-than-normal trace metal concentrations at any sampling site in the Georgia Bight. Sediment trace metal concentrations in the midshelf zone were essentially homogeneous and showed no significant geographical or seasonal variation. Continental-slope concentrations of chromium, iron, nickel, and zinc were in most cases 2 to 4 times higher than those of the shelf and varied more between stations; trends were not as clearcut for cadmium, copper and lead. Trace metal concentrations in epibenthic invertebrates and demersal fish varied, as would be expected, within and between species. However, a discernible pattern in tissue concentration indicated that the data will provide an acceptable benchmark for later studies. Water-column cadmium, chromium, and nickel concentrations throughout the area were below lower detection limits, of approximately 0.038, 0.063 and 0.2 µg/l, respectively. Copper (0.60 to 12.5 µg/l), iron (9.7 to 41.0 µg/l), lead (0.017 to 2.1 µg/l) and zinc (3.78 to 33.3 µg/l) concentrations were higher than expected, probably due to low levels of contamination inherent to the analytical procedure.

Sediment concentrations of high molecular weight hydrocarbons, like those of trace metals, showed little variation between stations or seasons. Throughout the study area, petroleum hydrocarbons were at or below the lower limits of detection. Invertebrate and demersal fish tissue concentrations varied between species as a function of metabolic divergence. Gas-liquid chromatographic determination of unresolved complex mixtures of hydrocarbons is generally accepted as evidence of petroleum; the absence of such mixtures from the tissues of Georgia Bight organisms indicates that the animals tested were not contaminated with petroleum hydrocarbons.

No seasonal variations were observed in concentrations of dissolved high molecular weight hydrocarbons. Average winter and spring concentrations of particulate hydrocarbons (0.50 and 0.75 µg/l) were higher and significantly different from those in summer and fall (0.15 and 0.10 µg/l); but they were low compared with those in other shelf regions and revealed little or no evidence of the presence of petroleum hydrocarbons.

The dynamics of benthic community structure on the shelf varied with physical factors (temperature, depth, sediment texture) as well as with population factors (natality, mortality, recruitment, migration). Generally, there was north-south homogeneity, with marked cross-shelf zonation, correlating with changes in hydrographic conditions and depth.

In general, benthic species diversity was quite high in the study area. Although community assemblages were characteristic in the nearshore and mid/outer-shelf zones, no single meiofaunal, macroinfaunal, or invertebrate epifaunal species or small group of species could be considered to be dominant. The foraminifera *Elphidium excavatum* forma *clavatum* and *Ammonia beccarii* dominated the nearshore zone, while *Bolivina lowmani* dominated in the mid/outer shelf region. No dominant foraminiferan was determined on the upper slope. Nearshore demersal fish catches were dominated by members of the drum family (spot, drum, kingfish, sea trout, croaker). The
spotted hake was present in high numbers inshore during the winter. The mid/outer-shelf area was dominated by demersal fishes characteristic of sand bottoms (sand perch, scup, dusky flounder, offshore lizard fish). There was no indication of species dominance or community continuity between stations on the upper continental slope. Disjunct communities of demersal fishes (e.g., tomtate, black seabass, butterfly fish, and angel fish) were associated with hard-bottom outcroppings in the middle-shelf region and along the shelf break. Seasonal changes in both density and community composition were observed in the macroinfaunal and demersal fish but not the meiofaunal or foraminiferan communities. Seasonal density and species composition changes in the epifaunal invertebrate communities of the various strata were indicated but were not as clearly discernible as those found for the macroinfaunal and demersal fish communities.

Animal parasites, especially the flatworms; lesions of unknown etiology; and bacterial infections were relatively common in the fishes and invertebrates examined. While the incidence of parasitic infestation was often high (e.g., 80 to 100 percent), structural and functional changes in responses to parasitic infestation were minimal; only a few individuals with extensive trauma were observed. Seasonal variation in the incidence of parasitic infestation was indicated, but there was no correlation with location. Overall, the degree of histopathology observed was consistent with a normal, unstressed community of benthic invertebrates and fishes.

Heterotrophic and hydrocarbon-oxidizing marine bacteria were cultured from the surface microlayer, near-surface water, and sediments of the Georgia Bight. Hydrocarbon-oxidizing forms were present at all stations sampled and the hydrocarbon-to-heterotrophic ratio ranged from a low $8.0 \times 10^{-6}$ hydrocarbon forms per heterotroph to a high in which hydrocarbon oxidizers appeared to outnumber heterotrophs by 2.3 to 1. In general, the water column showed higher relative populations of hydrocarbon oxidizers to heterotrophs than did the sediments. Seasonal variations in numbers of hydrocarbon-using bacteria paralleled changes in high molecular weight hydrocarbon concentrations at the same stations. Bacterial density was inversely proportional to distance from shore.

Cultures of Georgia Bight hydrocarbon-using bacteria were capable of degrading South Louisiana crude oil and decane. The degradation rate, while different for various mixed and pure cultures and regimes of phosphate and nitrate nutrient availability, clearly showed the ability of the microorganisms to respond to the addition of petroleum hydrocarbons at ambient laboratory temperature ($\approx 21^\circ$C). Cultures incubated at low temperatures ($9^\circ$C) showed no growth or cell proliferation.

The results on which this summary is based are organized into a six-volume report. Technical and managerial procedures and methodologies of the program are discussed in Volume 2. Volume 3 presents the results obtained by various principal investigators, and Volume 4 is an atlas of histology and histopathology. The results of the FY76 geological studies of the Georgia Bight performed by the USGS appear in Volume 5, and Volume 6 contains appendixes of data reports and statistical results which the principal investigators used in preparing their reports.