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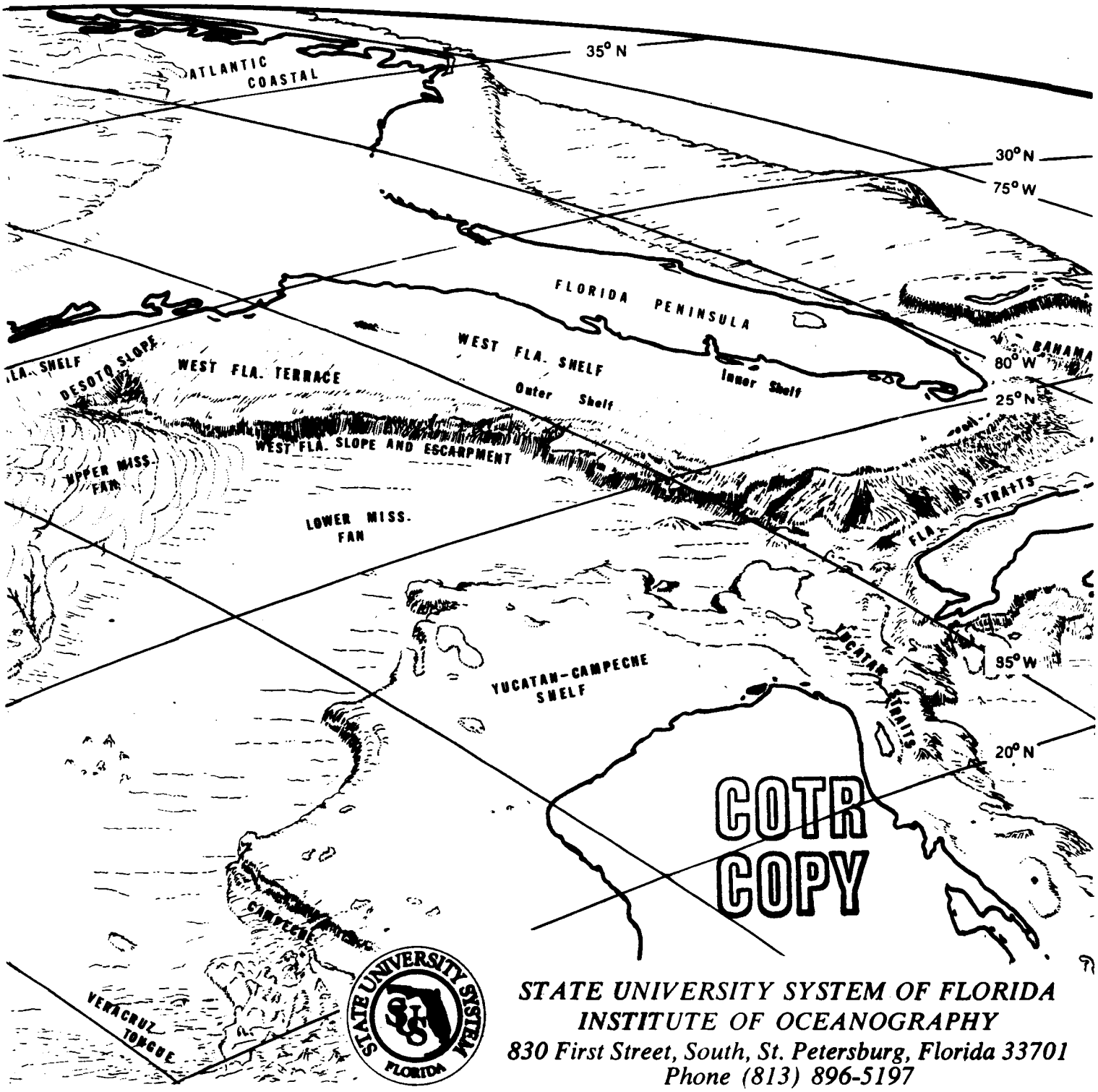
BASELINE ENVIRONMENTAL SURVEY OF THE MISSISSIPPI, ALABAMA, FLORIDA (MAFLA) LEASE AREAS CY 1974

FINAL REPORT

BLM CONTRACT NO. 08550-CT4-11



STATE UNIVERSITY SYSTEM OF FLORIDA
INSTITUTE OF OCEANOGRAPHY
830 First Street, South, St. Petersburg, Florida 33701
Phone (813) 896-5197

...rsity of Florida ...nesville · Florida State University Tallahassee · Florida A. & M. University Tallahassee · University of South Florida Tampa · Florida Atlantic University Boca Raton

...rsity of West Florida Pensacola · Florida Technological University Orlando · University of North Florida Jacksonville · Florida International University Miami

PREFACE

A FIRM FIXED PRICE CONTRACT, with a REIMBURSABLE EXPENSES portion included to cover costs of ship operations (BLM CONTRACT NO. 08550-CT4-11) was entered into on 8 May 1974 between the STATE UNIVERSITY SYSTEM OF FLORIDA, on behalf of the STATE UNIVERSITY SYSTEM INSTITUTE OF OCEANOGRAPHY (SUSIO) CONSORTIUM, and the U. S. DEPARTMENT OF THE INTERIOR, BUREAU OF LAND MANAGEMENT (BLM). The contract consisted of the Request for Proposal (RFP) 74-2 issued by BLM, the Contractor's proposal submitted in response to the RFP 74-2, and the resulting negotiated contract document with subsequent modifications. This document (ten copies) has been prepared for, and is submitted to, BLM as partial fulfillment of the terms of the subject contract; however, this FINAL REPORT constitutes the completion of the contractual obligations of the contract.

The State University System of Florida Institute of Oceanography (SUSIO), contained within the State Universities' governing body, the Board of Regents, is a coordinating office for interinstitutional oceanographic matters. The permanent professional staff is small. As such, for contracts with organizations outside of the State University System, SUSIO acts as the contracting and management body by further subcontracting with selected individuals through their respective organization, in order to assure the involvement of the most highly qualified people available to meet the requirements of the contract. To this end, professional and technical people from academia, government, and industry are utilized. Considerable success has been enjoyed in this approach of addressing large scale interdisciplinary programs--both in the advancement of scientific knowledge and in the application thereof.

The scientists (subcontractors) participating in this baseline survey of the eastern Gulf of Mexico are listed in the report.

FINAL REPORT

on the

BASELINE ENVIRONMENTAL SURVEY OF THE MAFLA LEASE AREAS

Submitted To

Bureau of Land Management
U. S. Department of the Interior
Washington, D.C.

In Accordance With

Contract No. 08550-CT4-11

Effective Date May 8, 1974

Submitted By

Florida Board of Regents Office

On Behalf Of

State University System of Florida
Institute of Oceanography Consortium

Date of Submission

15 March 1975

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I. SUMMARY OF BASELINE ENVIRONMENTAL SURVEY OF THE MISSISSIPPI, ALABAMA, FLORIDA (MAFLA) LEASE AREAS: CY 1974

A. Abridged General Area Description

The Gulf of Mexico is a semi-enclosed basin with a surface area of 1,540,000 square kilometers. On the north and east sides, the continental shelf makes up 22 percent (340,000 square kilometers) of this area and is covered by water shallower than 100 fathoms (180 meters). The continental slope, between 100 and 1,700 fathoms (180-3,060 meters), covers 20 percent (310,000 square kilometers), of the total area. Another 20 percent, below the depth of 1,700 fathoms, covers the Sigsbee and Florida plains. To the southeast are the two connections with other seas - the Straits of Florida with a sill depth of 475 fathoms (860 meters), and the Yucatan Channel, with a 1,120-fathom (2,000-meter) sill depth.

A comprehensive description of the water masses of the Gulf of Mexico, their interaction with the atmosphere, and circulation at the surface and at depths still remains to be compiled. However, the work that has been done to date indicates that a major current - the Loop Current - exists in the eastern Gulf and is the key to understanding and predicting general circulation patterns. The Loop Current enters the Gulf through the Yucatan Channel, moves in a clockwise loop and exits through the Straits, transporting one-third the volume of the Gulf Stream at rates of 1 to 4 knots. This transported volume is sufficient to fill the Gulf basin in 30 months. The Loop Current also

varies seasonally, can develop large eddies and influences the currents on the continental shelf.

The northeast continental shelf extends from the Mississippi Delta to the Dry Tortugas; it is in contact with major draining systems including the Mississippi discharge, the major rivers of Mississippi, Alabama and Florida and the very broad area of the Everglades. The water on the shelf is not only modified and changed by the interface of the Loop Current but also by the fluctuations in these draining sources. This shelf water is further modified by the influence of the tidal fluctuations and meteorological conditions. There are a number of important areas of enrichment by upwelling which further change the characteristics of the water masses.

The living and non-living marine and coastal resources of the eastern Gulf coast are important both economically and ecologically. The commercial and sport fisheries resources of the region are extensive and provide considerable income. Their value is great and is of significance not only to the region but to the nation.

The coastal zone of Florida contains approximately 800 miles of Gulf shoreline and 2560 miles of bay and estuary shoreline. It is characterized by either high energy sand beaches with accompanying developed or developing recreational and related entrepreneurial activities or low wetlands that are extremely valuable in terms of biological productivity.

B. State University System of Florida Institute of Oceanography (SUSIO) Consortium

A consortium of investigators from public and private institutions and agencies having special interests and expertise in the Gulf of Mexico Region has been coordinated and managed by the State University System of Florida Institute of Oceanography (SUSIO) in the performing of the Baseline Environmental Survey of the MAFLA Lease Areas.

In addition to the scientists participating in this contract in a formal manner as subcontractors, cooperation and/or liaison was coordinated with appropriate scientific agencies and individuals from state and federal governments.

Participation in the scientific aspects of this program includes the following discipline studies, Principal Investigators, and organizations, hereinafter referred to as the SUSIO Consortium:

DISCIPLINE STUDIES	DESCRIPTIVE TITLE	PRINCIPAL INVESTIGATOR
Water Column	Biota	
Phytoplankton	Phytoplankton Analysis	R. L. Iverson/FSU R. A. Woodmansee/GCRL
Zooplankton	Zooplankton Analysis	F. J. Maturo, Jr./UF R. A. Woodmansee/GCRL
Microbiological Biomass	Microbial Biomass (Water Sediment)	P. A. LaRock/FSU
Sample Collection and Training	POC/DOC	G. A. Knauer/FSU
Water Column	Chemistry	
Hydrocarbons	Water & Plankton Suspended Particulates	J. A. Calder/FSU R.H. Pierce/U So.Miss.

	Dissolved Hydrocarbons	W. M. Sackett/TAMU
	Dissolved Hydrocarbons	D. R. Schink/TAMU
Trace Metals	Zooplankton/ Particulate	P. R. Betzer/USF
	Dissolved	D. A. Segar/NOAA/AOML
Nutrients	Micronutrient Analysis	K. A. Fanning/USF
Benthos	Geology	
Sediment Geology		L. J. Doyle/USF
		T. V. Mayou/USF
	Carbonate Bottom Sediments	H. R. Wanless/UM
Benthos	Biota	
Histopathology/ Archiving	Macroinvertebrates	N. J. Blake/USF
Bottom Photography Remote	Bottom Photography	T. E. Pyle/USF
Benthic Epifauna/ Scientific Divers	Epifauna and Flora	T. S. Hopkins/UWF
Benthic Infauna	Polychaetes	B. A. Vittor/UA
	Polychaetes, Biomass	H. Kritzler/FSU
	Foraminifera	W. D. Bock/UM
	Micromolluscs	D. R. Moore/UM
Benthic Flora	Sargassum	H. J. Humm/USF
Benthos	Chemistry	
Hydrocarbons	Sediment/Algae	J. S. Lytle/GCRL
	Sediment/Algae	T. L. Lytle/GCRL
	Benthic Fauna	P. A. Meyers/U Mich.
Trace Metals	Sediments	B. J. Presley/TAMU
	Benthic Fauna	S. B. Betzer/USF
Management		
Procurement & Administration		R. E. Smith/SUSIO
Ship Operations, Logistics		M. O. Rinkel/SUSIO

AOML	Atlantic Oceanographic & Meteorological Laboratories/NOAA (Public/Federal) Miami, Florida.
FSU	Florida State University (Public/State) Tallahassee, Florida.
GCRL	Gulf Coast Research Laboratory (Public/State) Ocean Springs, Mississippi.
TAMU	Texas Agricultural & Mechanical University (Public/State) College Park, Texas.
UA	University of Alabama, Marine Sciences Program (Public/State) Dauphin Island, Alabama.
UF	University of Florida (Public/State) Gainesville, Florida.
UM	University of Miami (Private) Miami, Florida.
U MICH.	University of Michigan (Public/State) Ann Arbor, Michigan.
U. S. MISS.*	University of Southern Mississippi (Public/State) Hattiesburg, Mississippi.
URI*	University of Rhode Island (Public/State) Kingsport, Rhode Island.
USF	University of South Florida (Public/State) Tampa, Florida.
UWF	University of West Florida (Public/State) Pensacola, Florida.

* The Principal Investigator transferred from the University of Rhode Island to the University of Southern Mississippi after work on the contract had begun.

C. MAFLA Survey Plan

The subject survey provides quantitative and statistically valid baseline (benchmark) measurements of selected factors that may vary as a direct result of oil and gas exploitation at priority locations within the MAFLA area. Constraints of time and funding were recognized. To enhance continuation of the study of this area and the collection of comparable data in the future monitoring phase, special attention was paid to (a) precision location of bottom sampling sites, (b) careful documentation of design of sampling strategies, (c) efficient and contamination-free separation and handling of sample materials, (d) selection of proper, readily accessible archiving sites,

and (e) coordination of work between institutions and agencies having expertise in and special concern with the areas in question.

In the event of spills or other real or alleged acute or chronic pollution as a result of petroleum exploitation, these baseline studies have been designed within the restraints that have been imposed, to be sufficiently definitive, statistically and analytically, so that certain future changes might be identified with confidence. In this context, the Consortium's subject survey was planned to not only satisfy public and official desires for information, but also to set precedents or provide guidance for future work in the MAFLA and other areas.

The SUSIO Consortium MAFLA survey was performed as follows:

1. Water Column Survey

In each lease area, water column studies took into consideration the key elements present and their interrelations: biota; hydrocarbon; and trace metal composition of the water column and the biota.

a. Biology

Water column samples for biological studies were taken at fifteen (15) master stations and four (4) control stations. Each station consisted of 30-liter Niskin samples taken at three (3) depths. These samples were obtained from surface, mid-depth, and several (2-6) meters above bottom. If a thermocline existed, as determined from XBT data, mid-depth samples were taken at thermocline depth. If no thermocline

was present, the mid-depth sample was taken halfway to the bottom. A total of fifty-seven (57) discrete water samples were taken from all stations.

Sampling of the zooplankton was planned and performed on fifteen (15) master stations and four (4) control stations. Zooplankton sampling was accomplished in two ways:

(1) Three to five 15-minute stepped oblique trawls were made in surface, mid-depth, and bottom waters using ½ meter diameter Nitex nets of 202μ mesh with a double-trip opening and closing device. All nets were equipped with T-S or General Oceanic flowmeters. These resulted in two hundred sixty-seven (267) separate zooplankton samples.

(2) One to two one-hour stepped oblique tow was made in a manner similar to that described in the previous paragraph at each of the fifteen (15) master stations and four (4) control stations. These resulted in thirty-six (36) separate zooplankton tows in addition to those mentioned in the preceding paragraph.

Each fifteen (15) minute sample was split with a portion maintained for species identification, counting, and diversity analysis, and dry weight biomass determinations.

Each one (1) hour tow was split as follows:

One-fourth for displacement volume determination and maintained for species identification, counting, and diversity analysis

Three-eighths for wet and dry weight biomass determinations, and subsequent trace metal analysis

Three-eighths for hydrocarbon analysis

A total number of 303 tows were obtained.

Subsamples of these water samples were maintained for further laboratory analysis as follows:

Total No. of Subsamples	
267	Zooplankton identification
267	Dry weight biomass
36	Wet weight biomass
36	Trace Metal analysis
36	Hydrocarbon analysis
267	Tar ball analysis

b. Chemistry

Water column samples for chemical studies were taken in conjunction with biological studies as described above. Enough replicates were taken from the 30-liter samples to obtain the required volume of water for all subsamples. Subsamples of these water samples were taken for further laboratory analysis as follows:

Total No. of Subsamples	Size of Subsamples
208 Chlorophyll	3 liters
126 Particulate organic carbon	3 liters
114 Phytoplankton species identification	20 liters
114 Phytoplankton cell volumes	20 liters
111 Low molecular weight (hydrocarbons)	1 liter
42 High molecular weight (hydrocarbons)	40 liters
126 Dissolved organic carbon	40 milliliters
66 Trace Metal Analysis (dissolved)	9 liters

42 Particulate hydrocarbons
(filtered from same sample
as high molecular weight
hydrocarbons)
42 Trace metal analysis (on particulates)

Additional samples were taken at each station and prescribed depths using five (5) liter Niskin samplers. The total number of these samples was fifty-seven (57). Subsamples of these water samples were taken for further laboratory analysis as follows:

Total No. of Subsamples	Size of Samples
126 ATP - Total Living Biomass	2 liters
66 Micronutrients	0.1 liter
114 Dissolved Oxygen	0.5 liter

The dissolved low-molecular weight hydrocarbon portion of the survey consisted of two parts. For the first part, discrete samples (111) collected during various MAFLA cruises were analyzed ashore. For the second part, the Texas A & M hydrocarbon sniffer system was used to survey C_1 to C_5 hydrocarbon concentrations in the surface water (nine feet below sea level). The cruise track for this sampling went from St. Petersburg, Florida, through all five MAFLA lease areas and then around the Mississippi delta and across the Louisiana and Texas continental shelf to Galveston, Texas.

2. Bottom Survey

Benthic collections were performed of sufficient quantity to permit statistically significant evaluation of benthic community diversity, nature of benthic biota

and assessment of substrate. Multiple samples within each area were taken with a box core to permit: uniform sampling; description of area; depth of substratum for sediment; biota; and adequate quantity of sample for subdivision for quality control and archiving. Quantitative analysis of communities was made on selected stations. Benthic collections were supplemented by bottom photographs (35 mm) obtained by divers and/or by remote bottom cameras (prior to coring) on each of the sixty-five (65) benthic stations. A minimum of thirty (30) frames were taken with the remote camera at each station, although in practice many more were taken on most stations. These data, supported by ground truth via Capetown dredging of selected sites, have permitted assay and post cruise evaluation of faunal and floral communities. Special attention was given to the Middle Ground and Clearwater areas, where fauna and flora are extremely important, and bottom visibility permits maximum utilization of photographic observations.

a. Box Cores

Bottom samples were taken on sixty-three (63) total stations, including thirty-eight (38) master stations and twenty-five (25) control stations. Eleven replicates were collected from most stations resulting in six hundred forty-seven (647) total bottom samples. (Replicates could not be collected on some stations due to bottom texture): the eleventh core was taken to provide the 3 kg samples for hydro-

carbon analysis.

In the event samples sufficient to perform the required analysis could not be taken by box core (five (5) attempts at each station, as a minimum, were attempted to document inability to acquire samples by box core), a Capetown dredge was employed on those stations in lieu of box core sampling.

A visual description was recorded of each box core that was taken. In addition, 35 mm color photographs of each core were taken; tests for physical properties were made with a hand-held vane shear apparatus; from one box core at each station a slab approximately 2 cm x 6.5 cm x 20 cm was cut and x-radiographed for sedimentary structures, and a vertical epoxy peel was made from the slab.

Various subsamples of the 647 box cores collected were taken for further laboratory analysis as follows:

Total Nos.	Purpose	No. & Size of Subsamples
126	Sediment Analysis	2 - 3x15cm cores
125	Micromolluscs	2 - 3x5cm cores
128	Foraminifera	2 - 2½x15cm cores
63	Hydrocarbon Anal.	3 kg sample from top 10 cm
63	Hydrocarbon Archiving	3 kg sample from top 10 cm
57	Trace metals	1 - 2x15cm core
63	Total organic carbon	10 cc
260	Sediment ATP	1 cc
481	Microfaunal Analysis	Top 15 cm of remainder of 8 box cores sieved through 500 u Nitex screen
63	Key dominant microfauna	One box core sieved through μ Nitex screen.

Three equal groups of microbenthos maintained for trace metal analysis, hydrocarbon analysis, histopathological slides.

Sixty-three of the sixty-five (65) benthic collection sample sites produced sufficient material for sediment sampling. Station 51 and 58 were sampled by Capetown dredge, after unsuccessful box core attempts.

b. Benthic Biota Analysis

All infaunal samples were sorted into taxonomic groups, and subsequent biomass determinations were made. Polychaetous annelids were identified to at least family level, and in most cases to species level. In those instances where there were numerous individuals from other taxonomic groups, an attempt was made to identify those organisms to genus and species levels for purposes of characterizing the community. Analysis of the extractable hydrocarbon content of the benthic epifauna and infauna was performed.

For the key dominant macrofauna picked from the screened box core sample, a faunal list was prepared on which all such species were identified, and their relative abundance in the sample estimated.

All benthic floral samples, and samples of opportunity of planktonic flora were properly labeled, preserved, packaged, and processed for species identification and archiving as required.

c. Sediment Analysis

Standard parameters. Analyses for standard sediment parameters were performed on subcores from two separate box cores. Coarse fraction grain size analysis was accomplished using both the sieve technique and the rapid sediment analyzer (settling tube). In samples, where the fine fraction accounts for ten percent or more by weight of the total sample, analysis of fines were performed; results are presented as percent silt and percent clay. Sand sized material is reported as weight percents of full phi fractions.

All samples were analyzed for percent carbonate using an acid leaching-gas displacement method.

Two samples, one from each sediment subsample taken in Areas III, IV, and V, were prepared for clay mineralogy analysis. These samples were analyzed using X-ray diffractometry techniques. All clay minerals were identified, and their abundances determined on a semi-quantitative basis.

Carbonate sediment analysis. A split of each full phi fraction of the sieved sediment from each station in Areas I and II and those samples from Area III containing greater than five percent calcium carbonate were packaged dry and later analyzed.

The following analyses were made for each sample:

General description by microscope of sediment to include color, surface textural attributes, degree of

fragmentation of different grain constituents, and constituent composition.

Point count of 300 carbonate grains in each size fraction (greater than 2000, 2000-1000, 1000-500, 500-250, 250-125, less than 125 microns) for constituent analysis of skeletal grain types, non-skeletal grain types, and siliceous skeletal remains.

Concurrent point count of carbonate versus non-carbonate grains for each size fraction based on a total of 300 carbonate counts.

If less than 300 grains were present in a sample fraction, analysis was made on the total number of grains. For any samples in which grains were too abraded or bio-corroded for doing microscopic point counts, analysis was done from an impregnated whole sample. Constituent composition for the sample was made by point count analysis of the thin section using petrologic characteristics of skeletal microstructure for identification.

Descriptive and analytical data are presented in tabular, graphical and map form. Graphical results of constituent composition plotted against grain size are also reported.

d. Diving and Bottom Photography

At those stations where infauna could not be sampled, epifauna and flora were characterized by bottom photography. Open circuit SCUBA was used in conjunction with diver-towed vehicles and hand-held cameras (33 mm still and super 8 mm

movie) to make assessments of five (5) meter square quadrants at selected stations in each area where depth did not exceed 150 feet; normally no decompression time limitations were adhered to; however, limited decompression dives were performed on occasion, as a matter of necessity and safety. The numbers of such stations were as follows: Area I - five stations; Area II - twelve stations; Area III - five stations; Area IV - four stations; and Area V - two stations. The original number of dive stations in Areas IV and V was decreased due to extreme visibility conditions. In the deeper areas, topside operated remote bottom cameras were used.

Color and black and white photographic stations were established at the infaunal stations. Photographic data were supplemented by dredging as selected sites to provide "ground truth" for the photographic coverage.

Capetown dredges were used on select stations to gather representative samples of epifauna and epiflora as appropriate. Stations were selected on the basis of outcroppings or areas of relief as determined by shipboard fathometry. Selected macrofauna and macroflora recovered either from diver surveys or Capetown dredges were preserved in alcohol, formalin, or formalin-acetic acid depending on which was most suitable for that particular sample. Floral and faunal samples were frozen in the appropriate manner for chemical analyses for trace metals and hydrocarbons, and for archiving.

3. Physical Oceanography

Only temperature, dissolved oxygens and salinity measurements were taken in the present survey. These were necessary to identify water masses which may have a bearing on data interpretations, now and in the future.

Historically, Loop Current water has occurred throughout the MAFLA areas. In MAFLA Areas I, II, III, and IV, the loop current has occurred in May and June. For this reason, control stations were placed toward the continental slope seaward from the leased tracts. Model 9060 STD units were used to define water mass structure at these stations.

Expendable bathythermograph (XBT) casts were also made at every station, between stations, and during periods of sustained plankton tows.

The water column collections were planned and coordinated with satellite imagery data and information from a separate study of the physical-oceanographic-hydronamic phenomena of the MAFLA area as being compiled from existing historical data, both published and unpublished (SUSIO/BIM Contract No. 08550-CT4-16). The physical oceanography contract is to be completed in CY 1975 and reported on accordingly.

Multivariate techniques (MONOVA) have been employed for analysis of physico-chemical factors in conjunction with plankton component interactions.

4. Ship Scheduling/Operations

a. Water Column Survey

This work was accomplished by the use of three operating vessels and one standby; the R/V GULF RESEARCHER, R/V TURSIOPS, R/V BELLOWS, and R/V AQUARIUS. These vessels were scheduled as follows:

	Phyto-plankton	Zoo-Plankton	Trace Metal Hydro-carbons	Nutrients-Dissolved Low-Molecular Wt. Hydrocarbon
Area I	BELLOWS	TURSIOPS	TURSIOPS	BELLOWS
Area II	BELLOWS	TURSIOPS	TURSIOPS	BELLOWS
Area III	BELLOWS	TURSIOPS	TURSIOPS	BELLOWS
Area IV	GULF RESEARCHER	GULF RESEARCHER	GULF RESEARCHER	GULF RESEARCHER
Area V	GULF RESEARCHER	GULF RESEARCHER	GULF RESEARCHER	GULF RESEARCHER

(R/V ACQUARIUS was maintained on standby as a back-up vessel for contingency purposes.)

Each vessel was equipped with RADAR and LORAN A. Two hydro-winches were aboard each vessel; one winch had a minimum of 400 meters 3/16" polypropylene-coated cable, and the other had 3/17" steel cable. Each vessel had a minimum of four 30-liter bottles, four sets of opening and closing ½ meter 202 μ mesh plankton nets, a Model 9060 STD unit, an XBT System, and one case of T-10 XBT's.

b. Bottom Survey

A subcontract was executed with the Marine Biomedical Institute of the University of Texas Medical Branch at Galveston for use of the

R/V MISS FREEPORT for the collection of all box cores. The vessel was equipped with an electric winch with 3/8" cable, a hydraulic crane, and "A" frame of five-ton capacity, and a LORAC System and two operators, plus RADAR, LORAN A, and standard communications equipment. SUSIO furnished the vox core (on loan from the University of Rhode Island) and the 3/8" cable.

Diving operations in Areas I through V were conducted from the R/V BELLOWS. This vessel had a crew of three persons, a LORAC operator, and a scientific staff of seven qualified scientist divers. The vessel was equipped with RADAR and LORAN A and standard communications equipment.

The R/V AQUARIUS acted as a back-up vessel for these operations.

In general, the survey cruises were performed in the following manner. R/V MISS FREEPORT started work in Area V and moved east and southward, collecting stations through Areas IV, III, II, and I. Diving operations started in Area III then moved west to Areas IV and V, and then southeastward to Areas II and I. Water column work occurred first in Areas IV and V and then in III, II, and I.

All vessels worked in Areas V, IV, and III during May, and the R/V MISS FREEPORT, R/V

TURSIOPS, and R/V BELLOWS in Areas III, II, and I in June. This scheduling program allowed the complete set of water column sampling equipment, i.e., STD, XBT System, 1.7, 5, and 30-liter bottles and plankton nets to be in reserve in Areas III, IV and V in May, and Areas I, II and III in June, in case of wire breakage or loss of individual items.

Between the time the contract was executed on May 8, 1974, and cruises commenced on May 13, 1974, the activities of virtually all personnel connected with the contract, who conducted shipboard operations or who were responsible for shipboard collections, were channeled into the procurement of the necessary equipment for the at-sea operations. In an attempt to not exceed the six-day mobilization period permitted prior to the 60-day collecting period allowed before "liquidated charges" would be imposed, SUSIO assumed the responsibility of ordering equipment and supplies for those individual universities or institutions that could not purchase equipment or supplies until they had received formal contracts and budget numbers.

Despite the complete cooperation and unequivocal support of Dr. William H. Taft of the University of South Florida, Dr. Robert M. Johnson of

Florida State University, Dr. Woodmansee of the Gulf Coast Research Laboratory, Dr. Thomas S. Hopkins of the University of West Florida, Dr. Harold R. Wanless of the University of Miami, and others, and the assurances of the distributors and suppliers of the equipment, a number of items could not be secured by the starting date for ship operations, May 13, 1974. Fortunately, those items that were absolutely necessary were procured on loan from a variety of sources.

Before termination of this portion of the report, acknowledgment is appropriately given to one individual and his staff; without their effort it would have been impossible to mobilize the ships or commence this contract within the time constraints of this contract. This acknowledgment goes to Dr. William H. Taft, and the procurement personnel at the University of South Florida who took it upon themselves to issue over $44,000 worth of emergency purchase orders between 3:30 P.M. and 5:00 P.M. on May 8, 1974, the execution date of the contract. This support was given despite the fact that, in many cases, the purchase orders would have to be cancelled later and re-issued under the accounts of individual universities.

5. Navigation

To meet navigation precision required (± 20 meters) for the benthic and sediment sampling, LORAC Systems and operators were leased. LORAC navigation was employed in conjunction with box coring, bottom photography, dredging, and diving operations. At each of the master benthis stations a permanent cement marker was placed to permit precise station identification in the future.

6. Archiving

To meet time and funding limitations, the greater portion of the baseline sample materials has been archived rather than to attempt to analyze these immediately.

Subsamples were taken from the box cores and the disposition of these are as follows. One 10 cm diameter subcore and nine 5 cm diameter subcores of the box cores were shipped to the NOSF-sponsored core storage facility at Florida State University where they are refrigerated at 40° C. Two 5 cm diameter subcores from each station were shipped to Dr. Larry J. Doyle, University of South Florida, for standard sediment analysis. Sieved at full phi intervals, splits of the sand-sized sediments in Areas I, II, and III were shipped to Dr. Harold Wanless at the University of Miami for carbonate constituent analysis. Photographs of box cores and X-radiographs are in the possession of Dr. Larry J. Doyle at the University of South Florida.

Other individual Principal Investigators are archiving specimens/materials at their respective laboratories as appropriate.

D. Preliminary Scientific Observations on Environmental Applications and Conclusions Drawn from the MAFLA Survey

Crude oil-like hydrocarbons have not been identified in sediments, bottom organisms, or organisms or phases in the water column in Areas I, II and III. Moreover, the abundance and diversity of organisms, as well as evidence of similar populations living in the same niches on the shelf in the recent past, suggest that these organisms are living in an essentially pristine and natural ecological state, and show no evidence of stress owing to influx of pollutants. The situation is more complex in Area IV. Proximity to the Mississippi Delta and its strong turbidity and periodic freshwater influences, creates a similar kind of stress for the westernmost stations as that encountered more strongly in Area V. Some sediments in the area show influences of petroleum-type hydrocarbons in aliphatic components of lipids, whereas others show only the odd-number predominance typical of biologically synthesized hydrocarbons. Organism analyses show similar divergent trends. Heavy metals show background or subbackground levels. Area V sediments revealed universal indications of petroleum hydrocarbons in the sediments. Their weathered nature led the Lytles to infer a Mississippi River origin for them. However, the areas in question are to a large extent poorly productive of epi- and infauna other than stress-tolerant species, and it is problematical what influence the added hydrocarbons have on the system.

Distribution of suspended matter is significant for natural processes of removal of oil. Suspended matter and zooplankton productivity (via fecal pellet formation and sinking processes) are both known to be effective means of collection and sinking of oil pollutants. Hence, off areas V and IV, spills and surficial slicks of oil will be brought down more effectively and rapidly (perhaps by one or more orders of magnitude) than in the clear water areas to the south. This means that, in the absence of human clean-up or recovery, a greater percentage of the oil will remain in surface water of the southern areas to be either moved on by currents or impinged on and absorbed at the coastal zone, except under unusual conditions such as storm-related turbidity.

Heavy metals in sediments, waters, organisms or suspended matter have not shown concentrations beyond those expectable for comparable unpolluted materials. In fact, sediments have unusually low background levels for trace constituents over much of the area. In my opinion, it appears that heavy metals in petroleum or petroleum-related brine seepages are not a major hazard, owing to their low concentrations in oil and brine. Calculations show that some of the larger historical spills, if distributed over a typical bottom sediment area might have difficulty in building up ambient concentrations beyond background. Moreover, the chief elements in oils, vanadium and nickel, have relatively low toxicity. This does not preclude a buildup of detectable residues of vanadium and nickel in benthic and encrusting and

fouling organisms and sediments as a result of chronic low level spills.

The excellent background of analytical information on organisms from a clean environment should invite complementary analyses of similar species from "dirty" environments, if they can be found and vouched for, to establish comparative knowledge of metal influences on a wide spectrum of organisms.

Trace elements may be potentially more significant as pollution from land sources. The investigated sites were not close enough to shore and potential sources of pollutants to detect plumes and ranges of influence of land-derived wastes. Baseline maps of trace element and hydrocarbon constituents should, in the future, extend to the shore to delineate land-derived influences from potential offshore pollutants.

Over the short range, substrate largely controls bottom fauna. This is true to an extreme degree in the Middle Ground. Over wider areas other factors come into play: temperature, recruitment of eggs and larvae via water movements are examples. The unusual fauna and flora of both the Flower Garden and the Middle Ground reefs may require a combination of bottom substrate and impingement of Caribbean breeding stock, transported by the Loop Current.

II. MAFLA SURVEY

Final Report
BLM Contract #08550-CT4-11
MAFLA Survey Cruise Objectives

A. OBJECTIVES

1. BLM Cruise # 1 (R/V BELLOWS)

To execute baseline environmental surveys of the MAFLA lease areas I, II, III, between May 13-16, 1974, under the Department of the Interior, Bureau of Land Management Contract No. 08550-CT4-11 by:

a. Collecting physical data with XBT's or STD lowerings
b. Collecting phytoplankton samples.
c. Collecting dissolved oxygen samples.
d. Collecting dissolved micronutrient samples.
e. Collecting samples for chlorophyll determinations.
f. Collecting water samples for ATP analysis.

2. BLM Cruise # 2 (R/V MISS FREEPORT)

To execute baseline environmental surveys of the MAFLA lease areas I, II, II, IV, & V between May 16-June 6, 1974, under the Department of the Interior, Bureau of Land Management Contract No. 08550-CT4-11 by:

a. Photographing bottom profiles.
b. Collecting a quantitative sample for sediment analysis and archiving.
c. Collecting a quantitative sample for infaunal community structure determination.
d. Collecting a quantitative sample for key dominant species determination and chemical archiving.

3. BLM Cruise # 3 (R/V GULF RESEARCHER)

To execute baseline environmental surveys of the MAFLA lease areas IV and V between May 15-22, 1974, under the Department of the Interior, Bureau of Land Management, Contract No. 08550-CT4-11 by:

a. Collecting physical data with XBT's or STD lowerings.
b. Collecting phytoplankton samples.
c. Collecting low molecular weight hydrocarbon samples.
d. Collecting dissolved micronutrient samples.
e. Collecting samples for chlorophyll-a determinations.
f. Fixing one gallon of water for identification of plankton.

A. OBJECTIVES contd.

4. BLM Cruise #4 (R/V BELLOWS)

To execute baseline environmental surveys concerning benthic communities in the MAFLA lease areas I, II, III, IV & V between May 18-June 30, 1974, under the Department of the Interior, Bureau of Land Management Contract No. 08550-CT4-11 by:

a. Making in situ $5M^2$ quantitative investigations of bottom dwelling invertebrates (epifauna) and algae (epiflora) using open circuit SCUBA.
b. Documenting community structure using black and white and color photography.
c. Conducting dredging operation using a Capetown dredge to correlate with diving operations and photography ("ground truth" dredging).
d. Collecting biota for baseline chemical analysis (trace metal and hydrocarbon) by using participating institutions (USF, GCRL, TAMU).

5. BLM Cruise #5 (R/V TURSIOPS)

To execute baseline environmental surveys in the MAFLA lease areas I, II, and III between May 24-June 7, 1974, under the Department of the Interior, Bureau of Land Management Contract No. 08550-CT4-11 by:

a. Collecting physical data with XBT's and STD lowerings.
b. Collecting particulate and dissolved high molecular weight hydrocarbons.
c. Collecting dissolved low molecular weight hydrocarbons.
d. Collecting particulate and dissolved samples for trace metal analysis.
e. Collecting zooplankton samples for hydrocarbon analysis.
f. Collecting zooplankton samples for trace metal analysis.
g. Collecting zooplankton samples for species identification and statistical analysis.
h. Collecting samples for particulate organic carbon analysis and dissolved organic carbon analysis.
i. Training of personnel from Gulf Coast Research Laboratory in collection procedures for above items. GCRL group collecting in Areas IV and V.

A. OBJECTIVES contd.

6. BLM Cruises # 6/7 (R/V GULF RESEARCHER)

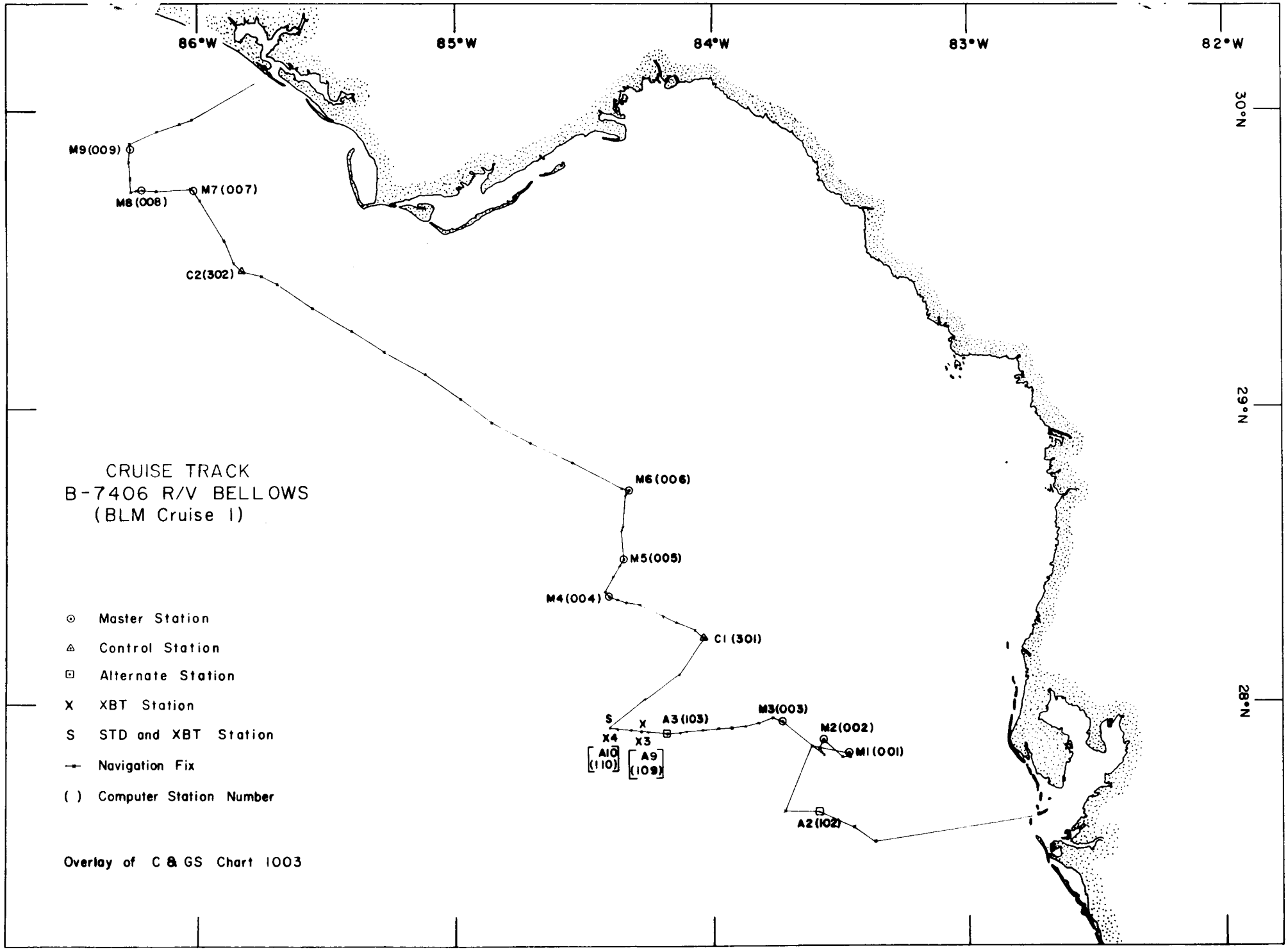
To execute baseline environmental surveys of the MAFLA lease areas IV & V between June 17-22 and June 26-30, 1974, under the Department of the Interior, Bureau of Land Management Contract No. 08550-CT4-11 by:

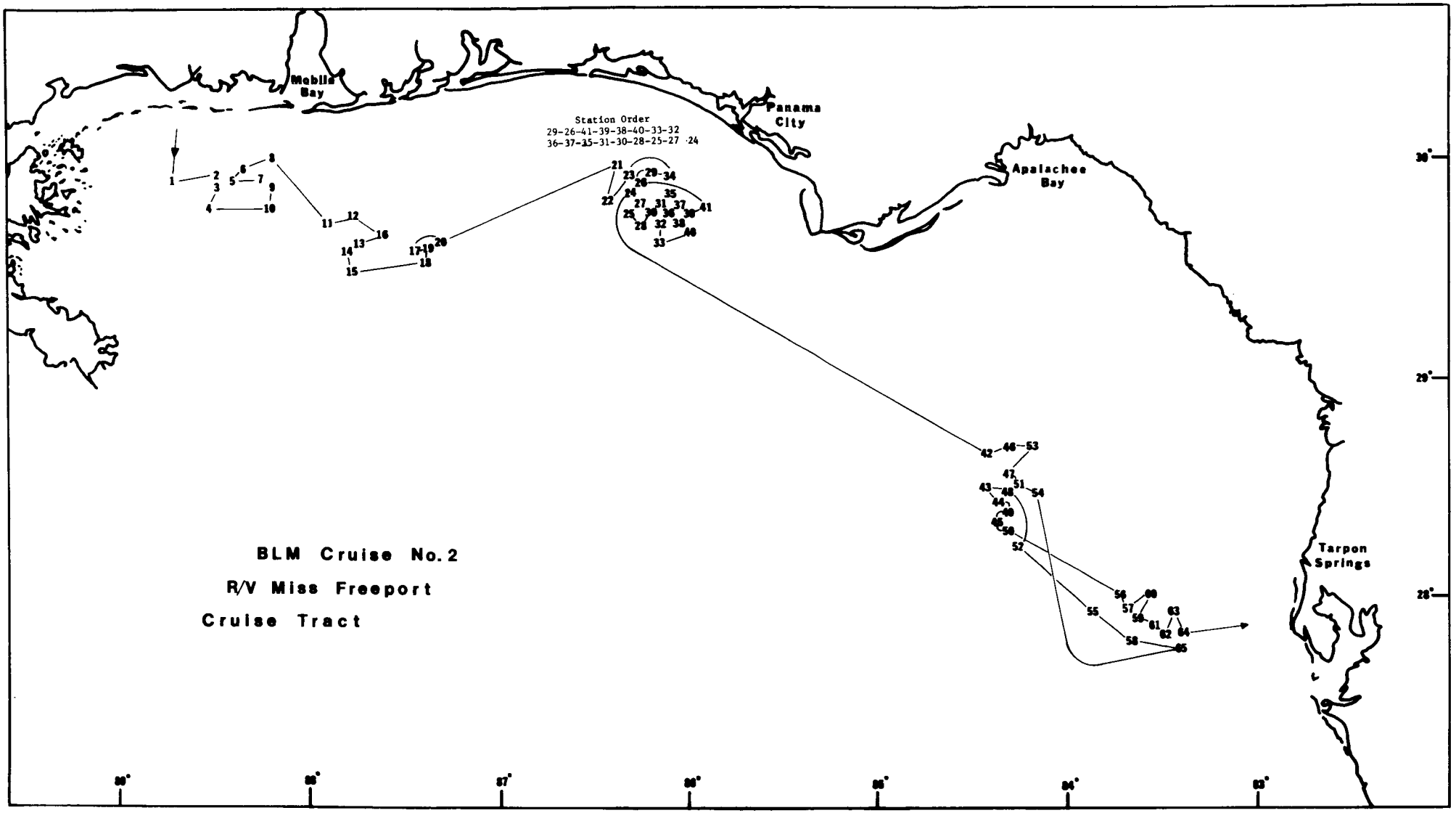
a. Collecting physical data with XBT's or STD lowerings, and dissolved oxygen samples.
b. Collecting samples for ATP determination.
c. Collecting samples for dissolved and particulate organic carbon determination.
d. Collecting samples for dissolved and particulate high molecular weight hydrocarbon determination.
e. Collecting samples for dissolved and particulate trace metal determination.
f. Fixing one gallon of water for identification of zooplankton.
g. Collecting samples at A7 which were missed on BLM Cruise #3.
h. Collecting 15 minute and one hour zooplankton samples.
i. Collecting samples for zooplankton trace metal determination.
j. Collecting samples for zooplankton hydrocarbon determination.

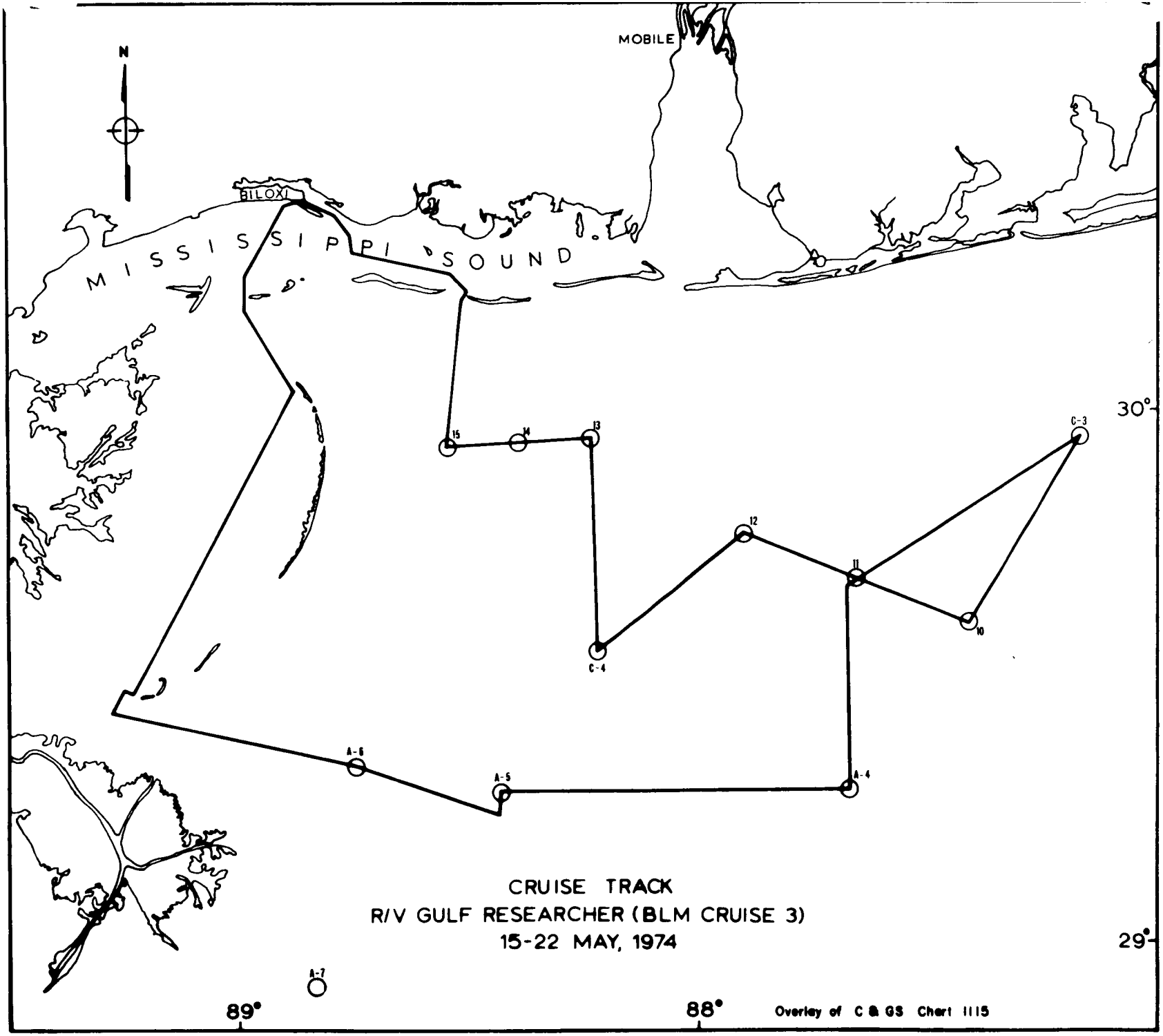
7. BLM Cruises # 8/9 (R/V MISS FREEPORT)

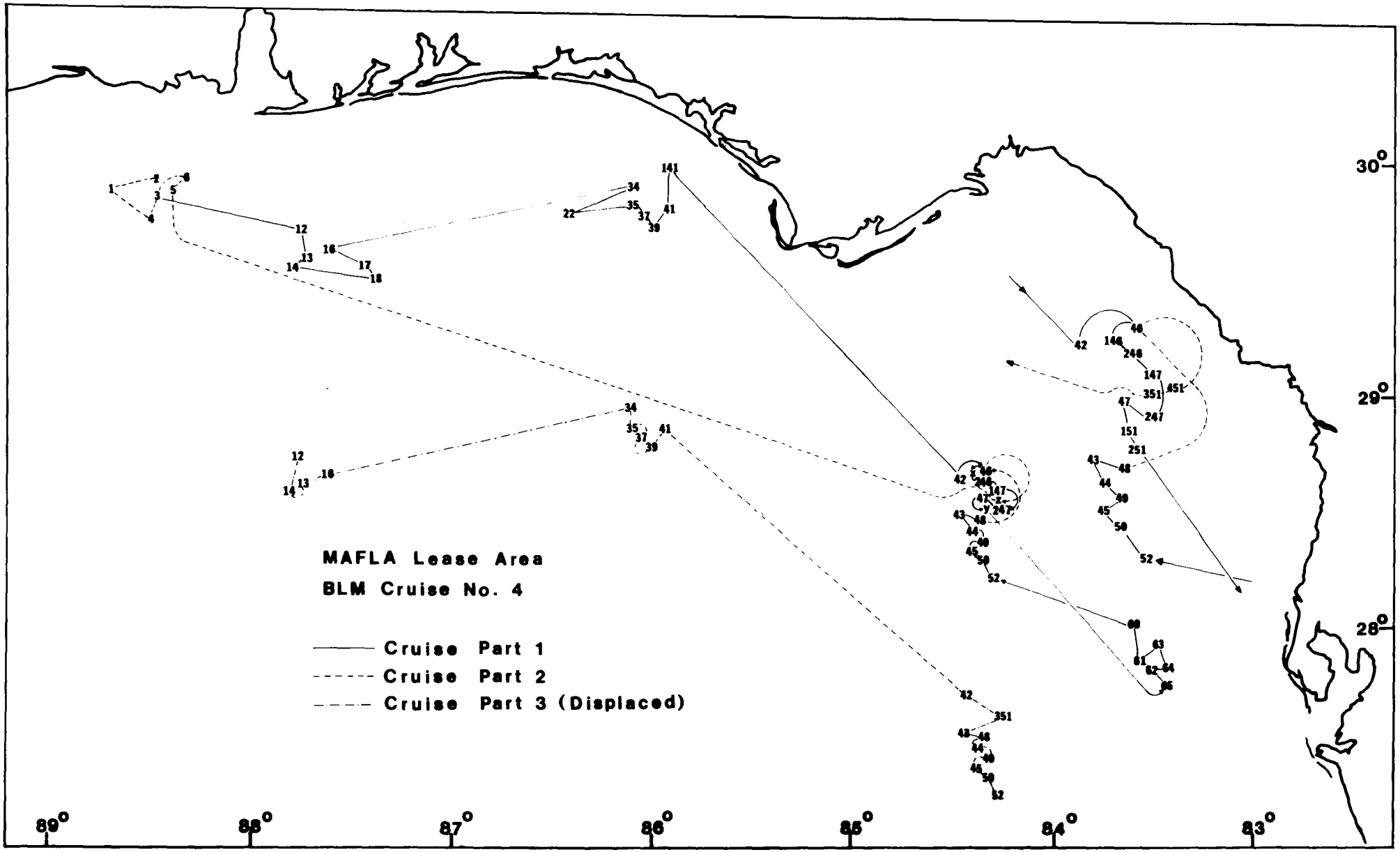
To execute baseline environmental surveys of the MAFLA lease areas I, II, III, IV, and V between June 20-21 and June 21-22, 1974, under the Department of the Interior, Bureau of Land Management Contract No. 08550-CT4-11 by:

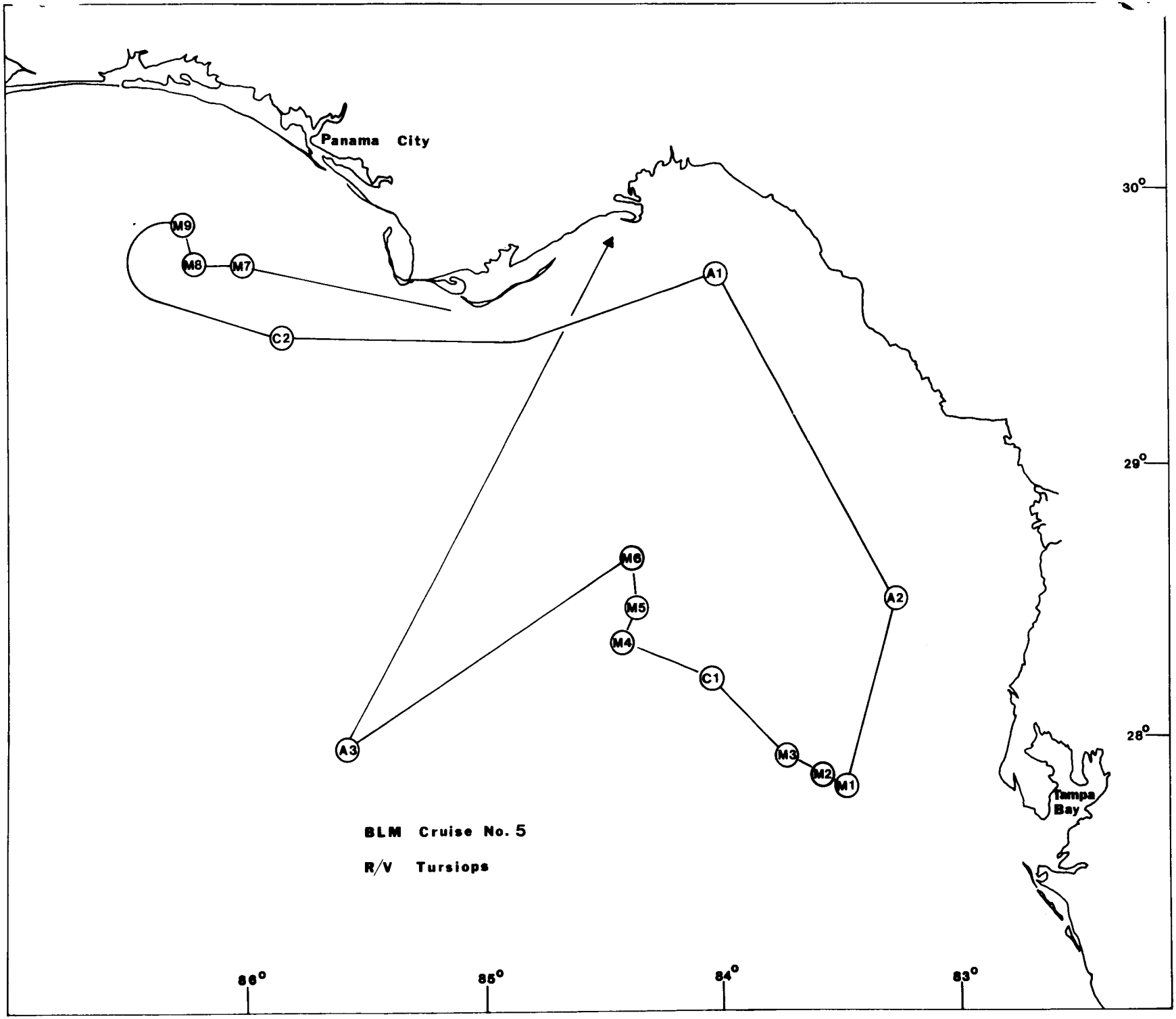
a. Determination of Light Hydrocarbons using "Sniffer" technique; Rephotograph Benthic Strata (BLM 8).

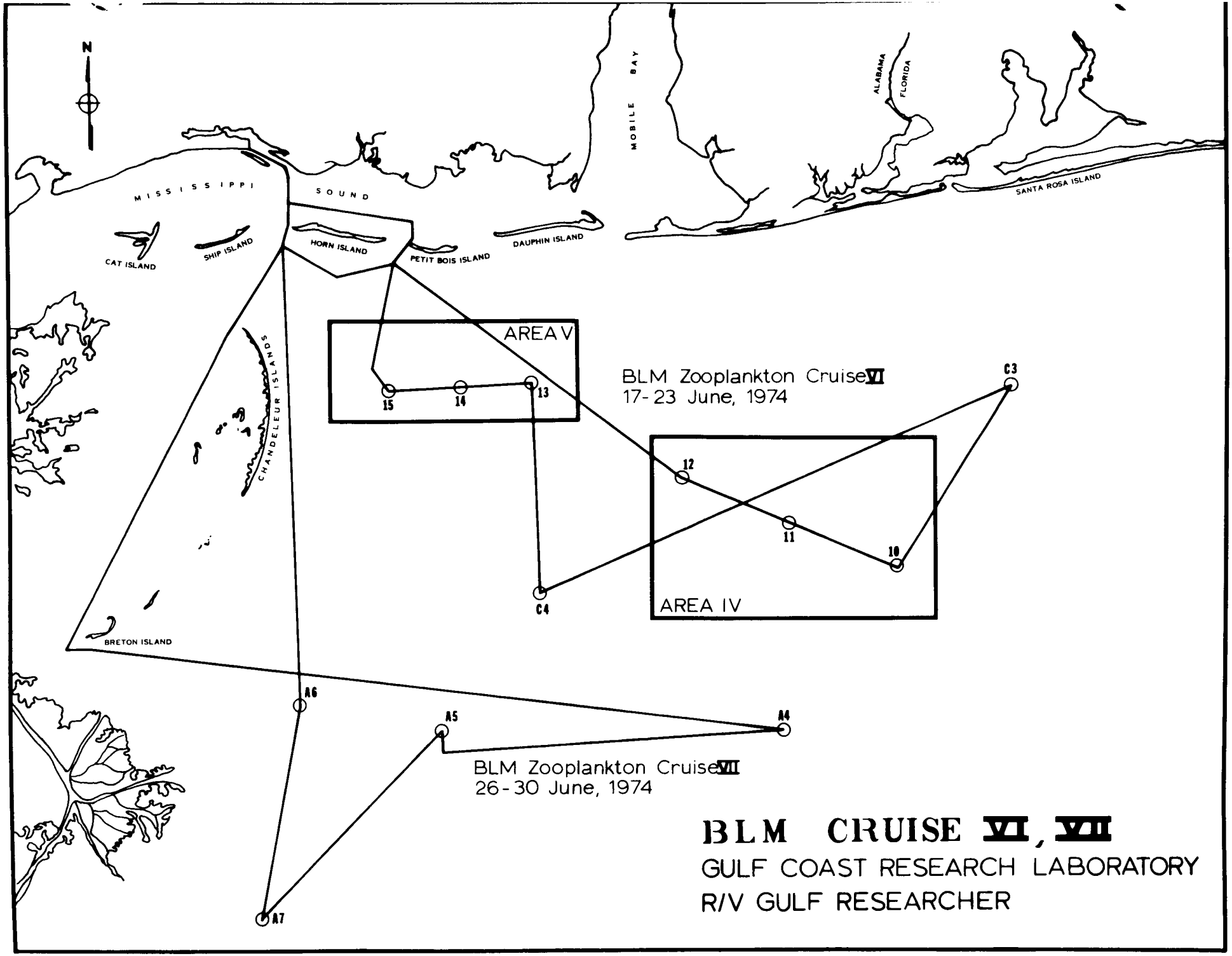

86°W
85°W
84°W
83°W
82°W
30°N
29°N
28°N
M9(009)
M8(008)
M7(007)
C2(302)
M6(006)
M5(005)
M4(004)
C1(301)
S
X
A3(103)
M3(003)
M2(002)
M1(001)
X4
X3
A10
(110)
A9
(109)
A2(102)
CRUISE TRACK
B-7406 R/V BELLOWS
(BLM Cruise 1)
Master Station
Control Station
Alternate Station
XBT Station
STD and XBT Station
Navigation Fix
( ) Computer Station Number
Overlay of C & GS Chart 1003

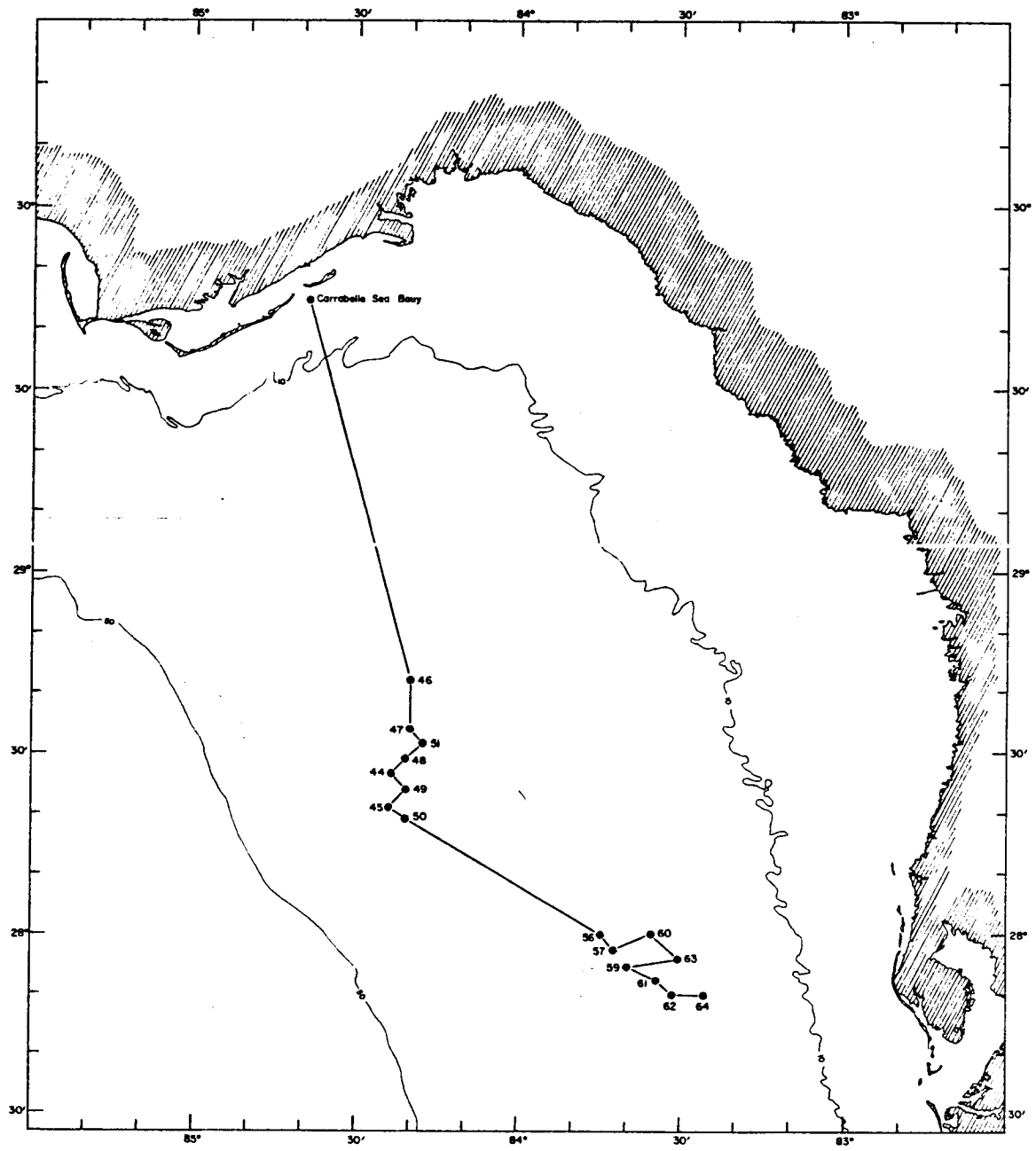

Mobile Bay
Panama City
Apalachee Bay
Tarpon Springs
Station Order
29-26-41-39-38-40-33-32
36-37-35-31-30-28-25-27-24
BLM Cruise No. 2
R/V Miss Freeport
Cruise Tract
30°
29°
28°
88°
87°
86°
85°
84°
83°


MOBILE
N
BILOXI
MISSISSIPPI SOUND
30°
C-3
15
14
13
12
11
10
C-4
A-6
A-5
A-4
A-7
89°
88°
29°
CRUISE TRACK
R/V GULF RESEARCHER (BLM CRUISE 3)
15-22 MAY, 1974
Overlay of C & GS Chart 1115

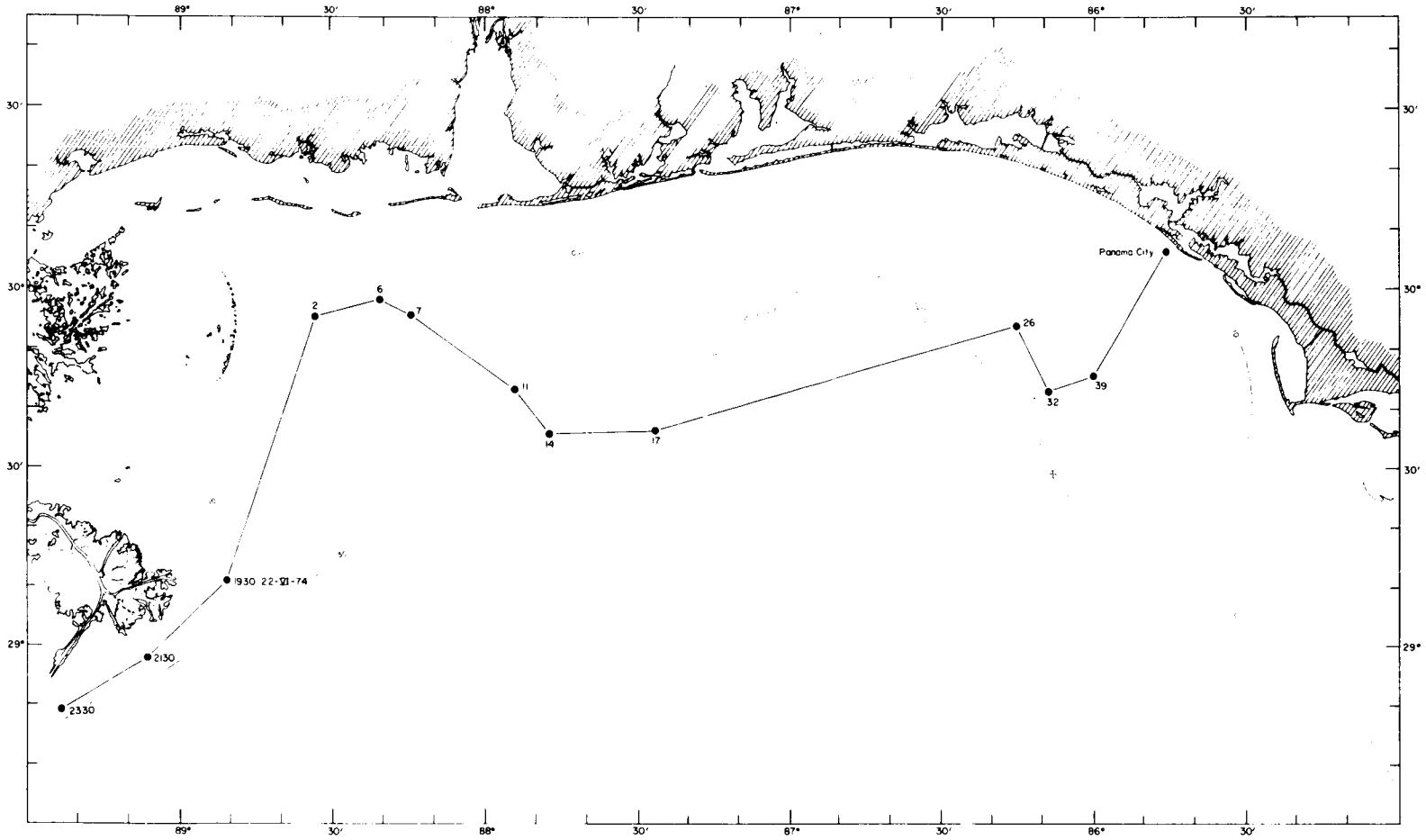

MAFLA Lease Area
BLM Cruise No. 4
Cruise Part 1
Cruise Part 2
Cruise Part 3 (Displaced)
30°
29°
28°
89°
88°
87°
86°
85°
84°
83°


Panama City
M9
M8
M7
C2
A1
M6
M5
M4
C1
A2
A3
M3
M2
M1
Tampa Bay
30°
29°
28°
86°
85°
84°
83°
BLM Cruise No. 5
R/V Tursiops

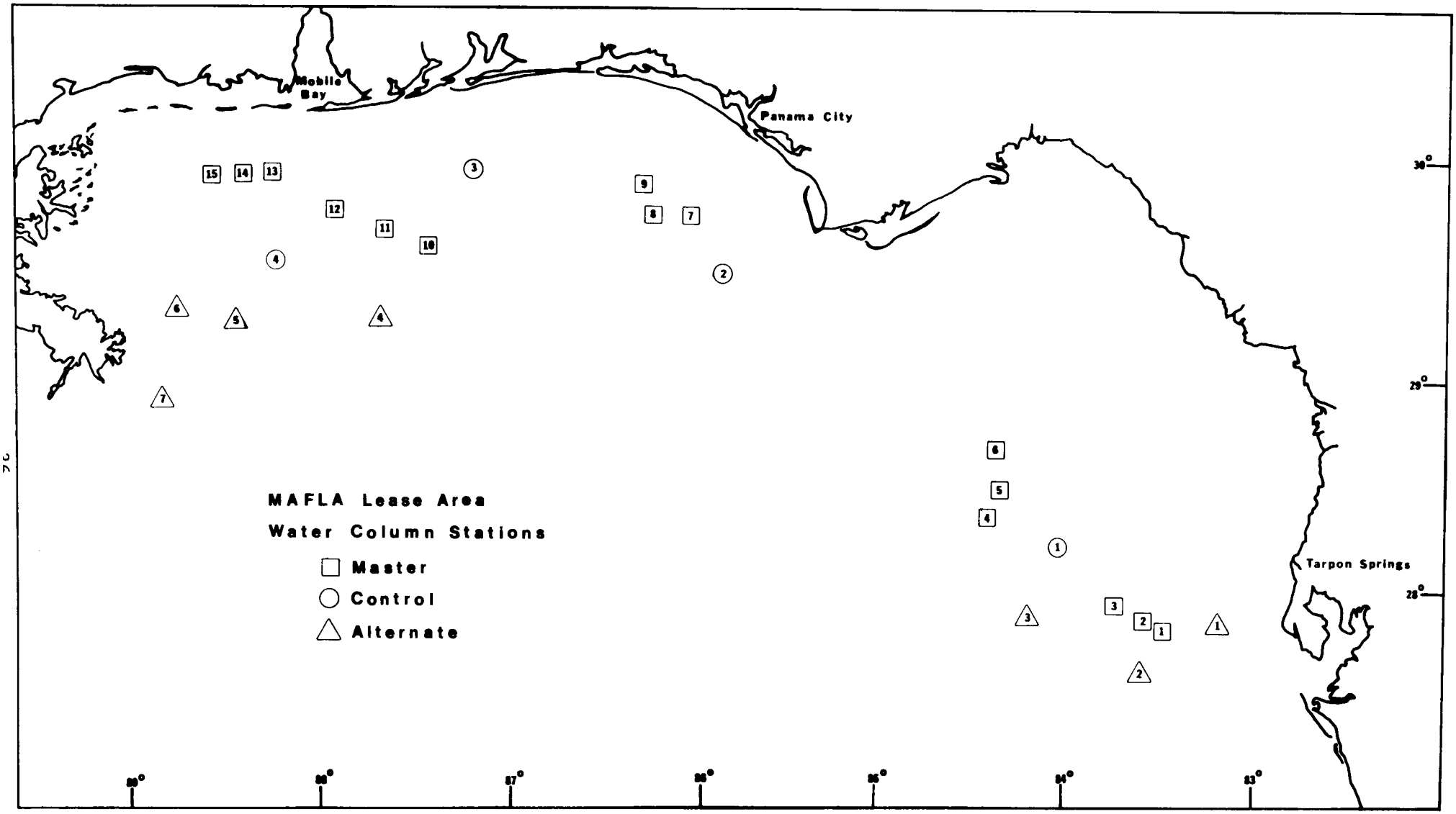

N
MISSISSIPPI SOUND
MOBILE BAY
ALABAMA
FLORIDA
SANTA ROSA ISLAND
CAT ISLAND
SHIP ISLAND
HORN ISLAND
PETIT BOIS ISLAND
DAUPHIN ISLAND
CHANDELEUR ISLANDS
BRETON ISLAND
AREA V
15
14
13
BLM Zooplankton Cruise VI
17-23 June, 1974
C3
12
11
10
C4
AREA IV
A6
A5
A4
A7
BLM Zooplankton Cruise VII
26-30 June, 1974
BLM CRUISE VI, VII
GULF COAST RESEARCH LABORATORY
R/V GULF RESEARCHER

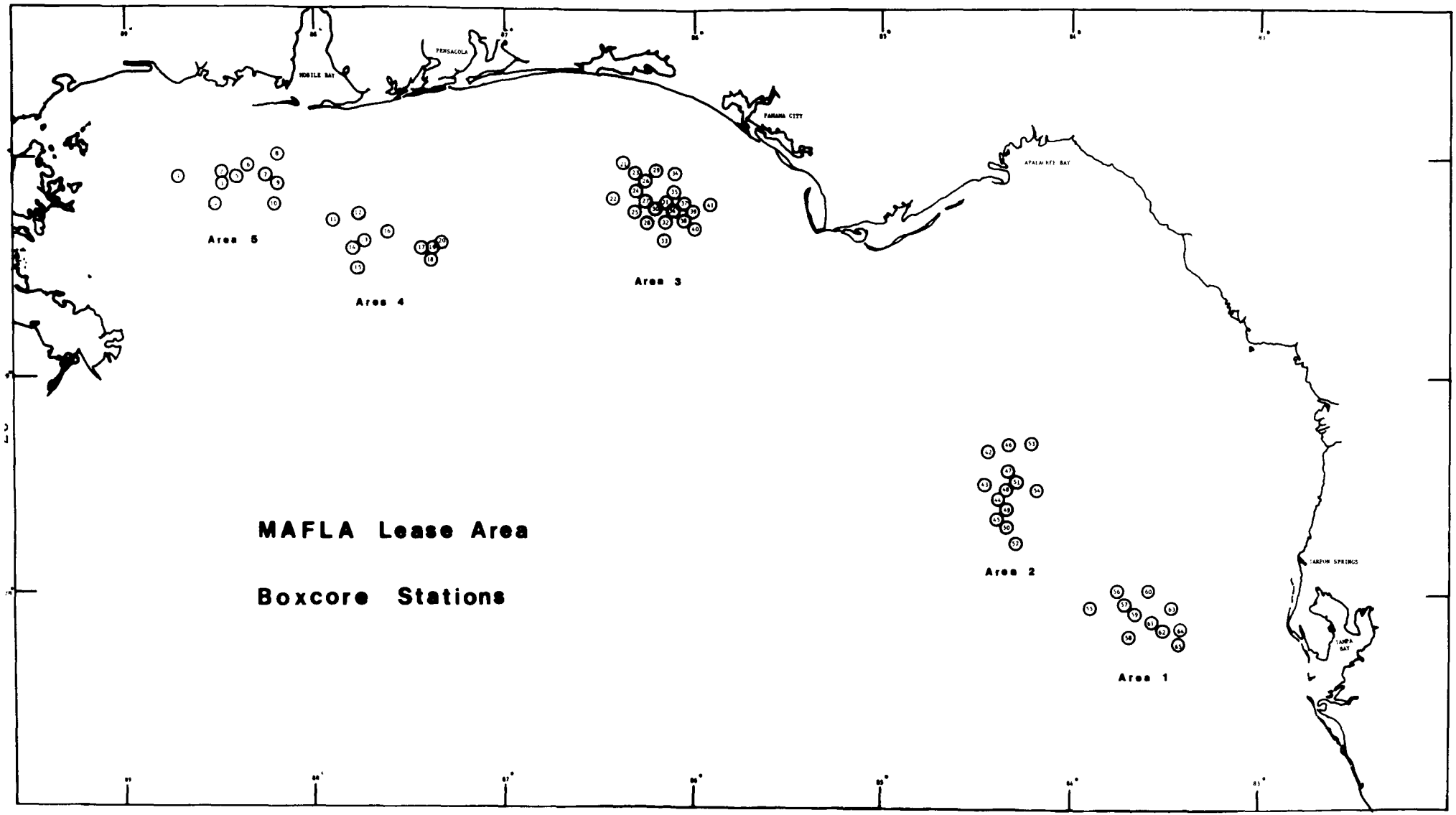


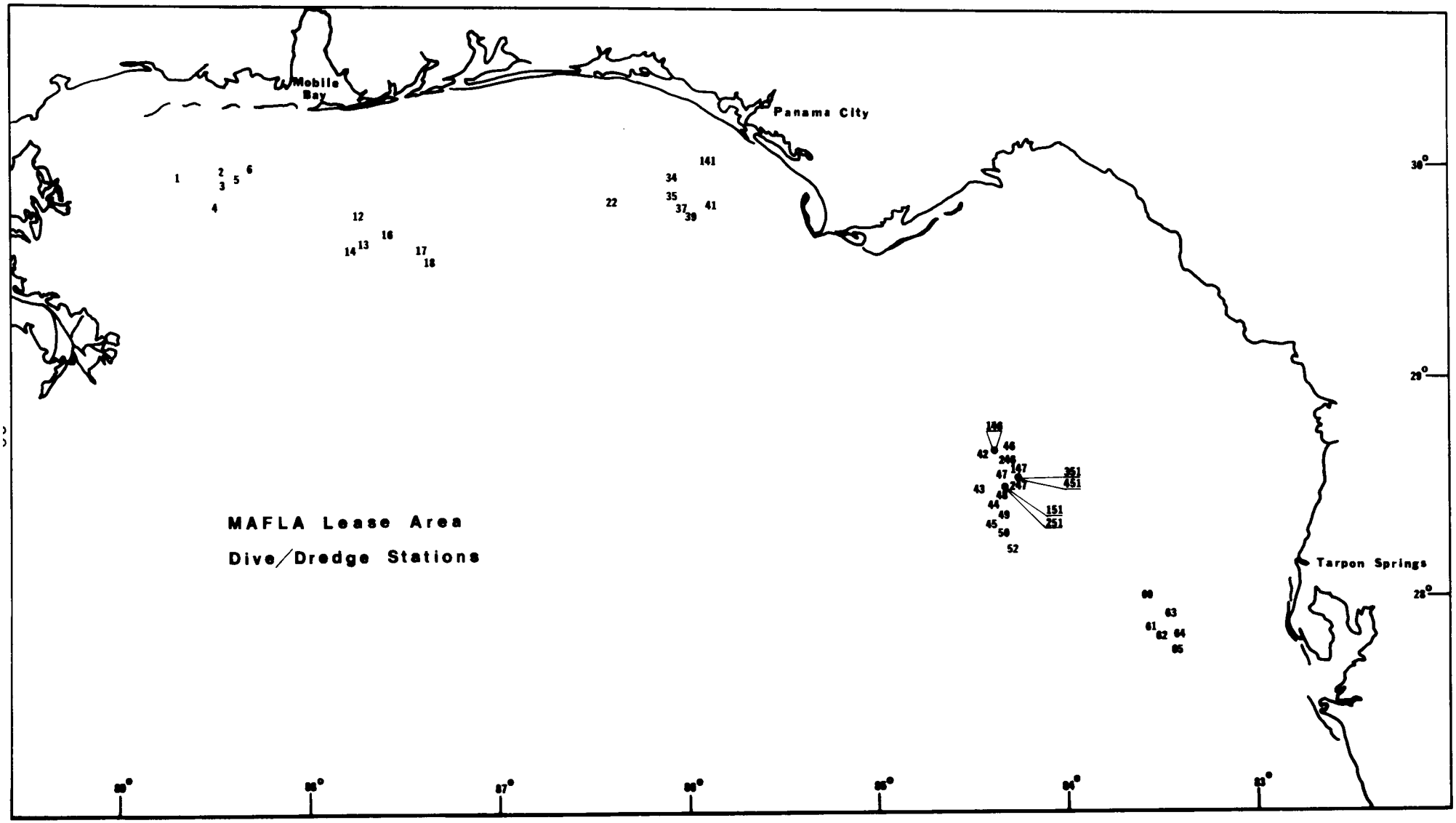
BLM Cruise 8/9
R/V Miss Freeport
Cruise Tract A



BLM Cruise 8/9
R/V Miss Freeport
Cruise Tract B


Mobile Bay
Panama City
Tarpon Springs
MAFLA Lease Area
Water Column Stations
Master
Control
Alternate
30°
29°
28°
88°
87°
86°
85°
84°
83°


MOBILE BAY
PENSACOLA
PANAMA CITY
APALACHEE BAY
TARPON SPRINGS
TAMPA BAY
Area 5
Area 4
Area 3
Area 2
Area 1
MAFLA Lease Area
Boxcore Stations


Mobile Bay
Panama City
Tarpon Springs
MAFLA Lease Area
Dive/Dredge Stations
1
2
3
4
5
6
12
13
14
16
17
18
22
34
35
37
39
41
141
42
43
44
45
46
47
49
50
52
151
251
351
451
60
61
62
63
64
65
30°
29°
28°
88°
87°
86°
85°
84°
83°

D. STATION IDENTIFICATION INDEX

The STATION IDENTIFICATION INDEX defines all stations sampled within the MAFLA lease areas during the baseline survey and correlates synonymous stations sampled by more than one research vessel. Each consecutive number represents a geographical location (station) and is defined by the appropriate latitude and longitude. A station may be designated by more than one station number due to the numerous research cruises involved in the survey. The "sample description" denotes the type of sampling performed at each station, and sample types are defined as follows:

a. Boxcore Sample: Boxcore replicates ranging from zero to eleven cores in number, dependent on physical properties of bottom

b. Dredge Sample: Capetown dredge used to supplement boxcoring and complement epifaunal sampling by divers

c. Bottom Photo: Refers to remote bottom photography

d. Dive Station: Epifauna description through photography, observation, and collection

e. Water Column: All chemical and biotic water column sampling including the hydrocarbon "sniffer" operation

VII. STATION IDENTIFICATION INDEX

CONSEC. NO.	STATION NO.	LEASE AREA	LATITUDE N.	LONGITUDE W.	BLM CRUISE NO.	SAMPLE DATE DAY/MO./YR.	BOTTOM DEPTH (FT.)	STATION CODE	SAMPLE DESCRIPTION				
									BOXCORE SAMPLE	DREDGE SAMPLE	BOTTOM PHOTO	DIVE STATION	WATER COLUMN
1	1	V	29°55'02"	88°43'24"	2	16/05/74	42	Control	X		X		
	1, V-E	V	29 55 00	88 43 30	4	25/06/74	70	Control		X			
2	2	V	29 55 16	88 26 54	2	17/05/74	78	Master	X		X		
	2, V-F	V	29 55 30	88 33 30	4	25/06/74	86	Master		X			
	2	V	29 55 30	88 33 30	8/9	22/06/74		Master					X
3	3	V	29 53 31	88 29 49	2	17/05/74	96	Master	X	X	X	X	
	3,V-A	V	29 53 30	88 30 00	4	23/05/74	100	Master		X			
	3, V-A	V	29 53 30	88 30 00	4	24/06/74	95	Master					
4	4	V	29 47 59	88 31 21	2	17/05/74	90	Control	X		X		
	4,V-D	V	29 48 00	88 31 30	4	25/06/74	100	Control		X			
5	5	V	29 55 30	88 25 00	2	24/05/74	102	Control	X		X		
	5,V-B	V	29 55 30	88 25 00	4	24/06/74	100	Control		X		X	
6	6	V	29 58 30	88 20 58	2	24/05/74	96	Master	X		X		
	6,V-C	V	29 58 30	88 21 00	4	24/06/74	102	Master		X			
	6	V	29 58 30	88 21 00	8/9	22/06/74		Master					X

VII. STATION IDENTIFICATION INDEX

CONSEC. NO.	STATION NO.	LEASE AREA	LATITUDE N.	LONGITUDE W.	BLM CRUISE NO.	SAMPLE DATE DAY/MO./YR.	BOTTOM DEPTH (FT.)	STATION CODE	SAMPLE DESCRIPTION				
									BOXCORE SAMPLE	DREDGE SAMPLE	BOTTOM PHOTO	DIVE STATION	WATER COLUMN
7	7	V	29°55'59"	88°14'58"	2	24/05/74	105	Master	X		X		
	7	V	29 56 00	88 15 00	8/9	22/06/74		Master					X
8	8	V	30 01 30	88 11 59	2	25/05/74	78	Control	X		X		
9	9	V	29 53 30	88 12 27	2	18/05/74	102	Master	X		X		
	9	V	29 53 33	88 12 59	2		102	Master	X		X		
10	10	V	29 48 05	88 13 28	2	18/05/74	114	Control	X		X		
11	11	IV	29 43 30	87 54 29	2	25/05/74	114	Master	X		X		
	11	IV	29 43 30	87 54 30	8/9	22/06/74		Master					X
12	11-A	IV	29 53 03	87 08 20	2			Alternate					
13	12	IV	29 45 29	87 46 30	2	26/05/74	120	Control	X		X		
	12,IV-A	IV	29 45 30	87 46 30	4	26/05/74	128	Control		X		X	

VII. STATION IDENTIFICATION INDEX

CONSEC. NO.	STATION NO.	LEASE AREA	LATITUDE N.	LONGITUDE W.	BLM CRUISE NO.	SAMPLE DATE DAY/MO./YR.	BOTTOM DEPTH (FT.)	STATION CODE	SAMPLE DESCRIPTION				
									BOXCORE SAMPLE	DREDGE SAMPLE	BOTTOM PHOTO	DIVE STATION	WATER COLUMN
14	13	IV	29°38'30"	87°44'59"	2	28/05/74	114	Master	X		X		
	13, IV-B	IV	29 38 30	87 45 00	4	27/05/74	115	Master		X		X	
15	14	IV	29 35 57	87 48 03	2	29/05/74	114	Master	X		X		
	14, IV-C	IV	29 36 00	87 48 00	4	29/05/74	120	Master		X		X	
	14	IV	29 36 00	87 48 00	8/9	22/05/74		Master					X
16	15	IV	29 30 29	87 47 00	2	29/05/74	174	Control	X		X		
17	16	IV	29 40 29	87 37 01	2	27/05/74	120	Control	X		X		
	16, IV-F	IV	29 40 30	87 37 00	4	29/05/74	120	Control		X		X	
18	17	IV	29 36 30	87 26 57	2	30 05 74	216	Master	X		X		
	17, IV-E	IV	29 36 30	87 27 00	4	29/05/74	225	Master		X			
	17	IV	29 36 30	87 21 00	8/9	22/05/74		Master					X
19	18	IV	29 33 01	87 24 00	2	29/05/74	270	Control	X		X		
	18, IV-D	IV	29 33 00	87 24 00	4	29/05/74	310	Control		X			
20	19	IV	29 36 19	87 23 25	2	30/05/74	270	Control	X		X		

VII. STATION IDENTIFICATION INDEX

CONSEC. NO.	STATION NO.	LEASE AREA	LATITUDE N.	LONGITUDE W.	BLM CRUISE NO.	SAMPLE DATE DAY/MO./YR.	BOTTOM DEPTH (FT.)	STATION CODE	SAMPLE DESCRIPTION				
									BOXCORE SAMPLE	DREDGE SAMPLE	BOTTOM PHOTO	DIVE STATION	WATER COLUMN
21	20	IV	29°37'48"	87°22'56"	2	30/05/74	280	Control	X				
22	21	III	29 58 59	86 23 01	2	31/05/74	168	Control	X				
23	22	III	29 48 53	86 24 15	2	31/05/74	270	Control	X				
	22, III-B	III	29 49 30	86 25-30	4	03/06/74	200	Control		X			
24	23	III	29 54 31	86 17 33	2	01/06/74	210	Master	X		X		
25	24	III	29 51 00	86 18 29	2	31/05/74	210	Master	X		X		
26	25	III	29 46 01	86 18 28	2	07/06/74	264	Master	X		X		
27	26	III	29 54 00	86 15 30	2	02/06/74	186	Master	X		X		
	26	III	29 54 00	86 15 30	8/9	22/06/74		Master					X
28	27	III	29 48 00	86 15 29	2	07/06/74	222	Master	X		X		

VII. STATION IDENTIFICATION INDEX

CONSEC. NO.	STATION NO.	LEASE AREA	LATITUDE N.	LONGITUDE W.	BLM CRUISE NO.	SAMPLE DATE DAY/MO./YR.	BOTTOM DEPTH (FT.)	STATION CODE	SAMPLE DESCRIPTION				
									BOXCORE SAMPLE	DREDGE SAMPLE	BOTTOM PHOTO	DIVE STATION	WATER COLUMN
29	28	III	29°42'59"	86°15'30"	2	06/(6/74	219	Master	X		X		
30	29	III	29 56 04	86 12 26	2	02/(6/74	150	Master	X		X		
31	30	III	29 45 59	86 12 30	2	06/(6/74	156	Master	X		X		
32	31	III	29 47 58	86 09 30	2	06/(6/74	135	Master	X		X		
33	32	III	29 42 59	86 09 29	2	05/(6/74	138	Master	X		X		
	32	III	29 43 00	86 09 30	8/9	22/(6/74		Master					X
34	33	III	29 37 59	86 10 29	2	05/(6/74	228	Control	X		X		
35	34	III	29 55 59	86 06 30	2	02/(6/74	114	Control	X		X		
	34, III-A	III	29 56	86 06 30	4	03/(6/74	124	Control		X		X	
36	35	III	29 51 00	86 06 29	2	06/(6/74	120	Master	X		X		
	35, III-C	III	29 51 00	86 06 30	4	04/(6/74	129	Master		X		X	

VII. STATION IDENTIFICATION INDEX

CONSEC. NO.	STATION NO.	LEASE AREA	LATITUDE N.	LONGITUDE W.	BLM CRUISE NO.	SAMPLE DATE DAY/MO./YR.	BOTTOM DEPTH (FT.)	STATION CODE	SAMPLE DESCRIPTION				
									BOXCORE SAMPLE	DREDGE SAMPLE	BOTTOM PHOTO	DIVE STATION	WATER COLUMN
37	'36	III	29°45'59"	86°06'29"	2	04/06/74	132	Master	X		X		
38	37	III	29 47 59	86 03 00	2	05/06/74	132	Master	X		X		
	37,III-D	III	29 48 00	86 03 30	4	04/06/74	130	Master		X			
39	38	III	29 42 59	86 03 30	2	04/06/74	126	Master	X		X		
40	39	III	29 45 27	86 00 51	2	04/06/74	120	Master	X		X		
	39, III-E	III	29 45 30	86 00 30	4	05/06/74	135	Master		X		X	
	39	III	29 45 30	86 00 30	8/9	21/06/74		Master					X
41	40	III	29 40 29	86 00 49	2	04/06/74	120	Master	X		X		
42	41	III	29 47 29	85 54 27	2	04/06/74	102	Control	X		X		
	41, III-F	III	29 47 30	85 54 30	4	06/06/74	116	Control		X		X	
43	42	II	28 41 59	84 26 30	2	09/06/74	120	Control	X		X		
	42, II-A	II	28 42 00	84 26 30	4	09/06/74	128	Control		X		X	

VII. STATION IDENTIFICATION INDEX

CONSEC. NO.	STATION NO.	LEASE AREA	LATITUDE N.	LONGITUDE W.	BLM CRUISE NO.	SAMPLE DATE DAY/MO./YR.	BOTTOM DEPTH (FT.)	STATION CODE	SAMPLE DESCRIPTION: BOXCORE SAMPLE	DREDGE SAMPLE	BOTTOM PHOTO	DIVE STATION	WATER COLUMN
44	43	II	28°30'00"	84°28'00"	2	14/C6/74	147	Control	X	X	X		
45	44	II	28 26 29	84 23 21	2	15/C6/74	144	Master	X		X		
	44, II-O	II	28 26 30	84 23 30	4	18/C6/74	150	Master		X			
	44	II		84 23 30	8/9	20/C6/74		Master					X
46	45	II	28 21 00	84 23 59	2	15/C6/74	175	Master	X				
	45, II-M	II	28 21 00	84 24 00	4	18/C6/74	165	Master		X			
	45	II	28 21 00	84 24 00	8/9			Master					X
47	46	II	28 41 59	84 20 01	2	09/C6/74	120	Master	X		X		
	46, II-B	II	28 42 00	84 20 00	4	10/06/74	118	Master				X	
	46, II-B	II	28 42 00	84 20 00	4	10/C6/74	120	Master		X		X	
	46, II-B	II	28 42 00	84 20 00	4	19/06/74	120	Master		X		X	
	46	II	28 42 00	84 20 00	8/9	21/06/74		Master					X
48	47	II	28 34 00	84 20 12	2	10/06/74	117	Master	X		X		
	47, II-G	II	28 34 00	84 20 12	4	12/06/74	96	Master				X	
	47	II	28 34 00	84 20 12	8/9	21/C6/74		Master					X

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CONSEC. NO.	STATION NO.	LEASE AREA	LATITUDE N.	LONGITUDE W.	BLM CRUISE NO.	SAMPLE DATE DAY/MO./YR.	BOTTOM DEPTH (FT.)	STATION CODE	SAMPLE DESCRIPTION				
									BOXCORE SAMPLE	DREDGE SAMPLE	BOTTOM PHOTO	DIVE STATION	WATER COLUMN
49	48	II	28°29'00"	84°21'00"	2	14/05/74	132	Master	X		X		
	48,II-Q	II	28 29 00	84 21 00	4	18/05/74	140	Master		X			
	48	II	28 29 00	84 21 00	8/9	20/05/74		Master					X
50	49	II	28 24 00	84 21 00	2	15/05/74	138	Master	X	X			
	49, II-N	II	28 24 00	84 21 00	4	18/05/74	150	Master		X			
	49	II	28 24 00	84 21 00	8/9	20/05/74		Master					X
51	50	II	28 19 00	84 20 58	2	15/05/74	156	Master	X				
	50, II-L	II	28 19 00	84 21 00	4	18/05/74	165	Master		X			
	50	II	28 19 00	84 21 00	8/9	20/05/74		Master					X
52	51	II	28 31 30	84 17 59	2	10/05/74	84	Master		X	X		
	51	II	28 31 30	84 18 00	8/9	20/05/74		Master					X
53	52	II	28 13 59	84 17 32	2	14/06/74	177	Control	X		X		
	52, II-K	II	28 14 00	84 17 30	4	18/06/74	175	Control		X			
54	53	II	28 41 59	84 13 01	2	10/06/74	120	Control	X		X		

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CONSEC. NO.	STATION NO.	LEASE AREA	LATITUDE N.	LONGITUDE W.	BLM CRUISE NO.	SAMPLE DATE DAY/MO./YR.	BOTTOM DEPTH (FT.)	STATION CODE	SAMPLE DESCRIPTION				
									BOXCORE SAMPLE	DREDGE SAMPLE	BOTTOM PHOTO	DIVE STATION	WATER COLUMN
55	'54	II	28°29'00"	84°10'59"	2	10/06/74	111	Control	X	X	X		
56	55	II	27 56 33	83 52 56	2	14/06/74	144	Control	X		X		
57	56	I	28 00 38	83 44 49	2	16/06/74	126	Master	X				
	56	I	28 00 30	83 45 00	8/9	20/06/74		Master					X
58	57	I	27 57 30	83 42 29	2	16/06/74	123	Master	X				
	57		27 57 30	83 42 30	8/9	20/06/74		Master					X
59	58	I	27 47 58	83 41 32	2	13/06/74	141	Control	X	X	X		
60	59	I	27 55 00	83 39 29	2	16/06/74	114	Master	X	X			
	59	I	27 55 00	83 39 30	8/9	20/06/74		Master					X
61	60	I	28 01 00	83 35 30	2	16/06/74	102	Control	X				
	60, I-E	I	28 01 00	83 35 30	4	17/06/74	102	Control		X		X	
	60	I	28 01 00	83 35 30	8/9	20/06/74		Control					X

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CONSEC. NO.	STATION NO.	LEASE AREA	LATITUDE N.	LONGITUDE W.	BLM CRUISE NO.	SAMPLE DATE DAY/MO./YR.	BOTTOM DEPTH (FT.)	STATION CODE	SAMPLE DESCRIPTION				
									BOXCORE SAMPLE	DREDGE SAMPLE	BOTTOM PHOTO	DIVE STATION	WATER COLUMN
62	61	I	27°52'31"	83°33'56"	2	17/06/74	108	Master	X				
	61,I-D	I	27 52 30	83 34 00	4	17/06/74	109	Master		X		X	
	61	I	27 52 30	83 34 00	8/9	20/06/74		Master					X
	M2(002)		27 52 00	83 34 00	1	13/05/74		Master					X
63	62	I	27 50 01	83 30-59	2	17/06/74	111	Master	X				
	62, I-B	I	27 50 00	83 31 00	4	16/06/74	114	Master		X		X	
	62	I	27 50 00	83 31 00	8/9	20/06/74		Master					X
64	63	I	27 56 00	83 27 29	2	17/06/74	99	Control	X				
	63	I	27 56 00	83 27 30	8/9	20/06/74		Control					X
65	64	I	27 50 00	83 25 00	2	17/06/74	99	Master	X				
	64, I-C	I	27 50 00	83 25 00	4	16/06/74	100	Master		X		X	
	64	I	27 50 00	83 25 00	8/9	20/06/74		Master					X
66	65	I	27 45 30	83 25 30	2	13 06 74	138	Control	X		X		
	65, I-A	I	27 45 30	83 25 30	4	15/06/74	100	Control		X		X	
67	146,II-C	II	28 41 00	84 23 18	4	11/06/74	125	Alternate				X	
68	147,II-E	II	28 38 18	84 13 54	4	11/06/74	80	Alternate				X	

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CONSEC. NO.	STATION NO.	LEASE AREA	LATITUDE N.	LONGITUDE W.	BLM CRUISE NO.	SAMPLE DATE DAY/MO./YR.	BOTTOM DEPTH (FT.)	STATION CODE	SAMPLE DESCRIPTION				
									BOXCORE SAMPLE	DREDGE SAMPLE	BOTTOM PHOTO	DIVE STATION	WATER COLUMN
69	151,II-H	II	28°32'06"	84°18'54"	4	12/06/74	110	Alternate				X	
70	246, II-D	II	28 38 06	84 19 06	4	11/06/74	125	Alternate				X	
71	247, II-F	II	28 36 18	84 19 42	4	11/06/74	98	Alternate				X	
72	251, II-J	II	28 32 54	84 16 24	4	12/06/74	90	Alternate				X	
73	451, II-S	II	28 33 18	84 15 54	4	20/06/74	105	Alternate				X	
74	141, III-G	III	30 01 30	85 54 54	4	06/06/74	91	Alternate				X	
75	A2(102)		27 37 00	83 35 30	1	13/05/74		Alternate					X
	A2(102)				5		56	Alternate					X
76	M3(003)	I	27 56 00	83 43 00	1	14/05/74		Master					X
	M3(003)	I	27 56 00	83 44 00	5	01/06/74	125	Master					X

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CONSEC. NO.	STATION NO.	LEASE AREA	LATITUDE N.	LONGITUDE W.	BLM CRUISE NO.	SAMPLE DATE DAY/MO./YR.	BOTTOM DEPTH (FT.)	STATION CODE	SAMPLE DESCRIPTION				
									BOXCORE SAMPLE	DREDGE SAMPLE	BOTTOM PHOTO	DIVE STATION	WATER COLUMN
77	A3(103)		27°54'00"	84°11'00"	1	14/05/74		Alternate					X
78	A9(109)		27 54 00	84 17 00	1	14/05/74		Alternate					X
79	A10(110)		27 55 00	84 24 00	1	14/05/74		Alternate					X
80	C1(301)		28 13 00	84 02 30	1	14/05/74		Control					X
	C1(301)		28 13 00	84 02 00	5	02/06/74	126	Control					X
81	M4(004)	II	28 21 00	84 24 00	1	14/05/74		Master					X
	M4(004)	II	28 21 00	84 25 00	5	03/06/74	194	Master					X
82	M5(005)	II	28 29 00	84 21 00	1	15/05/74		Master					X
	M5(005)	II	28 29 00	84 21 00	5	04/06/74		Master					X
83	M6(006)	II	28 43 00	84 20 00	1	15/05/74		Master					X
	M6(006)	II	28 43 00	84 22 00	5	05/06/74	115	Master					X
84	C2(302)		29 23 00	85 49 30	1	15/05/74		Control					X
	C2(302)		29 28 00	85 50 00	5	28/05/74	131	Control					X

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CONSEC. NO.	STATION NO.	LEASE AREA	LATITUDE N.	LONGITUDE W.	BLM CRUISE NO.	SAMPLE DATE DAY/MO./YR.	BOTTOM DEPTH (FT.)	STATION CODE	SAMPLE DESCRIPTION: BOXCORE SAMPLE	DREDGE SAMPLE	BOTTOM PHOTO	DIVE STATION	WATER COLUMN
85	M7(007)	III	29°43'00"	86°01'00"	1	15/05/74		Master					X
	M7(007)	III	29 44 00	86 01 00	5	26/05/74	132	Master					X
86	M8(008)	III	29 44 00	86 14 00	1	15/05/74		Master					X
	M8(008)	III	29 44 00	86 13 00	5	27/05/74	161	Master					X
87	M9(009)	III	29 52 00	86 15 30	1	15/05/74		Master					X
	M9(009)	III	29 52 00	86 13 00	5	28/05/74	197	Master					X
88	M1(001)	I	27 45 00	83 28 00	1	13/05/74		Master					X
	M1(001)	I	27 49 00	83 28	5	31/05/74	98	Master					X
89	M2(002)	I	27 52 00	83 34 00	1	13/05/74		Master					X
	M2(002)	I	27 52 00	83 34 00	5	11/06/74	108	Master					X
90	M15(015)	V	29 56 00	88 33 00	3	16/05/74	84	Master					X
	M15(015)	V	29 56 00	88 33 00	6/7	22/06/74		Master					X

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CONSEC. NO.	STATION NO.	LEASE AREA	LATITUDE N.	LONGITUDE W.	BLM CRUISE NO.	SAMPLE DATE DAY/MO./YR.	BOTTOM DEPTH (FT.)	STATION CODE	SAMPLE DESCRIPTION				
									BOXCORE SAMPLE	DREDGE SAMPLE	BOTTOM PHOTO	DIVE STATION	WATER COLUMN
91	M14(014)	V	29°56'30"	88°23'30"	3	17/06/74	105	Master					X
	M14(014)	V	29 56 30	88 23 30	6/7	22/06/74		Master					X
92	M13(013)	V	29 57 00	88 14 00	3	17/06/74	102	Master					X
	M13(013)	V	29 57 00	88 14 00	6/7	21/06/74		Master					X
93	C4(304)		29 33 00	88 13 00	3	17/06/74	138	Control					X
	C4(304)		29 33 00	88 13 00	6/7	21/06/74		Control					X
94	M12(012)	IV	29 46 00	87 54 00	3	18/06/74	126	Master					X
	M12(012)	IV	29 46 00	87 54 00	6/7	18/06/74		Master					X
95	M11(011)	IV	29 41 00	87 39 30	3	18/06/74	114	Master					X
	M11(011)	IV	29 41 00	87 39 30	6/7	19/06/74		Master					X
96	M10(010)	IV	29 36 00	87 25 00	3	18/06/74	240	Master					X
	M10(010)	IV	29 36 00	87 25 00	6/7	20/06/74		Master					X
97	C3(303)		29 57 00	87 10 00	3	18/06/74	168	Control					X
	C3(303)		29 57 00	87 10 00	6/7	20/06/74		Control					X

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CONSEC. NO.	STATION NO.	LEASE AREA	LATITUDE N.	LONGITUDE W.	BLM CRUISE NO.	SAMPLE DATE DAY/MO./YR.	BOTTOM DEPTH (FT.)	STATION CODE	SAMPLE DESCRIPTION				
									BOXCORE SAMPLE	DREDGE SAMPLE	BOTTOM PHOTO	DIVE STATION	WATER COLUMN
98	A4(104)		29°17'00"	87°40'00"	3	19/05/74	1200	Alternate					X
	A4(104)		29 17 00	87 40 00	6/7	28/05/74		Alternate					X
	A4				5		52	Alternate					X
99	A5(105)		29 17 00	88 26 00	3	19/05/74	216	Alternate					X
	A5(105)		29 17 00	88 26 00	6/7	29/05/74		Alternate					X
100	A6(106)		29 20 00	88 45 00	3	20/05/74	168	Alternate					X
	A6(106)		29 20 00	88 45 00	6/7	30/05/74		Alternate					X
101	A7(107)		28 55 00	88 50 00	6/7	29/05/74		Alternate					X

III. FIELD AND LABORATORY TECHNIQUES

III. FIELD AND LABORATORY TECHNIQUES

During the investigation, nine different cruises were employed in order to adequately sample the proposed lease areas within the limited time constraints. A number of sample types were duplicated by different cruises. This overlapping of sampling programs allowed particular sample types to be collected over the large area within the same time period. The following field techniques section, though not indicating what sample methods were duplicated among the cruises, does adequately describe each sample methodology. The subsequent laboratory techniques section describes all major materials and methods utilized for each type of sample analysis.

A. FIELD TECHNIQUES

1. STD STATIONS

STD lowerings were made to within a few meters of the bottom using a battery powered Model 9060 STD unit. All lowerings were made according to EGMEX 1970 Instructions for Sampling with Model 9060 STD Unit. Each cast was calibrated by one of two methods. The first method utilized two 1.7-liter Niskin bottles equipped with protected reversing thermometers. For each cast one bottle was set at one meter depth and the other set just above the STD unit. The second calibration method placed no bottles on the STD cast. Immediately prior to each STD cast a three-bottle hydrocast (using 30-liter Niskin bottles equipped with protected reversing thermometers) was executed and samples drawn from one meter, middle, and bottom depths. Both methods relied on the reversing thermometer readings, and salinity samples taken out of each bottle (NOTE: Instructions for Sampling Oxygen and Salinity).

2. XBT STATIONS

XBT-T10 probes were launched at every station and at the discretion of the Chief Scientist. Surface temperatures were taken with bucket thermometers for calibration. In instances where the XBT recorder was not adjusted for the T-10 probes, a correction was applied to the traces for depth discrepancies.

3. 30-LITER NISKIN BOTTLE CASTS

On each station a three-bottle cast was executed. Samples

were obtained from one meter, mid-depth, and several meters from the bottom. If a thermocline existed (illustrated by XBT/STD data) the middle depth sample was placed at the thermocline depth. From the 30-liter bottles, samples were drawn for the following:

a. Phytoplankton

A 20-liter water sample was filtered through 20 micron mesh screen (Nytex) to separate "net" plankton from nanno plankton. The "net" plankton collected on the screen was washed into glass bottles and preserved with a buffered formalin. For nanno plankton, a pre-determined portion of the above filtrate was passed through 0.45 micron millipore filter which was desiccated until analyzed.

b. Chlorophyll

Three one-liter samples were filtered through GF/A glass fiber filters and frozen. The samples were returned to a shore laboratory for analysis.

c. Dissolved Oxygen

Two 300 milliliter water samples were taken from Niskin bottles at each depth and 2.0 milliliters of manganous sulphate reagent and 2.0 milliliters of potassium iodide solution were added to each 300 milliliter B.O.D. bottle. The bottles were sealed with tape and placed in boxes for transport to shore.

d. ATP

Two 1000 milliliter water samples were taken from Niskin bottles at each depth and filtered through 0.45 μ millipore filters. The filters were placed immediately in boiling TRIS buffer in order to "fix" the ATP. Following a ten minute period of boiling, the TRIS containing ATP and the filter were transferred to Whirl-paks and frozen for later analysis.

e. Dissolved Micronutrients

One hundred milliliters of sea water were filtered through pre-washed 0.4 micron Nucleopore filters. The filtrate was stored in polypropylene bottles and frozen for later analysis under the direction of K. R. Fanning at the University of South Florida.

f. Fix - 1 gal. Water Samples for the Identification of Plankton

Approximately one gallon of sea water was fixed in 4% buffered formalin.

g. Dissolved Low Molecular Weight Hydrocarbon

Sample bottles, which had been pre-cleaned and fitted with ground glass stoppers, were over-filled with 1000 milliliters of water and poisoned with sodium azide. The ground glass stoppers were inserted and secured with tape. The sample bottles were cleaned just before the cruise by washing with tap water, hydrochloric acid followed by tap water, washed with distilled water, and

then finally washed with acetone.

h. Particulate and Dissolved Organic Carbon

To avoid contamination from internal rubber closures, all Niskin bottles used were fitted with metal springs. One-liter samples were filtered through precombusted glass fiber filters. The filters were then placed in precombusted glass ampoules, covered with aluminum foil, and frozen for later analysis. One hundred to three hundred milliliter aliquots of the above filtrate were placed into acid-washed, screw cap glass bottles fitted with Teflon cap liners. The filtrate was poisoned with $HgCl_2$ and then frozen for later analysis.

i. Particulate and Dissolved High Molecular Weight Hydrocarbons

Samples were drawn into acid/$CHCl_3$ cleaned stainless steel containers. Forty to sixty liters (for each sample) were filtered through precombusted glass fiber filters housed in a stainless steel Millipore filter holder. The filters were folded into precombusted aluminum foil and frozen. Forty liters of filtrate from above was drawn into acid/$CHCl_3$ cleaned stainless steel containers, poisoned with 20 milliliters of $CHCl_3$ and returned to the shore laboratory for analysis.

j. Particulate and Dissolved Trace Metals

The 30-liter Niskin bottles, equipped with internal

rubber closures, were attached to a wire rope which was sheathed with polyethylene. As the wire went out it was cleaned with chloroform. The Niskin bottles were allowed to flush for five minutes. Seawater was transferred from the Niskin bottles into acid washed, 20-liter Nalgene carboys via Teflon tubing. The carboys were rinsed with the seawater sample before being filled. Samples were immediately transferred to the laboratory where the filtration procedure was performed.

To separate trace metals associated with particulate matter from those associated with very finely divided "colloidal" particles and from those in solution, all water samples were filtered immediately through 47 mm diameter, 0.4 μ pore size, Nuclopore membranes enclosed in inline filter holders. Water from each 30-liter Niskin bottle was gravity fed from polyethylene reservoirs to all plastic inline, Millipore filter holders with silicone rubber tubing. Two liters of the filtrate (less than two liters were obtained in most cases) from each sample were captured in scrupulously clean, one-liter, high-density, polyethylene bottles and acidified with 1.0 milliliters of concentrated nitric acid. These bottles were tightly capped and stored. After filtration was completed, the Nuclopore membranes were rinsed with 25 milliliters of

dionized water. The inline filters were then transferred immediately to polyethylene bags, sealed, and stored at 5°C. One ml of concentrated nitric acid was added to each bottle of filtrate for dissolved trace metals before storage.

4. ZOOPLANKTON TOWS

At each station, three to five 15-minute and one 1-hour oblique tows, within specific depth ranges (surface, mid-depth, and bottom waters), were taken using ½ meter diameter Nytex nets of 202 micron mesh size equipped with double-trip mechanisms and flowmeters. All tows were taken while drifting from the leeward side of the vessel. Upon retrieval, the flowmeters were read and the nets thoroughly washed down from the outside of the net.

The contents of the cod-end from the 15-minute tows were drained through 20 micron Nytex netting, transferred to glass jars, and preserved in a 5% buffered formalin solution for later identification and statistical analysis.

For the one-hour plankton tow, acid-washed glass jars were used for cod-ends and the wire was wiped clean with chloroform. This was done to keep the contamination from metals to a minimum. Upon retrieval, the sample was split using a Folsom plankton splitter.

A ¼ split of the sample was drained on 20 micron Nytex netting, blotted as dry as possible, and a displacement volume determined.

This portion was then preserved in 5% buffered formalin for later identification and statistical analysis.

The remaining 3/4 portion of the sample was split in half. One half, a 3/8 split of the total sample, was drained on acid-washed 20 micron Nytex netting, placed in acid-washed, pre-weighed glass jars, and frozen. This split is to be used for biomass and trace metals determinations.

The other 3/8 portion was immediately placed in glass vials with Teflon-lined caps and frozen for later hydrocarbon analysis.

5. C_1 TO C_5 DISSOLVED HYDROCARBONS

A hydrocarbon sniff unit measuring C_1 to C_5 dissolved hydrocarbon concentrations was successfully towed behind the ship for the duration of the cruise. The sensor readouts were recorded every five minutes and MAFLA station numbers were assigned to the appropriate readout values. The established cruise track sampled a number of MAFLA stations in each of the five lease areas.

6. BOXCORE BENTHIC STUDY

At each station bottom photographs were taken using a remote system before boxcoring was begun; thus the bottom was undisturbed and technicians used the remaining time to develop the film. Equipment consisted of an EG&G Model 200-210A camera-100 wsec strobe combination. Exposures were accomplished with the camera oriented normal to about 2m above bottom - giving coverage of approximately $2.5m^2$. The camera film used produced black and white negatives.

Boxcoring was attempted at each of the sixty-five benthic stations, but when sediment was too thin for successful coring, Capetown dredging was employed. Initially, ten cores were taken at each station, as described in the MAFLA contract, but after sediment was removed for geological analysis from Core A, there was not sufficient sediment remaining for hydrocarbon analysis. Consequently, an additional core (A') was taken to provide the necessary sediment for hydrocarbon analysis.

After each boxcore was aboard, the core top was photographed in color with a Honeywell Pentax SLR camera with flash fixed on a frame. A vane shear measurement was taken using a hand-held unit. A side view color photograph was then taken. Each photograph includes an identification tag, a color code scale, a linear scale, and designation of the top of the core. Finally, a 5 cm deep sub-core was taken of nine cores for archiving for future standard sedimentary analyses.

One boxcore at each station was subsampled with a 10 cm deep sub-core for sediment archiving. In addition to photography and visual description, a 2 cm x 6.5 cm x 20 cm slab was taken from this core which was x-radiographed for sedimentary structures, especially those caused by burrowing organisms. An epoxy relief peel was also taken for detailed substrate characterization.

Each core was further sampled or treated as follows:

Core A: 5 cm diameter subcore for sediment analysis

Core A : 3 kg sediment for hydrocarbon analysis; 3 kg sediment for chemical archiving.

Core B: 10 cm core for sediment archiving, sieving of remaining sediment for key dominant macrofauna to frozen for trace metal or hydrocarbon analysis or preserved for histopathological archiving; temperature of sediment recorded.

Core C: 1 cc of sediment for ATP analysis; 2 cm diameter subcore for foraminifera; 3 cm diameter subcore for micromolluscs; sieving for infaunal community structure.

Core D: Subcore for foraminifera; subcore for micromolluscs, sieving for infaunal community structure.

Cores E, F, G, H, I and J: Sieving for infaunal community structure.

7. DIVE/DREDGE EPIBENTHIC STUDY

The sample sites varied in depth from 20 to 140 meters. Surveys executed by diver scientists using SCUBA were limited to depths of 45 meters. Deeper sites were sampled by Capetown dredging.

a. Dive Stations

Two to three dives were performed at each dive station with the exception of a few stations in Areas IV and V where one dive pair was sufficient to document a "zero visibility" condition. The dives were designed around

no-decompression time limitations; however, decompression dives were performed on occasion, as a matter of necessity and safety. Benthic photographs were taken with standard NIKONOS II cameras equipped with 35 mm and 28 mm lenses and coupled with SUBSEA 150 strobes. Movies were taken with a NIKON Super 8 movie camera in a GIDDINGS housing equipped with a 100 watt GIDDINGS light. Quantitative measurements were recorded by using a portable 5 M^2 frame. Each dive pair randomly set the frame on the bottom and documented species diversity and abundance through photography, counts, and specimen collection. The dive groups were coordinated in such a way as to prevent the succeeding dive teams from resampling an area already described.

Quantitative measurements were not recorded on the Florida Middle Ground reefs in Area II due to the limited dive times (no decompression dive plans) coupled with the large species diversity and individual abundance. Emphasis was placed on photography and specimen collections with special attention given to coelenterates, sponges, molluscs and algae. Quantitative estimates of sponges were made for one site, and of gorgonians at another site.

b. Dredge Stations

Capetown dredging was executed using 10-minute tows. The

dredge was brought on board and emptied onto a 4'x8' sorting board which was systematically prescrubbed with detergent and seawater before each haul. All dredge hauls were carefully sorted for differing species; excessive individuals were returned to the sea due to spatial and temporal considerations. Fish collected were preserved in 10% formalin buffered with calcium carbonate. The majority of the invertebrates were preserved in 70% Ethanol or 50% Isopropanol.

c. On-board Processing for Chemical Analysis

Pelagic Sargassum and associated communities were sampled, depending on availability, for hydrocarbon analyses. Samples were bagged, labeled and frozen.

Collections of the dominant benthic invertebrates were made at each station, either by dredging or diving, and divided among samples for hydrocarbon, trace metals, and histological analyses. The samples for hydrocarbon and trace metal work were bagged and frozen. Histological samples were fixed in Dietrich's fluid. Tentative identifications were made of all samples.

Benthic algae was collected by both dredging and diving when encountered throughout the areas. These collections were preserved and labeled for future identification of material.

B. LABORATORY TECHNIQUES

1. WATER COLUMN STUDIES

The chief items for study and intercorrelation in the water column are phytoplankton, zooplankton, hydrocarbons, and trace metals. These variables were coordinated insofar as possible with the physical oceanographic framework of the MAFLA area being compiled from existing data. Multivariate techniques (MANOVA) will be employed for the analyses of physico-chemical factors in conjunction with interactions of plankton components.

a. Biota

(1) Phytoplankton Analysis: (Iverson, FSU; Woodmansee, GCRL)

(a) Chlorophyll: Frozen filters were cut into small pieces and homogenized with 90% acetone in a Sorvall homogenizer (cup immersed in an ice bath) before being processed with the spectrophotometric method given in Strickland and Parsons (1972) using the SCOR - UNESCO wave-lengths.

(b) Particulate organic carbon: Samples were processed with an Oceanography International carbon analyzer (wet combustion method).

(c) Phytoplankton identification, cell counts, cell volume measurement: Net phytoplankton species identification, cell counts, and cell volume measurement were performed using the Utermohl (1958) method for aliquots or buffered formalin-preserved samples. Where greater optical resolution

was required in species identification, cells were washed, mounted in Hyrax, and examined with a phase contrast, compound research microscope. Cell volumes were converted to cell carbon with formulas given by Mullin, Sloan, and Eppley (1966).

Permanent mounts were made of Millipore filters cleared with immersion oil; mounted filters were examined with a phase contrast, compound research microscope. Identification was carried as far as possible; however, since the nannoplankton were not well described, only rarely was identification carried past the genus level. Cell number and cell volume were determined and cell carbon was estimated with formulas given by Mullin, Sloan, and Eppley (1966).

Instrumentation: A Sorvall homogenizer, Sorvall SS-1 and International Clinical centrifuge, and a Perkin-Elmer-Coleman Model 111 spectrophotometer necessary for chlorophyll analysis were available at the Florida State University phytoplankton laboratory. An Oceanography International carbon analyzer and a Zeiss RA-38 phase contrast compound microscope were available for use at Florida State University.

(d) Phytoplankton Distribution (Woodmansee)

(1) Methods

Water samples for phytoplankton collections were obtained from each of the three "standard depths" at the master and control stations. The net fraction of the phytoplankton community was separated by filtering a known volume of about 20 liters through netting of 20 micron mesh. The nannoplankton was collected by passing a known volume of sea water which had been previously passed through 20 micron mesh netting through a 0.45 micron Millepore filter.

In the laboratory aliquots of the net fraction of the phytoplankton were allowed to settle in combination chambers for 48 hours after which the cylinders were removed and counts were made on the plate chamber using a Zeiss Invertoscope D equipped with phase contrast. The filter pads bearing the nannoplankton were cleared and mounted. Counts were made using a Zeiss Photomicroscope II equipped with phase contrast and Nomarski differential interference contrast.

(2) Volume Calculations

The procedures used in valculating the volumes for the phytoplankton were those suggested by Mullin, Sloan, and Eppley (1966). Cell volume was computed from the linear dimensions of the cells, assuming the cells to be spherical, cylindrical, or ellipsoidal in shape.

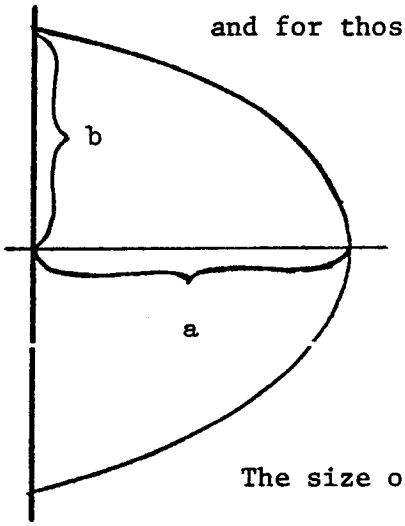
In the case of those cells assumed to be spherical, the following calculation was used:

Volume = $4/3\,\pi R^3$ R = radius

for those assumed to be cylindrical:

Volume = $R^2 H\,\pi$ R = radius
H = height

and for those assumed to be ellipsodial:



an integration of the ellipsoid shape was approximated by dividing ½ that shape into 20 cylinders and summing the volume of those cylinders and doubling for an approximation of the ellipsoid volume.

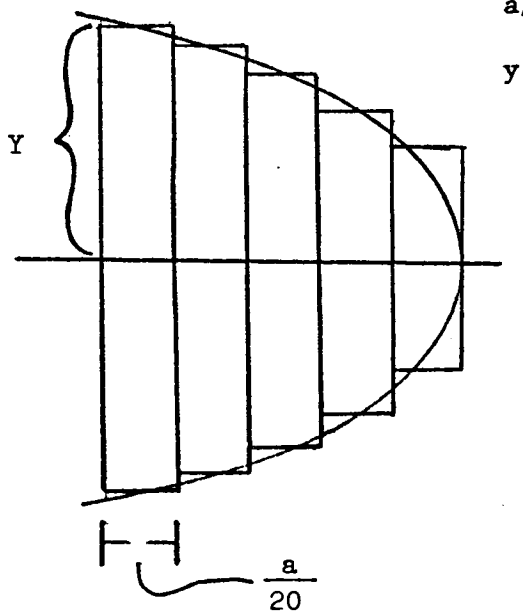
The size of the cylinders was determined by the following equation:

$$Y = \sqrt{b^2 - \frac{b^2 x^2}{a^2}}$$

where x increases from 0 to a by a/20 units

a/20 = height of cylinder

y = radius of cylinder



(e) Archiving

Until permanent facilities are obtained, all phytoplankton samples are being archived at the Gulf Coast Research Laboratory and Florida State University.

(2) Zooplankton Analysis

(a) Zooplankton Sample Processing (Maturo)

Samples from Lease Tracts I, II, and III were returned to the laboratory in Gainesville, Florida. Those from Lease Tracts IV and V were delivered to Ocean Springs, Mississippi. Each sample was split using a Folsom plankton splitter; one-half was archived and the other half split repeatedly until a subsample containing at least 200 adult copepods was obtained. A technique was used by which the sample analyst selected the split to be saved from each operation of the Folsom splitter by means of a random number table. Counting was done in a channelled counting tray.

Samples were assigned randomly to the processors. The order in which the samples were counted was also assigned randomly. The level of identification of organisms was governed by time and equipment available. The lists of the categories identified are given in Tables 1 and 2. The results of each sample count were recorded on a sheet which doubled as a coding sheet for computer card punching. Individual

analysts were tested for accuracy in identifying organisms during the sample processing.

The counted portion of each sample was gently washed with distilled water and placed in a labeled, pre-weighed aluminum weighing "boat," with a small amount of distilled water. These were then dried at 60° C until repetitive weighings remained constant, employing an analytical balance. The sample and "boat" were then weighed to determine biomass. All samples were processed simultaneously in drying ovens. Series weighings were made to adjust for hygoscopic differences.

(b) Zooplankton Sample Status

All reserve samples from Lease Tracts I, II, and III are in the possession of the University of Florida Marine Laboratory. Reserves from Lease Tracts IV and V are archived at the Gulf Coast Research Laboratory.

TABLE I

LIST OF ZOOPLANKTON CATEGORIES IDENTIFIED
IN LEASE TRACTS I, II AND III

An asterisk (*) indicates the actual category used for counts.

Phylum Protozoa
Subphylum Sarcomastigophora
Superclass Mastigophora
Class Phytomastigophorea
Order Dinoflagellida
Family Gymnodiniidae
*Pyrocystis
Superclass Sarcodina
Class Rhizopodea
Subclass Granuloreticulosia
Order Foraminiferida
*Globigerina
Class Ciliatea
*Order Tintinnida

Phylum Cnidaria
Class Hydrozoa
*Order Siphonophora
*Hydromedusae
Class Scyphozoa
*Schyphozoan medusae

Phylum Annelida
Class Polychaeta
*Polychaete larvae

Phylum Mollusca
Class Gastropoda
*Gastropod viligers
Subclass Opistobranchia
Order Thecosomata
Suborder Euthecosomata
Family Cavolinidae
*Cavolina longirostris
*Clio species
*Creseis virgula
Family Limacinidae
*Limacina leseuri
*Limacina inflata
*Other Thecosomata
Order Mesogastropoda
*Heteropods
Class Bivalvia (Pelecypoda)
*Bivalve larvae
*Class Cephalopoda

*Trochophore larvae

TABLE I contd.

Phylum Arthropoda
- Class Crustacea
  - Subclass Branchiopoda
    - Order Diplostraca
      - *Suborder Cladocera
  - *Subclass Ostracoda
  - Subclass Copepoda
    - Order Calanoida
      - *Candacia curta
      - *Centropages furcatus
      - *Eucalanus elongatus
      - *Eucalanus species
      - *Euchaeta marina
      - *Mecynocera clausii
      - *Pontella species
      - *Rhincalanus cornutus
      - *Scolecithrix danae
      - *Temora species
      - *Undinula vulgaris (female)
      - *Undinula vulgaris (male)
      - Other calanoids
      - Calanoid copepodites
    - Order Harpacticoida
      - *Harpacticoids
      - *Harpacticoid copepodites
    - Order Cyclopoida
      - *Copilia mirabilis (female)
      - *Copilia mirabilis (male)
      - *Copilia quadrata (female)
      - *Copilia quadrata (male)
      - *Corissa species
      - *Corycaeus species
      - *Farranula species
      - *Oithona species
      - *Oncaea species
      - *Sapphirina species
      - *Vettoria species
      - *Other cyclopoids
      - *Cyclopoid copepodites
      - *Copepod nauplii
  - Subclass Cirripedia
    - *Barnacle larvae
  - Subclass Malacostraca
    - Superorder Hoplocarida
      - Order Stomatopoda
        - *Stomatopod larvae
    - Superorder Peracarida
      - *Order Mysidacea
      - *Order Amphipoda
    - Superorder Eucarida
      - *Order Euphausiacea
      - *Order Decapoda

TABLE I contd.

Suborder Natantia
Section Penaeidea
Family Sergestidae
Subfamily Luciferinae
*Lucifer faxoni
*Lucifer mysis
*Other shrimp-like forms
Suborder Reptantia
Section Macrura
Superfamily Scyllaridea
*Phyllosoma larvae
Section Brachyura
*Crab zoea
*Crab megalops
*Section Anomura
*Other Crustacea

Phylum Echinodermata
*Echinoderm larvae

Phylum Chaetognatha
*Sagitta enflata
*Sagitta hispida-helena complex
*Sagitta tenuis-bipunctata complex
*Other chaetognaths

Phylum Chordata
Subphylum Urochordata
Class Thaliacea
*Order Doliolida
*Order Salpida
*Other Thaliaceans
Class Larvacea
*Family Oikopleuridae
*Family Fritillaridae
*Other larvaceans
Subphylum Vertebrata
Class Osteichthyes
Subclass Actinopterygii
Superorder Teleostei
*Fish eggs
*Fish larvae

*Other zooplankters

TABLE II
LIST OF ZOOPLANKTON CATEGORIES IDENTIFIED
IN LEASE TRACTS IV AND V

Copepods
- Acartia
- Calanus
- Centropages
- Colycaeus
- Eucalanus
- Euchaeta
- Eaterpina
- Oithona
- Oncaea
- Paracalanus
- Temora
- Undinula
- other calanoids
- other cyclopoids
- other harpacticoids
- nauplii

Other Forms
- cladocera
- ostracods
- amphipods
- zoea
- appendicularians
- salps
- gastropod veligers
- pelecypod veligers

Sagitta
- hydromedusae
- siphonophores
- fish eggs
- foraminifera

Pyrocystis
Ceratium
Lucifer
Mysid

(3) Total Living Biomass (including microbial) Analysis: (LaRock, FSU)

In order to obtain total living biomass in the water column, microbial biomass must be determined in addition to phytoplankton and zooplankton biomass. We have used the ATP technique.

(a) Extraction of ATP

Extraction was done by adding 5 ml of 0.6N H_2SO_4 (5C) to each sediment sample, and mixing the tubes on a vortex mixer intermittently at 10-sec. intervals for a total of 60 seconds. Longer vortex mixing did not enhance recovery. The tubes were then allowed to settle for 10 minutes. An internal standard consisting of 1 ml of 100 ng/ml ATP was added to one of the triplicate samples, and 1 ml of TRIS buffer to the remaining two samples. The sediments were vortex mixed for an additional 10 seconds and then centrifuged for five minutes at 1800 x g. After centrifugation, four ml of the supernatent was transferred to a 10 ml beaker, followed by addition of 1 ml of a 0.048M (18 g/1) solution of the disodium salt of ethylenedinitrilo-tetracetic acid (EDTA), made up in TRIS. The pH of the acid extract was adjusted to 7.8 with NaOH using a Corning

476050 combination electrode. TRIS has been reported to interfere with the accuracy of some electrodes (Sigma Chemical Company) but no effects were discernible at the molarity used. After neutralizing, the sample was quantitatively transferred to a calibrated test tube, the volume brought up to 10 ml with TRIS and frozen for subsequent analysis.

In assaying the acid-extracted ATP samples, a standard curve prepared in TRIS cannot be used to calculate final ATP concentrations. A series of ATP standards for acid-extracted samples was prepared at the same time the environmental samples were extracted. These standards were prepared by mixing 3 ml of 0.6N H_2SO_4, 1 ml of 0.048M EDTA solution and 1 ml of the desired ATP standard, neutralizing with NaOH and adding TRIS for a final volume of 10 ml. The standards covered a range of 0.3-50 ng ATP/ml and were frozen along with the extracted samples to be assayed by the bioluminescent reaction.

Boiling TRIS extractions were used for comparative purposes in a number of experiments with Escherichia coli purchased from the American Type Culture Collection (ATCC 11775). The cells were either collected on a

membrane filter (0.45 um) under 10 psi vacuum or 0.1 ml of cell suspension was added directly to the TRIS extractant. Sediments, sand or bacteria-coated glass beads were put directly into the TRIS. In all cases, the sample was added to 10 ml of boiling TRIS buffer contained in a calibrated 25 mm OD screw cap tube. The TRIS was maintained at 100C by an oil bath at 120 C. The sample was boiled for 10 minutes in the TRIS, cooled in an ice bath, and the volume restored to 10 ml with additional TRIS. The extract was frozen until assayed. The TRIS used in sample extraction and analysis was prepared as 0.1M and stored in a refrigerator to prevent spoilage. Just before use, the TRIS was diluted to 0.025M.

In one experiment, glass beads were coated with bacteria to determine the effects of the solid phase on efficiency of ATP extraction. Resting cells of E. coli were harvested from nutrient agar plates and washed three times with sterile 0.85% NaCl. The suspension was adjusted to an optical density of 0.3 with sterile NaCl solution, yielding a final cell density of 2×10^8 cells/ml. One-half ml of the washed cell suspension was added to 2 g of 0.5 mm diameter glass beads, mixed, and allowed to air dry. The entire 2 g of bacteria-coated beads were then

extracted using both the boiling TRIS and the H_2SO_4 procedures.

(b) The Bioluminescent Reaction and Its Measurement

The luciferin-luciferase mixture used in our work was prepared by reconstituting each vial of lyopilized firefly lantern extract (Sigma Chemical Company, FLE-50) with 12.5 ml distilled water, 7.5 ml of 0.1M arsenate buffer (Sigma Chemical Company, FF-AS-100) and 5 ml of 0.05M magnesium sulfate. The enzyme was allowed to stand for between 6-7 hours at 23-25°C, in order to remove endogenous ATP. After aging, the preparation was filtered (Whatman #2) to remove residual debris. After clarification and during use, the enzyme was kept in an ice bath. One-half ml of enzyme was used for each ATP assay permitting about 45 assays at an approximate cost of 3-4 cents per assay.

In our work the emitted light from the firefly reaction was measured on a manual liquid scintillation counter (LSC) (Nuclear Chicago model 4534). For ATP analysis, the scintillation counter was operated in a non-coincident mode using one photomultiplier tube (Schram 1970), and with a maximum window opening of 0.5 to 10.0 volts. For analysis 1 ml of either the sample extract or the ATP standard was added to a chronic acid washed LSC vial, followed by addition of

0.5 ml of 0.025M TRIS buffer (pH 7.75). Next, the vial was closed and 0.5 ml of the enzyme preparation injected into the vial through a small hole drilled in the cap. The vial was immediately inserted into the LSC and exactly one minute after enzyme injection, a 0.1 minute count was taken. This count is an integral measurement of the area under the luminescent decay curve between 60 and 66 seconds after the start of the reaction. For each enzyme preparation, a standard curve was made by plotting the logarithm of the integral count rate versus the logarithm of the appropriate ATP concentration. Standard solutions containing 1 mg/l disodium crystalline ATP (Sigma Chemical Company, A 3127) in 0.025M TRIS buffer, were prepared and stored frozen in 10 ml aliquots. When needed, the concentrated solution was diluted in TRIS or the acid extracting menstruum to cover a range of 0.3 to 50 ng/ml ATP.

b. Chemistry

All samples collected in the water column for hydrocarbons (greater than C_{14}) and trace metal analysis were collected aboard the R/V TURSIOPS (Areas I, II and III) and the R/V GULF RESEARCHER (Areas IV and V). The collection of samples for nutrient analysis and dissolved low molecular weight hydrocarbons (C_1 - C_3) were collected aboard the R/V BELLOWS (Areas I, II, and III) and the R/V GULF RESEARCHER (Areas IV and V).

(1) Hydrocarbon analysis: (Calder, FSU; Sackett,TAMU; and Pierce, USM)

(a) Zooplankton hydrocarbon analysis ($> C_{14}$) - tar balls: Samples were thawed and, under a dissecting scope tar balls and other non-plankton materials were picked out, and the tar balls saved for hydrocarbon analysis. Plankton was dried overnight at 60°C in a tared container to obtain dry weight. The plankton was then homogenized in $CHCl_3$:MeOH-KOH (1:1) overnight. The extract was taken to small volume in a rotary evaporator under prepurified N_2 at room temperature and stored in a freezer.

Immediately before saponification, extracts were taken to dryness under prepurified N_2 at room temperature. They were then saponified overnight in 10 ml of 0.5N KOH in MeOH. An equal volume of water was added to the saponification and non-saponifiables following extraction into hexane was diluted to known volume and an aliquot taken for weight and SC^{13} determination (SC^{13} optional). Volume was reduced to 1 ml (under N_2) for column chromatography. A column of 1:5 (V/V) microneutral alumina overlying silica gel was washed with 3 column volumes of hexane. The samples were charged into the column, allowed to percolate in, and then rinsed into the column with several small volume rinses of hexane, allowing each to percolate into the column. Aliphatic hydrocarbons were eluted with five column-volumes of hexane, and aromatics eluted with five volumes of benzene. Extracts were reduced to small volume in preweighed container, and analyzed by gas chromatography, using SCOT capillary columns, coated

with DEGS. Temperature programming and flame ionization detectors were utilized, and retention indices were computed based on known standards. Extracts were reduced to dryness (under N_2) and weighed.

(b) Dissolved low molecular weight hydrocarbons (C_1-C_3) Analysis: (Sackett, TAMU)

1000 ml of water were drawn into a bottle fitted with ground glass stopper. The bottle was over-filled and the stopper inserted and fixed in the bottle with tape for return to laboratory. There, dissolved light hydrocarbons were stripped from the water by applying a vacuum and the gases analyzed by flame ionization gas chromatography.

(c) Dissolved high molecular weight hydrocarbons (C_{14}) Analysis: (Calder)

Water which has been filtered to remove particulate hydrocarbons was collected in 20l stainless steel containers, poisoned with 10 ml $CHCl_3$, and then returned to a shore laboratory. There, the water was acidified to pH 2 with concentrated HCl and extracted with $CHCl_3$ in a separatory funnel or liquid-liquid extractor. Extracts from each sample were combined and reduced to small volume for storage in freezer. The extract was taken to dryness, under N_2, immediately before saponification. Saponification,

column chromatography, and gas chromatographic analysis were carried out on the extracts exactly as described under Zooplankton hydrocarbon analysis (1.a).

(d) Particulate hydrocarbons (greater than C_{14}) Analysis: (Pierce, USM)

Sixty liters of water (collected by 30L. Niskin bottle hydrocast) were filtered through precombusted glass fiber filters. The filters were frozen for return to the laboratory. There the filters were thawed and extracted three times with $CHCl_3$:MeOH (1:1) under sonication. The combined extracts were taken to a small volume in a rotary evaporator, frozen for storage, and saponified, separated on columns, and analyzed by gas chromatography as described under Zooplankton hydrocarbon analysis, with the exception of now using packed columns.

(2) Trace metal Analysis: (Betzer, USF and Segar, NOAA/AOML)

(a) Zooplankton analysis for trace metals:

The dried samples were ground with an acid-rinsed porcelain mortar and pestle; aliquots of the homogenate were transferred in a clean bench to an ali-Teflon bomb. Ten milliliters of redistilled* reagent-grade 70% nitric acid were added and the bomb sealed. (The nitric acid was redistilled in an all-quartz sub-boiling silica still at the National Oceanic and

Atmospheric Administration's Atlantic Oceanographic and Meteorological Laboratories.) The bomb was transferred to a waterbath and digested at 90°C for 58 hours. The solution was transferred from the all-Teflon bomb to a polypropylene volumetric flask and diluted to volume using double-deionized, redistilled water. The solution was analyzed for iron, chromium, nickel, vanadium, cadmium, copper, and lead on the Perkin-Elmer Model 503 atomic absorption spectrometer equipped with a Model 2100 heated graphite furnace and deuterium background corrector.

(b) Particulate trace metal Analysis: (Betzer, USF) The samples of suspended particulate matter collected at each hydrographic station were processed and analyzed as follows:

The filter pads were removed in a clean bench from the Inline filter holders and placed in polypropylene jars containing silica gel. After drying for 48 hours, the filters were weighed on the Mettler Model M5 balance so that a calculation of the mass of suspended particulate matter, which will be analyzed for trace metals, can be made (Betzer, et al, 1974).

After weighing, the filters were sealed in all-Teflon bombs and digested with aqua regia* and

hydrofluoric acid* using a modification of the methods specified in Bernas (1968) and Buckley and Cranston (1972). (In order to maximize signal to noise ratios, the acids used in the dissolution of the suspended material will either be J. T. Baker "Ultrex" grade or reagent grade acids, which have been redistilled in a sub-boiling silica still at NOAA/AOML).

The digested materials were transferred from the all-Teflon bomb to a volumetric flask and diluted to volume using double deionized, redistilled water.

This solution was then analyzed for iron. chromium. nickel, vanadium, cadmium, copper, and lead on the same Perkin-Elmer Model 503 atomic absorption spectrometer equipped with a Model 2100 heated graphite furnace and deuterium background corrector that was used to analyze the plankton and benthic samples.

Equipment Requested:

A Perkin-Elmer Model 503 atomic absorption spectrophotometer and Model 2100 heated graphite atomizer were requested so that analyses of benthic organisms, plankton and suspended matter for iron, chromium, nickel, vanadium, copper, cadmium, and lead could be completed by January 1, 1975. A fume hood was needed for the digestions of the benthic organisms which are carried out with concentrated nitric acid. The drying oven,

hot plates, and balance were all needed to help prepare the benthic organisms for atomic absorption analysis. The Eppendorf pipettes were used to inject aqueous samples into the graphite atomizer prior to excitation. The heater stirrer was needed to heat the aqua regia-hydrofluoric acid mixture, which is used to decompose the suspended particulate matter. This reaction must be carried out under pressure in Teflon bombs.

(c) Dissolved trace metals Analysis: (Segar, NOAA/AOML)

The filtered samples of sea water from the West Florida Shelf were analyzed for concentrations of dissolved iron, nickel, vanadium, copper, cadmium, lead, chromium, and barium. All of the analyses were carried out by flameless atomic absorption spectrophotometry using a Perkin-Elmer Model 503 atomic absorption spectrophotometer equipped with a Model 2100 heated graphite atomizer and a deuterium arc background corrector (Segar, 1971, 1973, 1974; Segar and Gonzales, 1972).

The samples were analyzed for barium by direct injection of 50 ml volumes of sea water into the graphite atomizer and selective volatilization analysis using standard additions for calibration. A number of the same samples were reanalyzed by ion exchange concentration of the barium (Bowen, 1956) and flameless atomic absorption.

The elements iron, vanadium, nickel, copper, cadmium, and lead were extracted from the sea water samples by methyl isobutyl ketone extraction after complexation with ammonium prollidine dithiocarbomate. After extraction the trace metals were reverted back to aqueous solution by evaporating the ketone to dryness and ashing the residue with a few milliliters of silica redistilled nitric acid.

The resulting aqueous solution was made up to a volume of 5 ml, and analysis was carried out by injections of this solution into the heated graphite atomizer (Segar, 1971, 1973, 1974). The analysis was carried out using a standard additions method similar to that used by Brewer et al. (1969). Water samples were also analyzed for some of these metals by direct injection analysis using the recently developed HGA 2100 heated graphite atomizer (Segar and Ediger, unpublished data).

Chromium was determined in the sea water samples by direct injection into the HGA 2100 (Segar and Ediger, unpublished data) and also by flameless atomic absorption spectrophotometry following concentration by extraction of its acetylacetonate into methyl isobutyl ketone (Chau et al., 1968).

(3) Particulate and dissolved organic carbon Analysis: (Kanuer, FSU)

DOC and POC were analyzed by standard methods as described in the instruction manual for the Oceanography International Carbon Analyzer Model 0524. All DOC and POC determinations were run in triplicate and averaged.

(4) Dissolved micronutrient Analysis: (Fanning, USF)

The samples were thawed and analyzed for dissolved nitrate, nitrite, phosphate plus arsenate, and silica. After analysis, the remaining portions of the samples were refrozen and stored for up to one year for archiving purposes. Stefansson and Richards (1963) demonstrated that, for low to moderate concentrations of nutrients, freezing of samples has very little effect on the measured concentration, and, according to the data from LaRock and Bittaker (1973), nutrient levels should be low enough that no freezing effects will occur.

Analyses for each of the above nutrients were conducted with a two-channel Technicon Autoanalyzer II. The methods to be used were modified from the recommendations of the Environmental Protection Agency (1971). The standards are solutions of KH_2PO_4, $NaNO_2$, and KNO_3 in deionized water and Na_2CO_3-fused SiO_2 in surface sea water. This

latter standard is required because of the salt effect on silica methods (Fanning and Pilson, 1973). Blank solutions are either deionized water or 0.7 M NaCl.

The analyses were run under the supervision of Valentine Maynard of the University of South Florida. For over three years she has been in charge of nutrient analyses by Autoanalyzer for the contracts of the Department of Marine Science at U.S.F. with the Florida Power Corporation for its estuarine surveys of power-plant sites. In addition, she has been responsible for nutrient analyses for the Mote Marine Laboratory in Sarasota and for nutrient analyses in support of projects funded by O.N.R. and N.S.F. in the deep sea. These last analyses were done both at sea and in our laboratory. Presently, our nutrient laboratory is running an average of 75 sea water samples per week for nitrate, nitrite, phosphate, silica, and ammonia.

2. BOTTOM STUDIES

a. Biota

(1) Infauna Analysis

All infaunal samples were sorted in the laboratory of Dr. Henry Kritzler at Florida State University. For this initial study, identification of infaunal polychaetes was

stressed. Polychaete worms were widely distributed in all sediment types. They were generally poorly mobile and would thus be subject to any environmental change affecting the sediments. All polychaetes from Areas I, II, and III were identified to at least the level of family by Dr. Kritzler, and those from Areas IV and V by Dr. Barry Vittor of the University of Alabama. Micromolluscs were identified to species by Dr. Don Moore of the University of Miami, and foraminifera were identified to species by Dr. Wayne Bock of the University of Miami. Benthic foraminiferans and micromolluscs were both abundant in the sediments and sensitive to the presence of hydrocarbons; thus they should be good indicator species for environmental changes brought about by oil exploitation.

After sorting of the macrofauna from each sample into taxonomic groups, the biomass of each group was determined in Dr. Kritzler's laboratory. Weights were on the basis of the preserved organisms (in 70% ethanol) corrected for shrinkage due to narcotization and preservation and converted to wet weight.

(2) Epifauna and flora Analysis (T. Hopkins, UWF)

Epifaunal and floral coverage was provided to all lease sites, but special attention was accorded to Areas I and II, with particular emphasis on the Florida Middle Ground.

This area includes a unique biological community, having a varying species composition dependent on topographic relief. The analysis of this area resulted from diver-scientists investigating 5 M^2 quadrats and developing a list-count and record of the number of species observed in-situ. Color and black and white photography has documented the community structure for post-cruise assessment and archiving purposes, including comparative studies at a future date.

Past experience suggests that key fauna considered include Poriferans, Milleporines, Actinarians, Alcyonarians, Macromolluscs, Polychaetes, Macro-decapod Crustacea, and Echinoderms. Key flora includes attached green, brown, and red algae. Careful consideration was given to epiphytes. This was possible only when diver-scientists making in-situ collections were deployed.

(3) Hydrocarbon, trace metal, and histological baseline in key dominant species analysis: (S. Betzer, USF; Meyers, U. of Mich.; Lytle, GCRL; Blake, USF)

Here, consideration was given to feeding type, sediment type, and location of the sampled communities with respect to land mass and circulation, all of which may affect exposure of and accumulation by benthic organisms (Phelps et al., 1969). Simultaneous, coordinated sampling of the benthic biota and sediments, water, and suspended matter is critical to understanding these relationships. Such

sampling allowed us to calculate concentration factors for hydrocarbon and trace metal accumulation by the organisms and will allow eventual relating of their histological state directly to the conditions they were experiencing. Continued regular sampling of the communities in the long-term phase will provide basic biological data about the organisms -- their variability in space, and changes over the year under normal environmental conditions. For hydrocarbon and trace metal analyses and archiving for histopathology, only a small number of species were chosen from those present in the diverse warm temperature and subtropical benthic communities of the shelf. The species selected represent the sessile or poorly mobile epi- and infaunal invertebrates and the flora which were found consistently and abundantly over large sections of the shelf lease areas.

(a) Hydrocarbons

Hydrocarbon analyses relate the quality and quantity of hydrocarbons in organisms to those in their environment. Certain hydrocarbons have unique sources and retain their identity despite a variety of biochemicals and geochemical transfers (Meinschein, 1969). Petroleum hydrocarbons are especially resistant to severe alteration under natural marine conditions (Blumer et al., 1973). Gas chromatographic analyses of tissues were used to demonstrate

the appearance of petroleum hydrocarbons if the organisms were exposed even to low "chronic" oil leaks.

(1) Fauna Analysis (Meyers, U. of Mich.)

Samples of benthic fauna (epifauna and infauna) were stored frozen until shipment to Michigan for analysis. Glass storage containers were used.

Analysis of the hydrocarbon content of selected benthic fauna was performed as outlined by Quinn (Farrington, et al, 1973). A known weight of tissue was extracted with benzene/methanol, 2/1. The lipid residue of this extraction was placed in a 50 ml screw-cap tube and saponified using 0.5 N KOH. Non-saponifiable lipids, including hydrocarbons, were separated by extraction into petroleum ether. Hydrocarbons were isolated from the non-saponifiables by column chromatography on alumina/silica gel columns. Aliphatic and unsaturated hydrocarbons were eluted with petroleum ether and benzene respectively.

The hydrocarbons were weighed on a Cahn Electro balance to yield the quantity of each of the two classes of carbons found in the

tissues of the organism. The hydrocarbons were injected into a flame ionization detector gas chromatograph to provide information about the relative amounts of different compounds comprising the total hydrocarbons. Varian Aerograph Model 1520-C Dual-Column Gas Chromatographs equipped with OU-101, FFAP columns, and a Hewlett Packard 5711 were used for this study.

While it was expected that many analyses of several organisms of a species were combined into one sample, it was necessary also to analyze selected individual organisms in order to evaluate the variability of the natural hydrocarbon content of the species.

(2) Flora Analysis: (Lytles, GCRL, Miss.)

Samples of benthic algae collected by dredging and/or diving were stored frozen in glass containers that had been prewashed with $CHCl_3$. At the laboratory, samples were thawed, macerated in MeOH, filtered, extracted three times in CHCl, using sonification. The combined extracts were taken to a small volume in a rotary evaporator at room temperature and washed with acidic (pH4) H_2O to remove salts. (An aliquot was taken of the lipid extracts for weight of total extractables and C^{13} determination. Immediately before

saponification, the extracts were taken to dryness under prepurified N_2 at room temperature. The extracts were saponified overnight in 10 ml of 0.5 N KOH in MeOH. An equal volume of H_2O was added after the saponification. The non-saponifiables were extracted thrice with 10 ml benzene. The volume of the non-saponifiable extract was reduced to dryness at 1 ml vol. (under N_2), taken up in hexane, and analyzed by column chromatography (1:5 V/V of microneutral alumina overlying silica gel, both activated or activity 1, after washing with 3 column volumes of hexane). The aliphatic hydrocarbons were eluted with three column volumes of hexane and the aromatic then was eluted with three column volumes of benzene. These eluted extracts were taken to dryness (under N_2) and weighed. Gas chromatographic analysis was performed using two columns, coated with SE-30 and FFAP. Flame ionization and temperature programming were employed. Retention indices based on known standards were computed.

(b) Trace metals Analysis

The analysis of trace metals (as of hydrocarbons)

offers a sensitive technique for indicating the effects of oil exploitation on the biota. Crude oils and brines from wells are greatly enriched in certain heavy metals, with concentrations up to 10^4 - 10^6 times those of sea water: nickel, vanadium, copper, lead, iron, chromium, and cadmium. Iron and chromium, as "ferrochrome," are added to drilling muds. These metals are strongly concentrated by organisms (e.g. Vinogradov, 1953; Riley and Segar, 1970; Segar, et al., 1971) and can be toxic. Analyses of organisms for these seven trace metals can thus be sensitive methods of detecting chronic sublethal effects of oil exploration. The key dominant species frozen at each benthic station were thawed, weighed (dried to constant weight), and oxidized in a fume hood with concentrated redistilled reagent-grade, purified 70% nitric acid. (Riley and Segar, 1970; Segar, et al., 1971). The solutions were diluted to volume with double-deionized water, and analyzed for Fe, Cr, Ni, V, Cd, Cu, and Phb, using a Perkin-Elmer model 503 atomic absorption unit equipped with a model 2100 heated graphite furnace and deuterium background corrector. Samples were run alternately with appropriate standards.

(c) Histopathological preparation Analysis: (Blake, USF) Close histological examination of the tissues is required to assess the importance to an organism of the presence and accumulation of hydrocarbons and trace metals. Specific changes, such as tumors, necrosis and sloughing of exposed mucosa, and amebocytic infiltration of blood vessels and gill sinuses are associated, in molluscs, with exposure to oils and trace metals (Betzer, 1972; Yevich, oral presentation, 1974). Such histological changes can provide positive evidence of environmental physiological disturbance (as opposed to the "negative" evidence often difficult to separate from sampling problems, of decreasing species numbers).

Individuals belonging to the same species selected for hydrocarbon and trace metal analysis were archived for histopathological analyses. The individuals were fixed in Dietrich's fixative at sea. Tissues were not allowed to remain in the fixative indefinitely but were further processed since fixation for periods greater than three months results in hardened tissues which are difficult to section.

Processing in the laboratory consisted of washing the tissues in tap water, dehydration with S-29,

clearing with UC-670, infiltrating with Paraplast, and embedding with Paraplast. The embedded tissues were sectioned (5-6μ) and the sections were stained with hematoxylin-eosin following the procedures developed by Paul Yevich of the National Marine Water Quality Lab at Narragansett, R.I. The prepared slides are archived in the lab of Dr. Norman Blake of the University of South Florida and are available for later examination and comparison with samples collected in the long-term monitoring phase or with samples collected from stations which become exposed to chronic low level releases or acute spills of hydrocarbons.

b. Geological Substrate

(1) Geology (Doyle, USF; Wanless, U of Mi; Mayou, USF; Tanner, FSU)

(a) Rationale

Sediments were sampled from boxcores taken for benthic studies. Box cores are generally recognized for their ability to collect undisturbed samples of bottom sediments, and to minimize common tendency of other types of samplers to deform the upper few centimeters of sediment.

(b) Archiving

All cores are archived at the Florida State University core repository under the direction of William Tanner.

(2) Chemistry Analysis (Lytle & Lytle, GCRL; Presley, TAMU)

(a) Total organic carbon (TOC) in sediments

(1) Collection: 10 cc sediment samples were removed from one of the box cores.

(2) Analysis: a weighed portion of carbonate-free, oven-dried (40°C) sediment was analyzed by the LECO carbon analyzer.

(b) Hydrocarbons

(1) Collection: a 3 Kg wet weight sediment sample was removed from the upper 10 cm. of one box core sample. The samples were placed in a $CHCl_3$ washed glass jar and frozen at sea. The remainder of the core was archived for future chemical analysis.

(2) Analysis: the frozen sediment samples were allowed to thaw in a Buchner funnel. As much water as possible was filtered off after acidification with constant boiling HCl if carbonate is present and in moderate amounts. Water removal was completed by addition of MeOH to filter cake.

The MeOH was back extracted with hexane, with the hexane saved for addition to the sediment extract. The water-free sediment was extracted

with $CHCl_3$ overnight then treated for 15 minutes with sonication and stirring. The sediment was filtered and re-extracted two additional times. The extracted sediment sample was oven-dried at 80°C to constant weight and weighed. All extracts (hexane & $CHCl_3$) were combined and reduced to a small volume in a rotary evaporator. The combined extracts were washed with water (PH 4) several times (until water remains clear) and then brought to dryness under N_2. Elemental sulfur was removed from the lipid extract by refluxing with copper wool after which the copper was washed with hexane. They were then saponified overnight in 10 ml of 0.5N KOH in MeoH after which equal volumes of water were added. The non-saponifiables were extracted 3 times with benzene (10ml).

An aliquot was taken of the non-saponifiable extract for weight and δC^{13} determination. The volume of the non-saponifiable extract was reduced to dryness (under N_2), taken up in hexane (1 ml), and analyzed by column chromatography (1:5 V/V of microneutral alumina overlying silica gel after washing with three column volumes

of hexane). The aliphatic hydrocarbons were eluted with three column volumes of hexane and the aromatics then were eluted with three column volumes of benzene. These eluted extracts were reduced to small volumes. Extracts were reduced to dryness under N_2 and weighed. Gas chromatographic analysis was performed using 1-150 ft. S.C.O.T. column coated with FFAP, and two 2 m x 1/8" FFAP and SE-30 columns. Flame ionization and temperature programming was employed. Retention indices based on known standards were computed.

(c) Trace Metals

Sediment samples from 57 locations were collected with a standard box coring device by the SUSIO group. As soon as the box core was recovered, a sub-sample was taken from it by pushing a pre-cleaned 50 cm long, 2 cm diameter plastic tube through the sediment. The sub-sample was taken from the center of the box to insure an undisturbed and uncontaminated sample. The plastic tubes containing the samples were tightly capped and stored at 5° C until the analytical work was begun. We received the samples from SUSIO on June 28, 1974.

Initial sample preparation involved drying the entire aliquot (~50 g) of wet sediment at 105° C and then reducing it to a fine powder with a porcelain lined Spex mixer-mill. Iron, lead, cadmium, nickel, copper, and chromium were determined by instrumental neutron activation analysis of the solid sample.

For total dissolution, approximately one gram of finely powdered sediment was heated in a muffle furnace at 400-450° C for eight hours to ash the organic matter present. Our observations that there is no loss of the pertinent metals on heating to 450° C confirms those of Gorsuch (1970). After heating, the samples were transferred to FEP teflon beakers and 3 ml of I^{6}N HNO_3, 5 ml of HF (48%), and 2 ml of $HClO_4$ were added. The acid-sediment mixture was heated to near dryness. A second acid mixture (3 ml HF, 2 ml $HClO_4$) was then added and again heated to dryness. The residue was redissolved in 5 ml of 5N HCl and diluted with deionized water to 25 ml.

Lead, nickel and copper were determined by direct aspiration into a Jarrell-Ash model 810, two channel atomic absorption spectrophotometer.

Iron was determined after appropriate dilution by the same technique. Background absorbance, due to molecular band absorption and light scattering, was monitored, where necessary, by simultaneously measuring the absorbance of a non-specific line and the analytical line of the element of interest. In addition, a method of additions analysis was used to check matrix effects.

Chromium and cadmium in all samples were determined by flameless atomic absorption techniques using a Perkin-Elmer 303 atomic absorption spectrophotometer equipped with an HGA-20000 graphite atomizer. In preparation for these analyses, 0.1 gram samples were dry-ashed at 450° C and transferred to screw-cap polyethylene centrifuge tubes. An acid mixture of 2 ml 12 N HCl, 2 ml aqua regia, and 2 ml HF (48%) was added to the tubes which were then sealed and heated at 90-95° C for two hours. After heating, the solutions were transferred to FEP teflon beakers and heated to dryness. The residue was redissolved with 3 ml of 4 N HCl and diluted to 50 ml with deionized water. Analysis was made by flameless atomic absorption

after the appropriate dilution (usually a 500-3000 fold dilution).

Lead, nickel, and copper were also run by flameless atomic absorption as a check on flame methods. USGS standard rocks W-1 and AGU-1 were analyzed by both flame and flameless atomic absorption to check precision and accuracy.

Instrumental neutron activation analysis was found to be more suitable than atomic absorption spectroscopy for vanadium and barium determination. Initial preparation for neutron activation involved accurately weighing approximately 0.5 gm of sediment, which had been dried at 105° C into a small 1-gm capacity polyethylene vial. The vial was heat-sealed to prevent any loss of sample during the analysis. The marked, encapsulated samples were irradiated by the 1 MW Triga reactor at the Texas A & M University Nuclear Science Center.

For vanadium analysis, each sample was irradiated separately for five minutes. This process was facilitated by a pneumatic transport system which can rapidly transfer samples in and out of the reactor core. The poly vial was placed in a secondary poly vial, together with an aluminum flux monitor, and transported to the

core for the five minute time period.

After return of the sample and a one-minute delay, the aluminum flux monitor was counted by a multichannel pulse height analyzer. After an appropriate delay period (usually 3-5 minutes, so that the dead time was $<30\%$) the irradiated sediment sample was placed on an Ortec Ge(Li) detector and counted using a separate GEOS Quarta 4096 analyzer (channel multichannel pulse height). The analyzer was set for a gain of 1.0 Kev per channel. The vanadium peak for the 51 analyzed is at 1434 Kev. After a five minute counting period, the spectrum was stored on magnetic tape.

Data reduction was done using the program HEVESY (Schlueter, 1972). The program calculates peak intensities and converts these to concentration by comparison with appropriate USGS standard rocks (DIS-2 and AGV-1). Corrections are made for varying delay times, dead times, and neutron fluxes.

For barium analysis, the sediments were irradiated for a 14 hour period. The samples were placed in aluminum Swagelok tubes along with standards and blanks and set in a rotisserie in

the reactor core. After irradiation the samples were allowed to "cool" for one to two weeks.

The irradiated samples were counted for two hours using an Ortec (Li) detector and Canberra model 8700, 1024 channel multichannel pulse height analyzer. The peak of interest was that produced by barium x-rays at 29 Kev; the gain was set so that the peak was recorded in channel 160. After the two hour counting period, the spectrum was stored on magnetic tape.

Data reduction was performed again by HEVESY using the USGS standard rock W-1 as a basis for sample concentration calculation.

(d) Sediment ATP Analysis: (LaRock)

(1) Onboard processing

The sediment samples were transferred to culture tubes and stored on ice until extraction. The ATP was extracted by mixing thawed sediment with 5 ml of 0.6N H_2SO_4 maintained at 5° C. After the sediment had settled the supernatent was recovered and stored frozen for ATP analysis.

(2) Analysis

The samples were thawed and 1 ml of the extracts were transferred to Liquid Scintillation Counter (LSC) vials. After adding buffer and luciferin-

luciferinase prepartion to the vials, the light emission was counted by the LSC during the period 1.0 to 1.1 minute following enzyme injection. The light output was compared to standard curve and the ATP concentration computed.

IV. INTERLABORATORY CALIBRATION AND QUALITY CONTROL

IV. INTER-LABORATORY CALIBRATION AND QUALITY CONTROL

The intercalibrations with the SUSIO Consortium studies were designed to provide high degrees of quality control for the biological and chemical survey of the MAFLA area. Coordinators were designated for each of the following studies; Phytoplankton- Richard Iverson, FSU; Zooplankton - Frank Maturo, UF; Benthos - Norman Blake, USF; Hydrocarbons - John Calder, FSU; Trace Metals - Peter Betzer, USF. Each of these scientists had responsibility for setting up inter-laboratory calibrations among all participating laboratories and/or co-investigators within their study. It was also their responsibility to present the results of all inter-laboratory calibrations to the scientific management committee of the SUSIO Consortium as time and resources permitted.

A. Biota

1. Water Column

a. Phytoplankton - R. Iverson (study coordinator) and R. Woodmansee

As the plankton samples were collected, several were split and processed at the two participating laboratories, Florida State University and Gulf Coast Research Laboratory. At least one sample from each of the five lease areas was treated in this manner, and the results compared and standardized.

b. Zooplankton - F. Maturo (study coordinator), G. Knauer, and R. Woodmansee.

Early in the program duplicate analyses were performed at both participating laboratories on randomly selected samples. In addition, samples were exchanged throughout the study between the Maturo and Woodmansee groups to insure continued taxonomic and counting standardization.

Four samples were selected randomly from Lease Tracts I, II, and III (MS-9-TD-N2, MS-6-TC-N2, MS-3-TC-N3, and C2-TA-N1). Both halves of the final split were counted. One half was saved in Gainesville and the other counted halves were sent to the Gulf Coast Research Laboratory.

The University of Florida Marine Laboratory received samples from Lease Tracts IV and V, (Master Station 13, Lease Tract V (0-9 meters) (N-46); Master Station 10, Lease Tract IV (0-15 meters) (N-34); and Control Station C-3-5 (0-12 meters)).

The variability of the Folsom plankton splitter has been checked previously and found to be an unbiased sample splitter. Also, the counting technique used in this study had been scrutinized and standardized to reduce sources of processing error by Maturo's group and had been published on.

Additional quality control was as follows: raw data sheets were inspected and verified for completeness (e.g. number of splits recorded, sample information complete,

etc.) prior to analysis, and data card decks were verified for accuracy.

2. Benthos - N. Blake (study coordinator), B. Vittor, H. Kritzler, T. Hopkins, W. Bock, D. Moore, H. Humm, and T. Pyle. Quality control in the benthic survey was exercised in collection of samples, standardized training of collection teams, identification of polychaetes, and chemical analyses of organisms. The polychaete samples were exchanged between B. Vittor and H. Kritzler. Members of the Florida Department of Natural Resources Marine Research Laboratory in St. Petersburg were available to verify any other identifications of other groups.

The quality of preparation of randomly selected samples from each lease area which have been archived for histopathology were verified by Paul Yevich of the Environmental Protection Agency (N.M.W.Q.L., West Kingston, R.I.).

B. Chemistry

1. Hydrocarbons - J. Calder (study coordinator), T. Lytle, J. Lytle, W. Sackett, P. Meyers, R. Pierce.

a. Standardization of methods

Principal Investigators and appropriate technical personnel gathered at Gulf Coast Research Laboratory to standardize laboratory procedures and perform practice analysis.

b. Intercalibration of laboratories

Representative samples were split among participating laboratories for analysis to confirm standardization.

The MAFLA hydrocarbon group also intercalibrated with the hydrocarbon standards circulated by the NSF-IDOE Environmental Quality Office. Once methods were standardized and reproducible among participating laboratories, analysis of environmental samples was begun. During the analysis period, samples were split and circulated among the laboratories to confirm maintenance of analytical consistency.

c. Special methods to minimize laboratory contaminations of samples

Organic solvents were double distilled in all-glass systems. Periodically, appropriate volumes of solvent were reduced to small volume and checked for trace impurities by GC analysis. KOH was heated overnight at 160° to remove hydrocarbon contaminants.

Silica gel and alumina were activated overnight at 120° and 250° respectively to remove hydrocarbons and were stored in tight containers.

All glassware was washed in detergent, rinsed with water, soaked overnight in chromic acid, rinsed with double distilled water, rinsed with double distilled hexane, and dried in an oven at 250° C before use.

2. Trace Metals - P. Betzer (study coordinator), B. Presley, and D. Segar

Members of the trace metals group standardized their analytical techniques, each using atomic absorption spectroscopy, before analysis of the samples. Two National

Bureau of Standards samples were used in the standardization: plastic clay and bovine liver. Since each of the participating laboratories had previously analyzed at lease one of these standards as a check on the analytical methods they used in other federally-funded programs, there was a successful inter-laboratory calibration.

After the analyses of the samples began, the trace metals group exchanged samples. Sediment samples were sent to each of the other participants and to a laboratory specified by BLM which then analyzed them for the same elements (iron, chromium, nickel, vanadium, copper, camium, lead). In addition, P. Betzer and S. Betzer forwarded samples of suspended matter and samples of a benthic organism which they had analyzed, respectively, to B. Presley, D. Segar, and the laboratory specified by BLM. Again, each participant analyzed each sample for the same suite of seven elements. The results of these intercalibrations were tabulated and were exchanged among the participants.

3. Dissolved Micronutrient Analysis - K. Fanning

Procedures for quality control have been applied to the dissolved micronutrient analysis techniques, including those recommended by the Environmental Protection Agency (1972).

The results of the comparison of values with EPA provided samples indicate that we are capable of providing

analytical results which are sufficiently accurate that they may be successfully compared with phytoplankton distributions and other aspects of the survey of the West Florida Shelf.

Because of the results of Johnson and Pilson (1972), we have proposed to measure only phosphate plus arsenate, and not phosphate. Their work indicates that, for low-nutrient surface water, the probability is quite high that an appreciable fraction of the material reacting in the phosphate determination is really arsenate, and the shallow waters overlying the West Florida Shelf should qualify as low-nutrient surface water according to LaRock and Bittaker (1973).

During the analyses on the thawed samples, several quality control procedures were applied. First, studies of reproducibility and standard addition were made on the actual samples as suggested by the Environmental Protection Agency (1972). Next, manual determinations of dissolved silica in some of the samples were made to compare with the automated analysis.

C. Quality Control

Listings of quality control designated samples transmitted by SUSIO investigators to the BLM, with the exception of the 24 zooplankton and six lipid-extract samples sent by FSU (January 7, 1975) and GCRL (December 16, 1974) respectively, for dissemination to BLM's non-SUSIO consortium laboratories for quality control, are as follows:

MAFLA TRACE METAL QUALITY CONTROL

(Samples In-Hand and Being Processed by Dr. Montalvo)
Report prepared on January 13, 1975

Sample	Station Number	LOCATION Coordinates Latitude-Longitude	General Area	Depth of Station	Sample Description	Trace Metal Investigation
11	WC-6-M	Lt. 28° 43' Lg. 84° 22'	RA III	20 fms.	Particulate Matter, Prefiltered, surface	Betzer
84	WC-4-C	Lt. 29° 33' Lg. 88° 13'	RA IV	25 fms.,	Particulate Matter, Surface	Betzer
45	WC-13-M	Lt. 29° 57' Lg. 88° 14'	RA V	17 fms.	Particulate Matter, Surface	Betzer
66	WC-1-M	Lt. 27° 49' Lg. 83° 28'	RA I	17 fms.	Particulate Matter, 15 meters depth	Betzer
14	WC-6-M	Lt. 28° 43' Lg. 84° 22'	RA II	20 fms.	Particulate Matter, 30 meters depth	Betzer
61	WC-9-M	Lt. 29° 52' Lg. 86° 16'	RA III	34 fms.	Particulate Matter, 55 meters depth	Betzer
76	WC-13-M	Lt. 29° 51' Lg. 88° 14'	RA V	17 fms.	Particulate Matter, middle depth	Betzer
13	WC-1-C	Lt. 28° 13' Lg. 84° 02'	RA I-II	20 fms.	Particulate Matter, prefiltered, 20 meter depth	Betzer
25	WC-6-M	Lt. 28° 43' Lg. 84° 22'	RA II	20 fms.	Particulate Matter, Prefiltered, surface depth	Betzer
36	WC-15-M	Lt. 29° 56' Lg. 88° 33'	RA V	14 fms.	Particulate Matter, Middle depth	Betzer
67	WC-9-M	Lt. 29° 52' Lg. 86° 16'	RA III	32 fms.	Particulate Matter, prefiltered, 55 meters	Betzer
7	WC-1-M	Lt. 27° 49' Lg. 83° 28'	RA I	17 fms.	Particulate Matter, 28 meters	Betzer
87	WC-3-C	Lt. 29° 57' Lg. 87° 10'	RA III-IV	30 fms.	Particulate Matter, Middle depth	Betzer
85	WC-4-C	Lt. 29° 33' Lg. 88° 13'	RA IV	25 fms.	Particulate Matter, Middle depth	Betzer
77	WC-10-M	Lt. 29° 36' Lg. 87° 25'	RA V	40 fms.	Particulate Matter, Bottom depth	Betzer
1	WC-7-M	Lt. 29° 44' Lg. 86° 01'	RA III	23 fms.	Zooplankton, 0-11 meters	Betzer
12	WC-1-M	Lt. 27°49' Lg. 83° 28'	RA I	18 fms.	Zooplankton, 18-27 meters	Betzer
14	WC-3-M	Lt. 28° 56' Lg. 83° 44'	RA I	22 fms.	Zooplankton, 10-20 meters	Betzer
22	WC-6-M	Lt. 28° 43' Lg. 84° 22'	RA II	20 fms.	Zooplankton, 0-9 meters	Betzer
23	WC-6-M	Lt. 28° 43' Lg. 84° 22'	RA II	20 fms.	Zooplankton, 9-18 meters	Betzer
2	WC-7-M	Lt. 29° 44' Lg. 86° 01'	RA III	23 fms.	Zooplankton, 11-22 meters	Betzer
16	WC-1-C	Lt. 28° 13' Lg. 84° 02'	RA I-II	18 fms.	Zoopkankton, 0-10 meters	Betzer
13	WC-3-M	Lt. 27° 56' Lg. 83° 44'	RA I	22 fms.	Zooplankton, 0-10 meters	Betzer
10	WC-1-M	Lt. 28° 13' Lg. 84° 02'	RA I	18 fms.	Zooplankton, 0-9 meters	Betzer
25	WC-1-C	Lt. 28° 13' Lg. 84° 02'	RA I-II	18 fms.	Zooplankton, 21-32 meters	Betzer
3	WC-7-M	Lt. 29° 44' Lg. 86° 01'	RA III	23 fms.	Zooplankton, 22-34 meters	Betzer
15	WC-3-M	Lt. 27° 56' Lg. 83° 44'	RA I	22 fms.	Zooplankton, 20-30 meters	Betzer

MAFLA TRACE METAL QUALITY CONTROL

(Samples In-Hand and Being Processed by Dr. Montalvo)
Report prepared on January 13, 1975

LOCATION

Sample	Station Number	Coordinates Latitude-Longitude	General Area	Depth of Station	Sample Description	Trace Metal Investigation
24	WC-6-M	Lt. 28° 43' Lg. 84° 22'	RA II	20 fms.	Zooplankton, 18-27 meters	Betzer
9	WC-2-C	Lt. 29° 28' Lg. 85° 50'	RA III	20 fms.	Zooplankton, 15-25 meters	Betzer
11	WC-1-M	Lt. 27° 49' Lg. 83° 28'	RA I	18 fms.	Zooplankton, 9-18 meters	Betzer
1	BC-1-C	Lt. 29° 55' Lg. 88° 43.5'	RA V	8 fms.	Sediment	Presley
2	BC-2-M	Lt. 29° 55.5' Lg. 88° 33.5'	RA V	14 fms.	Sediment	Presley
3	BC-3-M	Lt. 29° 53.5' Lg. 88° 30'	RA V	15 fms.	Sediment	Presley
5	BC-5-C	Lt. 29° 55.5' Lg. 88° 25'	RA V	17 fms.	Sediment	Presley
6	BC-6-M	Lt. 29° 58.5' Lg. 88° 21'	RA V	17 fms.	Sediment	Presley
7	BC-7-M	Lt. 29° 56' Lg. 88° 15'	RA V	17 fms.	Sediment	Presley
9	BC-9-M	Lt. 29° 53.5' Lg. 88° 12.5'	RA V	17 fms.	Sediment	Presley
11	BC-11-M	Lt. 29° 43.5' Lg. 87° 54.5'	RA IV	21 fms.	Sediment	Presley
13	BC-13-M	Lt. 29° 38.5' Lg. 87° 45'	RA IV	21 fms.	Sediment	Presley
16	BC-16-C	Lt. 29° 40.5' Lg. 87° 37'	RA IV	20 fms.	Sediment	Presley
19	BC-19-C	Lt. 29° 27' Lg. 87° 24.5'	RA IV	186 fms.	Sediment	Presley
22	BC-22-C	Lt. 29° 49.5' Lg. 86° 25.5'	RA III	48 fms.	Sediment	Presley
24	BC-24-M	Lt. 29° 51' Lg. 86° 18.5'	RA III	40 fms.	Sediment	Presley
25	BC-25-M	Lt. 29° 46' Lg. 86° 18.5'	RA III	45 fms.	Sediment	Presley
26	BC-26-M	Lt. 29° 54' Lg. 86° 15.5'	RA III	31 fms.	Sediment	Presley
27	BC-27-M	Lt. 29° 48' Lg. 86° 15.5'	RA III	35 fms.	Sediment	Presley
28	BC-28-M	Lt. 29° 43' Lg. 86° 15.5'	RA III	38 fms.	Sediment	Presley
29	BC-29-M	Lt. 29° 56' Lg. 86° 12.5'	RA III	29 fms.	Sediment	Presley
30	BC-30-M	Lt. 29° 46' Lg. 86° 12.5'	RA III	30 fms.	Sediment	Presley
32	BC-32-M	Lt. 29° 43' Lg. 86° 09.5'	RA III	26 fms.	Sediment	Presley
33	BC-33-C	Lt. 29° 38' Lg. 86° 10.5'	RA III	38 fms.	Sediment	Presley
34	BC-34-C	Lt. 29° 56' Lg. 86° 06.5'	RA III	21 fms.	Sediment	Presley
36	BC-36-M	Lt. 29° 46' Lg. 86° 06.5'	RA III	25 fms.	Sediment	Presley
38	BC-38-M	Lt. 29° 43' Lg. 86° 03.5'	RA III	24 fms.	Sediment	Presley

MAFLA TRACE METAL QUALITY CONTROL

(Samples In-Hand and Being Processed by Dr. Montalvo)
Report prepared on January 13, 1975

LOCATION

Sample	Station Number	Coordinates Latitude-Longitude	General Area	Depth of Station	Sample Description	Trace Metal Investigation
39	BC-39-C	Lt. 29° 45.5' Lg. 86° 00.5'	RA III	23 fms.	Sediment	Presley
41	BC-41-C	Lt. 29° 47.5' Lg. 86° 54.5'	RA V-III	100 fms.	Sediment	Presley
42	BC-42-C	Lt. 28° 42' Lg. 84° 26.5'	RA II	20 fms.	Sediment	Presley
44	BC-44-M	Lt. 28° 26.5' Lg. 84° 23.5'	RA II	26 fms.	Sediment	Presley
48	BC-48-M	Lt. 28° 29' Lg. 84° 21'	RA II	23 fms.	Sediment	Presley
49	BC-49-M	Lt. 28° 24' Lg. 84° 21'	RA II	25 fms.	Sediment	Presley
54	BC-54-C	Lt. 28° 29' Lg. 84° 11'	RA II	19 fms.	Sediment	Presley
56	BC-56-M	Lt. 28° 00.5' Lg. 83° 45'	RA I	21 fms.	Sediment	Presley
57	BC-57-M	Lt. 27° 57.5 Lg. 83° 42.5'	RA I	21 fms.	Sediment	Presley
60	BC-60-C	Lt. 28° 01' Lg. 83° 35.5'	RA I	17 fms.	Sediment	Presley
63	BC-63-C	Lt. 27° 56' Lg. 80° 27.5'	RA I	16 fms.	Sediment	Presley
TM-363	WC-7-M	Lt. 29° 44' Lg. 86° 01'	RA III	23 fms.	Dissolved, 20 meters	Segar
TM-366	WC-7-M	Lt. 29° 44' Lg. 86° 01'	RA III	23 fms.	Dissolved, 1 meter	Segar
TM-527	WC-13-M	Lt. 29° 57' Lg. 88° 14'	RA V	17 fms.	Dissolved, Surface	Segar
TM-530	WC-13-M	Lt. 29° 57' Lg. 88° 14'	RA V	17 fms.	Dissolved, Middle	Segar
TM-535	WC-13-M	Lt. 29° 57' Lg. 88° 14'	RA V	17 fms.	Dissolved, Bottom	Segar
TM-880	WC-10-M	Lt. 29° 36' Lg. 87° 25'	RA IV	40 fms.	Dissolved, Surface	Segar
TM-889	WC-10-M	Lt. 29° 36' Lg. 87° 25'	RA IV	40 fms.	Dissolved, Bottom	Segar
TM-891	WC-12-M	Lt. 29° 46' Lg. 87° 54'	RA IV	20 fms.	Dissolved, Bottom	Segar
TM-909	No Data Available				Dissolved	Segar
TM-917	WC-1-C	Lt. 28° 13' Lg. 84° 02'	RA I & II	20 fms.	Dissolved, 20 meters	Segar
TM-920	WC-4-M	Lt. 28° 21' Lg. 84° 25'	RA II	28 fms.	Dissolved, 27 meters	Segar
TM-921	WC-4-M	Lt. 28° 21' Lg. 84° 25'	RA II	28 fms.	Dissolved, 48 meters	Segar
TM-922	WC-4-M	Lt. 28° 21' Lg. 84° 25'	RA II	28 fms.	Dissolved, 1 meter	Segar
TM-924	WC-4-M	Lt. 28° 21' Lg. 84° 25'	RA II	28 fms.	Dissolved, 48 meters	Segar
TM-925	No Data Available				Dissolved	Segar

MAFLA TRACE METAL QUALITY CONTROL

(Samples In-Hand and Being Processed by Dr. Montalvo)
Report prepared on January 13, 1975

Sample	Station Number	LOCATION Coordinates Latitude-Longitude	General Area	Depth of Station	Sample Description	Trace Metal Investigation
62-E		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
62-B		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
62-A-1		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
60-B		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
60-A		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
6-18 II-K-1		Data Not Available At Time of Listing			Benthic Invertebrates.	Betzer
51-F		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
51-A		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
49-A		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
49		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
6-19 II-B-4		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
6-18 II-M-1A		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
6-18 II-O-1		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
43-A		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
6-5-III-F		Data Not Available At Time of Listing			Benthic Inverteb rates	Betzer
32-B		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
5-29-IV-F-4		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
2/I		Data Not Available At Time of Listing			Benthic Invertebrates.	Betzer
54-A		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer
32-A		Data Not Available At Time of Listing			Benthic Invertebrates	Betzer

MAFLA HYDROCARBON QUALITY CONTROL

Report Prepared January 21, 1975
(Samples In-Hard and Being Processed by Dr. Laseter)

Sample	Station Location				Sample Description	Hydrocarbon Investigation
	Station No.	Coordinates	General Area	Depth of Station In Fathoms		
FSU-1 HC,C-1	WC-C-1	Lt. 28° 13' Lg. 84° 02'	RAI-II	20 fms.	Surface Zooplankton	Calder
FSU-2 H-C,C-1	WC-C-1	Lt. 28° 13' Lg. 84° 02'	RAI-II	20 fms.	Bottom Zooplankton	Calder
FSU-3 C-2	WC-C-2	Lt. 29° 28' Lg. 85° 50'	RA-III	20 fms.	Surface Zooplankton	Calder
FSU-4 C-2	WC-C-2	Lt. 29° 28' Lg. 85° 50'	RA-III	20 fms.	Midwater Zooplankton	Calder
FSU-5 C-2	WC-C-2	Lt. 29° 28' Lg. 85° 50'	RA-III	20 fms.	Bottom Zooplankton	Calder
FSU-6 MS-3-H-C	WC-3	Lt. 27° 56' Lg. 83° 44'	RA-III-IV	30 fms.	Surface Zooplankton	Calder
FSU-7 MS-3-H-C	WC-3	Lt. 27° 56' Lg. 83° 44'	RA-III-IV	30 fms.	Bottom Zooplankton	Calder
FSU-8 MS-4-H-C	WC-4	Lt. 28° 21' Lg. 84° 25'	RA-IV	23 fms.	Midwater Zooplankton	Calder
FSU-9 MS-4-H-C	WC-4	Lt. 28° 21' Lg. 84° 25'	RA-II	30 fms.	Bottom Zooplankton	Calder
FSU-10 MS-6-H-C	WC-6	Lt. 28° 43' Lg. 84° 22'	RA-II	20 fms.	Surface Zooplankton	Calder
FSU-11 MS-6-H-C	WC-6	Lt. 28° 43' Lg. 84° 22'	RA-II	20 fms.	Midwater zooplankton	Calder
FSU-12 MS-6-H-C	WC-6	Lt. 28° 43' Lg. 84° 22'	RA-II	20 fms.	Bottom Zooplankton	Calder
FSU-13 MS-7	WC-7	Lt. 29° 44' Lg. 86° 01'	RA-III	23 fms.	Surface Zooplankton	Calder
FSU-14 MS-9	WC-9	Lt. 29° 52' Lg. 86° 16'	RA-III	33 fms.	Bottom Zooplankton	Calder
GCRL-1-L	—	——	—	—	Solvent Blank	Lytle
GCRL-2-L	BC-5-C	Lt. 29° 55.5' Lg. 88° 25'	RA-$\overline{V}$	17 fms.	Sediment	Lytle
GCRL-3-L	BC-7-M	Lt. 29° 56' Lg. 88° 15'	RA-$\overline{V}$	17 fms.	Sediment	Lytle
GCRL-4-L	BC-15-C	Lt. 29° 30.5' Lg. 87° 47'	RA-$\overline{IV}$	30 fms.	Sediment	Lytle
GCRL-5-L	BC-22-C	Lt. 29° 49.5' Lg. 86° 25.5'	RA-III	40 fms.	Sediment	Lytle
GCRL-6-L	BC-23-M	Lt. 29° 56' Lg. 86° 18.5'	RA-III	36 fms.	Sediment	Lytle
GCRL-7-L	BC-24-M	Lt. 29° 51' Lg. 86° 18.5'	RA-III	40 fms.	Sediment	Lytle
GCRL-8-L	BC-27-M	Lt. 29° 48' Lg. 86° 15.5'	RA-III	36 fms.	Sediment	Lytle
GCRL-9-L	BC-55-C	Lt. 27° 56.5' Lg. 85° 53'	RA-I	25 fms.	Sediment	Lytle
GCRL-10-L	BC-57-M	Lt. 27° 57.5' Lg. 83° 42.5'	RA-I	21 fms.	Sediment	Lytle

Report Prepared January 21, 1975.
(Samples In-Hand and Being Processed by Dr. Laseter)

Sample	Station No.	Station Location Coordinates	General Area	Depth of Station	Sample Description	Investigation
FSU-15 MS-3	WC-3	27° 56' 83° 44'	RA-I	38 m	Bottom Zooplankton	Calder
FSU-16 MS-7	WC-3	29° 44' 86° 01'	RA-I	38 m	Bottom Zooplankton	Calder
FSU-17 C-1	WC-1-C	28° 13' 84° 02'	RA-I-II	39 m	Midwater Zooplankton	Calder
FSU-19 MS-1	WC-1	27° 49' 83° 28'	RA-I	30 m	Surface Zooplankton	Calder
FSU-20 MS-1	WC-1	27° 49' 83° 28'	RA-I	30 m	Midwater Zooplankton	Calder
FSU-21 MS-1	WC-1	27° 49' 83° 28'	RA-I	30 m	Bottom Zooplankton	Calder
FSU-22 MS-9	WC-9	29° 52' 86° 13'	RA-III	33 fm 57 m	?	Calder
FSU-23 MS-3	WC-3	27° 56' 83° 44'	RA-I	38 m	Midwater Zooplankton	Calder
FSU-24 MS-9	WC-9	29° 52' 86° 13'	RA-III	33 fm 57 m	?	Calder

WC: Water Column Station

GCRL: Gulf Coast Research Laboratory

L: Lytle

BC: Box Core Station

M: Box Core Master Station

Lt.: Latitude

Lg.: Longitude

RA-I: Off Florida

RA-II: Off Florida

RA-III: Off Florida

RA-IV: Off Mississippi-Alabama

RA-V: Off Mississippi-Alabama

FSU: Florida State University

H-C: Hydrocarbon Sample

C: Control Station

MS: Water Column "Master Station" Stations (Caulder)

MAFLA HYDROCARBON QUALITY CONTROL

Report Prepared November 15, 1974
(Samples In-Hand and Being Processed by Dr. Laseter)

Sample	Station Location				Sample Description	Hydrocarbon Investigation
	Station No.	Coordinates	General Area	Depth of Station In Fathoms		
FSU-1 HC,C-1	WC-C-1	Lt. 28° 13' Lg. 84° 02'	RAI-II	20 fms.	Surface Zooplankton	Calder
FSU-2 H-C,C-1	WC-C-1	Lt. 28° 13' Lg. 84° 02'	RAI-II	20 fms.	Bottom Zooplankton	Calder
FSU-3 C-2	WC-C-2	Lt. 29° 28' Lg. 85° 50'	RA-III	20 fms.	Surface Zooplankton	Calder
FST-4 C-2	WC-C-2	Lt. 29° 28' Lg. 85° 50'	RA-III	20 fms.	Midwater Zooplankton	Calder
FSU-5 C-2	WC-C-2	Lt. 29° 28' Lg. 85° 50'	RA-III	20 fms.	Bottom Zooplankton	Calder
FSU-6 MS-3-H-C	WC-3	Lt. 27° 56' Lg. 83° 44'	RA-III-IV	30 fms.	Surface Zooplankton	Calder
FSU-7 MS-3-H-C	WC-3	Lt. 27° 56' Lg. 83° 44'	RA-III-IV	30 fms.	Bottom Zooplankton	Calder
FSU-8 MS-4-H-C	WC-4	Lt. 28° 21' Lg. 84° 25'	RA-IV	23 fms.	Midwater Zooplankton	Calder
FSU-9 MS-4-H-C	WC-4	Lt. 28° 21' Lg. 84° 25'	RA-II	30 fms.	Bottom Zooplankton	Calder
FSU-10 MS-6-H-C	WC-6	Lt. 28° 43' Lg. 84° 22'	RA-II	20 fms.	Surface Zooplankton	Calder
FSU-11 MS-6-H-C	WC-6	Lt. 28° 43' Lq. 84° 22'	RA-II	20 fms.	Midwater zooplankton	Calder
FSU-12 MS-6-H-C	WC-6	Lt. 28° 43' Lg. 84° 22'	RA-II	20 fms.	Bottom Zooplankton	Calder
FSU-13 MS-7	WC-7	Lt. 29° 44' Lg. 86° 01'	RA-III	23 fms.	Surface Zooplankton	Calder
FSU-14 MS-9	WC-9	Lt. 29° 52' Lg. 86° 16'	RA-III	33 fms.	Bottom Zooplankton	Calder
GCRL-1-L	--	----	---	---	Solvent Blank	Lytle
GCRL-2-L	BC-5-C	Lt. 29° 55.5' Lg. 88° 25'	RA-V	17 fms.	Sediment	Lytle
GCRL-3-L	BC-7-M	Lt. 29° 56' Lg. 88° 15'	RA-V	17 fms.	Sediment	Lytle
GCRL-4-L	BC-15-C	Lt. 29° 30.5' Lg. 87° 47'	RA-IV	30 fms.	Sediment	Lytle
GCRL-5-L	BC-22-C	Lt. 29° 49.5' Lg. 86° 25.5'	RA-III	40 fms.	Sediment	Lytle
GCRL-6-L	BC-23-M	Lt. 29° 56' Lg. 86° 18.5'	RA-III	36 fms.	Sediment	Lytle
GCRL-7-L	BC-24-M	Lt. 29° 51' Lg. 86° 18.5'	RA-III	40 fms.	Sediment	Lytle
GCRL-8-L	BC-27-M	Lt. 29° 48' Lg. 86° 15.5'	RA-III	36 fms.	Sediment	Lytle
GCRL-9-L	BC-55-C	Lt. 27° 56.5' Lg. 85° 53'	RA-I	25 fms.	Sediment	Lytle
GCRL-10-L	BC-57-M	Lt. 27° 57.5' Lg. 83° 42.5'	RA-I	21 fms.	Sediment	Lytle

FSU: Florida State University
H-C: Hydrocarbon Sample
C: Control Station
MS: Water Column "Master Station" Stations (Caulder)
WC: Water Column Station
GCRL: Gulf Coast Research Laboratory

L: Lytle
BC: Box Core Station
M: Box Core Master Station
Lt.: Latitude
Lg.: Longitude
RA-I: Off Florida

RA-II: Off Florida
RA-III: Off Florida
RA-IV: Off Mississippi-Alabama
RA-V: Off Mississippi-Alabama

V. SAMPLE INVENTORY

V. SYNOPSIS OF COLLECTIONS AND ANALYSIS CONTRACTED FOR:
COLLECTIONS AND ANALYSIS PERFORMED

PRINCIPAL INVESTIGATOR	SAMPLE ANALYSIS TYPE	SAMPLE NUMBERS CONTRACTED FOR	COLLECTED	DIFFERENCE	DISPOSITION OF COLLECTIONS/DATA	COMMENTS
P. Betzer	Trace metal, suspended matter	42	42	0	By nature of the study no samples and/or specimens were retained.	
	Trace metal, zooplankton	42	48	+6		
S. Betzer	Trace metal, benthic fauna	65	111	+36		
N. Blake	Histopathological Archiving	variable	240	---	Histopathological Slides (240 samples). All molluscs from all box core replicates sorted by Kritzler. Stored at USF, St. Pete.	
W. Bock	Live foraminifera	130	126	-4	All foraminifera Stored at UM, Miami	Bottom Sediments at Stations 51 and 58 were unsuitable for box coring, thus the remaining 4 cores were not collected. One complete series of samples (63 subsamples)were processed for both live and fossil foraminifera Though not contracted for, this extended study provided increased data for better describing the foraminfifera fauna.
	Fossil foraminifera	0	126	+126		
J. Calder	Hydrocarbons, zooplankton	42	42	0	By nature of the study no samples and/or specimens were retained.	
	Hydrocarbon, dissolved high molecular weight	42	42	0		
L. Doyle	Clay minerology	82	114	+32	Sediment samples Epoxy peels Stored at USF, St. Pete.	Epoxy peels were made from all core stations collected. Unsuitable bottom sediment prevente the sampling of the full compleme of cores originally proposed.
	Vane shear test	variable	550	---		
K. Fanning	Micronutrient analysis	57	66	+9	Refrozen portion of original sample retained. Stored at USF, St. Pete.	
T. Hopkins	Epifaunal samples	60	61	+1	35 mm color slides (developed) Super 8 mm movie film (developed) Sponges, hard & soft corals, echinoderms, molluscs, crustaceans, & algae (Chlorophyta, Phacophyta & Rhodophyta)collected during diving studies. Stored at UWF, Pensacola. Polychaetes sent to U.Ala.(See Vittor).	Dive stations were reduced in Areas IV & V due to extremely limited visibility. Dive & Dredg stations were sampled in excess of the contracted amount in Areas I-III where conditions permitted.
	35 mm slides	variable	300+	---		
	8 mm movies	variable	1200 ft. +	---		

V. SYNOPSIS OF COLLECTIONS AND ANALYSIS CONTRACTED FOR: COLLECTIONS AND ANALYSIS PERFORMED

PRINCIPAL INVESTIGATOR	SAMPLE ANALYSIS TYPE	SAMPLE NUMBERS CONTRACTED FOR	COLLECTED	DIFFERENCE	DISPOSITION OF COLLECTIONS/DATA	COMMENTS
H. Humm	*Sargassum* epiphytes	variable	87	---	*Sargassum* preserved in 5% sea water formaldehyde, for study of their epiphytes stored in USF Phycology Lab, St. Pete. Sargassum archived for hydrocarbon analysis, 52 samples. (See Lytle)	
R. Iverson	net phytoplankton	33	33	0	Portion of phytoplankton and nannoplankton samples stored at FSU, Tallahassee (see Woodmansee)	
	nanno phytoplankton	33	33	0		
	chlorophyll *a* analysis	198	208	+10		
	chlorophyll *b* analysis	0	208	+208		
	chlorophyll *c* analysis	0	208	+208		
	pheophytin analysis	0	208	+208		
	chlorophyll *a*:curotenoids (ratio)	0	208	+208		
G. Knauer	Particulate organic carbon	42	42	0	By nature of the study no samples and/or specimens were retained.	POC and DOC samples were collected in triplicate, producing 126 POC and 126 DOC subsamples.
	Dissolved organic carbon	42	42	0		
H. Kritzler	Biomass determinations	520	481	-39	All infauna from 481 cores (Stations 1-50, 52-57, 59-65) are stored at FSU Marine Lab except: 1) polychaetes from Areas IV & V (see Vittor) 2) all molluscs (see Blake) 3) all amphipods from one replicate of each of the 63 box core stations (sent to Larry McKinney, Texas A&M Univ.)	Unsuitable bottom sediments prevented the complete collectio of the proposed cores for infaunal analysis.
	Polychaete identification	520	321/481	-39		
	Amphipod preparation	0	variable	+		
	Mollusc preparation	0	variable	+		
P. LaRock	Sediment Adenosine Triphosphate	65	65	0	By nature of the study no samples and/or specimens were retained.	Four replicates were taken for sediment ATP, producing 260 subsamples. Seven replicates were taken for water column ATP, producing 126 subsamples.
	Water Column Adenosine Triphosphate	variable	18	---		
T. Lytle J. Lytle	Total Organic Carbon	65	61	-4	Sargassum frozen; retained for future hydrocarbon reference; box cores (½ core) frozen; retained for future hydrocarbon reference. Stored at GCRL, Ocean Springs, MS.	
	Sediment Hydrocarbon	65	62	-3		
	Algal Hydrocarbon	10	22	+12		

V. SYNOPSIS OF COLLECTIONS AND ANALYSIS CONTRACTED FOR:
COLLECTIONS AND ANALYSIS PERFORMED

PRINCIPAL INVESTIGATOR	SAMPLE ANALYSIS TYPE	SAMPLE NUMBERS CONTRACTED FOR	COLLECTED	DIFFERENCE	DISPOSITION OF COLLECTIONS/DATA	COMMENTS
F. Maturo	Zooplankton analysis	87-168	177	+9	Zooplankton reserve samples from Areas I,II,&III stored at UF, Gainesville.	Excess samples resulted from taking full complement of replicated samples at control stations 1 and 2.
P. Meyers	Hydrocarbons, Benthic Fauna	200	117	-83	Benthic fauna for future hydrocarbon analysis. Stored at U of Michigan	65 samples analyzed, yielding 177 gravimetric analyses and 118 gas chromatographic analyses.
D. Moore	Micromollusca	130	125	-5	Micromollusca stored at UM, Miami	Full complement of box cores were not collected due to unsuitable bottom sediment.
R. Pierce	Particulate hydrocarbons	42	42	0	Samples of particulate matter filtered from water samples & stored for future particulate hydrocarbon reference. Stored at US Miss.	
B. Presley	Trace metal, sediment	65	57	-8	By nature of the study no samples and/or specimens were retained.	
T. Pyle	Remote bottom photography	variable	681	--	35 mm black & white negatives, 648 exposures; 35 mm color, 33 exposures. Stored at USF, St. Pete.	
W. Sackett D. Schink	Dissolved low molecular weight hydrocarbons Hydrocarbon "sniffer"	57 0	111 1116	+54 +1116	By nature of the study no samples and/or specimens were retained.	Sniffer system produced a C_1-C_5 concentration data printout every 5 minutes. Cruise track covered 25 MAFLA stations.
D. Segar	Dissolved trace metals	42	66	+24	By nature of the study no samples and/or specimens were retained.	
W. Tanner	Sediment archiving	variable	589	--	Subcores, from one box core, from each of the 63 bottom stations, are stored in FSU NSF-sponsored freezer Core Repository.	
B. Vittor	Polychaete identification	520	160/481	-39	Polychaetes from Areas IV & V; 160 samples (Stations 1-20); polychaetes from diving studies (See Hopkins) stored at U. Ala., Dauphin Island.	321 of 481 total polychaete samples sent to Kritzler for I.D.

V. SYNOPSIS OF COLLECTIONS AND ANALYSIS CONTRACTED FOR: COLLECTIONS AND ANALYSIS PERFORMED

PRINCIPAL INVESTIGATOR	SAMPLE ANALYSIS TYPE	SAMPLE NUMBERS CONTRACTED FOR	COLLECTED	DIFFERENCE	DISPOSITION OF COLLECTIONS/DATA	COMMENTS
H. Wanless	Sieved sediment	65	76	+11	35 mm slides (developed) of box cores Radiographs (X-ray neg.) stored at UM, Miami	
	35 mm slides	variable	580	--		
	X-radiographs	65	71	+6		
R. Woodmansee	Nannoplankton	24	108	+84	Portion of phytoplankton and nannoplankton samples (see Iverson)	90 of the 15 min. tow samples were collected by Woodmansee, the remaining 177 were collected by Maturo.
	Netplankton	24	36	+12		
	15 min. tow samples	209-321	90/267	---	Zooplankton reserve samples from Areas IV & V (see Maturo)	
	60 min. tow samples	19	36	+17		
	Preserved sea water gallon	variable	69	---	Stored at GCRL, Ocean Springs, MS	
L. McKinney (non-P.I.)	Amphipod identification	0	63	+63	Samples stored at Texas A&M (see Kritzler)	
N. Blake	Mollusc preparation	0	approx. 481	+481	Samples stored at USF, St. Pete (see Kritzler)	

VI. MANAGEMENT

VI. MANAGEMENT

A. Scientific and Management Coordinating/Advisory Committee

A Scientific and Management Coordinating/Advisory Committee was established by scientists interested in participating in the MAFLA studies in March 1974, when it was definitely decided that a SUSIO Consortium approach would be taken to address the preparation of a joint proposal in response to the BLM RFP 74-2. The members of the Committee were elected by their peers and have functioned accordingly during the preparation of the proposal, negotiation of the contract, performance of the survey, and preparation of this final report. The membership of the Committee is as follows:

Water Column Biology:	Dr. George A. Knauer, FSU Dr. Frank J. S. Maturo, Jr., UF
Chemistry and Analytical Quality Control:	Dr. John A. Calder, FSU Dr. Frank T. Manheim, USF
Benthic Biology:	Dr. Norman Blake, USF
Geology:	Dr. Harold R. Wanless, RSMAS, UM Dr. Larry J. Doyle, USF
Physical:	Mr. Murice O. Rinkel, SUSIO
Data Management:	Mr. John C. Sylvester (Liaison/ Advisory, EDS/NODC) Mr. Murice O. Rinkel, SUSIO

State of Mississippi:	Dr. Robert A. Woodmansee, GCRL
State of Alabama:	Dr. George F. Crozier, UA
State of Florida:	Dr. J. I. Jones, Fla. Department of Administration *
Budget:	Dr. William H. Taft, USF
Program Coordinator/Mgr.:	Dr. Robert E. Smith, SUSIO
Co-Coordinator/Mgr.:	Mr. Murice O. Rinkel, SUSIO

* Resigned 28 March 1974 on basis of possible "conflict of interest"

B. Management Structure/Subcontractors

The survey work was performed as a coordinated, joint effort involving the participation of an interdisciplinary group of recognized scientists. These persons are affiliated with a cross section of public and private institutions and government agencies representing a special focus on the MAFLA areas.

The present contract documents the experimental design of the agreed upon program, with the responsibilities assumed by each individual Principal Investigator (P.I.). Formal proposals were submitted to SUSIO by each P.I. via the appropriate routing within their respective organizations for required signatures. These signed proposals committed the individual scientists and their respective organizations to the proposed work within the time restraints and the fixed price contract as depicted in the contract. These executed proposals, in turn, constituted the basis of sub-contracts between the P.I.'s and their institutions and SUSIO.

C. Program Coordination/Management

Program coordination and management for this contract were the responsibility of the prime contractor, the State University System of Florida. The Director of SUSIO was designated as the Program

Coordinator and Manager; the Assistant Director of SUSIO was designated as Co-Program Coordinator and Manager. The Director and Assistant Director are the administrative officers of SUSIO and are responsible for implementing the objectives of the Institute to include, but not limited to, this contract. They have no assigned teaching responsibilities nor research commitments per se; their primary function is administrative as relates to SUSIO in its mission and responsibilities.

SUSIO was responsible to: coordinate the overall sampling phase of the survey to assure that it was completed in the time frame and in the manner agreed upon in the contract; see that the P.I.'s, as subcontractors, provided an appropriate flow of work in order to achieve all contracted services in the agreed upon time periods; and work with the P.I.'s, Science and Management Coordinating/Advisory Committee and the BLM representatives to achieve the prescribed end-point of the contract. However, SUSIO, as Program Manager, accepts the overall responsibilities of the completion and quality of the contracted work. In turn, it has exercised the authority commensurate with said responsibility.

D. Operational Control and Ship Scheduling

SUSIO had ultimate responsibility of all ship scheduling, and control over all associated ship operations; it was responsible for having the survey work that was contracted for completed within the 60-day time limitation stated in BLM RFP 74-2 and subsequent Contract No. 08550-CT4-11. To assure operational control of the multi-ship activities, SUSIO executed individual

charter agreements with each of the ship operators identified herein that furnished services in support of this contract. Each ship was scheduled to operate in specified areas, to provide predetermined services, each of which was begun and completed within a prescribed time period. If and when any vessel failed, for any reason, to perform her assigned tasks, or to meet the milestones of operation as set forth in the experimental design of this program, and recorded in the respective charter agreements, alternate fail-safe scheduling was exercised. SUSIO determined under what circumstances, and at what time the alternate schedules were to be executed.

The number of vessels, types, and the allotment of resources were based on the severe operational limitations imposed by the terms of this contract, other conditions, and "normal" circumstances. These factors in part were:

1. Less than one week's notification was given the Contractor.
2. Only 60 days of ship operational time were allowed before liquidated damages were to be imposed; only five working days were given following the execution of the contract before the day one of the sixty was started.
3. Delays that would be witnessed in receiving specific pieces of equipment and supplies required for the ship operations; these items could not legally be procured by the contractor prior to the execution of the contract.
4. Necessity of arranging scientific cruises, equipment, and vessel capacity to insure the best and most accurate data collection.

5. Historical weather conditions within the area and experience of the investigators and agencies in operating the available vessels under these conditions.

In summation, as many vessels, equipment and people had to be procured in the shortest time frame possible to insure that the survey could be completed within the sixty days, accepting the potential delays.

From a cost-efficiency viewpoint, where practical, sampling/collecting operations were assigned to vessels and institutions in close proximation to the lease track areas. Not only was the transit time reduced, but the ship's crew, ship support facilities, and scientific personnel were familiar with the operational areas. Further, this policy allowed the availability and utilization of smaller vessels with a substantial decrease in the total operational costs.

The vessels scheduled in the survey consisted of the R/V AQUARIUS (65 ft.), University of Alabama, Dauphin Island, Alabama (this vessel did not actually become involved in the survey per se; however, she was readied and maintained by the operator as a back-up vessel for contingency support); R/V MISS FREEPORT (135 ft.), Flower Garden Ocean Research Center, Marine Biomedical Institute, University of Texas Medical Branch, Galveston, Texas; R/V GULF RESEARCHER (65 ft.) Gulf Coast Research Laboratory, Ocean Springs, Mississippi; R/V TURSIOPS (65 ft.) Florida State University, Turkey Point, Florida; and R/V BELLOWS (65 ft.) Gulfstream Research and Development

Corporation, Tarpon Springs, Florida.

To insure that adequate ships were available, each operating agency or institution for the research vessels blocked out a minimum of 60 days of shiptime for the survey.

Ship's operations were divided into two types: water column collected by plankton tows and 30-liter bottles; and benthic work performed by boxed core samples, bottom photography, and diving operations. Each of these collection requirements was divided further into operational patterns which allowed the concentration of the optimum number of highly trained professional and technical staff on appropriate vessels.

E. Navigation

Because of the requirement for precision navigation for the benthic biological and geological sampling, LORAC systems, with operators, were leased and utilized in support of the survey. Appropriate units were installed on board the R/V MISS FREEPORT for precise station location (± 20 meters) of box coring, bottom photography, and dredge sampling, and on the R/V BELLOWS for diving operations and associated work.

At each master bottom station a permanent cement marker was placed to permit exact station identification and verification in the future.

It is the consensus of the scientists participating in these studies that the navigational accuracy specified in the RFP 74-2 of ± 20 meters for 90% of the observations and ± 30 meters for the remaining 10% of the observations was not applicable for water column sampling. Since the water masses are known to be transient,

both temporally and spacially, it was agreed by BLM that existing LORAN A systems were adequate for station location of water column work.

Further, each of the five leased areas studied (surveyed) is in a distinct hydro-biological zone. These particular zones have essentially uniform hydro-biological characteristics, and for that reason any sample taken within the zone should be, in essence, a representative measure for virtually the entire area. Unless all samples/collections were to be taken simultaneously, their relationship within the five areas to existing transport systems, weather conditions, and hydro-bio-chemical interactions could not be properly interpreted anyway. Such synoptic measurements were beyond the funding and time restraints of the present contract; in turn, such a program was not planned.

F. Data Management

A Data Management Council was established to coordinate appropriate data management and processing needs. The chairman was the Co-Program Manager; the Council was comprised of members of scientific groups participating in the contract survey. In addition, there was a non-voting advisory member from the National Oceanographic Data Center (NODC). Data archiving has been rigorously adherred to.

Data flow began with the sampling/collection activites, quality control systems, intercalibration, and has progressed through lab analysis to the final report preparation.

Pertinent data have been reduced, processed, serviced (corrected, analyzed, summarized and copies), and disseminated in

considerable measure by the participants. An inventory control was conducted to record progress, check gaps in information, and to signal additional processing requirements.

Existing data formats and software packages available through the various data centers of the NOAA Environmental Data Service (EDS) were utilized in collaboration where feasible.

G. Performance Time for Sampling/Collecting

The experimental design, and the scheduling of ships and equipment were programmed so the sampling/collecting effort was to be completed within sixty (60) calendar days, plus five (5) working days, after execution of contract. However, the contract did contain an Act-of-God clause, and in same it was reflected that under certain weather conditions and associated phenomena the environmental effects could be such that it would be operationally and scientifically impractical to collect samples during such periods. If such a situation had arisen, the Chief Scientists on the scene were to have made this known as soon as possible to the Contractor's Program Manager. Fortunately, the Act-of-God clause did not have to be exercised.

H. Sampling/Collecting Work

The Contractor, in collaboration with Subcontractors, was responsible for making available all personnel and equipment (including ships and associated equipment and systems) necessary during the performance of the contract.

I. Deliverable Products

The Contractor, following the ship operations, submitted to the BLM an inventory of samples collected under the agreements of this contract, including geographic location, depth of water, date, time, group of collection, and any incidental observations pertinent to that collection. The Contractor indicated to whom such samples were sent, and when and how they were conveyed.

Subsequent to the ship operations the Contractor submitted to the BLM ten (10) copies of the final cruise reports which included cruise track(s), a day-to-day summary of activities, routine meteorological and oceanographic measurements, and pertinent calculations, projections, tables, graphs, notes, or other graphic information collected under this contract or derived by the location or quality of samples taken.

The Contractor submitted to BLM three (3) copies of monthly progress reports in sufficient detail to disclose and fully explain the subject contract work accomplished and results achieved, including analyses, during the reporting period.

The Contractor submits herewith to BLM ten (10) copies of a comprehensive final report. This report consists of a topical breakdown of the relevant data and analyses accrued under this contract. It also contains a summary characterization of the differences and similarities of sampling sites including bathymetry, substrate characteristics, community characterization and relationships where possible, and identification of the dominant floral and faunal elements.

J. Logistics of Equipment and Personnel

SUSIO, under its management responsibilities, made arrangements for transfer of scientific and technical personnel and equipment to and from vessels, including reservations and/or ticketing, rental of vehicles, processing of per diem payments, etc. Similar travel arrangements and services were made for meetings held for proposal writing, progress reports, finalizing of the draft final report and meeting with BLM representatives whereby the consortium members were asked to give recommendations for consideration by BLM in preparation of the RFP for the monitoring work to be performed in the MAFLA and other areas.

Details of the transporting of equipment and personnel to and from the vessels, and to the meetings, are covered, in part, in Appendices X and XI of Monthly Report No. 1.

K. Archiving

Specific methods of subdivision, treatment, and conditions of storage for various sample materials have been dealt with under other sections of this report (i.e. geological cores and subsamples; extracts for high molecular weight hydrocarbon analysis; extracts for trace metal analysis; etc.).

The intent here is to acknowledge that required archiving has been performed and to discuss the longer term placement of samples, recognizing that later environmental studies and monitoring efforts will generate increasing numbers of reference and/or voucher samples/specimens in the future. Sites for long-term archiving should be established and managed accordingly whereby ready access

to materials is permitted; too, the repositories should be planned to have the capacity to accommodate future loads. To assure the integrity of the materials, it will be desirable that sites have documented recognition and official responsibilities for their respective archiving functions.

Notwithstanding the need for long-term archiving commitments, at a proper time in the future, such as during the planning of the monitoring phase of the outer continental shelf development, sample/specimen holdings should be reviewed and bulk samples be adjusted to quantities that will meet more important potential long-term needs, yet not take up valuable space.

L. Liquidated Damages

The State University System of Florida could not accept unlimited liability or undeterminated liability as would have been the case with the RFP 74-2 "Liquidation Damages" clause as interpreted by the State; therefore, the Board of Regents office obtained authorization and, in turn, arranged to procure through the State of Florida Division of Purchasing, a "performance bond" in the amount of approximately five percent (5%) the total cost of the contract. The Contractor presented a performance bond in the amount of $50,000 for the purpose of payment of liquidated damages as specified in RFP 74-2, Article XI, Liquidated Damages.

M. Equipment Title Vested with Contractor

It was understood and agreed upon by the parties that title to the equipment listed in the Contractor's "Best and Final Offer," dated April 29, 1974, under the paragraph entitled "Cost-Shared Equipment," that equipment acquired for use under their contract,

is vested with the contractor (or subcontractors) as appropriate. The pricing of this contract was based on a 50/50 share of the costs of the subject listed equipment.

N. SUSIO Support to BLM for Photographic Coverage/Documentation of MAFLA Survey Work

In early June, 1974, SUSIO received a telephone call from BLM asking whether SUSIO would assist a BLM photographer/producer in making a public relations type film of the ongoing contract work; at the same time, as a spinoff, this film could be used as documentation of the contract work. This proposed filming was not part of the contract; however, it could prove to be important to both BLM and SUSIO and was therefore supported by SUSIO at no cost to BLM.

Mr. Tarpenning, BLM, made telephone contact with Dr. Smith, SUSIO, on Friday, June 7th; Mr. Tarpenning asked that he be assisted in hiring a camera crew for both landside and at-sea work, divers and associated equipment for underwater photography, and the chartering of a boat for offshore work. Mr. Tarpenning arrived in St. Petersburg on Sunday, June 9th to commence work on June 10th.

Two weeks of concentrated effort was provided Mr. Tarpenning by SUSIO and Principal Investigators of the SUSIO Consortium in support of the BLM photographic documentation of the contract work. Additional professional divers, cameramen, equipment, and vessels were provided; a substantial amount of these at no cost to BLM, as professional favors to SUSIO during this operation.

O. Meeting of SUSIO Consortium Participants and BLM Representatives for Detailed Discussions of Present MAFLA Survey and Future Monitoring Program

During a meeting on July 30, 1974, of the Science Advisory and Management Group of the SUSIO Consortium and BLM representatives, BLM expressed an interest in having a meeting in early September, 1974, whereby all Principal Investigators of this contract would meet to present to BLM a detailed verbal status report and in-depth discussion of same as appropriate.

The meeting was held in St. Petersburg as proposed; the Principal Investigators convened September 3rd for a planning session and held the status report and discussion session with BLM representatives on the 4th and 5th.

In addition to the verbal presentations made by the Principal Investigators, outlines of recommended projects in water column, benthic biology, geology, geochemistry, and chemical oceanography were prepared in hard-copy by the SUSIO group for BLM's consideration as information for future planning purposes. Follow-up letters with additional information were mailed directly to BLM subsequent to the meeting.

The Principal Investigators of the SUSIO Consortium convened in St. Petersburg again January 22-24, 1975, to address the preparation of the first draft of this final report. During this work session, BLM representatives were present and the consortium members were asked to give their professional recommendations with regard to specifications that might be considered by BLM in the preparation of the RFP for the monitoring of the MAFLA and other

areas. Subsequent to this session a number of the P.I.'s of the consortium participated in a BLM OCS Interagency Management Board work session held in Washington, D.C., January 27-29, 1975, to further discuss the specifics to be considered by BLM for incorporation into the upcoming MAFLA Monitoring RFP.

P. Authorized BLM Representatives

During the period of this contract, the SUSIO Consortium has had the opportunity of working with the following individuals in their respective capacities as cited:

Mr. William E. Hamm, Contracting Officer
Bureau of Land Management
U. S. Department of the Interior
Branch of Procurement (552)
Room 2452, 18th & C Streets, N.W.
Washington, D.C. 20240

Mr. Terry Nichols, Contracting Officer
Bureau of Land Management
U. S. Department of the Interior
18th & C Streets, N.W.
Washington, D.C. 20240

Mr. Vernon F. Ehlerding, Contracting Officer
Bureau of Land Management
U. S. Department of the Interior
18th & C Streets, N.W.
Washington, D.C. 20240

Mr. Linus J. Brown, Jr., Contracting Officer
Bureau of Land Management
U. S. Department of the Interior
18th & C Streets, N.W.
Washington, D.C. 20240

Dr. Francis C. Monastero
Contracting Officer's Authorized Representative
Bureau of Land Management
U. S. Department of the Interior
Division of Marine Minerals (732)
18th & C Streets N.W.
Washington, D.C. 20240

Mr. Charles J. Guice, Government Inspector
Outer Continental Shelf Office
U. S. Department of the Interior
Bureau of Land Management
Suite 3200 The Plaza Tower
1001 Howard Avenue
New Orleans, LA 70113

Mr. Douglas A. Lipka, Government Inspector
Outer Continental Shelf Office
U. S. Department of the Interior
Bureau of Land Management
Suite 3200 The Plaza Tower
1001 Howard Avenue
New Orleans, LA 70113

VII. SUMMARY OF SCIENTIFIC RESULTS

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Pursuant to a meeting in Washington, D. C. between the Program Manager and representatives of BLM at the time of "hand" delivery of the Draft Final Report, by mutual agreement it was decided that the Final Report should be reduced in size from the five (5) volume set consisting of approximately two thousand (2000) pages per set to a more manageable summary document.

This summary document is to provide for easier access, than was the case in the more detailed draft final report, to the scientific results, the nature of the study plan and the sampling scheme and subsequent analysis, particularly methodology and calibration. The volume, while summarizing the entire study and results, is to also serve as a readable briefing document for non-scientists and decision-makers, as well as a directory for the specific investigators and topical portions of the five (5) volume Draft Final Report.

In order to prepare the final summary document within the time frame as required in the contract, the Program Manager asked Dr. Frank T. Manheim, a member of the MAFLA SURVEY Science and Management Coordinating/Advisory Committee representing Chemistry and Analytical Quality Control, to assist in the preparation by writing a summary of scientific results per se. Dr. Manheim was asked to prepare the summary of scientific results, Section VII, based on his interpretation of the work statements presented in the RFP 74-2 and in the resulting SUSIO Consortium contract.

Special emphasis was placed on the need of preliminary areal characterizations based on survey results. These are noted in Section E. Item 5 D of the contract. Of particular interest are community characterizations and relationships. Some limited amount of cross-disciplinary integration was agreed upon as necessary to produce general characterizations of the areas and the important hydrodynamic and hydrobiologic processes occurring in each area.

Dr. Manheim accepted the request and diligently applied himself to the task at hand. Based on information he had derived from discussions in the SUSIO Consortium meetings, review of the various reports that had resulted from this contracted survey work, reading of the individual final reports of each of the principal investigators (subcontractors) as presented in the Draft Final Report, personal communications with numbers of his colleagues, and drawing on his own professional judgment, experiences in the subject area, and considered opinions, he has prepared the summary of scientific results of the MAFLA SURVEY that follows. As stated, the summary is his report and does not necessarily represent the views, interpretations of certain data and/or conclusions on same of the principal investigators (subcontractors) who have been involved in this contracted survey; in fact, the summary should be accepted by the reader as a preliminary review (summary) due to the time limitations imposed. Furthermore, the summary presented herein does not necessarily have the concurrence of the aforementioned principal investigators (subcontractors) since, unfortunately, time did not permit their individual reviews and responses accordingly.

For sources of detailed information and/or data that have resulted from the subject contract, the reader is provided the following list of titles of final reports, with names of principal investigators (subcontractors) accompanied by numbers of pages of text, tables, figures and appendices in same. In the meantime, a preliminary summary of scientific results of the survey, as discussed, is presented for the reader's general information and/or consideration as prepared by Dr. Manheim.

FINAL REPORT TITLE	PRINCIPAL INVESTIGATOR	NUMBER OF REPORT PAGES TEXT	TABLES	FIGURES	APPENDICES	TOTAL	COMMENTS
PARTICULATE HYDROCARBONS	R. H. Pierce/USMiss.	3	1(14)	0	0	17	Other Data/Analysis submitted in Monthly Progress Reports 1-8 (approx. 150 data sheets)
HISTOPATHOLOGICAL ARCHIVING	N. J. Blake/USF	1	2(5)	0	0	6	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
MACRO INFAUNA	H. Kritzler/FSU	11	3(6)	0	0	17	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
POLYCHAETOUS ANNELIDS IN AREAS IV AND V	B. A. Vittor/UA	4	2(4)	2(2)	2(35)	45	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
TRACE METALS IN BENTHIC ORGANISMS	S. B. Betzer/USF	6	2(4)	0	2(66)	76	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
SYNOPSIS OF REMOTE BOTTOM PHOTOGRAPHY	T. E. Pyle/USF J. C. McCarthy/USF	3	C	0	1(70)	73	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
MICROMOLLUSCA OF THE MAFLA PROJECT	D. R. Moore/UM	5	8(27)	2(2)	0	34	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
DISTRIBUTION AND SIGNIFICANCE OF FORAMINIFERA IN THE MAFLA AREA	W. D. Bock/UM	10	3(6)	7(21)	0	37	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
CHARACTERIZATION OF THE EPIFAUNAL AND EPIFLORAL BENTHIC COMMUNITIES IN THE MAFLA LEASE AREAS	T. S. Hopkins/UWF	10	3(8)	0	2(33)	51	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
HYDROCARBONS IN BENTHIC MACROFAUNA	P. A. Meyers/U of Mich.	1	C	0	0	1	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
SEDIMENT ADENOSINE TRIPHOSPHATE	P. A. LaRock/FSU	3	5(5)	0	0	8	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
STANDARD SEDIMENT PARAMETERS	L. J. Doyle/USF	2	16(16)	0	4(337)	355	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
CHARACTERIZATION OF CARBONATE SAND FRACTION FROM MAFLA AREAS I, II, III	H. R. Wanless/UM J. Dravies/UM	5	0	0	5(201)	206	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
FINAL REPORT ON SEDIMENT TRACE AND HEAVY METAL CONCENTRATIONS	B. J. Presley, et.al./TAMU	12	3(5)	7	0	24	Other Data/Analysis submitted in Monthly Progress Reports 1-8.

FINAL REPORT TITLE	PRINCIPAL INVESTIGATOR	NUMBER OF REPORT PAGES					COMMENTS
		TEXT	TABLES	FIGURES	APPENDICES	TOTAL	
PHYTOPLANKTON CELL CONCENTRATIONS; SPECIES COMPOSITION: CHLOROPHYLL	R. L. Iverson/FSU R. A. Woodmansee/GCRL	4	4(5)	0	4(118)	127	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
ANALYSIS OF BASELINE IN ZOOPLANKTON FROM OFFSHORE OIL LEASE SITES IN THE EASTERN GULF OF MEXICO	F. J. Maturo, Jr., et.al./UF R. A. Woodmansee, et.a./GCRL	35	21(20)	16(16)	2(23)	94	Other Data/Analysis submitted in Monthly Progress Reports 1-8 and Supplement Report, Section IV, (approx. 400 data sheets)
WATER COLUMN ADENOSINE TRIPHOSPHATE	P. A. LaRock/FSU	2	1(2)	0	0	4	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
PARTICULATE AND DISSOLVED ORGANIC CARBON CONCENTRATIONS IN THE MAFLA LEASE AREAS	G. A. Knauer/FSU C. Aller/FSU	4	5(9)	0	0	13	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
SUSPENDED MATTER AND TRACE METAL DETERMINATION	P. R. Betzer/USF	3	1(1)	0	0	4	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
ZOOPLANKTON TRACE METALS	G. A. Knauer/FSU P. R. Betzer/USF	4	2(2)	0	1(34)	40	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
TRACE METAL ANALYSIS OF SEA WATER SAMPLES COLLECTED IN THE MAFLA BASELINE SURVEY	D. A. Segar/AOML	5	4(3)	0	0	13	
MICRONUTRIENT ANALYSIS	K. A. Fanning/USF	4	3(4)	0	0	8	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
COMMUNITY STRUCTURE AND PRESENT HYDROCARBON CONTENT OF DRIFTING SARGASSUM	H. J. Humm/USF	1	3(4)	0	0	5	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
DISSOLVED LOW MOLECULAR WEIGHT HYDROCARBONS IN THE MAFLA LEASE AREAS	W. M. Sackett/TAMU D. R. Schink/TAMU	3	1(4)	0	0	7	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
HYDROCARBONS IN BENTHIC FAUNA	P. A. Meyers/U of Mich.	2	1(1)	0	0	3	Other Data/Analysis submitted in Monthly Progress Reports 1-8.
ZOOPLANKTON AND DISSOLVED HIGH MOLECULAR WEIGHT HYDROCARBONS	J. A. Calder/FSU	15	24(25)	0	0	40	Other Data/Analysis submitted in Monthly Progress Reports 1-8 and Supplement Report, Sections I & II (approx. 650 data sheets)
HIGH MOLECULAR WEIGHT HYDROCARBONS IN SEDIMENT AND BENTHIC ALGAE	T. F. Lytle/GCRL J. S. Lytle/GCRL	34	32(38)	6(6)	0	78	Other Data/Analysis submitted in Monthly Progress Reports 1-8 and Supplement Report, Section III (approx. 300 data sheets)

SUMMARY OF SCIENTIFIC RESULTS as prepared by Dr. F. T. Manheim

A. Introduction

This treatment will attempt to provide a descriptive synopsis of the extensive data presented by some 32 principal investigators, management staff and other personnel who have contributed to the first MAFLA survey. It will be evident that few persons could be sufficiently conversant with the great range of subject matter dealt with in this study to provide a truly critical synthesis of the work, even had time permitted such an effort. In attempting to strike a balance between presenting as much cogent data as possible, while limiting the bulk of this summary, difficult choices had to be made and it was possible to utilize only a small portion of the 14-inch plus stack of documents. Many summary tables and some figures have been drawn from the contributions themselves; others have been prepared or augmented from the data. I have not hesitated to draw inferences and conclusions where these appear to be appropriate, while attempting to stay within the scope of this survey.

Owing to the fact that some treatments lend themselves better, or have been prepared in such a way, as to allow more concise summary, the amount and scope of the original work is not necessarily correlative with the material represented here. Nevertheless, I hope that this overview will provide a guide to the nature and extent of the full contributions. These are referred to by the chief investigator's name(s) (without data) and are listed on the preceding pages.

Much of the data provided in the report will be entered into NODC and other computer banks and will be available to future investigators in this form. In addition, however, it would be a great advantage if the

entire report were placed on microfiche cards or other convenient reference form so that not only the raw data themselves but the tabulations as prepared by the individual authors (with notes and ancillary commentary), as well as the text and in-depth evaluations, could be made readily and inexpensively available to future investigators.

In preparing this report, I have received invaluable assistance by the SUSIO staff, especially P. Blizzard. Comments by most of the principal investigators during a recent meeting in St. Petersburg, and P. Yevich were helpful to put the work in perspective. Valuable assistance was provided by T. E. Pyle and L. J. Doyle. I am grateful to M. Bach and W. Jorgenson for their efforts with the manuscript and to Ose Manheim for preparing photographs from negatives kindly provided by T. E. Pyle.

B. Environmental Setting

The SUSIO Consortium's baseline survey is directed and largely restricted to five discrete lease tracts in the MAFLA* shelf areas of the eastern Gulf of Mexico, extending from approximately 89°W, south of Pascagoula, Mississippi, to a tract west of Clearwater, off Tampa Bay, Florida (Fig. 1). Although it is not possible to deal with these tracts as a continuum, they intercept major changes in environmental habitat. Near the Mississippi Delta, silt-clay, turbid bottoms having low benthic productivity occur. Eastward toward peninsular Florida a transition occurs to a carbonate substrate, more transparent waters, and significant benthic productivity. One high relief area, the Middle Ground, on the outer shelf roughly midway between St. Petersburg and Apalachicola, Florida, represents a unique hermatypic coral reef environment whose associated flora and fauna are displaced far north of their usual limits. It is also a major fishing resource for the northwestern Gulf. Drowned algal reefs have been reported at the edge of the continental shelf south of Mobile Bay. Although topographic and lithologic data are sketchy, other lesser patches of relief and living coral occur on the limestone shelf south of 29°N and provide shelter and habitat for significant bottom populations. These have a still poorly understood significance for fish populations, including tropical species not found in the northwestern Gulf of Mexico.

Facing the lease tracts V, IV, and to some extent III, are a series of offshore barrier bars and islands with sandy beaches on their seaward

* Mississippi-Alabama-Florida

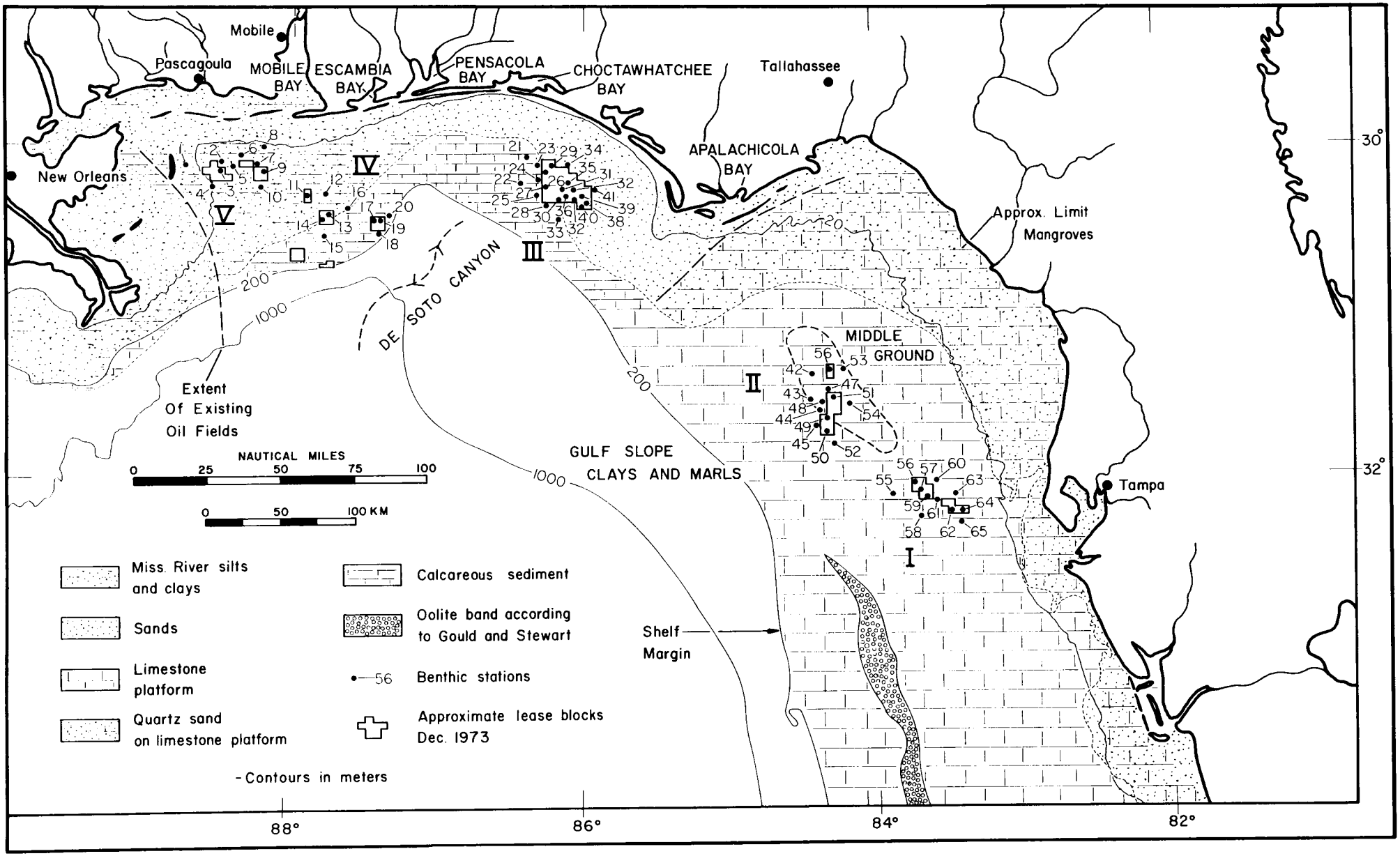


Figure 1. General Location Map of Bottom Stations.
Sources: Ludwick, 1964
Brooks in Jones et al., 1973
Emery and Uchupi, 1972
Gould and Stewart, 1955

sides, and silt-mud and tidal marshes on their bay sides. Off tracts II and I are beds of seagrasses and algae that form a productive element challenging or exceeding phytoplankton productivity in the region. At the shore zone itself fine quartz sand beaches alternate with mangrove vegetation that serves to protect shorelines from storm erosion, and provides shelter and organic matter for fish, invertebrate marine and other marine organisms and their food chain elements. The west Florida shelf as a whole is one of the least investigated shelf areas around the U. S. continental margin. Nevertheless, it is known to contain many elements of unusual character. One of these is the Tortugas banks, which form perhaps the most prolific shrimping grounds in the Gulf of Mexico. A band of the inner-central shelf is both the site of recurring outbreaks of red tide (blooms of the toxic dinoflagellate, Gymnodinium breve) and a well-developed drowned karst zone. Submarine discharge is known in this area, the best-known of the occurrences being "Mudhole Spring," 10 miles off Sanibel Island, near Charlotte Harbor and Ft. Myers, Florida. The warm (97° F) character of its discharge indicates that the water is issuing from considerable depth, and provides an indication that the frequently cavernous and possibly fault-related hydrologic pathways that characterize the upper 1000 m and sometimes deeper strata in southwest-central Florida extend offshore.

One of the keys to the clarity of the Florida shelf waters south of about 29°N, which plays a role in benthic productivity, is the relative paucity of clay minerals in bottom sediments. The carbonate-rich bottoms that extend beyond an inner sand belt to the shelf edge have relatively coarse sediments that are not easily transported long distances under normal conditions. Owing to the generally favorable climate, the attractiveness

of the coastline and good fishing, the eastern Gulf shore south of Tarpon Springs has an exceptionally strong tourist industry. Sports fishing follows closely after construction as an economic base of the region, leading commercial fishing by a factor of about 15 to one in terms of dollar value. Although no breakdown is currently available for the west coast of Florida and eastern Gulf States, the total value of the sports fisheries for Florida have recently been estimated by the Florida Coastal Coordinating Council (M. Stursa, personal communication) at about $480 million per year.

Existing pollutants in the offshore land area are an important consideration, for in order to make meaningful use of baseline surveys on the shelves one must quantify contaminant levels, as well as be able to distinguish their origin, if possible. Significant inputs of pollutants of both hydrocarbons and heavy metals and pesticides were noted from a number of estuaries, bays and other areas in the Escarosa study (1973), notably Mobile, Escambia and Choctawhatchee Bays, and phosphate wastes, other industrial effluents and sewage waste inputs still occur in Tampa Bay, though at reduced levels. Hydrocarbons in selected barrier bar sediments have been investigated in work in preparation (Palacas, 1975). In the investigated cases, the traceable pollutants (chiefly in sediments) do not extend far offshore. One must not overlook the enormous volume of sediments from the Mississippi River, which contain significant though still relatively sparsely documented pollutants, and are intermittently swept far eastward under special current conditions.

A fact that affects both faunal and floral character in the eastern Gulf of Mexico is the exceptionally irregular nature of current patterns, notably the Loop current, which surges into the Gulf during the late summer-

winter period. Warm Caribbean surface waters in some years extend as far northward as the Mississippi Delta before losing coherence. Loop waters have been observed to impinge on the shelf as far landward as the Anclote (Tarpon Springs) estuary. When such loop masses meet flood conditions in the Mississippi River, special entrainment and water movement patterns have caused transport of freshened waters having a salinity as low as 22 °/oo (compared to normal Gulf waters having 35+ °/oo, and 36.5 °/oo and upward for Loop current incursions) southward along the shelf. Such freshened-water masses may contain river-related turbidity and trash and have been observed during 1973 to round the Florida straits and travel northward along the east coast of Florida to Georgia and South Carolina offshore (Wallace, 1975; Atkinson and Wallace, 1975).

Only a few physical oceanographic features will be included in this report since an extensive data search and summary is being presented parallel with this report.

Although substantial literature is available in scattered sources on the area in question, many facets are known only in a sketchy or fragmentary way. The existing data are summarized in two useful compendia. Jones et al. (1973) present an encyclopedic summary of information on the eastern Gulf of Mexico. McNulty et al. (1972) provide an overall survey of the coasts and estuaries along the western margin of Florida, as the first in a proposed 4-volume series.

C. Objectives of Study

One of the chief objectives of the study, as mandated by the Bureau of Land Management, was to complete sampling of waters, sediments and organisms on the leased tracts before arrival of drilling rigs in mid-

summer of 1974. Scientific targets include the following chief elements.

Water column measurements were to include elements of zoo-and phytoplankton, neuston, basic water properties, nutrients, trace metals, and hydrocarbons in various forms along an extended traverse with stations concentrating on the lease sites.

The chief strategy of the bottom survey was to employ a relatively limited number of master stations (65) with sufficient subsamples (10 at each master station) to obtain a statistically significant evaluation of the existing benthic community. All box cores utilized for this work were to be sieved and sorted for basic organism groups, whereas only a few organism groups, polychaete worms, micromolluscs, and foraminifera were to be determined quantitatively at the species level. Selected invertebrates were to be sectioned, stained and analyzed histopathologically. Such analyses are more sensitive than measure of population changes to impact of pollutants, since influences on specific organs (tumors and necrosis, etc.) may be detected before pollutant levels affecting survival are reached. The remainder of the materials were to be archived as benchmark materials permitting comparison with other seasonal surveys, and in particular, surveys after possible future hydrocarbon discovery and production on the shelf. Where cores were not possible owing to hard substrates, investigation and documenting of surficial flora and fauna and sediment type was to be performed by divers, dredging, and bottom photography, both by diver and by remote camera. All locations for benthic surveys were stipulated to be fixed by state-of-the-art, precision systems (Raydist).

Especial attention was to be given to the Middle Ground and Clearwater areas, where bottom flora and fauna are highly developed, and bottom visibility is good.

In addition, description and analysis of basic properties of sediments (carbonate content, grain size, clay mineralogy, petrographic description), carbonate skeletal and organism remains from areas I, II, and III were to be described and categorized by statistical and graphic methods as providing longer-term clues to bottom habitats. All these measurements were to be performed on one box core from the 10 at each master station.

A perhaps unprecedentedly intensive study of chemical properties of sediments, waters and organisms was performed. Cadmium, copper, and lead were analyzed to provide a base for evaluating potential toxic pollutants. Barium, used as a weighting material, (as barium sulfate) in drilling muds, was included to provide a tracer for drilling mud; nickel and vanadium concentrations are high in crude oils and hence serve as inorganic (trace) indicators of petroleum residues where the organic fraction has been partially or wholly dissipated by leaching or microbial attack. Iron and chromium may be included in drilling mud additives and also serve as control elements for evaluating levels of other constituents. These metals were studied in bottom sediments (master stations), selected bottom organisms and waters, suspended matter, and zooplankton.

Heavy (extractable) hydrocarbons were analyzed by gas chromatography in waters, sediments, benthic organisms and zooplankton, and particulate matter in the water column. All of these measurements were performed to establish baseline levels of hydrocarbons in the pertinent phases. It is realized that sediments, bottom organisms, zooplankton, and finally water and particulate matter in the water column have successively shorter residence times in the environment in question. However, to the extent that the short range phenomena can be related to typical water mass structures,

productivity, physico-chemical interrelations, or influence on more permanent phases, their chemical properties were held to have significance worth evaluating. Light hydrocarbons (C_1 - C_5) were determined on bottom, intermediate and surface waters to attempt to detect natural hydrocarbon seeps or other emanations from the sea floor, or evidence of pre-existing pollutants.

Measurements of ATP (Adenosine triphosphate) were performed on the water column and sediments. It serves as a measure of living microbial activity, and protoplasmic biomass (including foraminifera and other micro-fauna) which may have implications for general metabolic activity, including the rate at which hydrocarbons may be degraded by natural processes.

Careful attention was paid to intercalibration and other checks on analytical validity, especially in the case of chemical parameters that require state-of-the-art technique or are otherwise critical, such as hydrocarbons. Baseline values of key parameters are useful only insofar as their accuracy and freedom from excessive error occasioned by sampling and handling procedures can be assured. The level of analytical and manipulative variability must be determined to separate it from natural variability. Checks were performed both by the chief investigators, and outside laboratories chosen by the Bureau of Land Management.

Finally, it was recognized that single occupations of stations do not, for many parameters (especially faunal and floral) constitute adequate baseline information. Though not included in the current program, it was understood that reoccupation of stations and resurvey of parameters would form an element of future continuation studies.

D. Geological Substrate Characterization

1. Lithology

Major geological parameters are shown in Table 1 (from Doyle et al.). These indicate the following general features. Areas I and II are dominated by carbonate, the greater part being present in sand and silt-size skeletal debris. Clay size matter (<.004 mm) is less than 10%, often below 4%. This paucity of clay-sized materials accounts in part for the clarity of the water, since particulate matter, once stirred by currents, will normally settle out quickly.

These sites include a great variety of carbonate skeletal matter, described in detail by Wanless and Dravies. The dominant carbonate organisms contributing to skeletal debris over these areas, as well as area III are molluscan shells, followed by foraminifera, bryozoa and echinoids, and worm encrustations and remains, with the exception of the high-relief areas of the Middle Ground. These areas contain large accumulations of coral-algal debris, derived from breakdown of reef products. Calcareous algae typically encrust ridge prominences. The carbonate studies were not performed in areas IV and V.

A sample of the skeletal description is given in Fig. 2 for station 37, in area III (Wanless and Dravies). The diagram shows that in the greater than 2000μ fraction more than 70% of fragments are of molluscan origin, the remaining material being about 15% bryozoans and 10% coralline algae. Benthic foraminifera reach their greatest extent in the 500-1000μ fraction. In general, sizes over 250μ were almost exclusively carbonate.

An interesting petrographic observation relates to finding that weathering and biocorrosion of skeletal particles signifies appreciable reworking and exposure of materials and attack of particles on exposed surfaces. This

was marked in the Middle Ground area. In contrast, rippled bottoms off Clearwater were frequently characterized by clear, uncorroded grains.

Table 1. Chief geological parameters of bottom (box core) sediments (from Doyle et al.) Clays are defined as <.004 mm; silt is 0.004 - .63 mm; sand is 0.65 - 2 mm; coarse fraction is >2 mm. Size data based on sieve and pipette analysis.

Sta.	Depth (m)	Coarse Frac. (%)	Sand (%)	Silt (%)	Clay (%)	CO_2(%) as $CaCO_3$	Lithologic description
			Area I				
55A	44	1.0	38	55	6.1	86	Coarse calcareous sand, shell hash, coral; calcareous silt, inhomogen. substations.
56A	37	.1	62	31	6.5	83	Calcareous silt and sand with shell fragments
57A	38	.7	69	28	2.3	87	Fine calcareous sand, shell fragments, grass and reddish branchlets mud burrow
58A	43	-	-	-	-	high	Very coarse carbonate rubble; sponge
59A	35	-	-	-	-	high	Carbonate bedrock; no sample
60A	31	.3	62	34	3.7	82	Calcareous sand and silt; sparse shell grass; black particles
61A	33	.8	62	33	3.8	73	Calcareous sand and mud, grass tubes
62A	34	1.5	92	2.5	3.4	89	Very coarse calcareous sand and rubble, pink coral and black particles
63A	30	1.0	46	45	9.3	75	Calcareous sandy silt; shell and black particles
64A	30	.3	50	45	4.6	84	Well sorted fine calcareous sand and silt; shell and black particles, mud tubes
65A	42	.1	57	40	2.1	80	Fine-medium calcareous sand
			Area II				
42A	37	9.7	67	18.6	4.4	82	Calcareous sand and fine silt, small shells; debris-filled burrows
43A	45	-	-	-	-	high	Coarse shell and carbonate rock rubble
44A	53	4.3	92	3.3		82	Very coarse calc.and shell rubble, black material and grass tubes
45A	44	1.4	85	8.1	5.3	73	Calcareous sand with high percent black material
46A	37	1.9	86	10	2.3	52	Fine-medium calcareous sand
47A	36	12	85	2.9		93	Shell hash with worm holes, sponges and seaweed, algae
48A	40	1.7	63	34	2.0	82	Calcareous sand with shell and black particles
49A	42	-	-	-	-	high	Top surface clay; fine to coarse sand of carbonate material with black particles
50A	48	1.4	91	7.3		77.4	Coarse calcareous sand and rubble, grass fragments; layered
51A	27	-	-	-	-	high	
52A	54	3.4	49	40.9	6.2	87	Fine calcareous mud with shell and black particles
53A	37	1.8	62	13.2	1.4	88	Medium-coarse calcareous sand with 2 cm fine carbonate on top with shell hash, worm burrows
54A	34	-	-	-	-	-	

Table 1. Continued.

Sta.	Depth (m)	Coarse Frac. (%)	Sand (%)	Silt (%)	Clay (%)	CO_2 (%) as $CaCO_3$	Lithologic description
			Area III				
21A	51	9.1	58	31	1.7	76	Calcareous sand, coarse
22A	82	7.6	74	16	3.1	83	Calcareous sand, v. coarse, shell debris
23A	64	.2	36	59	5.1	63	Sandy, calcareous mud, tubes on surface
24A	64	.2	27	67	5.7	68	Fine carbonate mud, burrowed
25A	80	.3	40	51	9.1	73	Sandy carbonate mud
26A	57	2.0	73	18	7.0	56	Medium calcareous sand with appreciable quartz silt
27C	68	.2	34	45	21	67	Sandy carbonate mud with quartz
28A	66	7.1	89	3.2		82	Silt and clay, coarse calcareous sand
29A	46	1.7	80	12	6.1	65	Calcareous sand, fine-medium with some quartz admixture
30A	48	2.4	93	4.1		76	Well-sorted calcareous sand -shell hash with quartz
31A	41	5.9	89	4.5		85	Coarse calcareous sand-shell hash
32C	42	-	-	-	-	-	Coarse calcareous sand-shell hash
33A	69	15	80	5.2		80	Layered coarse calcareous sand-shell hash
34A	35	39	59	1.9		80	Coarse shell hash and calcareous algae
35A	36	3.0	94	2.6		70	Coarse calcareous sand-shell hash with quartz sand-clay admixture of calcareous red algae
36A	40	4.3	93	2.5		57	Shell hash in cone-shaped holes; calc. algae
37A	40	9.4	87	3.8		65	Coarse calcareous sand with shell hash
38A	38	6.1	83	5.9	4.7	62	Graded (inverse) calcareous sand, shell fragments, polychaete tubes
39A	36	3.1	93	3.3		24	Coarse calcareous sand with larger fragments
40A	36	14.9	83	1.7		34	Coarse quartz sand with carbonate fragments
41A	31	.4	94	4.5	1.0	14.2	Medium quartz sand with shell hash, some calcareous algae

Table 1. Continued.

Sta.	Depth (m)	Coarse Frac. (%)	Sand (%)	Silt (%)	Clay (%)	CO_2(%) as $CaCO_3$	Lithologic description
			Area IV				
11A	35	4.1	96	2		13	Brown medium-coarse sa nd, lower layers include shell hash
12A	36	17	78	3.6		34	Coarse sand and abundant shell frags
13A	35	.5	97	1.9		3.2	Fine-medium, well-sorted sand
14A	35	.9	97	2.1		4.9	" " " " "
15A	45	.1	96	3.4		6.9	Medium sand, sparse shell debris
16A	36	.3	97	1.9		3.5	Fine sand, well sorted, sparse shell darker bioturbated (?) zones
17A	66	11	85	3.7		84	V. coarse, calc. sand, some quartz sand.
18A	82	8.0	85	7.2		84	V. coarse,quartz*calc. sand, mud-filled burrows; sds. well-rounded
19A	82	9.2	72	5.8	3.3	45	V. coarse quartz sand and calc. sand occ. muddy inclusions.
20A	85	2.9	91	5.7		83	V. coarse calc. sand, worm tubes on surface only.
			Area V				
1A	13	.2	12	53	35	7.4	Soft clayey silt (quartz), minor shell, burrowed
2A	24	2	14	47	33	18	Soft clayey silt (quartz) with shell, burrowed near top
3A	29	.1	20	51	28	16	Soft brnsh. gray clayey silt, streaked with black material and sand, burrowed
4A	29	<.1	12	73	15	16	Clayey shelly silt with black organic matter and sand streaks, burrowed
5A	31	.1	25	58	17	19	Brownish silty clay, black streaks and burrows
6A	29	1.4	61	25	12	19	Brownish silty sand with appreciable clay; burrows and shells
7A	32	.6	31	20.2	9.0	17	Fine silty sand, clayey, shelly surface burrow only
8A	24	.6	89	5.0	5.1	8.0	Fine gray sand, trails and tubes on top.
9A	31	2.1	74	6.6	5.6	14	Med-fine gray sand, shelly
10A	35	2.2	43	11	2.7	21	Varicolored sand, shelly, some burrows

*quartz. = quartzose

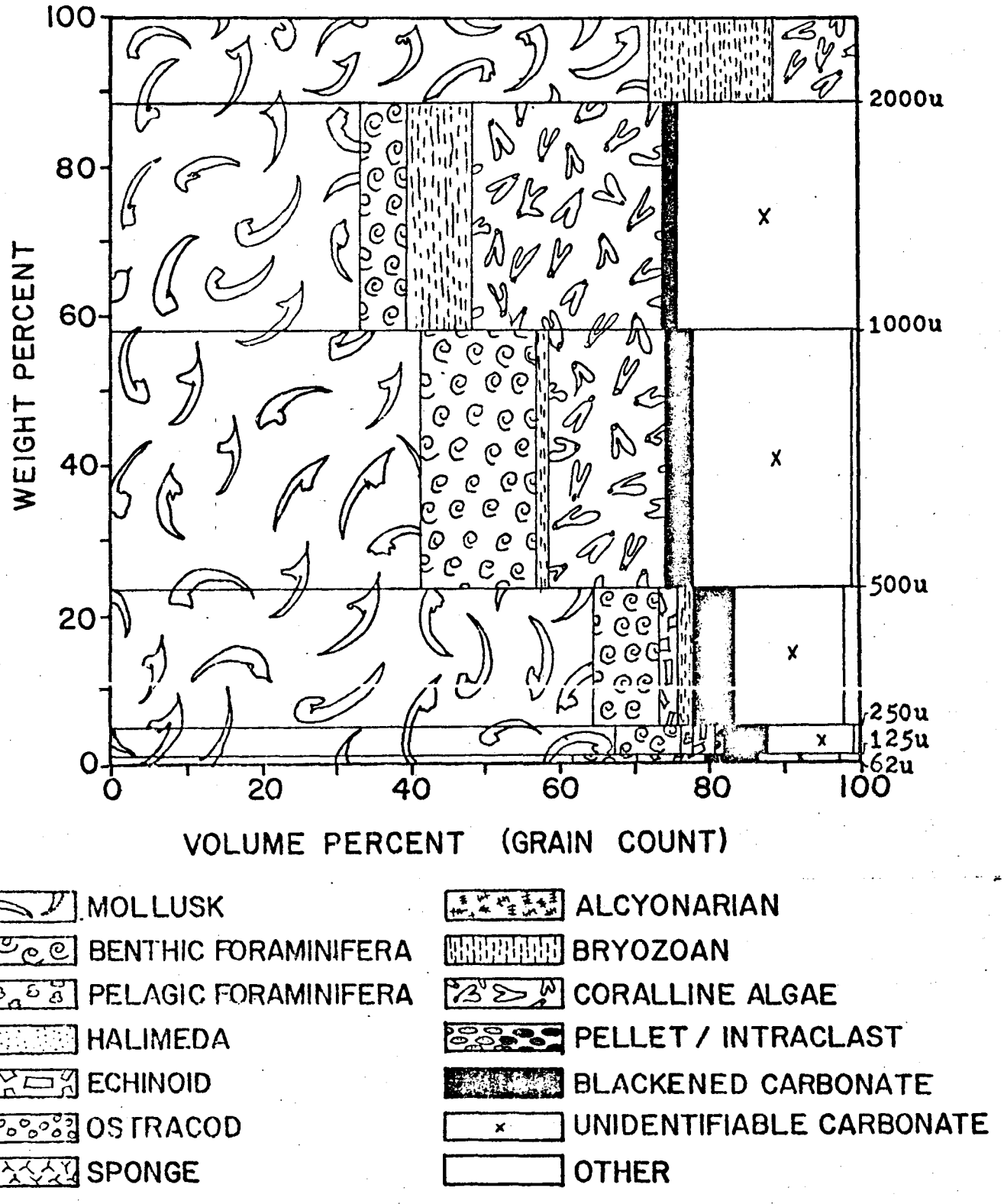


Figure 2. Graphic display of skeletal particle distribution, Area III, Station 37 (Wanless and Dravies).

In area III carbonate is still predominant, but larger quantities of quartz silt and sand occur, especially in the northeastern part of the area. The petrographic studies in some cases also shed light on the degree of dispersal of organism remains by currents after death. For example, Fig. 3 (redrawn from data of Wanless and Dravies) reveals that the coarser echinoid fragments were deposited in a pattern transverse to depth contours in area III. As finer (and more transportable) sizes are reached, the pattern shifts to a longshore or contour-parallel pattern. Such patterns are useful since they place in perspective integrated accumulations of organisms over a longer period of time, in contrast to the variable occurrence that may be present for any samplings of live materials. However, such studies are complicated by the fact that it is not always possible to ascertain the time period over which the accumulations have occurred.

Area IV shows a marked change in lithologic type. The area is divided into a southeastern carbonate facies similar to that of area III, and a northwestern quartz sand facies with limited clay and silt. This area is clearly affected by detrital material from the Mississippi River, and begins to show significant increases in bottom turbidity (see photograph, Fig. 4g, following section), and suspended matter (data of Betzer). Some of the coarser carbonate deposits show evidences of worm borings in the upper portions of the sediment, whereas the quartz sand sediments tend to be bored to greater depth.

Area V is dominated by silts and sands, with appreciable clays. Black streaks, presumably of organic matter,are common, as is extensive worm burrowing. In spite of this, the organic carbon content is surprisingly low, as given in Table 2.

Figure 3. Distribution of echinoid fragments in sand fractions (Wanless & Dravies)

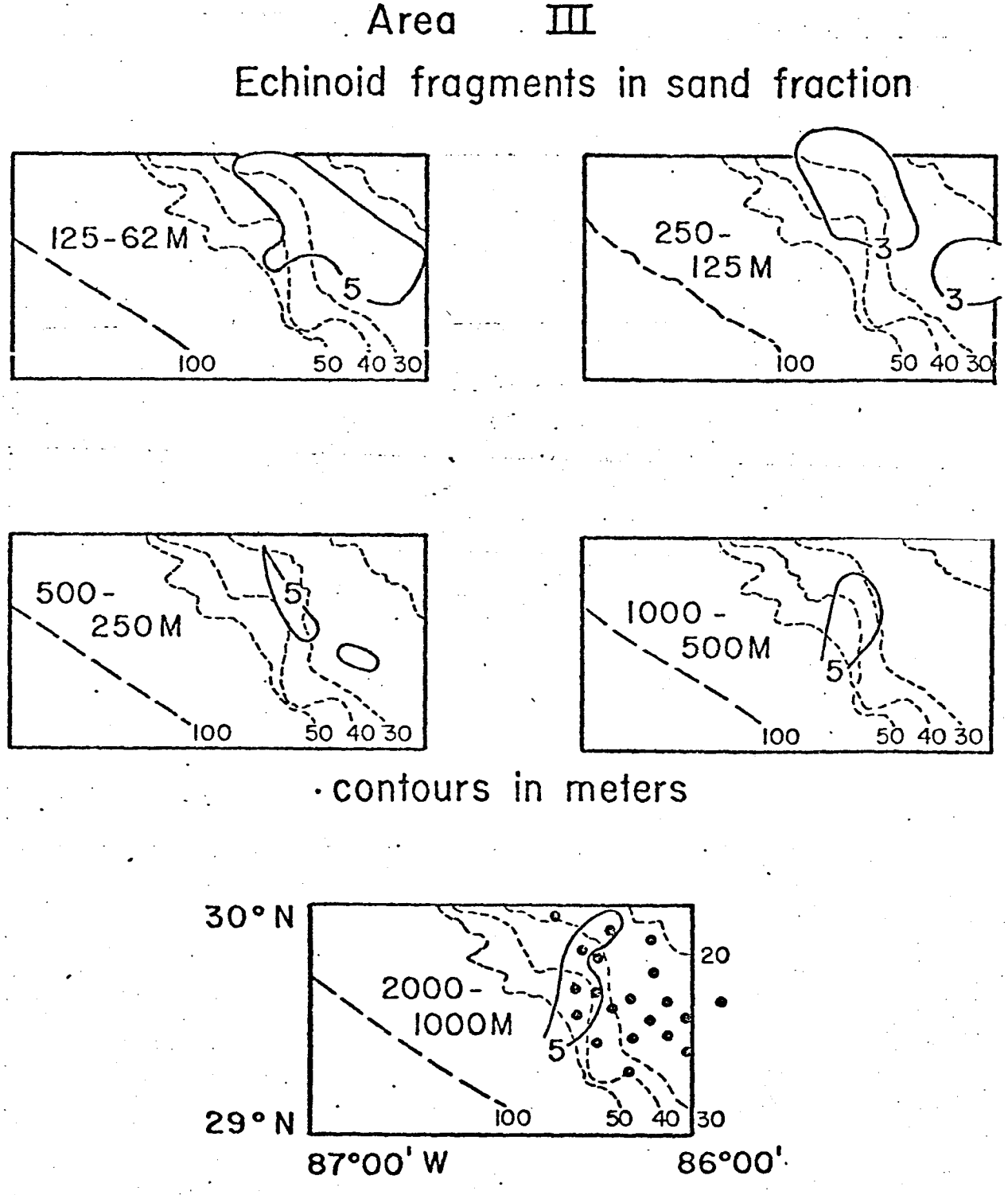


Table 2. Carbonate and organic carbon content in dry sediments, by area. From Lytle and Lytle, except as noted.

Lease area	C_{org} (%)[1]	$CO_3^=$ as $CaCO_3$ (%)
I	3.60	86.4
II	2.08	85.9
III	1.42	71.0
IV	0.77	56.4
V	0.58	15.5[2]

1. On carbonate-free basis.
2. From Doyle, et al.

Clay minerals are shown in Table 3 (Huang). These data are in agreement with clay mineral assemblages reported from bottom sediments and suspended matter in the northeastern Gulf of Mexico (Griffin, 1962; Manheim et al., 1972). A montmorillonite-kaolinite suite is being contributed by the Mississippi River. Toward the Apalachicola River kaolinite dominance increases, whereas southward (areas I and II) montmorillonite virtually disappears in favor of kaolinite, with subsidiary concentrations of chlorite and illite.

One should bear in mind that in the latter areas these minerals do not make up a significant proportion of the bulk sediment, since the silicate clay fraction is very small. However, these data are useful both to identify sources of mineral detritus and establish baseline concentrations for the sediment. For example, discharged drilling muds in quantities of a few to 30 tons per deep hole, should these not be retained at the drill site and dumped elsewhere, will probably have little significance for clay-rich areas such as V, and might be very

Table 3. Clay minerals as a per cent of total clay mineral fraction. Range shown excludes a few fringe or aberrant values (from Huang).

	Montmorillonite	Chlorite	Illite	Kaolinite
I	Trace-6	21-33	3-10	56-72
II	Trace-10	13-30	6-16	60-75
III	15-28	10-19	5-12	50-76
IV	50-81	Trace	10-20	16-45
V	66-87	Trace-3	5- 7	50-76

difficult to detect. In areas I and II, on the other hand, the montmorillonite-rich drilling muds would contrast sharply with local bottoms and might be readily detected. It was earlier feared that drilling mud might be an ecological hazard in the delicate Middle Ground reef sites. Although no documentation on this question is apparently available as yet, on site observations during drilling on area II have as yet not noted significant accumulations of mud or deleterious effects on local organisms (D. Beaumariage, personal communication).

Strength of sediments (vane-shear measurements) as determined on the box-cored samples by shipboard geologists (students of W. R. Bryant contributing to studies of Doyle). These data vary greatly from minimal strength to over 1800 lb/ft^2. The highest rigidities were observed in shell rubble, which also presented difficulties in penetrating core with the vane. The lowest strengths were reported in area I (a few tens to a few 100's lb/ft^2) with remaining areas fluctuating widely in the hundreds of lb/ft^2. It is evident that poor sorting, especially box-like frameworks of coarse skeletal debris, mixed with finer sediment, contributes to sediment rigidity, whereas relatively homogeneous, finer silts and carbonate muds are minimally rigid.

2. Remote bottom photography (Pyle and McCarthy)

65 remote bottom photography stations were occupied at each of the master stations between 16 May and 20 June, in conjunction with box coring. An EG&G, Incorporated Model 200 camera and Model 210A 100 wsec strobe were triggered by a lead weight connected to a tilt switch. The distance from bottom was about 2m, giving bottom coverage of about $2.5m^2$. A total of 648 exposures (615 black and white and 33 color) are available in 35 mm format, and have been rated in terms of photographic visual

quality. Nearly all "C" (poor) negatives (92%) came from area V, and appear to be due to "nepheloid" layers or turbidity near bottom. Divers on R/V BELLOWS reported only a few cm visibility near bottom, and zero visibility after diver perturbation. According to suspended matter-Secchi disk plots in Manheim et al. (1972), such conditions imply particulate concentrations upwards of 100 mg/l. In the remainder of the areas, photographic quality is generally good.

Though the contract called only for archiving of negative materials, a few samples of bottom photo coverage for the lease tracts are offered here to reveal some of the significant features in the areas (Fig. 4 a-g).

The marked change in visibility conditions on moving from area V to IV and III are observable in Figs. 4g-e. Borings of the kind depicted in many of the photographs were found filled with shell hash in some box cores. Evidences of fish and tracks and trails were abundant.

Although a dramatic increase in benthic fauna and flora is depicted in Site 51, on the Middle Ground, it must be remembered that this area was also subject to rapid changes in substrate, with bottom types more resembling those of areas I and III occurring in patches of lower relief. Except in the poor visibility areas, evidences of boring and reworking were ubiquitous in the photographs, corresponding with observations on the cores, and the findings of the polychaete and other specialists.

Figure 4. Bottom photographs (Pyle). See text for explanations. All photographs, except 4f, depict approximately 2.5 m^2 of bottom.

a. Area I. Station 56.

b. Area I. Station 57.

c. Area II. Station 51.

d. Area III. Station 32.

e. Area III. Station 27.

f. Area IV. Station 12B.

g. Area V. Station 10.

Figure 4a. Area I. Station 56.

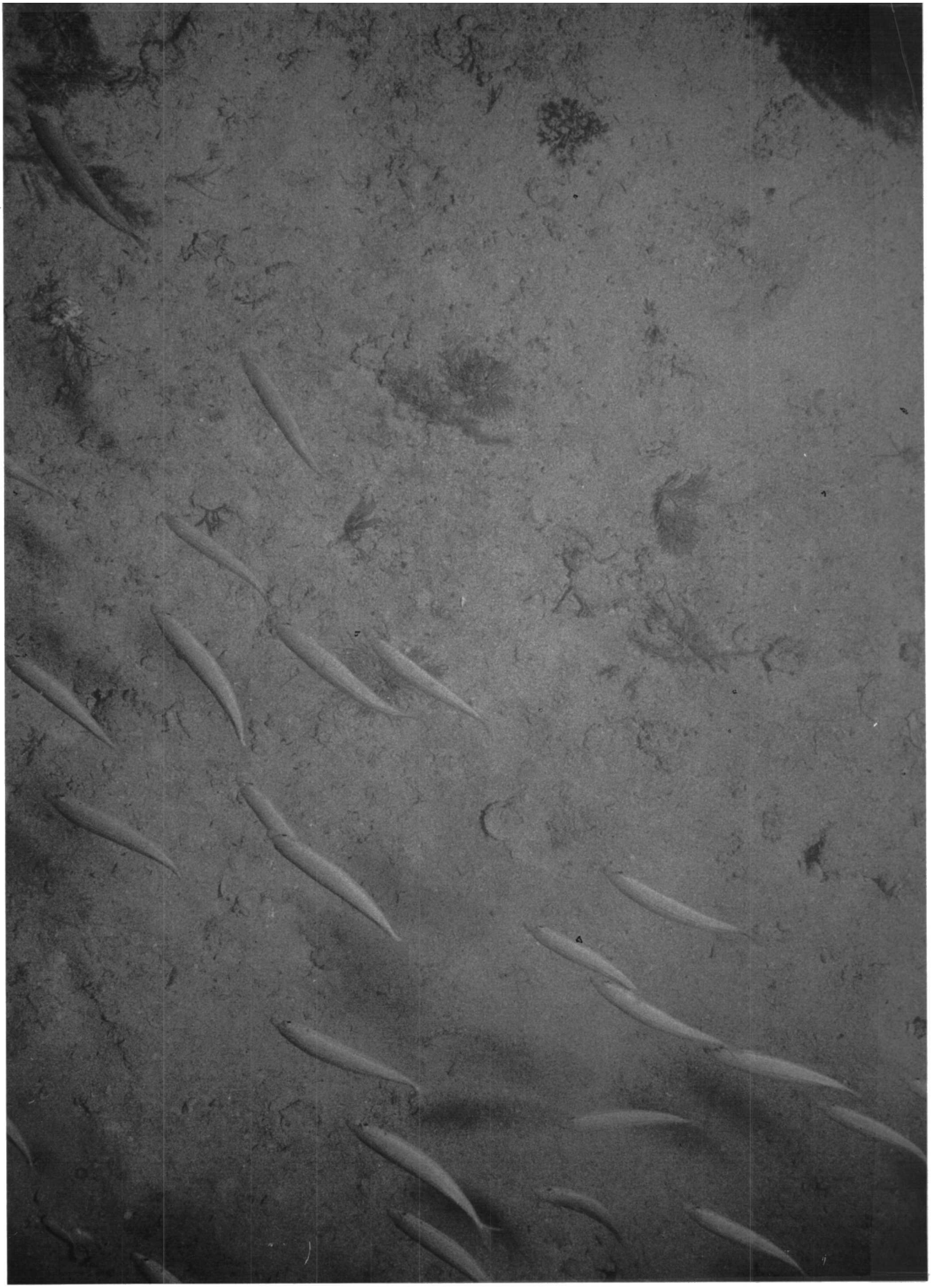


Figure 4b. Area I. Station 57.

Figure 4c. Area II. Station 51.

Figure 4d. Area III. Station 32.

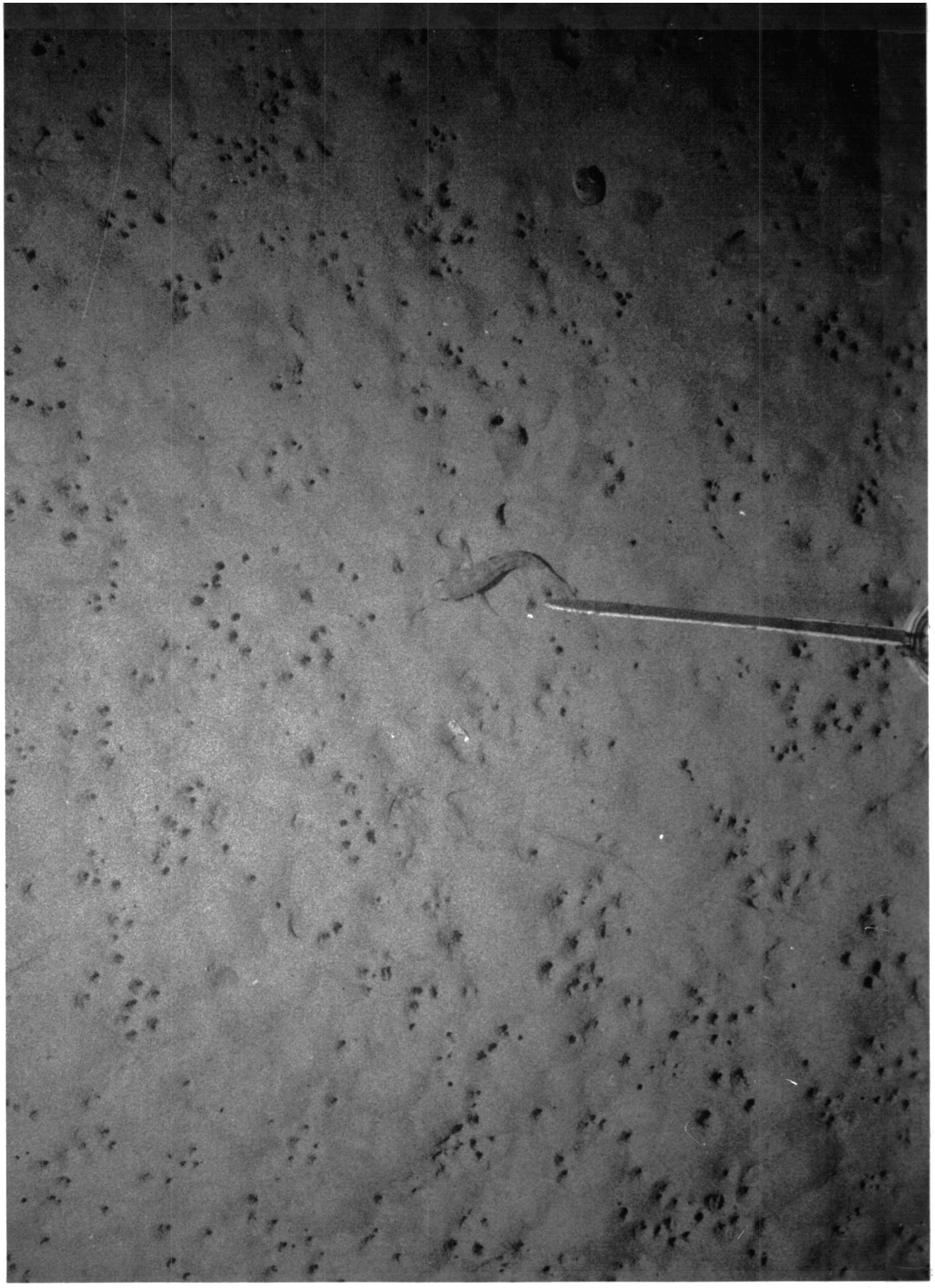


Figure 4e. Area III. Station 27.

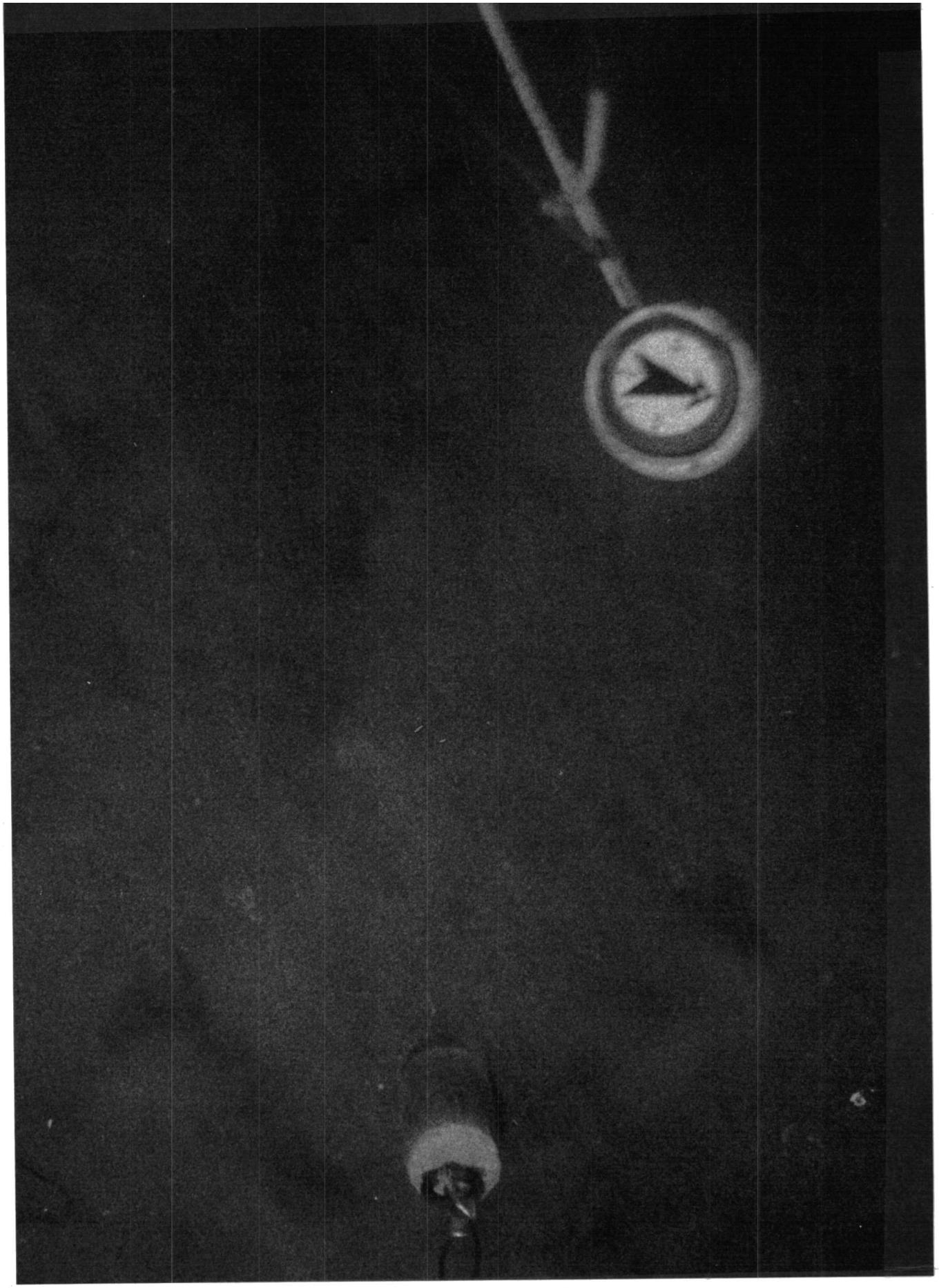


Figure 4f. Area IV. Station 12B.

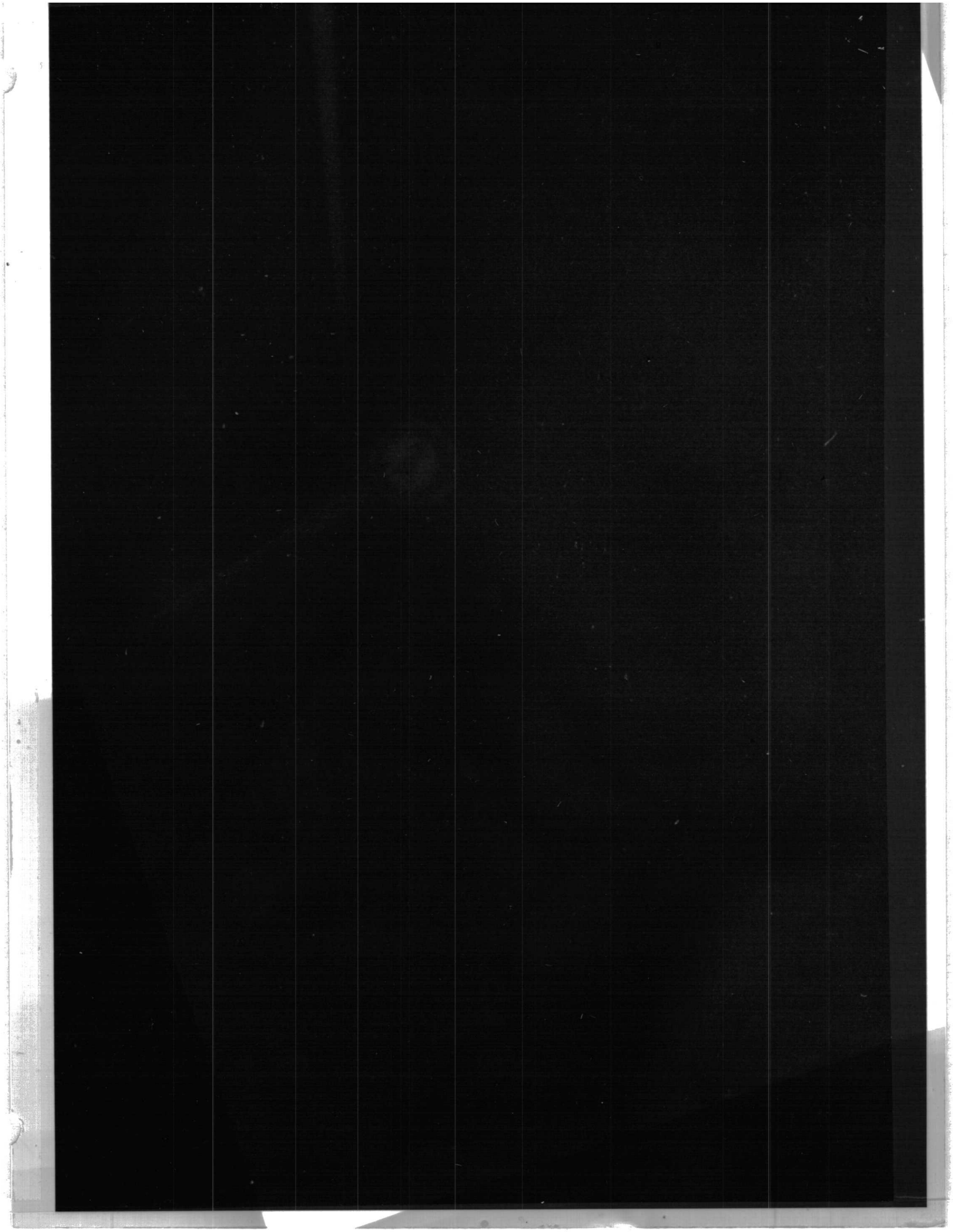


Figure 4g. Area V. Station 10.

E. Benthic Populations

1. Sampling strategy and gross biomass

The prime focus of the benthic studies was to obtain material that would characterize bottom populations in and around the lease tracts in a statistically valid way. Past experience has shown that, in many areas, this is best achieved by combining the information from a larger number of subsamples rather than by sorting and counting an equivalent mass of material from a single large sample. Empirically, studies of N. J. Blake have shown that 10 box cores of the size utilized in this work (21.5 x 30.5 cm) yield the bulk of recoverable species for a variety of benthic invertebrates, in terms of the flattening out of a plot of total species against sample area (see figures in polychaete section).

Box coring has been taken as the method of choice in soft bottoms, since it provides a reliable sample with good preservation of the critical uppermost layers of the sediment, adequate volume to provide subsamples for the many types of investigations, and adequate area to accommodate larger organism forms. For hard bottoms, a combination of quadrat measurements and annotations, photography and samplings by divers, and Capetown dredging was employed to describe epifauna and flora. The latter were called upon when successive tries with the box corer failed to yield significant sediment, and also to cover certain critical areas such as the Middle Ground where epifauna was luxuriant.

The chief biomass sorting utilized eight box core contents less a small amount of subcore removed. The top 15 cm (approx. 9 l.) were sieved, when penetration was sufficient, through a .5 mm nylon monofilament bolting cloth, and retained materials were placed in bags, narcotized in 15% $MgSO_4$ in sea water to relax organisms, then transferred to drums

with 3.8% formaldehyde in sea water buffered with borax to prevent dissolution of carbonate. Through a combination of rough and fine sorting (see Kritzler), macro-infauna were separated into five major taxonomic categories - molluscs, arthropods, echinoderms, polychaetes and miscellaneous. After wet weighing (blotted free of excess moisture), materials were packaged in the smallest jar or vial that could contain them and preserved in 60% ethyl alcohol (polychaetes) and 40% isopropyl alcohol for everything else. The gross biomass for the five major groups varied widely (Kritzler):

Molluscs:	.034 - 20.1 g
Arthropods:	.05 - 11.0 g
Echinoderms:	.0 - 110.6 g
Polychaetes:	.61 - 12.2 g
Miscellaneous	.05 -1239 g

The total penetration of the box cores varied between stations, with the greatest penetration being in Area V and the least being in Areas I and II (Table 4). It must be recognized that the gross biomass data may be partially affected by penetration and greatly affected by chance recovery of large, heavy specimens (shell), particularly molluscs. Table 5 shows total biomass corresponding to an areal basis.

From the gross biomass, several organism types were selected for detailed identification and counting as indicator groups to shed light on productivity and ecological conditions in the areas in question. The groups selected were polychaetous annelids, foraminifera, and micromolluscs. Criteria for selection include ubiquity, variety of life-adaptations, number of species and individuals, the state of knowledge of the organisms in question, as well as the expertise available for this study. These selections proved to be highly successful.

Table 4. The average length of cores A and B (data of L. J. Doyle) for each master station was multiplied by the area of the eight cores (21.5 x 30.5 cm each) to arrive at an estimate of total volume in each core. Only the top 15 cm was sieved for biomass determinations. At these stations where the total volume was less than 9 l., less than 15 cm was sieved.

Station	Sieved Volume (liters)
1	17.4
2	14.6
3	19.6
4	18.1
5	17.0
6	17.8
7	12.0
8	11.3
9	7.4
10	8.7
11	11.9
12	12.0
13	13.0
14	12.3
15	11.2
16	17.2
17	8.1
18	9.6
19	12.2
20	11.9
21	11.0
22	11.5
23	11.0
24	16.4
25	15.4
26	13.1
27	8.4
28	11.3
29	10.4
30	15.7
31	11.9
33	8.9
34	8.4
35	11.2
36	9.9
37	10.2
38	12.6
39	11.3
40	11.0

Table 4. Continued.

Station	Sieved Volume (liters)
41	13.9
42	10.4
44	16.7
45	7.8
46	8.9
47	10.4
48	9.4
50	13.8
52	7.0
53	16.7
55	13.6
56	8.0
57	8.4
60	8.7
61	9.0
62	5.2
63	7.3
64	9.9
65	9.7

2. Polychaetous annelids

Polychaete worms were found in all areas of the survey, including areas IV and V. Here some 190 species were identified, comprising 41 families, and 10,020 individuals were catalogued. Two families, Scalibregmidae and Sphaerodiriidae,have not been previously reported from the Gulf of Mexico. Since some closely related species and more obscure forms require time-consuming analysis for exact identification, some further new forms may be turned up at a later date.

The major species (defined as making up 5% or more of the sample)are given in Table 6. Although some ubiquitous forms (e.g., Lumbrineris parvipedata and Paraprionospio pinnata) are present, differences in assemblages can be discerned. Stations 1-5 are populated by species typical of fine sediments rich in organic matter, particularly the maldanid species Asychis carolinae and Clymenella torquata, and the nereid Ceratonereis tridentata. In general, this group of stations exhibits low species diversity and abundance.

A highly diverse and abundant assemblage is present in stations 6-16, typical for sand-silt-shell substrates, whereas a third association occurs in the shell-hash sediments at stations 17-20 (area IV).

The relationship of sampling strategy to community identification is shown in Figures 5 and 6, depicting a plot of sample area against species total. The figure of .48 m^2 approximates the total area of 8 box cores less subsidiary samples. In Figure 5, station 1, samples from only one box core would have yielded only a third of the total species recovered. Yet further box cores would not have added significantly to the total. In Figure 6, an extremely diverse assemblage (station 11) is still increasing at the tenth core, whereas at station 17 the characteristic change in slope toward the asymptote is already marked.

TABLE 5 (Kritzler)

BIOMASS OF MAJOR MACRO-INFAUNA GROUPS IN GRAMS, WET WEIGHT, PRESERVED

8 cores = $0.48m^2$

STATION	MOLLUSCS	ARTHROPODS	ECHINODERMS	POLYCHAETES	MISCELLANEOUS
1	1.9653	.0965	3.5677	4.6947	.2024
2	.3442	1.0137	.3111	3.3048	.1241
3	.1710	.2987	.1882	3.0722	.0760
4	.1525	.2149	46.3035	1.6385	.3366
5	.4605	.0397	.5255	2.0125	1.2518
6	9.9998	.0783	2.3781	8.3006	.4908
7	3.7315	.6008	.5262	3.8692	.3602
8	2.5373	.4549	.2054	7.4364	.9691
9	1.9810	.3461	.9297	7.6078	2.3181
10	1.6170	.2202	.8268	5.1552	1.5847
11	2.9283	10.9692	.1315	3.1475	.6320
12	.2814	.5664	1.1540	4.3523	17.7654
13	.5772	.1032	21.2325	2.7876	.3707
14	.9882	1.0281	.5745	4.2544	14.2854
15	.7510	.0536	.0765	2.0157	.2930
16	13.6503	.4462	.0349	4.0134	2.8461
17	2.0319	.5619	.7317	2.5065	3.2560
18	.4168	.1310	1.1235	1.1822	11.9669
19	19.9838	.6144	.7230	2.1581	10.5763
20	.4835	1.0918	.1997	2.1884	1.8299
21	2.2253	.1828	.2683	1.3510	.9180
22	1.1379	2.7666	.0162	1.5870	3.7093
23	.4988	.1726	.0043	1.8340	.1069
24 [1]	.0339	.2093	.0822	2.6660	.1840
25	.3368	.3887	.8241	.8615	.6212
26	1.2486	.2060	.0654	2.5550	.1751
27	.5901	.1992	.8134	.9322	5.6734
28	2.5501	1.8675	.0262	1.1965	.2752
29	.3589	.2138	2.6721	1.5348	.9736
30	.3637	.1269	.0282	1.0099	.1229
31	2.0136	1.0338	.2892	2.3717	3.8885
32 [2]	.0383	.1838	.0684	.6119	.0502
33	1.3484	.3949	1.6081	1.1867	.5765
34	4.5422	1.6025	.1071	3.4975	7.0008
35	.8572	.9865	.4855	1.8868	2.5632
36	5.0898	.4951	.6046 [3]	2.4617	1.6262
37	2.0821	.8509		2.8954	1.4007
38	.9621	.7424	.3418	1.9925	2.1486
39	10.9619	2.8885	.4384	3.3744	17.8035
40	1.4403	.3767	.2516	3.2080	17.0829

TABLE 5 contd.

STATION	MOLLUSCS	ARTHROPODS	ECHINODERMS	POLYCHAETES	MISCELLANEOUS
41	3.10004	10.2647	[3]	2.0924	36.0020
42	3.5142	1.2709	2.6699	2.6352	6.2115
43	NO BIOMASS ESTIMATE:		DREDGE STATION.		
44	.3133	.8430	16.6984	.9749	16.2542
45	.9242	.1840	1.0792	1.4138	.8497
46	20.1074	.6414	.3557	2.8481	7.6579
47	9.7454	2.6369	6.4664	12.1778	1239.5329
48	.1389	.3285	.2685	1.4612	5.7093
49	NO BIOMASS ESTIMATE:		DREDGE STATION		
50	.9600	2.9809	.1432	1.1700	4.6741
51	NO BIOMASS ESTIMATE:		DREDGE STATION		
52	7.1285	.2381	.2899	.9896	.2144
53	.4901	.4024	2.5772	1.5155	1.2492
54[4]	2.2382	1.3079	.0891	2.0923	4.7541
55	3.0533	2.2769	.0866	.7836	2.0809
56	2.2220	.3897	110.6179	.6740	7.2116
57	.0766	.9619	.5354	1.0118	9.8362
58	NO BIOMASS ESTIMATE:		DREDGE STATION		
59	NO BIOMASS ESTIMATE:		DREDGE STATION		
60	.4709	5.4956	1.0977	1.8469	.8490
61	1.2482	1.1352	.0494	1.0451	3.2575
62	.8595	.5862	.0100	.9258	1.7114
63	.1711	4.1002	[3]	.8327	.8587
64	.2498	2.0810	.0190	1.8975	6.6643
65	.1366	1.4729	.0210	1.3574	9.5395

[1] Based on 7 box core replicates; 1 lost
[2] Based on 2 box core replicates (dredge station)
[3] Blank under echinoderms denotes no echinoderms in the sample; not that anything was lost
[4] Based on 4 box core replicates (dredge station)

TABLE 6a

"DOMINANT TAXA" (POLYCHAETES) DEFINED AS THOSE SPECIES REPRESENTING AT LEAST 5% OF TOTAL INDIVIDUALS IN MAFLA AREAS I, II, AND III

STATIONS

DOMINANT TAXON	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	6
Sangerhansia cornuta	X	X									X		X				X	X																											
Naglaophamus verrilli	X		X	X	X	X	X		X													X			X	X										X								
Onuphis eremita oculata	X	X						X					X																			X	X			X								
Nedicira belgicu	X					X			X												X	X			X											X	X			X	X		X	X
Chrysaspio bielemi	X																																											
Sumbrineris branchiata		X	X																																									
Nareulepis sp.			X			X	X																																				X	
Naploscoloplos fragilis			X	X	X		X																																					
Orionospio cirrifera			X		X		X																		X																			
Nossura delta			X	X	X		X																												X	X								
Naulophorus babirusa				X																																								
Naralacydonia paradoxa				X																																								
Sumbrineris parvapedata					X		X								X	X																								X	X		X	
Orionospio cirrobranchiata						X		X		X			X																															
Sumbrineris mucronata							X																																					
Diophanes soederstromi								X																																				
Nagelona longicornis									X																																			
Notomastus latericeus									X													X			X							X			X		X				X		
Nagelona n. californica										X																											X			X				
Myosyllis vittata											X			X	X														X															
Glycera tenuis											X										X								X															
Goniada teres											X		X		X	X	X	X	X	X				X		X				X				X						X			
Naplosyllis spongicola												X											X				X		X		X												
Nunice vittata												X		X			X							X		X	X			X				X						X			
Harmothoe lunulata												X																																
Myllis gracilis												X																																
Nunice rubra												X											X						X												X	X		
Onbergineneis inermis																												X																

TABLE 6a contd.

DOMINANT TAXON	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
Poecilochaetus johnsoni													X																																
Nerinides agilis															X																															
Lipponoa multibranchiata																	X																												
Typosyllis variegata																	X																												
Lasmineira elegans																	X		X	X				X		X				X							X				X	X			
Nephtys bucera																					X																								
Goniada littorea																					X																								
Lumbrineris inflata																					X																								
Kinbergonereis inermis																						X						X					X		X									
Paraonis gracilis																						X																							
Spiophanes bombyx																						X																							
Anaitides madeirensis																							X						X															
Exogone sp.																								X																				
Prionospio pamibranchiata																									X																				
Harmothoe bobo																													X										X					
Typosyllis alternata																													X		X								X					
Streblosoma hartmanae																													X										X					
Prionospio pinnata																													X										X					
Longosoma prionota																															X													
Lysidice ninetta																															X													
Sigambra tentaculata																																		X										
Maldane sarsi																																			X	X	X				X			
Cirratulus filiformis																																			X									
Ceratonereis costae																																				X								
Armandia polyophthalma																																						X						
Pygospio elegans																																								X		X		X

TABLE 6b

"Dominant Taxa", Defined as Those Species Representing at Least 5% of Total Individuals

MAFLA Areas IV and V (Vittor)

Dominant Taxon	Station																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Paraprionospiopinnata	X	X	X	X	X	X	X	X	X				X			X				
Asychis carolinae	X	X																		
Aglaophasmus verrilli	X														X					
Clumenella torguata	X																			
Ceratonereis tridentata		X	X	X	X	X	X													
Lumbrineris parvipedata		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	
Ceratoneries irritabilis		X																		
Ninoe nigripes			X	X																
Diopatra caprea			X	X																
Nephtys picta				X																
Cirrophorus lyriformis				X																
Notomastus latericeus				X																
Cossura sp.A					X		X													
Aedicira belgicae						X	X	X			X	X	X	X	X			X	X	X
Mediomastus californiensis						X	X	X		X				X	X	X				
Magelona pettiboneae		X						X								X				
Cirratulid Species								X	X	X					X	X				
Poecilochaetus johnsoni									X	X						X				
Paraonid Species									X	X	X		X	X	X	X				
Samythella elliasoni												X							X	
Eunice antennata												X								
Syllis spongicola												X								
Glycinde nordmanni																X				
Glycera oxycephala																	X			
Dorvillea sociabilis																	X			
Onuphis eremita																	X		X	X
Exogene dispar																	X	X	X	X
Melinna maculata																		X	X	
Syllis cornuta																		X	X	X
Synelmis albini																		X	X	
Chone duneri																			X	
Amage auricula																				X
Myriochele bioculata																				X
Onuphis microcephala								X												

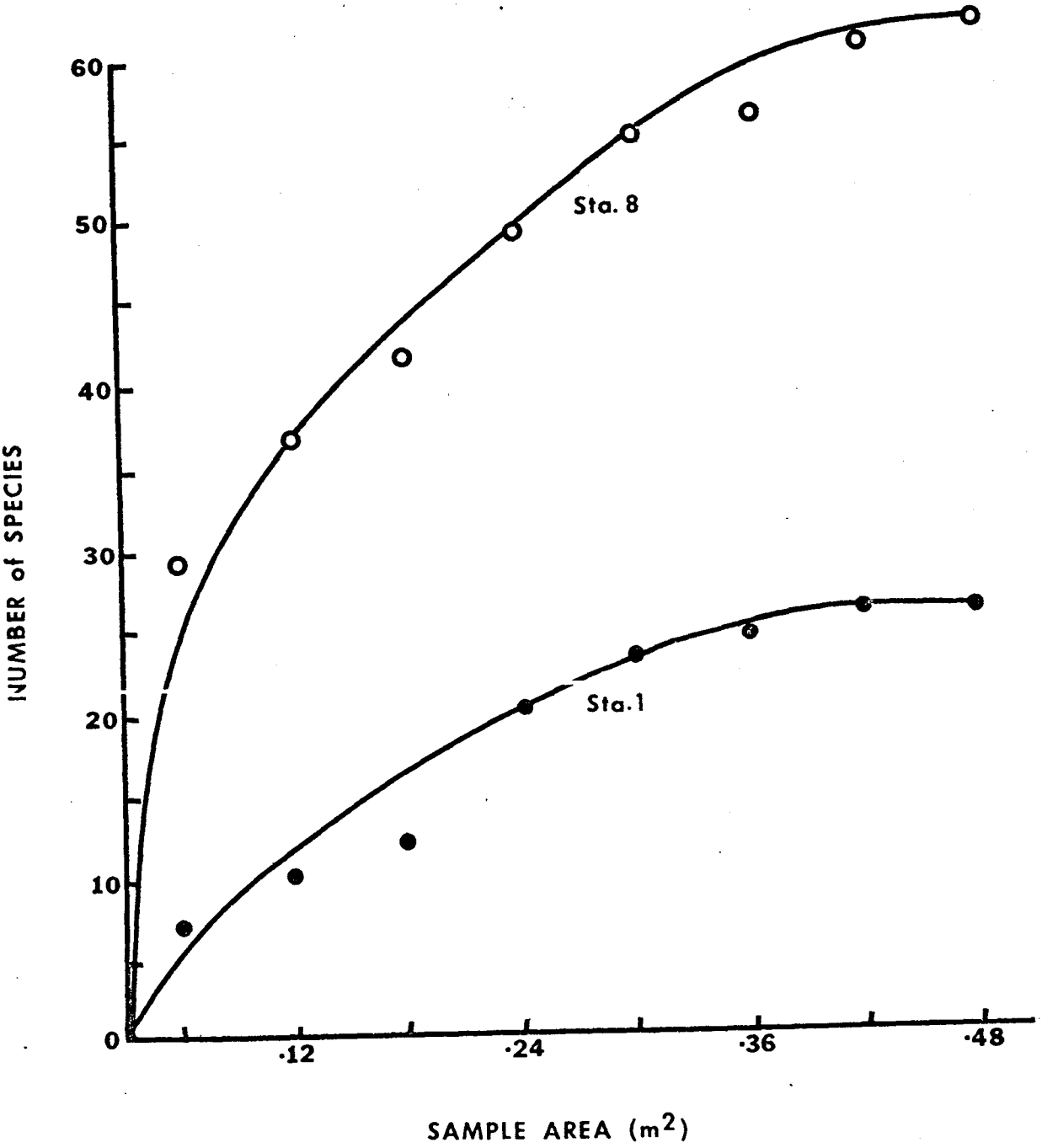


Figure 5. Relationship between sample area and abundance of species at two stations in MAFLA Area V. (from Vittor)

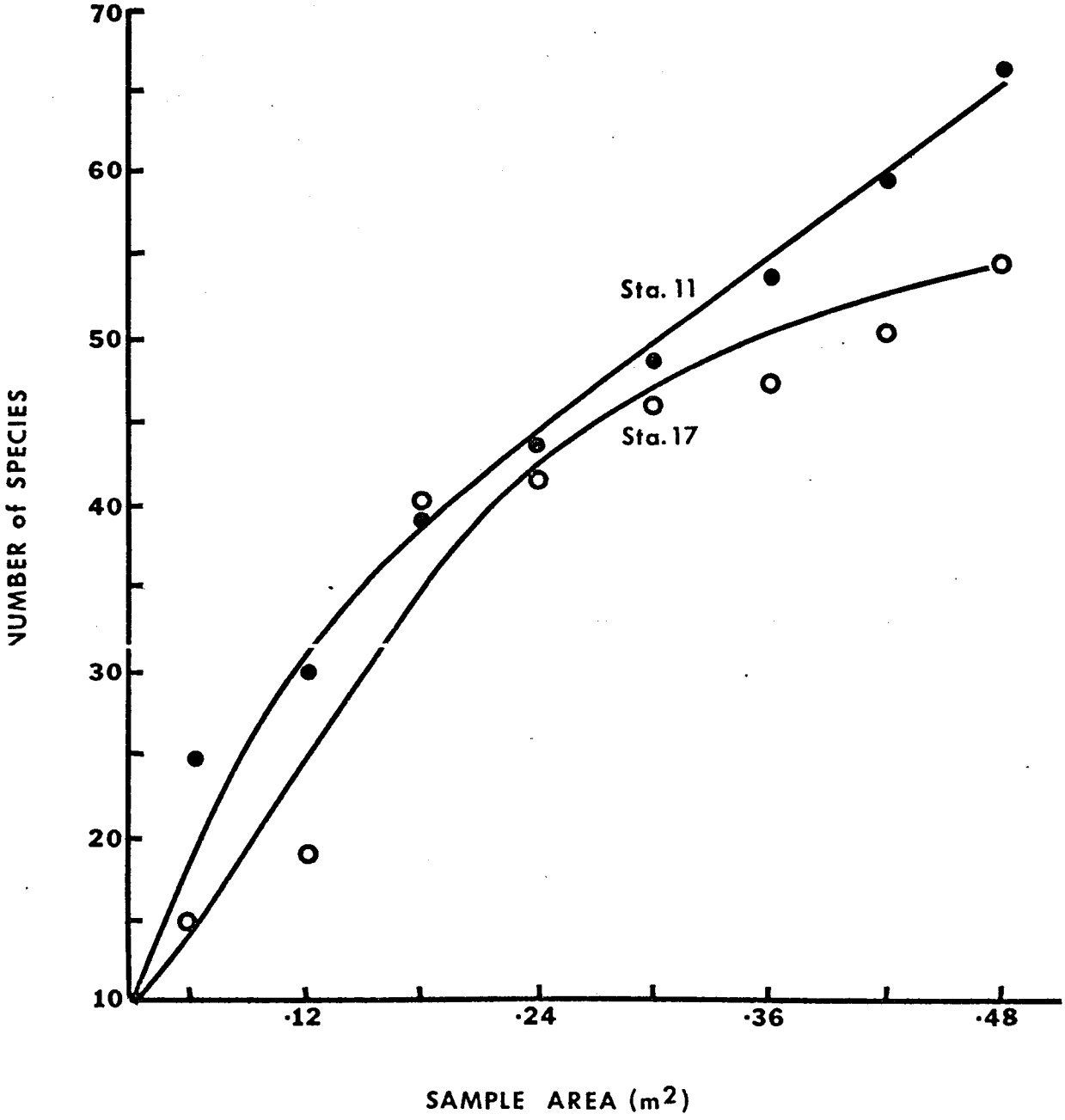


Figure 6. Relationship between sample area and abundance of species at two stations in MAFLA Area IV. (From Vittor)

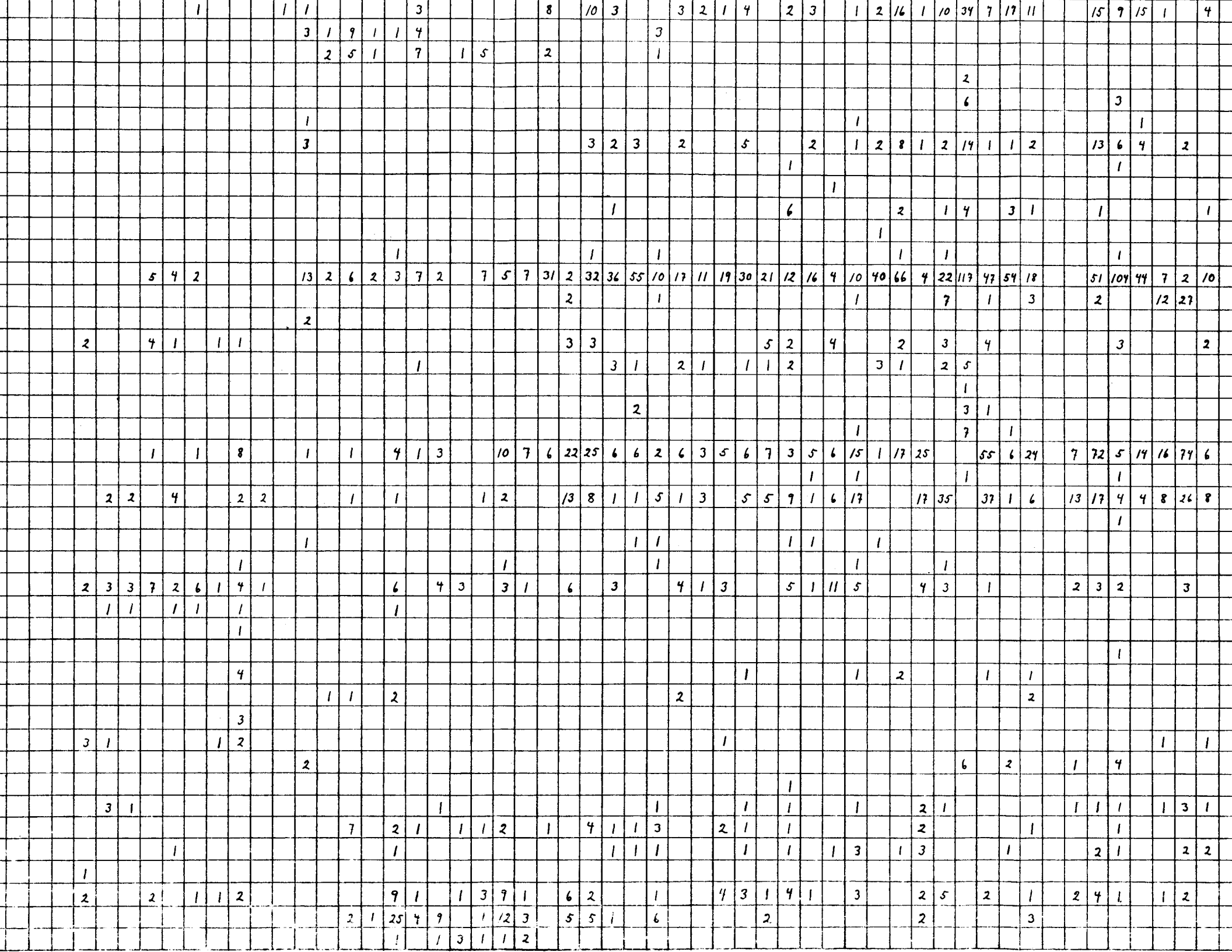
3. Micromollusca (Moore)

Micromolluscs are small species of molluscs that reach a maximum size of 7 mm, some never reaching 1 mm in maximum length. There generally are no taxonomic divisions separating them from macromolluscs. Micromolluscs in the northeastern Gulf belong to three classes - Bivalvia, Gastropoda, and Scaphopoda. Most Bivalvia are filter feeders, although a few forms feed on small animals (e.g., Cuspidariidae) or are deposit feeders. Gastropods are browsers, predators, or parasites. Since the abundance of micromollusca is largely determined by their method of feeding and the abundance of the appropriate food, filter feeders and browsers are much more numerous than carnivores and parasites.

In the sampled areas micromolluscs ranked third in abundance among invertebrate microfauna according to the following sequence: foraminifera, micromolluscs, bryozoans, ostracods, echinoid spines and remains, barnacles, microcorals (Guynia), and rare brachiopods. A total of 4,241 bivalves, 3,084 gastropods, and 90 scaphopods were identified and counted, and some species remain to be identified fully. The main data are provided in Table 7.

Bottom type and its related physical parameters appeared to be the most important factor in determining abundance and distribution of the species, but in a few cases, depth seemed to be the controlling factor. Signs of heavy predation were everywhere (crabs, shrimp and fish). For this reason, live adult micromolluscs were quite rare, whereas live larval or young postlarval molluscs were fairly common in the fine fractions of the sediment. Thus, these animals appear to be an important part of the food chain for larger predatory animals.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
	42	78	96	90	102	96	105	78	102	114	114	120	114	114	114	120	216	270	270	280	168	270	210	210	267	186	222	219	150	156	135	138	228	114	120	132	132	126	120	120	102	120	147	144	175	120	117	132	138	156		177	120	111	144
	6	8	5	3	18	19	29	36	8	7	23	36	29	21	30	15	31	35	37	32	22	33	3	3	6	19	5	18	10	22	45	34	43	30	33	53	72	40	35	44	43	12	32	37	15	18	38	16	35	33		5	45	39	8
	5	17	5	4	62	101	196	65	122	123	51	29	11	67	51	16	75	31	88	25	230	112	144	50	137	193	81	95	145	165	115	107	87	57	42	65	131	83	139	50	62	166	64	177	137	272	250	272	192	123		82	238	199	205
T	.8	2	1	1.3	3.4	5.3	6.8	1.8	15.2	17.5	2.4	.8	.4	3.2	1.7	1.1	2.5	.9	2.4	.8	10.4	3.4	48	16.7	23	10	16.2	5.3	14.5	7.5	2.5	3.1	2	1.9	1.3	1.2	3.1	2.1	4	1.1	1.4	13.8	2	4.8	9.1	15.1	6.6	17	4	3.7		16.4	5.5	5.1	25.6
		1			5	5	32	4	10	13	1	1		1							8		14	10	14	7	9		1				1				1			1		2				1								1	1	
		6	4	4	47	83	87	13	42	21	5	1																																														
															16		1				69		28		5	42	4	1	15	2			3				1				2			9			3				15				
																	6	9	5	1		1																																		
																			5	1		16				2		2					2	1			2			2							1								
																	8		2			2						10		4		2																								
														1											1		1				2	2	4				1		2						6	2	3	1	2			2		4
															3			2	5																																					
									4	9	6			4	6			1	1	1	2		3		5	2	6	1	7	4	9	6	3	2	1	3	9	1	20	2	1	3			7	9	2	3		5		1	5		4
																		2	4	1												1																							
					3		3		4	11	3	2			1		9	4	9	6	15	17	9	2	18	23	22	19	22	40	29	15	13	4	11	12	25	24	25	4	2	13	9	42	16	30	6	27	25	22			16	18	49
																	12					2				1		3		3	2	2				1	1		1				1	1				4	2					1
														2																														2			14	4					7	1
																		2	1		1	4	3		1				1	5	5	2	5						3						1	1							
																	1						1																													1				
					1	5	30	3	18	20																																														
							2		2	4					3			4	9	8	42	31	43	8	44	6	4	2	3				10													2							3			
															6		2	1	7	1		2			3	19	3	4	6	7	2		4			1								1	3				3	2					
																					3																																		1			
		5	1		3	3	5	3		2				1																																	2			1				
										2				3	1						4		2			5	2		10	3	1					1		2	4	1		62			9	96	1	39	2	4		12	10	1	18
																																																				4			1
													3		1	2					5	1	5	11	22	3	9		2	1								1		2														1
													1	2																																									
					3	4	13	11	8		11	6	3	13	5	7					5		4			15			15		2		1		1	1			4	1	3	4		1	3	4		3						1
								1									1																																		1			
									1																																													
	2	2					2	6	12	17	11	7		3	5	1	5		5	1	8	7			4	18		5			5	2	4	4	3	9	21	11	13	8	10	5	1	5	11	7	9	23	4	8		3	12	12	21
														4																																									
									1								4		1		1												1	1		1		1	3	4	1	1	1	1	2		2	10	1	5				2	8	5
																																																				1	1	1			
	2	1					7	5	11	4	1												4	8					1																												3
														4	1	3								2	1										8	3	1	10		6	1	6	7			10	29		2		1		16	3		7

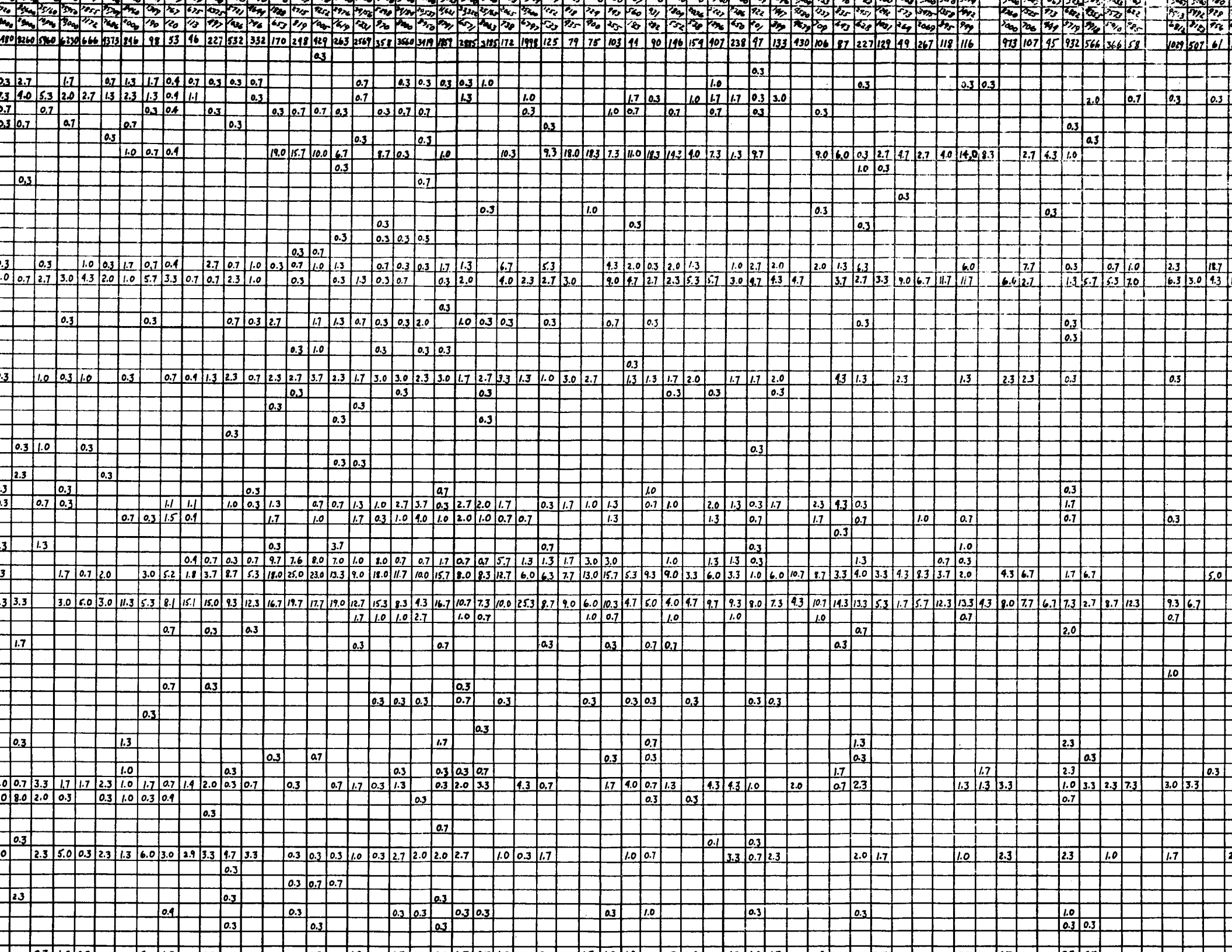


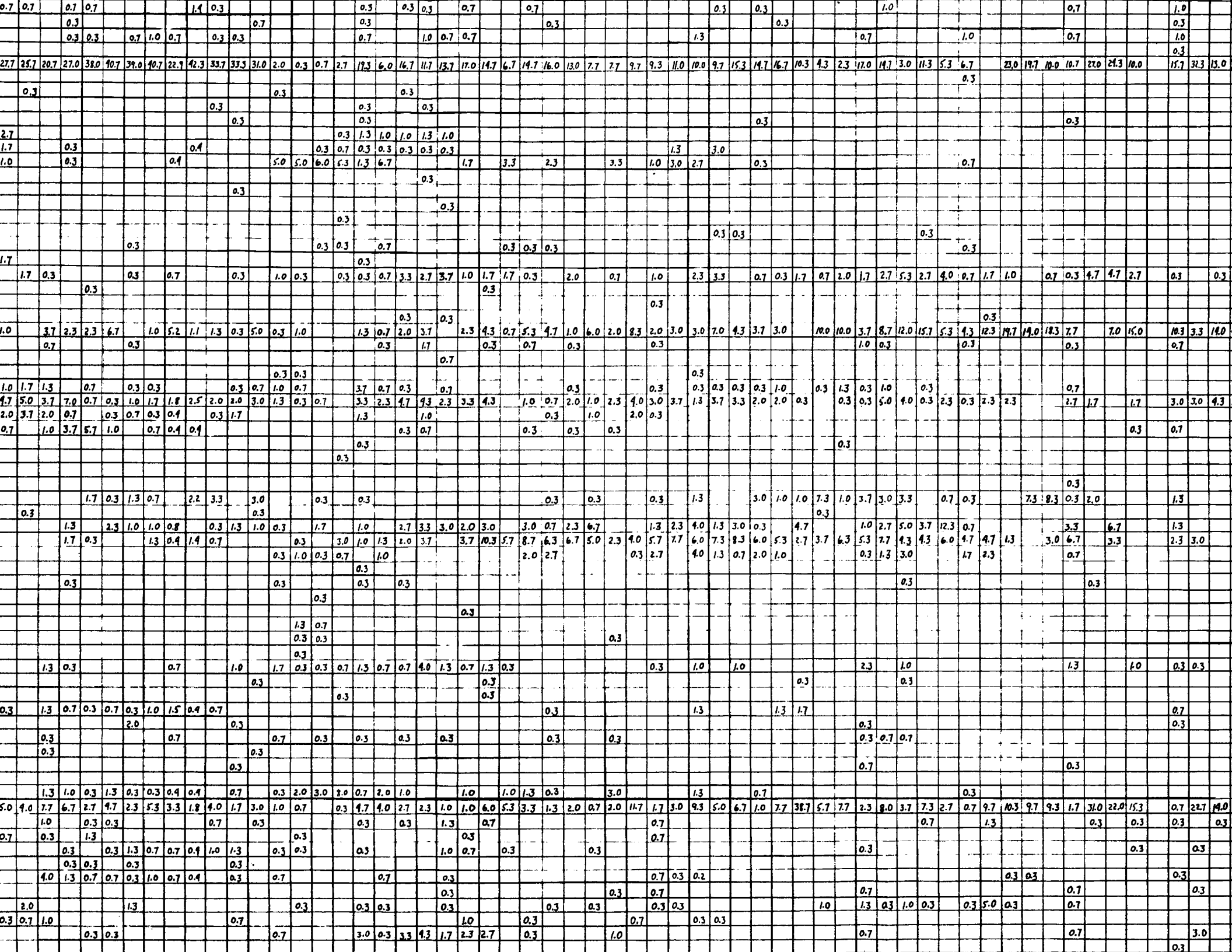
4. Foraminifera (Bock)

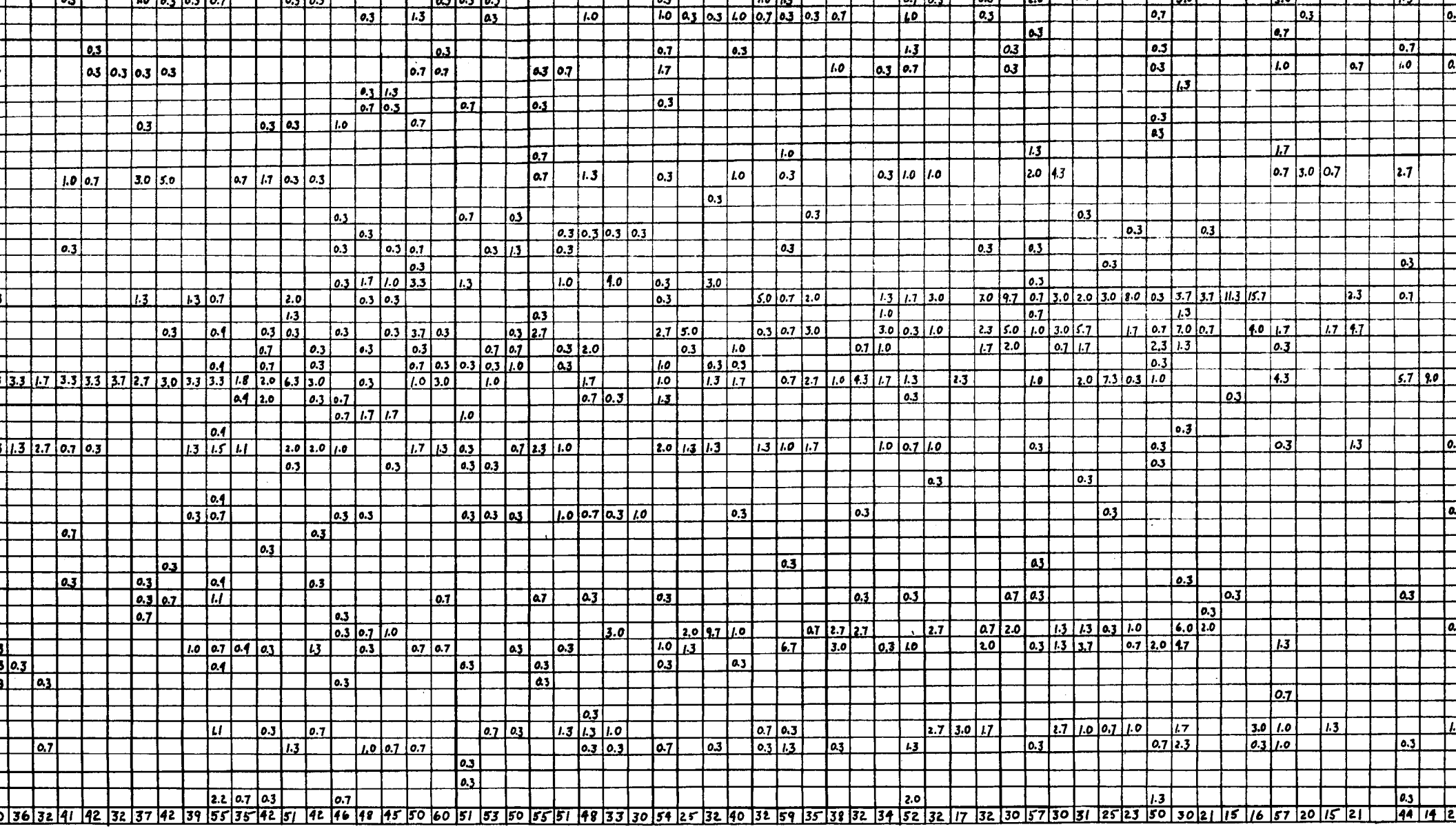
Samples were collected from both the upper 3 cm of cores and the 12-15 cm interval, wet sieved through a 63 micron sieve, and retained wet for analysis. In this, identification of living forms (protoplasm content) is possible without the use of staining methods that have been questioned. The number of total and living specimens was determined per ml of sample, and two samplings of 300 were picked, identified and counted: the first for total specimens, the second for a 300 specimen living population. The percentage distribution of living benthonic foraminifera is given in Table 8. A total of 193 living species was reported.

The percentage of living species is very high in area V (to 66.7%) and decreases to the east and south with the lowest percentage in area I (6%). However, all percentages were higher than expected; many abundant species were represented by high percentages of juvenile specimens. Bock attributes these facts to possible seasonal blooms of foraminifera, and in areas V and IV, high sediment loads with large amounts of nutrients. One may also note that other investigators pointed out heavy grazing pressures, and this may in part account for the preponderance of juveniles. If so, benthonic foraminifera would appear to form key food elements for fish and crustacea.

Overall, fauna are relatively uniform, but areas II and V contain species found abundantly only in their respective areas. Area II contains Peneroplis carinatus, Textularia agglutinans and T. conica, along with Amphistegina gibbosa which indicate reef-like conditions, or at least, high energy, hard substrate environments. In contrast, area V contains Ammonia becarii, varieties parkinsoniana and tepida, Elphidium galvestonense, and other species capable of withstanding high degrees of stress. These







species also contain symbiotic zooxanthellae and dinoflagellate zoochlorellae (green algae) that assist the organisms to survive if turbidity becomes too great for other species. Three species occur in abundance in all five areas and at almost all stations: Cibicides floridanus, Hanzawaia strattoni and Rosalina columbiensis.

A significant observation relates to the fact that specimens at 0-3 and 12-15 cm showed relatively minor differences in their planktonic/benthonic ratios. These ranged from 54:100 to 1:100 (the latter at stations 5 and 65). These data imply that incursions of pelagic fauna (via the Loop current) have been relatively stable in their patterns for the period of time involved between the depths in the sediment.

5. Epifauna and epiflora (Hopkins)

According to Hopkins, examination of samples recovered by diving and dredging in the current investigations has revealed new and unusual species in every major epifaunal and epifloral group. The epifaunal groups referred to in this account are decapod crustaceans, sponges, molluscs, echinoderms, and hard and soft corals. Epifloral groups are Chlorophyta, Phaeophyta, and Rhodophyta (green, brown, and red algae). The new species will be dealt with in later journal publications by specialists. Identification of suspected species, except sponges, is proceeding with the assistance of museum repositories at the U. S. National Museum, the Florida Department of Natural Resources Museum, and collections of the University of Miami and appropriate specialists. S. Earle has provided identification for the archived algal specimens.

Quantitative measurements were recorded by use of a portable $5m^2$ frame. Because of species diversity[1] and abundance[2], quantitative measurements were not made on the reefs in area II. Here emphasis was placed on photography and collections with emphasis on coelenterates, sponges, molluscs and algae. Capetown dredging was executed using 10 minute tows. Numbers of species and suspected species are as follows:

Soft corals	19
Hard corals	24
Molluscs	107
Crustaceans	104
Algae	154
Echinoderms	50
Sponges	260

Species diversity as well as abundance varied markedly from station to station within an area, as well as between areas, largely controlled by

1. Diversity is used to represent the number of different species within a genus.
2. Abundance refers to the total number of species within a given faunal or floral group.

substrate. In area II even the swinging of the vessel on its anchor chain could direct divers to different subenvironments.

Table 9 provides a summary of biotopes (sediment substrates harboring a given faunal-floral assemblage), indicator organisms, and relative abundance. The numbers following epifaunal-floral groups are coded according to the percentage which has been identified and archived among the total MAFLA species.

The linkages that Hopkins provides between faunal-floral groups and substrate types are particularly valuable because these show coherent patterns for given regions. Thus, in area I, soft carbonate mud areas tended to be depauperate, whereas firm substrates such as hard compacted calcareous sand and shell rubble showed increasing abundance depending on the degree of firmness and occurrence of crevices and other shelters. The highest diversity and abundance for corals, sponges and algae are found in high relief rock ridge areas of area II. Area III biotopes offer wide areas of shell hash and rubble over an apparently hard substrate. Molluscan and crustacean diversity is high, including a large food web. An example of this type of environment is found in Figure 4e. In contrast, fine sand-mud bottoms revealed little by dredge. Area IV resembles area II in point of contrasting biotopes over short distances. However, whereas shell rubble produced abundant populations in areas II and III, both species diversity and abundance for all fauna were low in station 12. A distinct departure in fauna was noted in station 18, containing mud, shell and gravel; this included a deep water ophiuroid not collected elsewhere. Area V was the most depauperate area in the group. Only station 1 revealed indicator species (ophiuroid, Hemipholis, and the sea whip, Leptogorgia).

TABLE 9 (Hopkins)

SUMMARY OF BIOTOPES AND COMMUNITY INDICATORS
IN THE MAFLA LEASE TRACT BY AREA

AREA I

BIOTOPE	STATION NO'S.	INDICATOR ORGANISMS BY GENERA IN GROUP	RELATIVE SPECIES ABUNDANCE IN EACH EPIFAUNAL-EPIFLORAL GROUP	COMMENTS
1) Hard Compacted Sand w/Silt	65	a) SPONGES Ircinia Haliclona Spheciospongia b) ECHINODERMS Astropecten Encope c) HARD CORALS Cladocora d) ALGAE Caulerpa Dictyota Gracilaria e) DECAPOD CRUST. Synalpheus Pylopagurus Raninoides	SPONGES - Moderately Low 17/66 ECHINODERMS - Low 5/36 HARD CORALS - Low 5/22 MOLLUSCS - Very Low 2/86 CRUSTACEANS - Low 20/96 ALGAE - Moderately Low	
2) Shell Rubble, Sand w/Silt	62,64	a) SPONGES As @ #65 b) ECHINODERMS Astropecten Echinaster c) ALGAE As @ #65 d) HARD CORALS Cladocora e) MOLLUSCS Fasciolaria f) DECAPOD CRUST. Synalpheus Pylopagurus Ranilia	SPONGES - Moderately Low 24/66 ECHINODERMS - Low 8/36 HARD CORALS - Low 4/22 MOLLUSCS - Very Low 7/86 CRUSTACEANS - Moderately Low 25/96 ALGAE - Moderately Low	St. 64 Crevices 3-4' deep. Reef fish and epifauna in association wi crevices.
3) Soft and Silty	60,61	No definitive organisms established	All Groups Low to absent	

TABLE 9 contd.

AREA 11

BIOTOPE	STATION NO'S	INDICATOR ORGANISMS BY GENERA IN GROUP	RELATIVE SPECIES ABUNDANCE IN EACH EPIFAUNAL-EPIFLORAL GROUP	COMMENTS
High Profile Rock Ridges	47, 146, 147 151, 247, 251, 451	SPONGES Ircinia Spheciospongia Callyspongia ECHINODERMS Ophiothrix Diadema Astrophyton DECAPOD CRUST. Mithrax Macrocoeloma Stenorynchus HARD CORALS Dichocoenia Scolymia Millepora SOFT CORALS Muricea Plexaura Eunicea MOLLUSCS Chlamys Spondylus Vermicularia ALGAE Kallymenia Sporochnus Microdictyon	Sponges - Moderate 30/66 Echinoderms - Low Decapod Crustacea - Very Low 13/96 Hard Corals - Moderately High 15/22 Soft Corals - Moderate 9/19 Molluscs - Very Low 8/86 Algae	St. 146 & 147 rich in algal species St. 142 Soft coral forest 42 colonies / $5M^2$ Sponge species diversity estimate: 15 spp/$5M^2$. St. 47 & 247 show reduction in algal spp. and increase in hard coral diversity; increase in sponge density and diversity St. 257 & 451 Millepora, hard coral and soft coral are abundant; algal reduc
Low Profile Rock Patches with Intermittent Sand	42	SPONGES Ircinia Placospongia Haliclona ECHINODERMS Eucidaris Echinaster Diadema DECAPOD CRUST. Pylopagurus Stenorynchus Alpheus HARD CORALS Cladocora Scolymia Millepora SOFT CORALS Eunicea MOLLUSCS Laevicardium Pecten Vermicularia ALGAE Microdictyon Udotea Sargassum	Sponges - Moderately Low 20/66 Echinoderms - Moderately Low 14/36 Decapod Crustacea - Very Low 13/96 Hard Corals - Very Low 1/22 Soft Corals - Very Low 1/19 Molluscs - Very Low 9/86 Algae - High	

TABLE 9 contd.
AREA II

BIOTOPE	STATION NO'S	INDICATOR ORGANISMS BY GENERA IN GROUP		RELATIVE SPECIES ABUNDANCE IN EACH EPIFAUNAL-EPIFLORAL GROUP	COMMENTS
3) Coarse Sand	45, 46, 52, 351	SPONGES Fibulia ECHINODERMS Encope Echinaster Goniaster DECAPOD CRUST. Munida Parthenope Scyllarus	HARD CORALS Oculina SOFT CORALS Muricea MOLLUSCS Chlamys Tellina ALGAE Gigartina	SPONGES - Very Low 5/66 ECHINODERMS-Moderate 18/36 DECAPOD CRUSTACEANS - Moderate 42/96 HARD CORALS - Very Low 3/22 SOFT CORALS - Moderately Low 6/19 MOLLUSCS - Moderately Low 15/86 ALGAE - Very Low	St. 46. 3 Meoma, 5 Eucidaris per 5 M^2.
4) Coarse Sand, Broken Rock & Shell	43, 44, 48, 49, 50	SPONGES Ircinia Geodia Tethya ECHINODERMS Eucidaris Echinaster Lytechinus DECAPOD CRUST. Munida Parthenope Pilumnus	HARD CORALS Oculina SOFT CORALS Lophogorgia MOLLUSCS Vermicularia Chlamys Laevocardium ALGAE Caulerpa Microdictyon Dictyota	SPONGES - Moderate 33/66 ECHINODERMS - Moderate 19/36 DECAPOD CRUSTACEANS Moderate 40/96 HARD CORALS - Very Low 1/22 SOFT CORALS - Very Low 1/22 MOLLUSCS - Moderately Low 20/86 ALGAE - Moderate	
5) Hard Packed Sand	246	ECHINODERMS Lytechinus Luidia DECAPOD CRUST. Symethis Calappa Macrocoeloma	ALGAE Caulerpa	SPONGES - Absent ECHINODERMS - Very Low 3/36 DECAPOD CRUSTACEANS - Moderately Low 34/96 HARD CORALS - Very Low 1/22 SOFT CORALS - Absent MOLLUSCS - Very Low 1/86 ALGAE - Low	

TABLE 9 contd.
AREA III

BIOTOPE	STATION NO'S	INDICATOR ORGANISMS BY GENERA IN GROUP	RELATIVE SPECIES ABUNDANCE IN EACH EPIFAUNAL-EPIFLORAL GROUP	COMMENTS
1) Shell Rubble and Coralline Algae	34; 35, 37, 39, 41	SPONGES Placospongia Ircinia Haliclona ECHINODERMS Echinaster Arbacia Eucidaris HARD CORALS Oculina SOFT CORALS Leptogorgia DECAPOD CRUST. Pylopagurus Stenorhynchus Munida MOLLUSCS Vermicularia Chlamys Aequipecten ALGAE Botryocladia Struvea Rhodymenia	SPONGES - Moderately Low 20/66 ECHINODERMS - Moderate 16/36 HARD CORALS - Very Low 3/22 SOFT CORALS - Low 4/19 MOLLUSCS - Moderate 51/86 DECAPOD CRUSTACEANS - Moderately High 59/96 ALGAE - Low	St. 34 Eucidaris 1/5M^2 Munida form large biomass St. 35, 37 & 39 Rock outcrops 6-1 Rich in Commercial fish species. St. 41 Astropecte 7/5M^2.
2) Fine Sand - Mud	22	No definite organisms established	All groups virtually absent	St. 134 Astropect 3/5M^2.
3) Coarse Sand - Occasional Shell	134	SPONGES Cliona ECHINODERMS Astropecten Echinaster Goniaster DECAPOD CRUSTACEANS As in 1) above MOLLUSCS Vermicularia Chlamys Octopus ALGAE As in 1) above	SPONGES - Absent ECHINODERMS - Moderately Low 11/36 DECAPOD CRUSTACEANS - Moderately High 59/96 MOLLUSCS - Moderately Low 14/86 ALGAE - Low	

TABLE 9 contd.
AREA IV

BIOTOPE	STATION NO'S	INDICATOR ORGANISMS BY GENERA IN GROUP		RELATIVE SPECIES ABUNDANCE IN EACH EPIFAUNAL-EPIFLORAL GROUP	COMMENTS
1) Shell Rubble	12	SPONGES Haliclona ECHINODERMS Echinaster Goniaster Astropecten	DECAPOD CRUST. Dromida Munida MOLLUSCS Dis orsio	ALL GROUPS LOW TO ABSENT	
2) Fine Sand	13	ECHINODERMS Clypeaster Encope Astropecten	DECAPOD CRUST. Ana imus MOLLUSCS Argopecten Laevicardium	ALL GROUPS LOW TO ABSENT	St. 13. Clypeaste 6/5M^2. Encope 2/5M^2.
3) Hard Sand w/occasional Shell	14, 16, 17	ECHINODERMS Astropecten Luidia Echinaster DECAPOD CRUST. Calappa Petrochirus	MOLLUSCS Dis orsio MOLLUSCS Dis orsio Mur x	ALL GROUPS LOW TO ABSENT	St. 16. Clypeaste 7/5M^2. No Encope Luidia common
4) Mud, Shell-Gravel	18	ECHINODERMS Stylocidaris Astroporpa annulata Luidia SPONGES Halichondria		ALL GROUPS LOW TO ABSENT	

TABLE 9 contd.
AREA V

	BIOTOPE	STATION NO.'S	INDICATOR ORGANISMS BY GENERA IN GROUP		RELATIVE SPECIES ABUNDANCE IN EACH EPIFAUNAL-EPIFLORAL GROUP	COMMENTS
1)	Very Soft Black Mud	2-6	None established		ALL GROUPS VIRTUALLY ABSENT	
2)	Mud, Sand, Shell	1	ECHINODERMS Hemipholis SOFT CORALS Leptogorgia	DECAPOD CRUST. Callinectes Penaeus	ALL GROUPS VERY LOW TO ABSENT	

Inter-area comparison reveals that crabs and shrimps were most abundant in areas II and III, well correlated with shell and rubble. Area III had the greatest number of species of molluscs, followed by II and IV, each with 50. Echinoderms were most abundant in area II. Sponges and soft corals, requiring hard substrates, reach greatest species abundance in area II.

In summary, substrate remains the key abiotic factor influencing the structure of benthic communities. Beyond this, Collard and D'Asaro (1973) point out that in depths from about 30 to 200 m the benthic fauna of the Gulf is generally West Indian in composition, whereas the deep Gulf fauna has Atlantic affinities. These relationships may partly be related to egg and larval transport via surficial Loop waters to the shelf areas of the Eastern Gulf.

6. Histopathology of benthic invertebrates

As described by Blake, 240 samples of benthic invertebrates were fixed in Dietrich's fixative and embedded in Paraplast, utilizing a 15 hour processing routine on a Technicon tissue processor. The tissues were sectioned at 6μ and stained with hematoxylin-eosin. Two slides each of 2-6 tissue blocks per animal were prepared. These samples are to be archived for future comparison with organism resamplings from the lease tracts. Species included in the sampling are shown in Table 10. One may note that in the future, samples for histopathological analysis should be collected by dredging or diving, since the specimens obtained in box cores may be too small and too few for meaningful study.

Although the scope of the study did not include analysis of the sectioned samples, some qualitative and preliminary observations may be pertinent. Histopathological study of marine organisms is a relatively new field, hence many of the organic structures observed in the collected organisms are unknown or previously undescribed. This applies, for example, to alcyonarian corals and other epifauna from area II (Middle Ground). From the limited observations made during control of tissue preparation, most organisms and organ development appeared to be normal in character. The chief pathologies noted were reactions to parasites - a normal feature in undisturbed bottoms.

Scallops recovered from areas I-III showed males with spermatozoan development and females ready to spawn. Such developments are significant because the reproductive cycle is one of the organism functions most sensitive to influence of pollutants or other stress conditions. Since reproduction is frequently related to or triggered by variations in temperature, further observations may also reveal useful information about

TABLE 10 (Blake)

LIST OF SPECIES FOR
HISTOPATHOLOGICAL ARCHIVING

Porifera
- *Callyspongia* sp.
- *Ircinia fasciculata*
- *Ircinia campana*
- unid. spp.

Cnidaria
- *Dichocoenia stokesii*
- *Muricea* sp.
- *Oculina diffusa*
- *Plexaurella* sp.
- *Porites furcata*
- *Scolymia* sp.

Annelida
- Polychaeta
  - unid spp.

Mollusca
- Gastropoda
  - *Cassis madagascariensis*
  - unid. spp.
- Pelecypoda
  - *Argopecten gibbus*
  - *Argopecten mucosus*
  - *Echinochama cornuta*
  - *Lyropecten nodosus*
  - *Spondylus americanus*
- Caphalopoda
  - *Octopus joubini*

Arthropoda
- Crustacea
  - *Calappa angusta*
  - *Calappa flammea*
  - *Lysiosquilla excavatrix*
  - *Mithrax spinossisimus*
  - *Pachycheles rugimonus*
  - *Paguristes sericeus*
  - *Penalopsis goodi*
  - *Portunus ordwayi*
  - *Portunus anceps*
  - *Scyllarus* sp.
  - *Sicyione parri*
  - *Synalpheus longicarpus*

Table 10 contd.

Echinodermata
  Asteroidea
    Astropecten duplicatus
    Astropecten sp.
    Echinaster sp.
    Goniaster tessellatus
    Luidia clathrata

  Echinoidea
    Eucidaris tribuloides

  Holothuroidea
    Holothuria sp.

  Ophiuroidea
    Ophioderma brevispinum

Miscellaneous species
    Membranipora sp.
    Styella sp.
    unid. tunicate spp.
    Amphioxus

timing and reproductive strategy in valuable marine species.

Dredging or other disturbance of marine bottoms may be more disruptive at a time of spawning than at other times.

7. Adenoisine triphosphate (ATP) measurements (La Rock)

The ATP technique provides a measure of total living biomass, since ATP is present in living protoplasm but is quickly dissipated on tissue death. That high-energy organo-phosphate compounds play a prime role in energy transfer in all metabolic processes, was already observed systematically by Harden and Young in 1905. However, analytical studies of these compounds to characterize marine biosystems have been employed only very recently, and the present studies are among the first to be linked with broad surveys of marine parameters.

ATP is extracted from water or sediment samples with sulfuric acid followed by equilibration of extracts with EDTA - TRIS buffer solution. The preparations are frozen prior to laboratory assay. The end determination involves measurement of bioluminescence induced by addition of the ATP extract to a luciferin-luciferase mixture (firefly lantern extract). Detrital and colloidal matter are known to adsorb ATP from solution. Therefore, an internal standard technique is utilized by La Rock in his studies to determine efficiency of extraction, and the final values are obtained by correcting raw data to a 100% extracted basis.

In practice, the bulk of living biomass may frequently lie in bacteria and allied microorganisms with a subsidiary quantity contributed by zooplankton, phytoplankton, micro-infauna, such as foraminifera and the like (see discussion of benthic populations). Unlike virtually all other organisms, bacteria are not only present in aerobic systems (respiration requirement) but can occur in appreciable quantities in anaerobic (anoxic) conditions, owing to the activities of sulfate-reducing and fermenting bacteria. Strictly anoxic conditions in near-surface surficial sediments are likely to be present in the present investigated

areas chiefly in the high-organic, high sedimentation rate areas east of the Mississippi Delta (Areas V and in part, IV). Nevertheless, one must recognize that whereas other organisms may be concentrated in the uppermost portions of box cores, or on sediment and rock surfaces, bacteria, and hence ATP, may not only decrease, but actually increase with depth. This effect must be taken into account when relating ATP measurements to surface and near-surface productivity.

The values in Table 11 show regional means for both the water column and sediment measurements. La Rock notes that ATP surface values for areas 1, 2 and 3 were equivalent to twice concentrations found elsewhere in the Gulf of Mexico, the Florida Straits, and the Caribbean. The normal range of ATP concentrations for surface samples in the open ocean range between 80 and 120 ng/l (.08 - .12 µg/l). Variations with depth for all tracts appeared to be irregular, with no consistent change with depth. As may be noted, the fluctuations in concentrations for areas IV and V in the water column were extremely great, and the very marked enrichments here are interpreted as being due to high nutrient and organic content of water, coupled with concentrations of microorganisms on the suspended particulate material. In contrast, the relatively low sediment ATP in areas IV and V reflected the generally impoverished benthic fauna.

Table 11. Adenosine triphosphate concentrations (ATP). Compiled from data of La Rock. Variations of the means for stations are given as standard deviations.

Area	Sediment values		Water columns	Stations
	Wet Weight ppb	Dry Weight ppb	µg/l (≈ppb)	
I	285 ± 39	399 ± 32	.16 ± .08	1, 2, 3
II	601 ± 117	764 ± 143	.22 ± .09	4, 5, 6
III	537 ± 71	699 ± 79	.15 ± .04	7, 8, 9
IV	314 ± 27	359 ± 46	1.4 ± .9	10, 11, 12
V	206 ± 46	343 ± 70	4.6 ± 4.6	13, 14, 15
Control Station (Outside V-IV)	—	—	1.2 ± 1.1	C-4

F. Water Column Studies

1. General approach and water properties

Water column studies were performed on three cruises described in the report by Smith: BLM Cruise #1 (R/V BELLOWS), BLM Cruise #3 (R/V GULF RESEARCHER, and BLM Cruise #5 (R/V TURSIOPS), in May-early June, 1974. Two further cruises #6/7 and #8/9 (R/V GULF RESEARCHER and R/V MISS FREEPORT) were completed between June 17 and June 30.

Some of the water properties such as expendable bathythermograph (XBT) and salinity-temperature-depth determinations (STD), dissolved oxygen measurements were not intended for physical oceanographic studies as such, but rather to link the water column measurements to physical oceanographic compilations and modelling studies being reported simultaneously by the group coordinated by M. Rinkel.

Other collections included: phytoplankton tows, micronutrient and chlorophyll samples, water for ATP, light and heavy hydrocarbon, trace metal, particulate and dissolved organic carbon analysis, and collection of zooplankton for species identification, statistical analysis, hydrocarbon, and trace metal analysis. In addition, surface water "sniffer surveys" were performed for light hydrocarbons on the return cruise of MISS FREEPORT from St. Petersburg to Galveston via Panama City, Florida.

2. Nutrients, chlorophyll, organic carbon, total particulate matter, ATP

Nitrate (NO_3), nitrite (NO_2), silica (SiO_2), and phosphate + arsenate (PO_4 + AsO_4) were determined on 66 samples by Fanning. Thirty-three were sampled by Iverson aboard R/V Bellows (Sites I-III), and 33 by Woodmansee aboard R/V Gulf Researcher (Sites IV and V), each representing 11 stations with samplings at surface (S), middle (M), and bottom (B). Samples were membrane-filtered through .4 μ Nuclepore filters as soon as possible. They were then stored in a clean polyethylene bottle and frozen until analyzed (in triplicate). Replicate samplings showed standard deviations of .01 μg-at/l. Some nitrate samples showed loss in last replicates, presumed to be due to growth of algae after thawing. Silica and phosphate measurements were performed both by autoanalyzer and manual methods, with agreement usually better than 10% for the generally low values of silica.

The results, shown in Table 12, reveal generally low surface and intermediate values but a pronounced tendency for enrichment in nutrients in the bottommost water samples, especially in the westernmost stations, 10-15, (see location map, Fig. 7). Fanning discusses several possible sources of this effect. Upwelling at the shelf edge is rejected because all nutrients should be approximately equally enriched, yet silica is much more concentrated in the western (Woodmansee) than in the eastern (Iverson) group, without corresponding increase in nitrate. A possible source is held to be release from interstitial waters of underlying sediments through diffusion or seepage. One may point out, however, that an alternative explanation for the lower nitrate enrichments may be uptake by benthic algae, including zoochlorellae that exist symbiotically on benthic foraminifera, as mentioned by Bock.

Table 12. (Fanning) Final Nutrient Concentrations from the MAFLA. (All concentrations in µg-at/l)

Iverson's Set

Sample		PO_4-P*	NO_3-N	AutoAnal. SiO_2-Si	Manual SiO_2-Si	NO_2-N
1	T	0.71	1.26	1.22	0.9	0.01
	M	0.50	0.28	1.11	7.6	0.03
	B	0.61	0.19	1.75	2.0	0.03
2	T	0.08	0.30	0.71	0.8	0.03
	M	<0.01	0.19	0.47	2.0	0.02
	B	0.06	0.16	1.46	0.5	0.01
3	T	0.01	0.19	0.96	5.9	0.04
	M	0.01	0.20	0.98	1.1	0.05
	B	0.19	0.25	2.19	2.5	0.02
4	T	0.04	0.18	0.61	0.8	0.03
	M	0.01	0.18	0.57		0.02
	B	0.10	1.98	2.45		0.51
5	T	<0.01	0.20	0.80		0.04
	M	0.02	0.14	0.54		0.03
	B	<0.01	0.18	0.83		0.03
6	T	0.03	0.09	0.78		0.08
	M	0.05	0.22	0.98		0.02
	B	0.03	0.15	1.66		0.02
7	T	<0.01	0.20	1.34		0.01
	M	<0.01	0.20	2.33		<0.01
	B	0.16	0.44	3.43		0.17
8	T	0.03	0.20	0.96		0.02
	M	0.04	0.30	2.76		0.13
	B	0.44	6.63	5.34		0.57
9	T	0.08	0.22	1.12		0.02
	M	<0.01	0.18	0.82		0.03
	B	0.41	5.71	7.83		0.25
C1	T	0.02	0.19	0.55		0.04
	M	0.02	0.13	0.42		0.08
	B	0.20	0.30	1.30		0.04
C2	T	0.03	0.18	1.16		0.03
	M	<0.01	0.19	1.17		0.02
	B	0.05	0.27	2.66		0.40

* includes AsO_4-As

TABLE 12 contd.

Woodmansee's Set

Sample	AutoAnal. PO_4-P*	Manual PO_4-P*	NO_3-N	AutoAnal. SiO_2-Si	Manual SiO_2-Si	NO_2-N
10 T	0	0.02	0.20	1.91	1.76	0.04
M	0.13	0.11	0.06	2.00	2.26	0.02
B	0.46	0.56	3.38	9.96	10.42	0.07
11 T	0.02	0	0.24	1.06	1.01	0
M	0	0	0.26	1.48	1.49	0
B	0.22	0.27	1.20	13.00	13.31	0.47
12 T	0.01	0	0.24	2.82	2.47	0
M	0.01	0.05	0.35	4.07	4.22	0.05
B	0.12	0.17	0.76	9.30	9.22	0.46
13 T	0	0.05	0.19	0.43	0.24	0.04
M	0.28	0.28	1.21	9.25	9.92	0.26
B	0.47	0.44	0.43	15.53	15.98	0.20
14 T	0.02	0.05	0.08	0.04	0.17	0
M	0.02	0	0.23	0	0	0.02
B	0.29	0.22	4.96	8.39	8.42	0.23
15 T	0.09	0.11	0.39	2.44	2.75	0.02
M	0.06	0.06	0.09	0.16	0.47	0.03
B	0.44	0.42	7.25	14.88	15.17	0.21
A4 T	0.05	0.05	0.06	0.89	1.06	0.02
M	0	0.04	0.07	1.47	1.26	0.02
B	0.88	0.81	17.42	8.21	8.32	0
A5 T	0	0.04	0.14	0.58	0.48	0
M	0	0.04	0.11	0.95	1.07	0.01
B	0.38	0.39	7.17	8.61	8.96	0.13
A6 T	0.01	0	0.22	0.64	0.52	0.02
M	0.05	0.11	0.08	2.32	2.55	0.24
B	0.26	0.33	1.34	9.72	10.12	1.18
C3 T	0	0.04	0.06	0.58	0.48	0.01
M	0	0	0.30	1.64	1.79	0.09
B	0.25	0.26	6.65	7.92	8.07	0.48
C4 T	0.02	0	0.23	0	0	0
M	0	0.05	0.31	1.78	1.56	0.05
B	0.26	0.28	5.64	10.85	11.14	0.26

* includes AsO_4-As

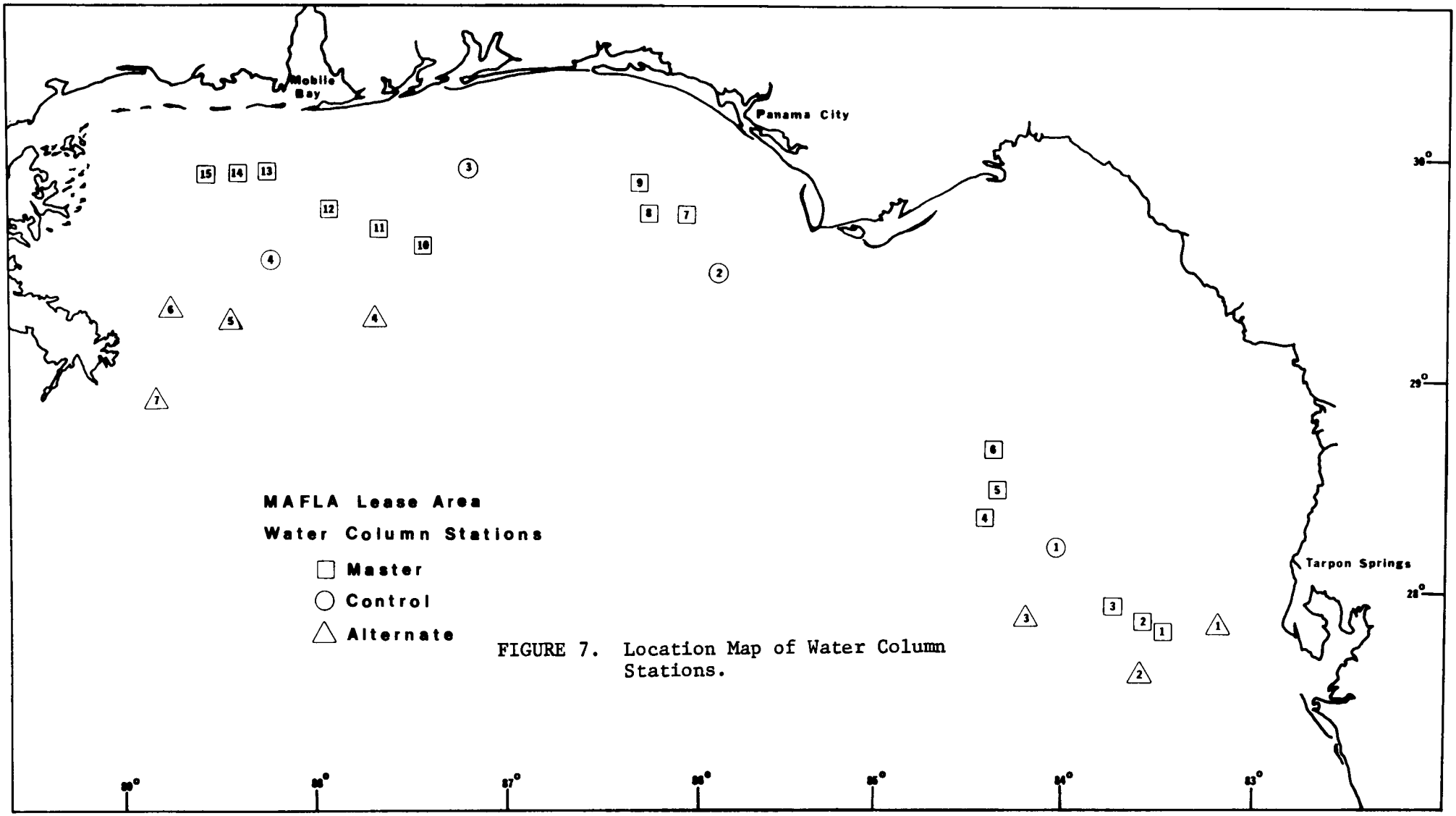


FIGURE 7. Location Map of Water Column Stations.

Chlorophyll analyses (Iverson, Woodmansee) were performed on frozen filters by the standard method of Strickland and Parsons. A persistent increase in depth is revealed by the data in Table 13.

Particulate organic carbon was determined on glass fiber filters by wet combustion. It and dissolved organic carbon were determined according to standard methods described in the instruction manual for the Oceanography International Carbon Analyzer Model 0524. The results are shown in Table 14. Mean values for the 5 lease tracts are shown in Table 14.

Table 14. Dissolved organic carbon (DOC), particulate organic carbon (POC) (Knauer and Aller) and total suspended particulate matter (SPM) (Betzer) for the 5 lease areas. Values in mg/l.

Area	Water Stations	DOC	POC	SPM
I	1,2,3,A1	1.81	.200	.129
II	4,5,6	1.00	.181	.217
III	C-2,7,8,9	1.88	.151	.091
IV	10,11,12	2.19	.147	.125
V	13,14,15	4.00	.215	.368

These data show some puzzling inconsistencies, in that POC values are higher in several cases than total suspended matter. This cannot be due to different sampling dates, for the water samples were presumably drawn simultaneously on cruises of the Tursiops and Gulf Researcher. In neither case were significant systematic differences with depth noted, though Betzer reported a sharp increase in total particulate matter from Station 13 to 1.8 mg/l.

Another surprise is that these particulate determinations did not register greater total particulate content toward the Mississippi Delta in view of known turbidities there, and strikingly confirmed by bottom

TABLE 13. (Iverson, Woodmansee)

AREA CHLOROPHYLL SUMMARY

(Grand Mean over all depths, all stations, mg chl*a* m^{-3})

	I	C1	II	C2	III	C3	IV	V	C4
S	0.08	0.11	0.10	0.07	0.05	0.05	0.09	0.19	0.02
M	0.08	0.12	0.17	0.12	0.33	0.23	0.18	0.23	0.22
B	0.35	0.29	0.56	0.52	0.55	0.21	0.43	0.62	0.86
$\overline{C}$	0.17	0.18	0.28	0.27	0.31	0.16	0.23	0.35	0.37

CHLOROPHYLL *a* PER CELL

I	C1	II	C2	III	C3	IV	V	C4
$1.72*10^{-5}$	$1.38*10^{-5}$	$5.40*10^{-5}$	$1.03*10^{-4}$	$2.59*10^{-5}$	$2.36*10^{-5}$	$1.93*10^{-5}$	$2.20*10^{-5}$	$6.40*10^{-6}$

photography (Fig. 4g). As was pointed out earlier, at least bottom waters must have in excess of 100 mg/l in several of the benthic stations (1 - 10) in area V. Moreover, ATP measurements by La Rock found up to 20 fold increases here.

Interesting data are supplied by Table 15, calculating total living carbon from ATP measurements. These show that living carbon makes up from a third to an appreciable part of particulate organic carbon, or even more in one case. However, these data do not appear to correlate well with the ATP measurements of La Rock, reported in Table 11, and in the original tables on which the averages are based. It is therefore suggested that the particulate chemistry be reviewed for computer or other errors.

3. Phytoplankton; sargassum (Iverson, Woodmansee); Sargassum (Humm)

Net phytoplankton and filtered nannoplankton are tabulated in Tables 16, 17, and 18. The highest concentration of cells in net phytoplankton fraction (55,000 per liter) was located at station C-4, where the pennate diatom, Nitzschia delicatissima made up 73% of the population. Subsidiary highs were recorded in nearby area V, where the mean of 14,600 cells was also dominated by Nitzschia delicatissima. The third ranked station was C-1, where a mean of about 11,000 cells was made up primarily of a centric diatom, Chaetoceros compressum, (49%) and Oscillatoria erythrae (30%), a blue-green filamentous alga. Total concentrations of nannoplankton showed marked uniformity throughout the MAFLA lease areas, and they were generally lower than net phytoplankton means. Maximum concentration was encountered in area IV (4,900 cells/liter). In brief, diatoms greatly dominated shelf plankton in the MAFLA area, reaching maximum values in the coastal areas.

TABLE 15. (Knauer and Aller)

COMPARISON OF TOTAL LIVING CARBON
CALCULATED FROM C/ATP RATIOS AND POC CONCENTRATIONS
AT SELECTED MAFLA STATIONS (mgc^{-3})

STATION NO.	DEPTH (M)	LIVING CARBON (ATP)	POC
MS 1	SFC	48	216
	15	51	161
	28	106	298
MS 3		41	178
	15	65	194
	36	91	218
C-1	SFC	50	176
	20	80	172
	36	57	191
MS 4	SFC	141	176
	27	78	151
	48	116	174
MS 6	SFC	34	165
	20	85	144
	30	387	279

TABLE 16 (Iverson and Woodmansee)

AREA PHYTOPLANKTON SUMMARY

(Grand mean over all depths and all stations in cells per liter)

	AREA I	STATION C-1	AREA II	STATION C-2	AREA III	STATION C-3	AREA IV	AREA V	STATION C-4
NET PHYTOPLANKTON	6,298	10,998	3,310	994	7,757	5,300	6,966	14,665	55,305
NANNOPHYTOPLANKTON	3,527	1,981	1,854	1,611	4,196	1,472	4,933	1,212	2,296
NET/NANNO	1.79	5.55	1.79	0.62	1.85	3.60	1.41	12.10	24.09

TABLE 17 (Iverson and Woodmansee)

Phytoplankter	V #/L	IV #/L	C-4 #/L	C-3 #/L
Chaetoceros spp.	850	4290(2)	11,170(3)	7900(1)
Leptocylindicus danicus	1160(3)	820	24,600(2)	830
Nitzschia closterium	380	1530(4)	0	80
Nitzschia delicatissima	31,400(1)	6390(1)	120,900(1)	1890(2)
Rhizosolenia alata f. gracillima	720	1500	3430	990(4)
Rhizosolenia fragilissima	940(4)	490	1680	70
Thalassionema nitzschioides	1980(2)	1890(3)	3600	1420(3)
Thalassiothrix mediterranea	700	490	4300(4)	310

Table 17. Concentrations of the dominant elements of the phytoplankton communities in Areas V and IV and at stations C-4 and C-3.

TABLE 18. (Iverson and Woodmansee)

NET PHYTOPLANKTON SUMMARY

(Grand Mean over all depths, all stations, cells per liter)

Species	I	C1	II	C2	III	
Cyclotella sp.	-	-	-	362	926	Inc.
Coscinodiscus eccentricus	10	-	20	13	111	
Hemiaulus Haukii	165	378	40	5	22	Dec.
Hemiaulus Membranaceus	65	110	18	-	3	Dec.
Chaetoceros atlanticum	18	49	15	11	100	
Chaetoceros decipiens	101	200	67	35	297	
Chaetoceros compressum	1405	5377	335	4	2947	
Chaetoceros didymum	9	-	30	22	120	
Bacteriastrum delicatulum	38	217	-	11	-	
Bacteriastrum hyalinum	259	189	71	5	483	
Leptocylindricus danicus	13	16	5	4	347	Inc.
Rhizosolenio alata	42	70	38	12	685	
Rhizosolenio fragilissima	23	23	5	15	40	
Rhizosolenio stolterfothii	27	82	3	3	26	
Thalassionema nitzchioides	2	-	-	8	98	Inc.
Thalassiothrix frauenfoldi	3	1	3	12	38	Inc.
Thalassiothrix mediterronea	2	-	1	-	93	Inc.

TABLE 18. contd.

	I	C1	II	C2	III	
Nitzschia closterium	28	13	76	53	112	Inc.
Oscillatoria erythrae	4509	3305	2137	88	962	Dec.

NANNO PHYTOPLANKTON SUMMARY

(Grand Mean over all depths, all stations, cells per liter)

Species	I	C1	II	C2	III	
Navicula spp.	>	>	>	>	>	
Syracosphaeva sp.	446	22[illegible]	93	101	43	
Gephyrocapsa oceania	1041	445	858	332	2964	Dec.
Oscillatoria erythrae	698	408	219	100	69	Dec.

Another kind of macro phytoplankton, sargassum weed, has properties and a life history that fit it particularly well to serve as a monitor for pollutants in sea water. Eighty-one samples of these algae, as well as benthic algae have been collected and archived for analysis or potential analysis of hydrocarbons or other constituents (Humm). These pelagic forms fall into two species: Sargassum fluitans, and Sargassum natans, which are closely related and tend to overlap. These large forms remain at the surface of the sea by flotation of their air sacs, and harbor an extraordinary community of organisms: bryozoa, mollusca, coelenterates, and fishes. Thus, "benthic" organisms are exposed at the sea surface to films of oil at their most concentrated for long periods of time. The selected samples have been frozen in preparation for analysis. A species list of the algae has been prepared by S. Earle.

4. Zooplankton (Maturo, Woodmansee group)

The chief zooplankton species encountered in areas V and IV are shown in Table 19. Examination of the extensive tabulated data of Maturo and Woodmansee indicates that in areas I and II, much lower biomasses ranging from 5 to 60 mg/m^3 are typical. Although calanoid copepods remain prominent, other zooplankters, such as gastropod veligers, shrimp bivalve larvae, ostracods, tunicates (oikopleura), globigerina, fish larvae, and pteropods are becoming significant. Area III falls in an intermediate position between I and II on the one hand, and IV and V on the other, yielding decreasing bivalve larvae, shrimp and other tunicates. In a very gross way, these relationships correlate also with macrofauna on the respective shelf area, insofar as impinging larvae and eggs are precursors of adult bivalves, ostracods, foraminifera, gastropods and fish.

To grapple with the complex variations in zooplankton within lease tracts, Maturo, Hearne, Ingram, Caldwell and Antonielli have developed an elaborate multivariate statistical program. This is used to study interactions with canonical variables such as hydrocarbon gases, C_3H_8, C_2H_4, CH_4 (data of Sackett and Schink), sunlight, hour, depth, intra-lease tract, and inter-lease tract variables. Whereas hour and hydrocarbon gases did not show correlations, significant relationships were obtained with lease tract, station, and, to a lesser extent, depth variables.

To these variables one may wish to add another important one - time and changing water masses.

Mangiordi (Maturo group) has briefly reviewed the literature on the effect of hydrocarbons on marine organisms, and, in particular, zooplankton. The main impacts are direct lethal toxicity, sublethal disruption of activities, effects of oil coatings, tainting and incorporation in food chains, and long-range changes of community. The great variability in organism

TABLE 19. Mean zooplankton examples for areas IV and V. Numbers/m^3. (Maturo and Woodmansee)

Category	V	IV	Category	V	IV
Total Copepods	9277	6527	Euchaeta	57	71
Paracalanus	3036	1586	Siphonophores	56	126
Acartia	2170	585	Calanus	20	53
Corycaeus	1699	353	Pyrocystis	19	48
Centropages	1320	483	Amphipods	15	29
Appendicularius	742	-	Hydromedusae	15	10
Eucalanus	701	106	Salps	14	252
Cladocera	497	19	Decapod larvae	11	26
Oithona	388	395	Ostracods	11	10
Oncaea	367	496	Ceratium	7	51
Sagitta	341	138	Lucifer (decapod)	4	12
Crab zoea	115	49	Megalops	4	5
Gastropod veligers	112	136	Fish larvae	2	23
Polychaetes	110	45	Foraminifera	1	2
Pelecypod veligers	92	27	Copilia	1	4
Nauplii	72	39	Tintinnids	1	2
Other calanoids	70	81	Egg cases	0	1
Fish eggs	62	57	Echinoderm larvae	0	1
Euterpina	61	20	Oikopleura (tunicate)	0	0
			Dry wt. mg/m^3	189	101

behavior is cited. In the area of sublethal effects, interference with chemoreception is suggested to be an effect of water-soluble components of petroleum products, particularly aromatic compounds. Microbial chemotaxis may also be affected, and affect the rate of degradation of organic substrates in the sea. Although there are few data on oil's effect on zooplankton, inferences from organisms as diverse as bacteria and fish leave open many possibilities. Oil slicks may reduce light penetration. Oil coatings have obviously adverse implications for marine organisms. Suggestive evidence is cited that oil may be passed through the food chain to produce tainting or accumulate carcinogenic compounds. The discussions of Blumer at Woods Hole are noted with regard to the possibility that crude oil hydrocarbons may follow metabolic or systematic pathways along trails blazed by naturally synthesized hydrocarbons. Finally long-range changes of community owing to reduction of diversity (due to increase in more petroleum-resistant species) is discussed. Changes leading to increased resistance to oil may simultaneously change other factors altering an individual or faunal group's overall probability of survival. These factors are held to play significant roles in determining the ultimate effect of oil in the marine environment.

In discussion Mangiordi points out that chronic sources of hydrocarbon pollution may be more severe than single dosage sources (spills, etc). One may note that in at least one area the recently published "Petroleum in the Marine Environment" (National Academy of Sciences) takes issue with the above critique. It indicates that there is no evidence for food web magnification in the case of petroleum hydrocarbons in the marine environment.

G. Hydrocarbons

1. Water column: sea water, zooplankton, suspended matter, and benthic organisms

The composition and components of sea water are recognized as transient properties which may change markedly depending on current movements and systems, input of materials from the shore or the sea floor, the atmosphere - or, in the case of man's entry, from the surface of the sea. As a part of the baseline survey it was regarded as desirable to evaluate the hydrocarbon composition of the water column as reflecting a state of semi-equilibrium or exchange with a "normal," or pre-drilling state environment in the eastern Gulf.

Sea water and zooplankton (Calder)

Hydrocarbons in water samples over the MAFLA tract showed no consistent trends with depth for either the aliphatic or aromatic fractions of any particular station. Nor were unique hydrocarbon concentrations found in different geographic lease areas; concentrations were extremely low and not far from the limit of analytical detectability. Some typical data, in this case from area III (Destin Dome) are shown in Tables 20 and 21. Similar results were obtained for zooplankton. Whereas aliphatic hydrocarbons tend to have rather similar concentrations at different depths, the aromatics vary widely. The lack of consistent relationships between concentration of aliphatics or aromatics in water and plankton may be either introduced by dietary hydrocarbons or zooplankton synthesis of endogenous hydrocarbon.

TABLE 20. Hydrocarbon properties for water column stations 7 and 9 (MS refers to master stations), Destin Dome area. Data of Calder.

		C17/PRIS		C18/PHY		PRIS/PHY		Odd/Even n-Paraffin		n-Paraffin/ Phytane		n-Paraffin/ C16	
		MS7	MS9	MS7	MS9	MS7	MS9	MS7	MS9	MS7	MS9	MS7	MS9
Surface:	Water	1.22	0.98	1.44	1.34	0.73	1.13	1.14	0.82	53.3	73.5	197	60.4
	Zoopl	0.06	0.10	1.54	2.06	73.9	184	1.43	1.40	49.7	244	28.1	105
Mid:	Water	NA	NA	2.35	1.69	NA	NA	0.97	1.11	150	56.8	NA	NA
	Zoopl	0.18	0.15	3.60	2.58	55.3	99.5	0.94	1.11	1950	355	149	89.4
Bottom:	Water	NA	1.02	NA	2.42	NA	1.17	NA	1.02	NA	39.5	NA	NA
	Zoopl	0.24	0.49	1.50	2.83	9.07	33.9	1.14	1.06	44.5	1020	54.9	248

		n-Paraffin range		Max n-Paraffin		Aromatic range		Max Aromatic	
		MS7	MS9	MS7	MS9	MS7	MS9	MS7	MS9
Surface:	Water	16-31	15-30	23,24	24	21.5-29.6	16.6-31.0	29.6	21.6
	Zoopl	15-25	13-31	21	25	15.9-25.4	14.1-29.7	21.1	27.0
Mid:	Water	18-28	18-28	25	25	21.8-29.6	26.0(only)	29.6	26.0
	Zoopl	13-30	13-30	25,26	25	13.4-29.1	12.3-29.1	14.0	22.6
Bottom:	Water	NA	17-29	NA	25,26	NA	16.5-29.5	NA	29.5
	Zoopl	15-30	12-31	25	25	16.1-29.7	12.0-27.6	27.5	22.6

TABLE 21. Gravimetric data for hydrocarbons in water and zooplankton, water stations 7 and 9, Destin Dome (Calder). Concentrations in original sample

		Aliphatics		Aromatics	
		MS7	MS9	MS7	MS9
Surface:	Water	2.25	0.38 µg/l	3.23	0.70 µg/l
	Zoopl	0.10	0.31 mg/g	0.10	3.77 mg/g
Mid:	Water	3.1	3.75	0.13	3.00
	Zoopl	1.63	0.40	4.47	0.75
Bottom:	Water	Lost	4.63	Lost	1.63
	Zoopl	0.34	0.42	0.72	0.57

Water column: light hydrocarbons (Sackett, Schink and Brooks)

Two types of investigations were carried out. The first, done in May, in conjunction with retrieval of water samples for other purposes, recovered 111 water samples from surface, middle, and bottom layers of the water column. These samples were extracted and subsequently analyzed in the laboratory at Texas A&M University, Department of Oceanography. Results showed that virtually all samples yielded levels of hydrocarbon that could be expected for equilibrium with the atmosphere (Table 22).

In June the Texas A&M "sniffer" system, incorporating underway recovery of surface water by means of a hose and pump, was put aboard the MISS FREEPORT for the cruise from St. Petersburg back to Galveston via Panama City (June). On this occasion hydrocarbon levels from two to 20 times equilibrium were obtained in areas III, IV, and V. Areas I and II had near equilibrium values. Additional rechecks were performed for stations A4, A5, and A6, south of area V in late June confirmed the enhanced concentrations.

One explanation of these results might be that the hydrocarbons reported in June represent pollutants carried by the Mississippi River and dispersed in the Gulf. However, in view of the relatively rapid loss of light hydrocarbons to the atmosphere in the upper water column (scrubbed by air in the wave zone), this is not regarded as likely. Sudden sea floor emanations over the large area in question also seem unlikely. More probably, the light hydrocarbons emanate from water masses in the vicinity of the oil production platforms around the Mississippi Delta (see dashed line, Figure 1). This explanation is supported by anomalously low salinities recorded around Panama City in early June (D. Wallace, personal communication), indicating that a mass of river-freshened water had moved eastward,

TABLE 22. Dissolved light by hydrocarbons in the water column (Sackett, Schink and Brooks)

Sample and Depth	Method	Concentrations in Nannoliters/Liter								Coordinates
		CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	$i\text{-}C_4H_{10}$	C_4H_8	$n\text{-}C_4H_{10}$	
MS 1, 5/74, 0 m	SM	35	27	t	t	6.4	---	---	---	27°45N 83°28W
		--	37	a	---	7.5	---	---	---	
15 m	SM	36	23	a	---	5.4	---	---	---	
		--	26	a	---	7.5	---	---	---	
28 m	SM	36	13	a	---	8.8	---	---	---	
		--	7.4	a	---	12	---	---	---	
MS 2, 5/74, 0 m	SM	49	25	5.4	---	8.0	---	---	---	27°52N 83°34W
		--	22	5.4	---	8.0	---	---	---	
15 m	SM	50	18	a	---	6.4	---	---	---	
		57	13	a	---	5.6	---	---	---	
30 m	SM	33	14	a	---	5.6	---	---	---	
MS 3, 5/74, 0 m	SM	52	22	a	---	8.0	---	---	---	27°56N 83°43W
15 m	SM	35	19	a	---	8.0	---	---	---	
		--	24	a	---	11	---	---	---	
36 m	SM	33	8.3	a	---	7.3	---	---	---	
MS 4, 6/74, 0 m	SM	84	21	t	0.8	8.0	---	---	---	28°21N 84°24W
27 m	SM	39	7.2	t	t	3.2	---	---	---	
48 m	SM	29	3.6	a	---	2.4	---	---	---	
MS 5, 6/74, 0 m	SM	45	24	t	4.8	4.0	---	---	---	28°29N 84°21W
		--	15	t	t	7.0	---	---	---	
25 m	SM	37	9.9	t	1.6	3.7	---	---	---	
		--	12	t	t	4.0	---	---	---	
40 m	SM	42	5.4	t	t	2.4	---	---	---	
MS 6, 6.74, 0 m	SM	41	35	a	6.4	3.8	---	---	---	28°43N 84°20W
		47	15	a	t	3.2	---	---	---	
20 m	SM	34	14	3.6	t	3.9	---	---	---	
		33	9.4	t	t	3.4	---	---	---	
30 m	SM	30	7.2	2.0	t	4.8	---	---	---	
		--	7.4	t	t	-	---	---	---	

TABLE 22. contd.

Sample and Depth	Method	Concentrations in Nannoliters/Liter								Coordinates
		CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	$i\text{-}C_4H_{10}$	C_4H_8	$n\text{-}C_4H_{10}$	
MS 7, 5/74, 0 m	SM	40	18	a	1.6	3.2	---	---	---	29°43N 86°01W
		42	7.2	a	1.0	3.4	---	---	---	
18 m	SM	35	6.7	a	---	2.4	---	---	---	
		41	8.5	a	---	3.2	---	---	---	
35 m	SM	34	11	a	---	4.0	---	---	---	
MS 8, 5/74, 0 m	SM	49	13	t	---	2.4	---	---	---	29°44N 86°14W
22 m	SM	34	16	a	---	3.2	---	---	---	
		38	--	a	---	4.0	---	---	---	
45 m	SM	34	2.7	a	---	2.4	---	---	---	
		38	4.1	a	---	2.4	---	---	---	
MS 9, 5/74, 0 m	SM	36	30	t	---	3.6	---	---	---	29°52N 86°16W
		38	9.0	t	---	3.6	---	---	---	
26 m	SM	44	4.1	a	---	3.6	---	---	---	
		48	9.5	a	---	3.6	---	---	---	
55 m	SM	30	2.7	---	---	1.8	---	---	---	
		44	3.2	---	---	1.8	---	---	---	
IA 4, 5/74, 1 m	SM	49	16	---	---	4.0	---	---	---	29°17N 87°40W
28 m	SM	44	14	---	---	3.2	---	---	---	
245 m	SM	53	2.7	---	---	2.4	---	---	---	
IA 5, 5/74, 1 m	SM	58	t	49	---	8.0	---	---	---	29°17N 88°26W
46 m	SM	56	16[c]		---	4.8	---	---	---	
60 m	SM	49	4.5	---	---	---	---	---	---	
IA 6, 5/74, 1 m	SM	53	14	7.2	t	4.0	---	---	---	29°20N 88°45W
8 m	SM	95	t	63	---	8.0	---	---	---	
47 m	SM	29	5.8	---	---	4.0	---	---	---	

TABLE 22. contd.

Sample and Depth		Method	Concentrations in Nannoliters/Liter								Coordinates
			CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	$i\text{-}C_4H_{10}$	C_4H_8	$n\text{-}C_4H_{10}$	
C 1, 6/74	1 m	SM	45	18	---	---	6.4	---	---	---	28°13N 84°03W
			45	16	---	---	4.0	---	---	---	
	20 m	SM	50	14	---	---	4.0	---	---	---	
			53	14	---	---	4.0	---	---	---	
	36 m	SM	43	6.3	---	---	4.0	---	---	---	
			36	3.6	---	---	4.0	---	---	---	
C 2, 5/74,	5 m	SM	--	14	7.2	---	2.4	---	---	---	29°28N 85°50W
	30 m	SM	65	9.4	---	---	3.6	---	---	---	
	38 m	SM	58	4.4	5.5	---	6.0	---	---	---	
C 3, 5/74,	1 m	SM	42	14	t	1.6	5.6	---	---	---	29°57N 87°10W
	23 m	SM	--	7.2	---	1.6	3.6	---	---	---	
	51 m	SM	33	14	---	1.6	2.4	---	---	---	
C 4, 5/74,	1 m	SM	40	t	99	---	10	---	---	---	29°33N 88°13W
	22 m	SM	42	13	---	t	4.0	---	---	---	
	38 m	SM	25	7.2	---	t	2.8	---	---	---	
I 10, 5/74,	1 m	SM	51	6.2	---	---	2.4	---	---	---	29°36N 87°25W
	18 m	SM	45	12	---	---	3.2	---	---	---	
	69 m	SM	37	5.4	---	---	1.2	---	---	---	
I 11, 5/74,	1 m	SM	56	8.0	---	---	3.2	---	---	---	29°41N 87°40W
	11 m	SM	45	3.0	---	---	2.4	---	---	---	
	30 m	SM	70	12	---	---	2.4	---	---	---	
I 12, 5/74	1 m	SM	54	10	---	---	3.2	---	---	---	29°46N 87°54W
	25 m	SM	39	8.0	---	---	4.0	---	---	---	
	34 m	SM	42	8.0	---	---	t	---	---	---	

TABLE 22. contd.

Sample and Depth	Method	Concentrations in Nannoliters/Liter								Coordinates
		CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	$i\text{-}C_4H_{10}$	C_4H_8	$n\text{-}C_4H_{10}$	
I 13, 5/74 1 m	SM	40	14	80	---	3.2	---	---	---	29°57N 88°14W
18 m	SM	50	11	---	t	2.0	---	---	---	
26 m	SM	34	15	---	1.6	6.8	---	---	---	
I 14, 5/74, 1 m	SM	42	16	---	---	5.6	---	---	---	29°56N 88°24W
12 m	SM	49	180[c]		---	24	---	---	---	
26 m	SM	36	8.1	---	---	8.8	---	---	---	
I 15, 5/74, 1 m	SM	36	15	3.6	---	4.8	---	---	---	29°56N 88°33W
10 m	SM	51	12	---	---	4.0	---	---	---	
20 m	SM	59	4.5	---	---	4.0	---	---	---	
A 5, 6/74 1 m	SM	82	51	51	3.0	20	-	-	-	29°17N 88°26W
8 m	SM	365	b	25	5.0	14	-	-	-	
56 m	SM	465	b	660	t	175	-	-	-	
A 4, 6/74 1 m	SM	44	40	9.0	14	13	-	-	-	29°17N 87°40W
169 m	SM	46	t	t	2.0	2.0	-	-	-	
340 m	SM	41	t	t	3.0	16	-	-	-	
A 6, 6/74 1 m	SM	61	50	55	13	27	-	-	-	29°20N 88°45W
19 m	SM	94	48	57	6.0	13	-	-	-	
43 m	SM	55	11	7.0	2.0	6.0	-	-	-	
A 7, 6/74 1 m	SM	2200	51	37	8.0	17	-	-	-	28°55N 88°50W
28 m	SM	249	40	41	8.0	12	-	-	-	
320 m	SM	45	t	t	4.0	3.0	-	-	-	

[1]M=McAullife (1971) Method; S=Swinnerton and Linnenbom (1967) Method; SM=Methane analyzed by McAullife and C_2 and greater analyzed by Swinnerton and Linnenbom.
[2]Concentrations expressed in nannoliters (10^{-9})of gas at STP per liter of sea water.
[3](-) indicates analysis of the component was not obtained; (---) indicates component was below detection limits of the method employed.
a = Ethene peak masked Ethane peak.
b = Ethane peak masked Ethene peak.
c = Insufficient separation of Ethane and Ethene to identify peak.
() = Brackets indicate only a tentative identification of peak.
*Concentrations are averages of two duplicate samples.

carrying with it regional waters containing anomalous concentrations of hydrocarbons.

These observations suggest several conclusions.

1) Measurements of hydrocarbons in water at given locations may be less meaningful than identifying hydrocarbons in water masses.
2) No significant amount of hydrocarbon seepage or other emanations were observed over the leased tracts, including the Destin Dome, at a time when there was no communication with oilfield-influences waters to the west.
3) Routine monitoring of low-molecular weight hydrocarbons in the MAFLA lease areas should be done only if and when oil and natural gas are discovered.

Further data on high molecular weight hydrocarbons in zooplankton and water have been obtained by Myers. He noted that concentration of hydrocarbon in net plankton greater than 202μ averaged .31 mg/g for the aliphatic fraction and 1.79 mg/g for the aromatic fraction (Table 23). Mass spectrometer and hydrogenation data indicate that these are probably polyolefins. The principal aliphatic hydrocarbon was always pristane, which is probably derived from the phytol portion of phytoplankton chlorophyll. Hence the low C_{17}/pristane ratios in zooplankton, averaging $0.13 \pm .10$. Pristane/phytane was high, averaging 167 ± 156. Areas IV and V have much higher pristane/phytane averages than do areas I and II.

No petroleum contamination, including tar balls, was noted on plankton or nets.

High molecular weight hydrocarbons in the water samples ranged from .08 to 7.23 μg/l in the hexane fraction, with an average of 2.1 μg/l. The benzene fraction (aromatic and polyolefinic hydrocarbons) ranged from

TABLE 23. (Calder)

SUMMARY OF DISSOLVED HIGH MOLECULAR WEIGHT HYDROCARBON DATA

	TOTAL SAMPLES	AREAS 1	2	3	4	5	ALL SURFACE	ALL MID	ALL BOTTOM
Water Hex. Frac. (Conc. ug/1)	2.10±1.55	1.11±.73	3.01±2.63	2.82±1.62	1.27±.88	2.60±.86	1.73±1.12	2.21±1.88	2.21±1.55
Water Benz.Frac. (Conc. ug/1)	2.06±1.85	3.44±3.02	2.28±2.26	1.74±1.37	1.55±.52	2.00±1.64	2.86±2.22	1.61±1.51	1.48±1.30
Water C_{17} Pris.	1.52±1.13	2.89±2.20	2.17±.77	1.07±.13	1.29±.68	1.31±.43	1.66±1.66	1.56±.91	1.33±.54
Water C_{18} Phyt.	1.71±.43	1.70±.21	2.18±.70	1.85±.51	1.77±.52	1.64±.27	1.59±.25	1.93±.52	1.58±.39
Water Pris/Phyt	1.14±.37	.82±.41	1.34±.29	1.01±.24	1.37±.18	1.38±.43	1.12±.43	1.09±.37	1.22±.30
Water n-par/phyt	47.44±34.79	30.63±18.23	19.24±3.46	74.62±43.84	43.06±17.02	78.58±44.49	42.52±30.83	46.95±34.26	52.93±40.93
Water n-par/C_{16}	55.56±49.39	33.63±31.81	15.58±9.78	128.55±96.38	41.80±32.39	75.14±36.54	66.26±60.03	40.73±22.44	58.87±58.25
Water O/E	0.99±.19	.95±.14	1.13±.38	1.01±.13	.97±.11	.93±.21	1.06±.26	.96±.14	.94±.15
DOC mgC/1 (From Knauer)	---	1.81±.52	1.10±.30	1.95±.73	2.19±.86	4.00±2.11	2.67±1.55	2.07±.94	1.76±1.09
Hex.Frac/DOC g/mgC	---	.61	2.74	1.45	.58	.65	.65	1.07	1.26
Benz.Frac.ug/mgC	---	1.90	2.07	.89	.71	.50	1.07	.78	.84

.08 to 8.4 µg/l. Normalized to total DOC, area II had the highest average aromatic concentrations and area IV the lowest. The chromatographic spectra were among the least complex observed, suggesting that the hydrocarbons may be of recent biosynthetic origin. None of the water samples showed clear evidence of petroleum-derived hydrocarbons.

Particulate hydrocarbons (Pierce)

Approximately 50 l of sea water was passed through .3µglass fiber filters. Lipids were extracted from the filters with $CHCl_3$/MeOH and the extract analyzed by gas chromatography. Results showed that samples C-1 through 6 had total lipid concentration in the range of .1 to .5 mg total sample (2-10 µg/l). Samples MS-7 and MS-9 (area III) had less than .1 mg/sample. Aliphatics were not detected below .05 mg/sample. Aromatic hydrocarbons were present in concentrations up to .15 mg/sample in MS-9 and .13 mg/sample in MS-7. Petroleum hydrocarbons were not indicated from the chromatographic results. From sites C-3, C-4, 10, 12, 13, and 15 (areas IV and V) similar lipids were obtained. However, here all sites showed .01 mg to .05 mg aliphatic hydrocarbons/sample (.2-1.0 µg/l). Aromatic hydrocarbons gave the same 3-peak pattern as before. The unresolved aliphatic envelope from n-C_{18} to n-C_{30} suggests weathered petroleum hydrocarbons stemming from low-level, chronic influx.

Benthic organisms (Meyers)

According to data on benthic organisms(Meyers) Table 24), most organisms studied contained considerably larger amounts of unsaturated hydrocarbons than saturated hydrocarbons, and the same group of the former appeared in essentially all organisms. Biogenic hydrocarbons such as pris-

TABLE 24. (Meyers)

HYDROCARBONS IN BENTHIC MACROFAUNA

Lease Area	Individuals	% (aliphatics/lipids)	% (aromatic/lipids)
I	7	0.04 to 0.66	0.29 to 0.97
II	7	0.05 to 0.38	0.05 to 3.70
III	3	0.15 to 0.28	0.33 to 2.30
IV	10	0.05 to 0.70	0.27 to 2.33
V	2	0.32 to 0.69	1.02 to 1.34

tane and squalene were important components. No series of homologous n-alkanes resembling Gulf crudes were evident. Thus, a variety of organisms including shellfish, echinoderms and sponges, indicated no evidence of chronic or severe petroleum pollution. Note, however, the algal data of Lytle and Lytle from area IV.

2. Sediments (Lytle & Lytle)

65 samples, or one for each master box core station (plus archive samples) were collected for sediment hydrocarbon study. Organic carbon, lipid, and aliphatic and aromatic data (gravimetric) indicated that most samples would be amenable to analysis. There appears to be relatively little aliphatic/aromatic variation in area I, suggesting a uniform source for hydrocarbons in the area. (Tables 24 and 26a-e.) Table 25 indicates that aromatic hydrocarbons are more abundant in peripheral stations than in the center of the area. The isoprenoid parameters of the lipids (Table27) suggest that in areas I-III organic sources of hydrocarbons such as algae or plankton are more likely than petroleum hydrocarbons. On the other hand, all of area V and a part of area IV (stations 15-20) contain an envelope of aliphatics containing appreciable quantities of C_{14}- C_{20} n-alkanes with a fairly smooth distribution (compare Figures 8 and 9). The alkane distribution and the isoprenoid ratios are those typical of sediments that have been exposed to crude oil. The petroleum-like hydrocarbons have been weathered only slightly. More severe weathering would cause relatively lower C_{14} - C_{20} concentrations and the C_{17}/pristane and phytane ratios would be correspondingly lower. The pristane/phytane ratio average is in agreement with oils produced in the Gulf. The dual maxima at C_{17} and C_{29}in the

Table 25. (Lytle and Lytle)

Comparison of Gravimetric Data Among Lease Areas

Lease Area	% Lipid/ Sed	% Aliph/ Lipid	ppm Aliph/ Sed	% Arom/ Lipid	ppm Arom/ Sed	% Org. C	% $CO_3^=$
I	0.147	1.14	17.41	1.55	21.31	3.60	86.42
II	0.086	1.22	10.25	1.92	15.96	2.08	85.92
III	0.473	1.43	5.09	1.78	6.20	1.42	71.0
IV	0.019	2.18	5.45	1.91	3.33	0.77	56.36
V	0.028	3.21	7.69	2.56	6.16	0.58	-

TABLE 26

Lease Site I

Station #	Dry Weight Sediment (g)	Percent Carbonate	Percent Organic Carbon*	Weight Lipids (g)	Weight Aliphatic Hydrocarbons (g)	Weight Aromatic Hydrocarbons (g)
55	177.2	91.8	6.68	0.4805	0.00727	0.00875
56	196.4	89.9	3.91	0.2734	0.00293	0.00413
57	238.9	89.3	3.96	0.677	0.00433	0.00573
58	47.43	97.2	5.92	0.098	0.00128	0.00114
59	Dredge Sample					
60	752.9	62.5	1.82	0.315	0.00304	0.00427
61	240.9	88.3	2.54	0.41125	0.00402	0.00572
62	40.35	96.27	4.28	0.03375		0.00128
63	328.97	84.2	1.63	0.337	0.00473	0.00338
64	368.7	83.5	4.34	0.33925	0.00391	0.00511
65	434.0	81.2	0.90	0.35625	0.00431	0.00407

*on a carbonate-free basis

TABLE 26 contd.

Lease Site II

Station #	Dry Weight Sediment (g)	Percent Carbonate	Percent Organic Carbon*	Weight Lipids (g)	Weight Aliphatic Hydrocarbons (g)	Weight Aromatic Hydrocarbons (g)
42	471.7	77.6	1.06	0.09388	0.00111	0.00136
43	No Sample					
44	148.5	92.6	2.33	0.10275	0.00171	0.00318
45	496.0	77.5	1.24	0.18075	0.00215	0.00420
46	801.5	63.8	0.52	0.28175	0.00377	0.00359
47	42.18	97.7		0.0925	0.00132	0.00154
48	371.0	83.7	1.91	0.1686	0.00221	0.00376
49	73.0	93.4	2.77	0.06125	0.00098	0.001696
50	200.8	90.3	2.59	0.2005	0.00161	0.00217
51	No Sample					
52	158.27	91.5	3.54	0.24363	0.00189	0.00407
53	213.6	91.1	2.82	0.2055	0.00192	0.00342
54	No Sample					

*on a carbonate-free basis

TABLE 26 contd.

Lease Site III

Station #	Dry Weight Sediment (g)	Percent Carbonate	Percent Organic Carbon*	Weight Lipids (g)	Weight Aliphatic Hydrocarbons (g)	Weight Aromatic Hydrocarbons (g)
21	467.8	80.8	1.95	0.19175	0.00296	0.00498
22	193.6	92.5	4.15	0.31112	0.00407	0.00283
23	641.83		1.66	0.837	0.00301	0.00353
24	503.46		2.27	0.47875	0.00043	0.00089
25	571.6	76.6	2.17	0.1931	0.00265	0.00364
26	665.33		0.59	0.2385	0.00250	0.00261
27	473.2	76.2	2.32	0.32775	0.00217	0.00251
28	210.96	90.3	2.12	0.1016	0.00155	0.00250
29	464.5	67.8	1.78	0.2000	0.00209	0.00291
30	395.4	78.0	1.43	0.13925	0.00233	0.00137
31	239.2	89.7	2.21	0.0955	0.00225	0.00203
32	No Sample					
33	152.06	93.0	2.74	0.1485	0.00149	0.00342
34	364.6	78.0	0.62	0.08725	0.0008	0.00102
35	597.9	74.3	0.43	0.10500	0.00218	0.00206

*on a carbonate-free basis

TABLE 26 contd.

Lease Site III Cont'd

Station #	Dry Weight Sediment (g)	Percent Carbonate	Percent Organic Carbon*	Weight Lipids (g)	Weight Aliphatic Hydrocarbons (g)	Weight Aromatic Hydrocarbons (g)
36	730.3	70.3	0.59	0.1490	0.00206	0.00243
37	589.5	72.2	0.49	0.09925	0.00193	0.00243
38	572.89	71.4	0.41	0.0921	0.00154	0.00168
39	1126.6	30.1	0.14	0.0631	0.00133	0.00177
40	1296.6	48.3	0.21	0.15325	0.00232	0.00386
41	1473.9	17.5	0.14	0.07838	0.00230	0.00316

*on a carbonate-free basis

TABLE 26 contd.

Lease Site IV

Station #	Dry Weight Sediment (g)	Percent Carbonate	Percent Organic Carbon*	Weight Lipids (g)	Weight Aliphatic Hydrocarbons (g)	Weight Aromatic Hydrocarbons (g)
11	1427.24		0.10	0.03162	0.00059	0.00088
12	1664.2	39.8	0.13	0.0386	0.00155	0.00170
13	2271.27		0.03	0.13375**	0.00014	0.00021
14	2355.1	10.6	0.06	0.04188	0.00020	0.00025
15	2457.2	13.2	0.12	0.254	0.00190	0.00120
16	2572.7		0.05	0.125	0.00016	0.00039
17	312.74		1.33	0.2445	0.00626	0.00311
18	201.0	93.1	2.29	0.0755	0.00315	0.00183
19	244.9	92.4	2.13	0.0283	0.00111	0.00134
20	344.9	89.1	1.41	0.10983	0.00414	0.00216

*on a carbonate-free basis

** Approximately 4/5 of the lipid spilled in work up.

TABLE 26 contd.

Lease Site V

Station #	Dry Weight Sediment (g)	Percent Carbonate	Percent Organic Carbon*	Weight Lipids (g)	Weight Aliphatic Hydrocarbons (g)	Weight Aromatic Hydrocarbons (g)
1	456.65		0.63	0.1512	0.003625	0.00435
2	722.7		0.75	0.2377	0.00421	0.00462
3	409.0		0.80	0.138	0.00574	0.00472
4	271.92		0.74	0.07375	0.00478	0.00328
5	1311.7		0.79	0.73144	0.01025	0.00717
6	1507.3		0.43		0.00916	0.00474
7	2023.7		0.54	0.5906	0.01288	0.01436
8	2043.0		0.23	0.4706	0.01037	0.00549
9	1991.0		0.30	0.06812	0.00240	0.00220
10	988.43		0.61	0.1016	0.00489	0.00257

*on a carbonate-free basis

TABLE 27

Isoprenoid Ratios* in Sediment Aliphatic Hydrocarbons

Station No.	C_{17}/pristane	C_{18}/phytane	pristane/phytane
1	2.25	3	2
2	2.5	2.75	1.5
3	2.25	4	2
4	2.3	3.6	2
5	2.14	3.3	2.33
6	2.17	2	1.5
7	1.5	2	1.6
8	1.56	2.6	1.8
9	1.6	3	2.5
10	2.33	3	1.5
11	2.86	2.17	1.17
12	2.73	3.57	2.14
13	1.36	1.5	1.4
14	Too Small		
15	2.86	3	1.4
16	2.2	2	1.67
17	4.75	3	1.6
18	2.4	2.57	1.43
19	2.5	2.83	1.67
20	2.8	5.5	2.5
21	3.0	6.5	2.5
22	3.29	8	3.5
23	5.25	5	2
24	4	8	3
25	2.71	14	7
26	4	6.5	1.87
27	2.88	10.67	2.67
28	2.88	7.33	5.33
29	4.1	4.67	1.66
30	2.33	2.8	1.2
31	4.4	9.14	2.86
33	2.12	5.6	3.2
34	2.38	3.17	1.3
35	3.14	10	4.67
36	2.14	4	2.33
37	3.08	6.75	3.25
38	3.75	18	8
39	4	6	2
40	4.29	5	2.33
41	5.5	5	3
42	3.2	3.6	2
44	3.6	4	2
45	3.5	6.8	3.2
46	4.38	3.22	0.89
47	5.6	8.39	2.42

TABLE 27 contd.

Isoprenoid Ratios* in Sediment Aliphatic Hydrocarbons

Station No.	C_{17}/pristane	C_{18}/phytane	pristane/phytane
48	6	16.43	3.57
49	6.96	4.5	2.33
50	3.08	6.5	3.25
52	3	7.5	3.5
53	5.0	8.57	0.57
55	22	9	0.67
56	70	5.62	0.5
57	100	12	0.5
58	6.14	3.67	1.83
60	16.67	1.2	0.36
61	17	2	0.5
63	3.5	4	2
64	14.29	1.67	1.17
65	10.67	1.0	0.75

*Ratios were computed from planimetric calculation of component concentration using the peak and upper boundary of the unresolved envelope on FFAP chromatograms as the area.

FIGURE 8. Chromatogram of hydrocarbon extract from sediment, station 12, area IV (Lytle and Lytle)

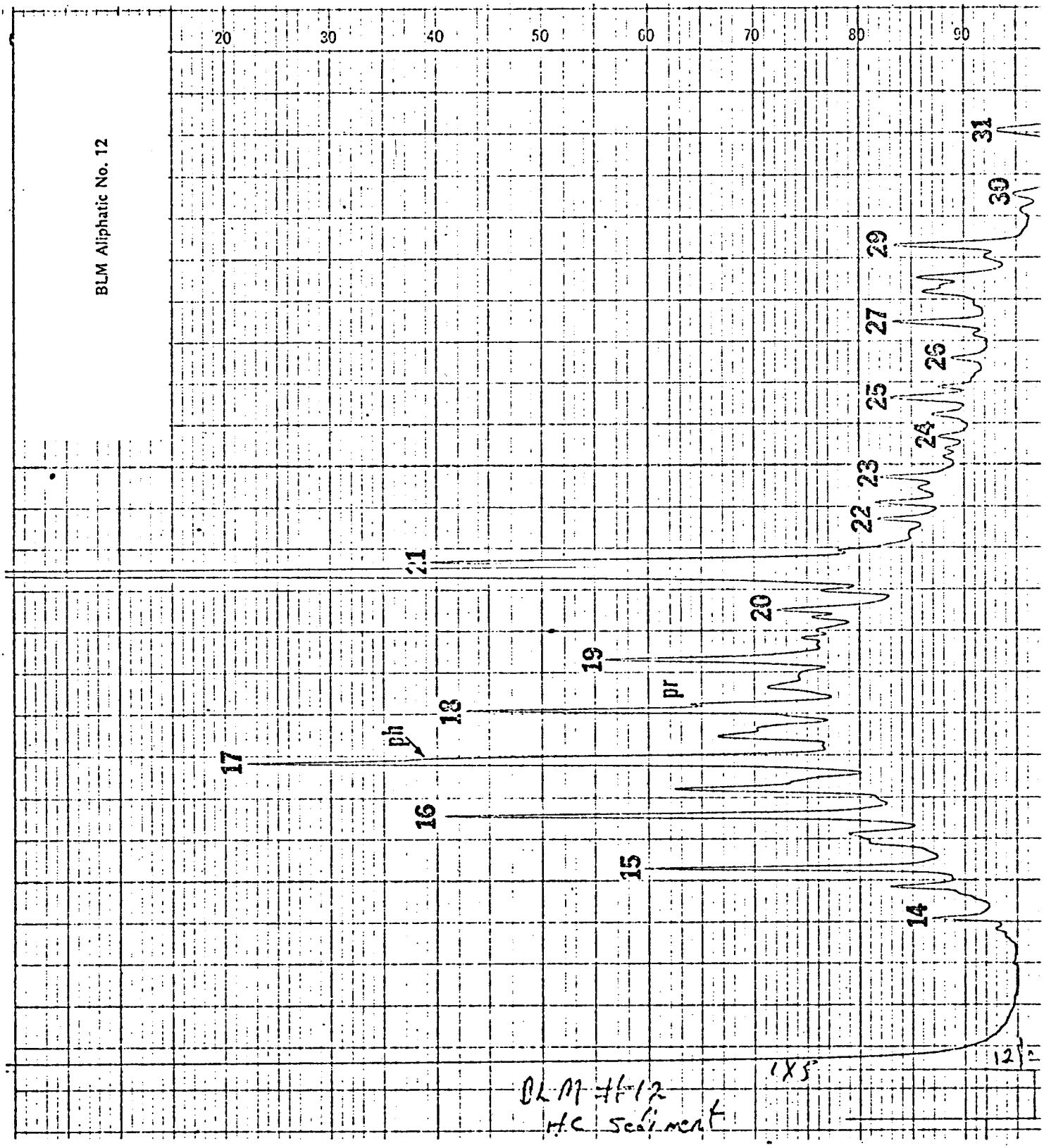


FIGURE 9. Chromatogram of hydrocarbon extract from sediment, station 55, area I (Lytle and Lytle)

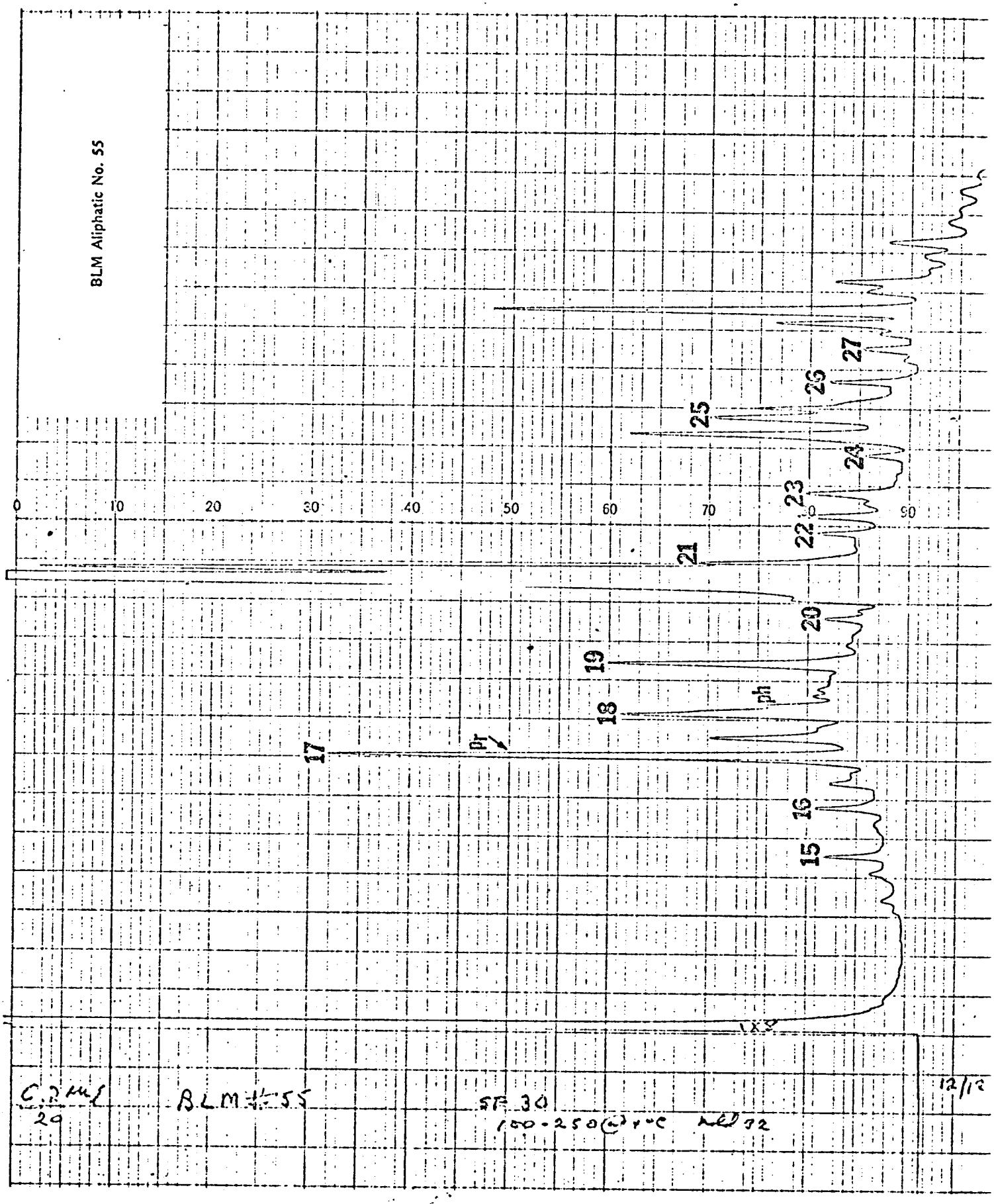


TABLE 28
(Lytle and Lytle)
Identification of Algae

Identification of dredge samples for Chemistry Section by Dr. Lionel N. Eleuterius, 14 January 1975.

Division Phaeophyta (brown algae)
Division Rhodophyta (red algae)
Division Chlorophyta (green algae)

Lease Site	Plant	Animal
I	#59 *Sargassum filipendula* (brown alga)	
	#59 *Gracilaria* sp. (probably *domingensis*) (red alga)	
II	#45 *Rhodymenia* sp. (red alga) (probably *pseudopalmata*)	*Bugula* sp. (Bryozoan)
	#46 *Padina vickersiae* (brown alga) *Halimeda favulosa* (green alga) *Pterocladia bartletii* (red alga)	Class Ectoprocta
	#49 *Sargassum* sp. (brown alga) *Thalassia testudinum* (rhizome) (flowering plant) *Halymenia* sp. (red alga)	*Membranipora* sp.
	#351 *Halimeda favulosa* (green alga) *Dictyota* sp. (brown alga) *Spyridia* sp. (red alga)	
III	#34 *Padina vickersiae* (brown alga)	*Bugula* sp. (Bryozoan) *Serptularella* sp. *Halecuim* sp.
	#39 *Leptofauchea rhodymenioides* (red alga) *Gracilaria* sp. (red alga)	*Bugula* sp. (Bryozoan)
	#41 *Gymnogongrus* sp. (red alga) *Halimeda* sp. (green alga)	Class Ectoprocta *Serpula* sp. (worm tubes)
IV	#13 *Goniolithon* sp. (red alga)	Class Ectoprocta

TABLE 29
(Lytle and Lytle)

Ratios Resolved Peaks/Unresolved Envelope

Algal Samples

Sample Number	Ratio in Aliphatic HC	Ratio in Aromatic HC
II-46	0.49	1.15
II-45	0.22	0.74
II-351	0.67	1.83
IV-13	0.09	0.56
III-34	0.23	0.66
III-39	0.19	0.71
II-49	0.36	1.06
Red-59	0.35	0.58
59-Sargassum	0.29	2.02
III-41	0.26	1.23
Average	0.32	1.05

chromatograms may be seen in Figure 9, whereas it is not present in Figure 10, a chromatogram from the carbonate-rich area I (station 53).

In addition to hydrocarbons, a suite of algal samples (Tables 28 and 29) were analyzed. Chromatograms of natural algae show that these aliphatic hydrocarbons have a rather simple structure with prominent C_{15} and C_{17}. Their spectra may be complicated by encrusting animals such as bryozoa. However, one sample (red alga Goniolithon) from station 13 contains a series of normal aliphatics from C_{20} to C_{30} in large quantities and with no odd-even preference. The sample also has a low ratio of resolved peak/unresolved envelope. That has been used to characterize petroleum pollution, and points to hydrocarbon of petroleum origin in this case.

H. Heavy Metals

1. Water column: zooplankton, suspended matter, and benthic organisms

Water column (Segar)

A threefold system was used by Segar to analyze trace metals in waters: waters were injected directly into the graphite furnace of an advanced atomic absorption spectrometer; acidified waters were injected, and organic extracts (APDC-MIBK) were injected. Bottles were delivered to the laboratory by hand. They had been filled with water filtered on shipboard through a Nuclepore 0.4μ filter under carefully controlled conditions. The following observations were made regarding reliability for these difficult (in terms of potential contamination or other systematic error) ultra-low trace metal analyses.

Vanadium showed consistent values on the order of 1.5 ppb, not far from accepted oceanic values. Extractable Ni and Pb show significant variations, but both are in the accepted range for nearshore areas. They show values ranging from .25 - 2.5 ppm Ni, and .07 to 1.7 ppm Pb. Extractable Cu and Fe show some major discrepancies from the listed values, or with each other; they are often well above the directly injected samples in concentration. 15% of the extractable analyses gave concentrations higher than total injection. This and similar discrepancies for Cr, Cd, Cu and Fe are attributed, by Segar, to contamination in the laboratory or handling on ship.

The full analyses are shown in Table 30. Inspection of the data shows immediately that certain values, especially Cu and Fe, appear high and out of context. Nonetheless these are among the lowest general values obtained in the literature for shelf waters, and we may regard them -

TABLE 30
Trace analysis of sea water (Segar)

	Direct Injection of Extracted Sea Water Samples (ppb)					Direct Injection of Sea Water			
	V	Ni	Pb	Cu	Fe	Cr	Cd	Cu	Fe
361	1.3	1.1	0.07	3.0	4.5	1.9	0.3	1.1	4.2
365						0.45	<0.1	1.0	3.2
362	1.3	0.70	<0.07	4.5	2.5	2.1	<0.1	3.6	6.7
366						0.72	<0.1	3.2	7.8
363	1.6	1.7	0.68	0.90	21	1.6	<0.1	1.5	7.2
364						5.9	<0.1	1.3	3.7
367	1.4	0.50	0.19	0.70	1.9	3.1	<0.1	1.8	45
371						0.72	5.8	31	5.2
368	1.3	0.35	0.36	2.7	0.8	7.7	<0.1	1.0	3.5
372						0.48	4.1		5.5
369	1.4	2.4	0.93	2.8	4.7	0.68	<0.1	1.2	7.0
370						0.72	<0.1	2.0	5.1
521	2.1	2.2	0.90	11	20	1.8	16	8.3	188
522						2.1	4.3	4.7	35
539	1.0	0.10	0.20	1.9	2.9	1.4	7.2	10	17
523	3.4	12	1.5	22	55	2.6	4.5	8.5	54
524						1.4	1.9	7.0	19
527	1.1	0.70	1.7	2.4	2.8	0.94	<0.1	4.0	25
525						5.8	2.6	3.5	22
530	1.2	0.70	0.32	6.2	3.5	4.7	11	13	22
526	1.0	1.1	0.65	4.1	4.4	4.2	0.10	2.0	11
876						1.2	2.7	1.6	8.6
528	1.4	0.15	0.09	1.4	1.3	2.1	1.4	10	65
878						1.7	2.2	3.7	32
529						4.4	<0.1	9.4	43
925	1.4	1.3	0.21	1.0	6.0	1.2	<0.1	2.0	20
531						1.2	0.48	2.2	37
540	1.6	0.60	0.58	1.7	3.9	1.0	<0.1	2.9	29
532						2.1	2.1	2.5	19
535	1.4	0.80	0.30	6.0	3.6	2.4	0.35	7.8	18
533	1.0	0.05	0.59	0.6	3.1	1.8	<0.1	2.2	30
537						1.6	<0.1	2.2	34

TABLE 30 contd.

	V	Ni	Pb	Cu	Fe	Cr	Cd	Cu	Fe
534	1.3	0.75	1.6	1.9	4.8	1.6	<0.1	5.2	11
538						1.1	<0.1	14	11
536	1.3	1.0	2.2	6.4	5.1	1.1	6.0	5.4	56
877	1.2	0.40	0.10	2.0	2.7	1.6	6.3	2.1	10
879	1.5	0.90	0.09	3.8	5.3	1.6	2.0	7.8	14
896						3.4	5.5	22	56
880	1.4	0.60	<0.07	2.5	4.5	2.3	14	2.1	9.7
883						2.0	1.3	3.2	28
881						1.6	1.2	3.5	18
891	1.1	3.1	0.25	2.7	32	3.0	2.3	1.9	55
882	1.1	0.45	1.0	2.2	5.3	1.4	5.6	3.7	28
885						2.5	18	29	7.7
884						2.0	<0.1	2.4	21
889	1.7	0.22	0.40	4.4	3.0	2.0	1.2	5.1	58
886	1.4	0.92	0.34	4.8	9.0	1.6	1.7	8.1	42
888						2.4	30	22	20
897	0.92	0.70	0.34	2.3	20	2.2	<40	8.4	63
901						3.0	0.4	1.9	8.1
905						1.6	<0.1	3.9	8.6
902						2.3	<0.1	1.6	10
906	1.2	0.15	0.14	0.90	<0.04	1.8	<0.1	2.2	11
903						2.8	<0.1	2.2	1.7
904						1.2	0.4	2.8	9.2
907						1.6	0.11	2.3	37
910	1.3	1.0	1.2	1.9	2.1	1.7	<0.1	2.1	8.9
908						1.2	<0.1	2.8	39
911	1.4	1.4	0.45	1.8	4.8	1.4	0.2	2.6	6.9
909						3.4	<0.1	2.2	44
912	0.5	0.65	0.25	1.3	0.4	1.0	<0.1	2.6	5.4
913	1.4	4.4	3.2	3.5	17	1.6	<0.1	2.1	18
916						1.2	<0.1	2.6	8.9

TABLE 30 contd.

	V	Ni	Pb	Cu	Fe	Cr	Cd	Cu	Fe
914						1.4	3.7	2.2	18
917	1.3	0.75	1.3	1.8	6.2	2.9	<0.1	2.2	6.9
915						2.8	<0.1	2.7	10
918	1.4	1.5	2.2	1.1	11	6.9	<0.1	1.5	5.4
919						5.0	5.3	13	35
922	1.4	1.9	1.2	1.4	21	5.1	<0.1	7.1	23
920	1.3	0.85	1.0	2.2	2.6	3.1	<0.1	2.1	8.8
923						2.0	<0.1	2.7	9.3
921	0.85	0.55	0.21	1.4	3.3	4.4	<0.1	1.5	17
924						1.9	<0.1	2.6	22
2001						1.4	<0.1	1.3	1.1
2007		0.15	2.0	0.8	<0.4	1.0	<0.1	1.5	0.80
2002						1.8	<0.1	1.3	2.2
2005	1.3	0.80	2.1	0.6	1.2	1.2	<0.1	1.5	1.3
2003						1.4	<0.1	2.7	0.48
2004	1.3	0.80		0.70	<0.4	1.1	<0.1	1.4	0.80

at the least, as an upper maximum, and confirmation of absence of dissolved metalliferous pollutants.

Suspended matter (P. Betzer)

Suspended particle mass and trace metal determinations were made on 42 samples from 14 stations. Mean value for total suspended matter was 184 µg/l.

Previous work has shown that organic-rich suspended matter tends to be enriched in trace metals with respect to normal bottom sediments. The present trace metal composition of suspended matter is likewise characterized by such enrichment, particularly with respect to Cd and Ni in areas I and II. If such enrichment is organic in nature, then the values toward the Mississippi River influence (clays) should be lower. This was, in fact, observed for Ni, Cu, and Cd for Station 13, where values at 26 m depth dropped to 2 ppm Cd and 17 ppm Cu. These are values that might easily be found in river-bottom sediment. One must express surprise that more samples from area V did not show much higher suspended matter values, in view of the many evidences of high turbidity there. The means are shown in Table 31.

Zooplankton (Knauer and P. Betzer, and benthic organisms (S. Betzer)

As might be expected of highly diverse organisms collected among zooplankton, their metal levels were extremely variable. Again, concentrations were higher than expected, and in comparison with Pacific zooplankton (Table 32). However, one may note that dissolved composition of sea water, as well as suspended matter tends to become relatively more enriched with trace constituents, the more free from particulate matter and the more impoverished in nutrients it is.

TABLE 31
(P. Betzer)

SUSPENDED MATTER TRACE METAL SUMMARY +

AREA	NO. OF SAMPLES		S.P.M.* (µg/l)	Fe	Pb	Cd	Cu	Cr	Ni	V
I	9	Average	129	.57	200	59	199	160	1486	N.D.
		Range	81-266	.24-.98	76-322	8-243	51-684	-	-	-
II	6	Average	217	.22	145	15	103	N.D.	3609	N.D.
		Range	74-200	.11-.47	44-316	3-25	31-187	-	-	-
III	9	Average	91	1.26	273	29	481	N.D.	N.D.	N.D.
		Range	49-161	.28-4.3	19-975	8-73	133-898	-	-	-
IV	9	Average	125	1.09	189	55	328	144	174	N.D.
		Range	50-334	.10-4.2	107-364	14-100	162-563	64-276	-	-
V	9	Average	368	1.19	109	45	254	120	52	57
		Range	61-1788	.25-4.8	14-209	2-226	17-715	45-191	-	-

+ Values for all elements are in µg/g dry weight except iron which is in percent

* Suspended Particulate Matter in micrograms per Liter of water filtered.

TABLE 32
(Knauer and P. Betzer)

Average concentrations (μg/gram dry weight) trace metals in zooplankton from three MAFLA regions. Average concentration of these metals in the Pacific zooplankton is included for comparative purposes.*

I. West Florida Shelf / Middle Grounds

ELEMENT	Fe	Cr	Ni	Cu	V	Cd	Pb
$\bar{X}$	251	1.2	3.5	16.0	2.8	9.2	2.3

II. Destin Dome / Apalachicola

ELEMENT	Fe	Cr	Ni	Cu	V	Cd	Pb
$\bar{X}$	268	4.1	7.8	21.0	2.3	16.3	6.0

III. Mississippi River / Alabama

ELEMENT	Fe	Cr	Ni	Cu	V	Cd	Pb
$\bar{X}$	1345	4.1	3.4	22.4	6.2	3.0	4.6

Pacific Zooplankton

ELEMENT	Fe	Cr	Ni	Cu	V	Cd	Pb
$\bar{X}$	221	<1.0	3.6	12.6	<3.1	4.3	3.5

* These values are integrated values of one hour tows taken from three depths at each station.

111 samples of benthic organisms were placed in plastic bags and frozen on board ship. At the shore laboratory samples were thawed, dried and ashed on a teflon watch glass in a low temperature asher. The ash was then transferred to a Teflon bomb and digested four to five hours with hot ultra-pure nitric acid. The solution was analyzed for trace metals utilizing a graphite furnace atomic absorption spectrophotometer (S. Betzer). The results are shown in Table 33.

Copper is, as expected highest in crustaceans, which utilize the element in their respiratory pigment, hemocyanin. Echinoderms and molluscs showed copper concentration on the same order as the sediments, whereas sponges and corals had an order of magnitude of lower concentration. Instead of copper, tunicates use vanadium in their respiratory pigments, and, not surprisingly, showed by far the highest concentration of this element (7 ppm). Nickel is extraordinarily enriched in sponges; their average concentration was more than 100-fold higher than average sediments. It was a matter of regret that lease area V yielded so few macro-organisms, since it would have been expected to show marked differences from the other areas. Though at low levels, lead did increase markedly in crustaceans from this area (1.5 ppm).

Sediments (Presley, Linadau and Trefry)

Samples of each of the 65 master stations were selected for analysis of the 8 trace elements, as shown in Table 34. These data show that trace metals are generally well below the average concentration for nearshore sediments, due principally to the large admixture of metal-poor carbonate. As may be noted in Figure 10, many of the trace elements correlate with iron, not necessarily as a direct correlation, but merely

because increase in iron signifies an increase in detrital clay components known to contain most of the metal concentrations. As pointed out by Presley, a map of trace constituents prepared by Holmes (1973) agrees with the low concentrations found here on much of the west Florida shelf. However, some discrepancies may be noted. Holmes' map predicts between 100 and 150 ppm vanadium in much of area V whereas a mean of only 56 was found in this report. Moreover, Holmes' map indicates more than 300 ppm V, some in an arc of sediments to the south, and between 70 and 100 ppm lead at a depth of about 600 m, south of Mobile Bay. We should recall, however, that the analyses on which the maps are based are semiquantitative, and the differences may be more apparent than real. However, this comparison does show that if chemical parameters or threshholds are to have indicative value or environmental significance, the stress placed on analytical accuracy in this survey was not misplaced.

TABLE 33 (S. Betzer)

SUMMARY OF TRACE METAL CONCENTRATIONS IN EACH TAXONOMIC GROUP IN EACH LEASE AREA

Average μg/g dry wt. ± 1 S.E.M.

	NUMBER ANALYZED	Cr	Ni	V	Fe	Cd	Pb	Cu
LEASE AREA I								
Sponges	16	2.6±0.7	380±143	1.5±.3	625±146	5.8±2.3	0.48±0.12	4.96±0.70
Soft Corals	1	0.62	0.79	0.9	137	0.50	0.30	0.76
Hard Corals	4	0.67±.14	0.38±0.1	1.2±0.1	173±35	0.49±0.03	0.28±0.08	0.48±0.19
Crustaceans	6	0.43±0.1	10±9.6	1.0±0.3	64±20	1.7±1.0	0.17±0.06	32.3±12.4
Echinoderms	7	0.16±.07	8.8±6	1.9±0.7	187±145	0.70±0.21	0.34±0.08	5.9±3.7
LEASE AREA II								
Sponges	24	1.25±0.41	121±80	1.13±0.18	208±53	3.12±1.22	1.17±0.4	5.63±1.06
Soft Corals	6	0.13±0.04	1.1±0.6	1.7±0.4	59±22	1.54±0.33	0.17±0.04	0.85±0.22
Hard Corals	9	0.32±0.14	3.1±1.5	1.6±0.2	100±31	0.43±0.06	0.21±0.04	0.65±0.18
Molluscs	7	5.0±2.5	18.2±5.1	4.1±1.2	170±30	7.48±3.22	0.70±0.21	3.84±1.55
Polychaete	1	1.25	111	1.9±0.6	552	5.06	1.25	5.65
Crustaceans	1	0.35	0.42	1.3±0.3	91	0.55	0.07	20

TABLE 33 contd.

SUMMARY OF TRACE METAL CONCENTRATIONS IN EACH TAXONOMIC GROUP IN EACH LEASE AREA

Average μg/g dry wt. ± 1 S.E.M.

	NUMBER ANALYZED	Cr	Ni	V	Fe	Cd	Pb	Cu
LEASE AREA II Cont.								
Echinoderms	5	0.27	0.51±.07	1.9±0.4	49±12	2.96±2.4	0.24±0.08	4.63±2.70
Tunicates	4	7.9±0.8	3.7±0.9	7.4±1.4	718±458	0.34±0.14	0.60±0.19	2.84±1.10
LEASE AREA III								
Sponges	6	5.1±1.6	154±104	3.1±0.8	901±436	11.5±7.5	1.38±0.38	3.20±1.16
Echinoderms	3	0.14±0.08	0.32±0.16	0.31±0.18	68±26	1.2±0.4	0.23±0.09	2.30±1.60
Tunicates	1	4.38	5.6±0.9	6.8	1.58	0.60	0.98±0.19	3.50±1.10
Amphioxus	1	0.38	3.9	2.5	92	3.4	0.29	1.4
LEASE AREA IV								
Molluscs	1	0.85	N.D.*	4.97	357	11.4	0.29	9.7
Crustaceans	1	0.085	N.D.*	N.I.*	7.7	1.05	0.068	12.4
Echinoderms	3	0.24±0.09	8.2±7.6	0.84±0.59	45±19	0.66±0.33	0.22±0.06	1.59±0.64

* Not Deductible

TABLE 33 contd.

SUMMARY OF TRACE METAL CONCENTRATIONS IN EACH TAXONOMIC GROUP IN EACH LEASE AREA

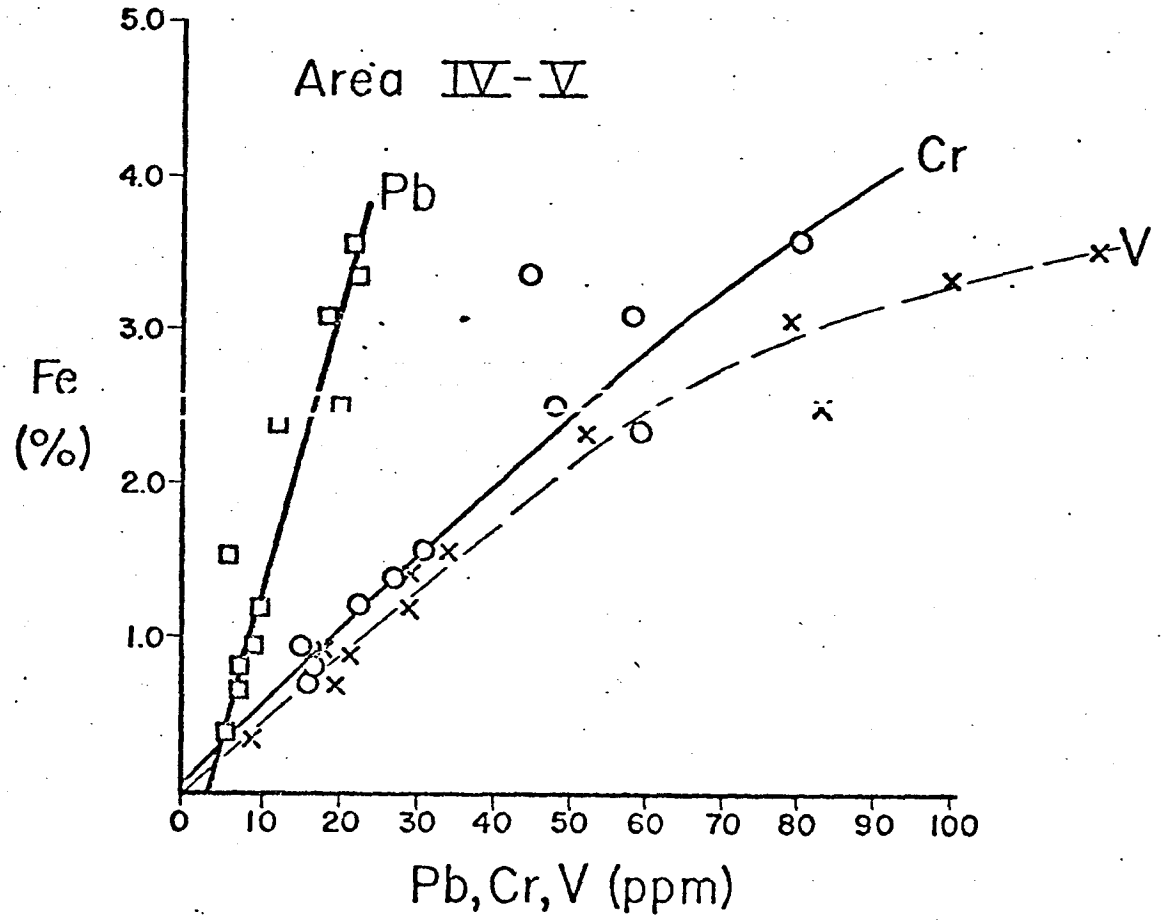
Average µg/g dry wt. ± 1 S.E.M.

	NUMBER ANALYZED	Cr	Ni	V	Fe	Cd	Pb	Cu
LEASE AREA V								
Molluscs	2	0.66±0.11	3.70±1.79	2.05±0.63	412±118	2.38±0.05	0.24±0.04	4.95±0.39
Crustaceans	2	2.65±0.25	0.57±0.49	4.91±0.32	1700±77	0.57±0.18	1.47±0.72	40±10

Table 34. Sediment heavy metal concentrations (from Presley, et al.). N = number of samples. Standard deviation in parentheses.

Area	N	Fe(%)	Cd(ppm)	Cu(ppm)	Cr(ppm)	Ni(ppm)	Pb(ppm)	V(ppm)	Ba(ppm)
I	9	.16(.04)	<.05(0)	4 (.6)	18(5.4)	2 (1)	6 (1.3)	5(1.5)	49(15)
II	8	.16(.08)	<.07(.02)	4.4(1.3)	13(6.8)	3 (1.5)	3.5(1.8)	6(4.5)	46(12)
III	20	.52(.19)	<.09(.05)	4.9(2.7)	19(7.5)	4.5(1.9)	6 (1.6)	10(4)	68(31)
IV	10	.66(.51)	<.08(.03)	4.5(3.8)	16(20)	4 (2.7)	7 (2.7)	13(7)	76(39)
V	10	2.01(1.11)	.2 (.08)	10.5(7.1)	39(23)	17 (13)	13 (6.5)	56(37)	339(213)
Carbonate rocks		.4	0.0X	14	11	12	8	15	150
Nearshore sediments		3.5	0.X	48	100	55	20	130	750

Figure 10. Concentrations of trace metals and iron in MAFLA sediments (Presley)



Metal concentrations in sediments

I. Environmental Applications and Conclusions

1. Crude oil-like hydrocarbons have not been identified in sediments, bottom organisms, or organisms or phases in the water column in areas I, II and III. Moreover, the abundance and diversity of organisms, as well as evidence of similar populations living in the same niches on the shelf in the recent past, suggest that these organisms are living in an essentially pristine and natural ecological state, and show no evidence of stress owing to influx of pollutants. The situation is more complex in area IV. Proximity to the Mississippi Delta and its strong turbidity and periodic freshwater influences, creates a similar kind of stress for the westernmost stations as that encountered more strongly in area V. Some sediments in the area show influences of petroleum-type hydrocarbons in aliphatic components of lipids, whereas others show only the odd-number predominance typical of biologically synthesized hydrocarbons. Organism analyses show similar divergent trends. Heavy metals show background or subbackground levels. Area V sediments revealed universal indications of petroleum hydrocarbons in the sediments. Their weathered nature led the Lytles to infer a Mississippi River origin for them. However, the areas in question are to a large extent poorly productive of epi-and infauna other than stress-tolerant species, and it is problematical what influence the added hydrocarbons have on the system.

2. Distribution of suspended matter is significant for natural processes of removal of oil. Suspended matter and zooplankton productivity (via fecal pellet formation and sinking processes) are both known to be effective means of collection and sinking of oil pollutants. Hence, off areas V and IV, spills and surficial slicks of oil will be brought down more effectively and rapidly (perhaps by one or more orders of mag-

nitude) than in the clear water areas to the south. This means that, in the absence of human clean-up or recovery, a greater percentage of the oil will remain in surface water of the southern areas to be either moved on by currents or impinged on and absorbed at the coastal zone, except under unusual conditions such as storm-related turbidity.

3. Heavy metals in sediments, waters, organisms or suspended matter have not shown concentrations beyond those expectable for comparable unpolluted materials. In fact, sediments have unusually low background levels for trace constituents over much of the area. In my opinion, heavy metals in petroleum or petroleum-related brine seepages are not a major hazard, owing to their low concentrations in oil and brine. Calculations show that some of the larger historical spills, if distributed over a typical bottom sediment area might have difficulty in building up ambient concentrations beyond background. Moreover, the chief elements in oils, vanadium and nickel, have relatively low toxicity. This does not preclude a buildup of detectable residues of vanadium and nickel in benthic and encrusting and fouling organisms and sediments as a result of chronic low level spills.

The excellent background of analytical information on organisms from a clean environment should invite complementary analyses of similar species from "dirty" environments, if they can be found and vouched for, to establish comparative knowledge of metal influences on a wide spectrum of organisms.

Trace elements may be potentially more significant as pollution from land sources. The investigated sites were not close enough to shore and potential sources of pollutants to detect plumes and ranges of influence of land-derived wastes. Baseline maps of trace element and hydrocarbon

constituents should, in the future extend to the shore to delineate land-derived influences from potential offshore pollutants.

4. Over the short range, substrate largely controls bottom fauna. This is true to an extreme degree in the Middle Ground. Over wider areas other factors come into play: temperature, recruitment of eggs and larvae via water movements are examples. The unusual fauna and flora of both the Flower Garden (Bright and Pequegnat, 1974), and the Middle Ground reefs may require a combination of bottom substrate and impingement of Caribbean breeding stock, transported by the Loop Current.

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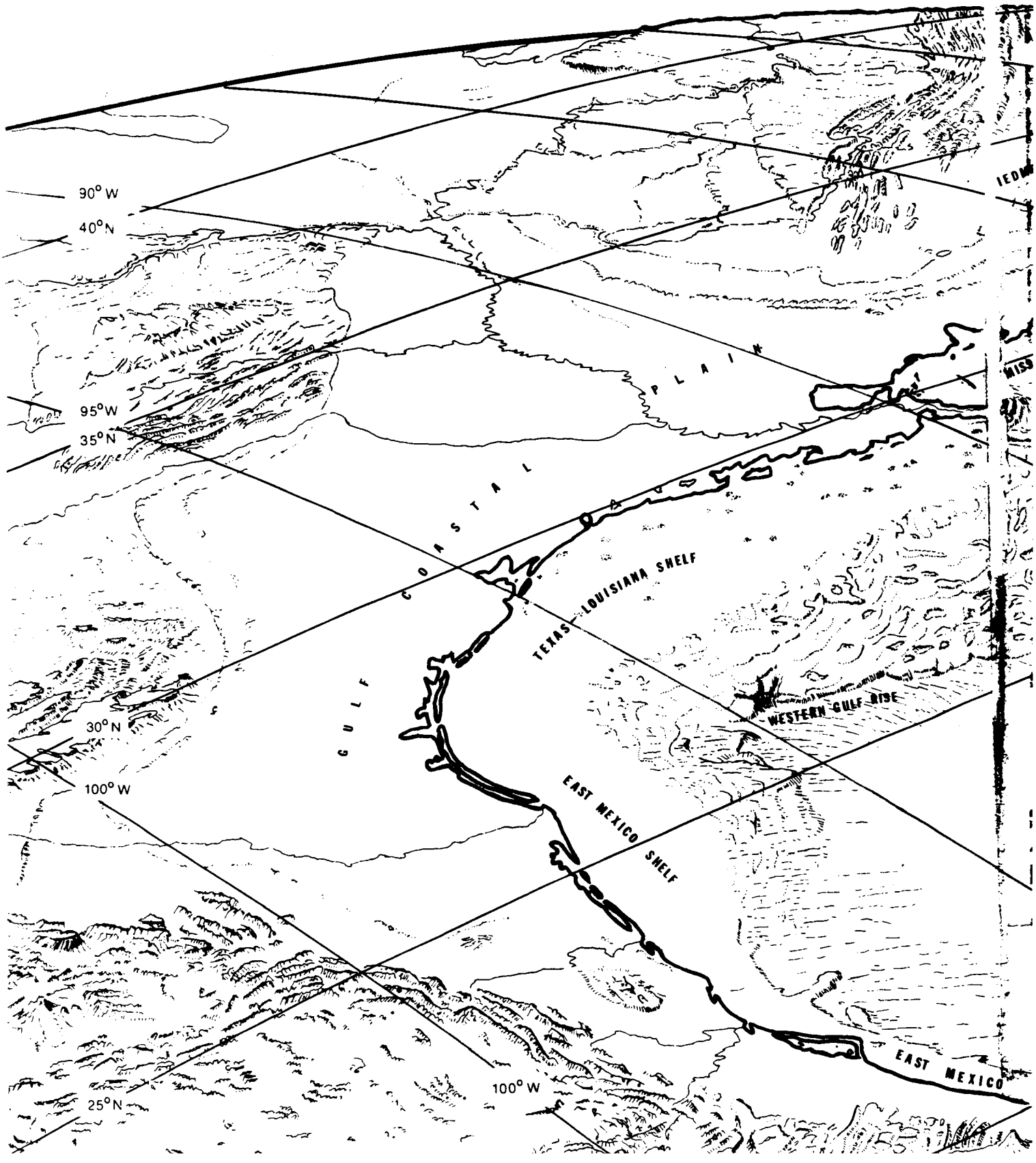
90° W
40° N
95° W
35° N
30° N
100° W
25° N
100° W
GULF COASTAL PLAIN
TEXAS-LOUISIANA SHELF
WESTERN GULF RISE
EAST MEXICO SHELF
EAST MEXICO