This research phase is being generated from two procedures: a) observation and photography and b) review of secondary data. (The project budget does not permit nor does the study require the generation of primary data on specific factors, such as soils, climate, or wildlife).

The following factors were found to be important. They have been studied to some degree but several more months will be required for their complete analysis. They are:

External Factors:	Proximity
	Transportation
	Alternative Destinations
	Image of Area
Internal Factors:	Climate
	Water and Wildlife
	Vegetative Cover
	Land Relief
	Wildlife
	Extractive Land Industries
	Marine Industries
	Tourism-Recreation Development
	Communities
	Manufacturing
	Transportation
	Historic, Archeologic, Ethnic, Esthetic Conditions

Survey of Local Experts. Planning and guideline studies often fall because the project leaders utilize none but their own professionalism and application of limited research methodology. They often lack any citizen involvement. In order to avoid this pitfall, a special socio-psychological phase was introduced. This is directed toward obtaining opinions, attitudes and knowledge from key persons in the area of Corpus Christi. An interview system was devised to systematically probe area tourist use, the area's propensity for development, and problems and opportunities as seen by such key informants.

Knowledgeables were selected from those categories of functions that relate to tourism and recreation generally, including tourist business, services, transportation, attractions-resources-parks, education, research, professional, and governmental-political. Through the assistance of a Texas A&M University resources development specialist, Mr. Jack Jones, a list was prepared and reviewed by local leaders in the area. At least three referrals were required for a name to remain on the list to be interviewed. The following individuals have been interviewed:

William Anderson	Ed Harper
Jack Alexander	R. L. Eckman

Don Tumminia	Delmer Hiller
James McLaughlin	Emory Spencer
Bill Witt	C. L. Castor
Jeff Boudreau	Johnny Roberts
Robert Flato	Dr. Carl Oppenheimer
Robert Conwell	Dr. Kenneth Gordon
Albert Heinie	Winn Smith
Larry Urban	Carl Krueger
Beswick Wray	Robert MacLean
Judge Robert N. Barnes	Phil Gilbert
Joe Watson	Gay Walker
Tom McGlathery	Gordon Reid
J. C. Barr	Jim Denton
Buddy Harris	Dr. Henry Hildebrand
Steve Frischman	W. A. Bill Skyeagle
George Yarrington	Frances T. Farenthold
W. W. Ousley	George Hawn
Mrs. Bonnie Durbin	Edward Harte
A. N. Garrett	Bill Cobb
Robert Spears	Ben Glusing
Reggie Wendell	Dr. Hans A. Suter

This phase is not only very productive regarding basic data about the region but provides local consensus (or lack thereof) regarding resource strengths and weaknesses. It is now being summarized in a special report.

Recreation Vehicle Study. A special project, related to previous research by the Recreation and Parks Department of Texas A&M University, was an investigation of recreation vehicle use (pickup camper, camper trailer, travel trailer, motor home) on the Texas Gulf coast. Because previous studies had been made in summer, this was carried out in winter.

Information was obtained on origins of users, types of vehicles used, reasons for selecting, years of ownership, cost and opinion concerning vehicle, activities engaged in, seasons used, and preferences regarding park development. Data have been collected, analyzed and a special report is in process.

Organizations and Agencies Contacted. In the process of the general overall study and the survey of local experts, the following agencies and organizations have been contacted.

Central Power and Light, Corpus Christi
Corpus Christi Planning Department
Coastal Bend Regional Planning Commission
Neuces County Recreation and Park Department
The National Park Service, Headquarters, Padre Island National Seashore
Corpus Christi Park and Recreation Department
Corpus Christi Area Tourist Bureau

City Museum
Nueces County Judge
Corpus Christi Chamber of Commerce
Parks and Recreation Division Office, Parks and Wildlife Department
South Jetty (Port Aransas Newspaper)
U. S. Coast Guard
Woody's Marine Service, Port Aransas
Aransas Pass Chamber of Commerce
Mayor, Aransas Pass
Little Bob's, Aransas Pass
Roquette & Wendell (shrimp processing), Fulton
Harpers Real Estate, Rockport
Rockport Chamber of Commerce
Mayor, Rockport
Spencer Oil Co., Rockport
Harris Real Estate, Mustang Island
Port Aransas Planning Commission
Marine Science Institute, University of Texas, Port Aransas
Island Bank, Port Aransas
Key Allegro, Rockport
Wilson Company, Corpus Christi
Corps of Engineers, U. S. Army
State Representative
Hawn Brothers, Inc., Corpus Christi
Corpus Christi Caller (Newspaper)
King Ranch, Kingsville
Department of Economic Geology, University of Texas, Austin
Texas Transportation Institute, Texas A&M University
Texas Employment Commission, Corpus Christi
Texas Highway Department, Planning Division, Austin
Texas Highway Department, District Office, Corpus Christi
Garrett Oil Company, Aransas Pass
Texas Parks and Wildlife Department, Austin
Texas Tourist Development Agency
Travel Division, Texas Highway Department

Typology. The study is making progress on the development of a coastal tourism-recreation activity typology.

It has been found that generally two categories of users participate in tourism-recreation: DOMESTIC USERS and VISITORS. The kinds of land requirements by these two groups are different in some instances and similar in others. Visitors are of two types: Vacationers and weekenders.

A general structure of tourism-recreation activities:

I. DOMESTIC ACTIVITIES
   A. Outdoor Recreation
   B. Attending Events

II. WEEKEND VISITOR ACTIVITIES
   A. Outdoor Recreation
   B. Vacation Home Use

III. VACATION VISITOR ACTIVITIES
   A. Resorting
   B. Sightseeing/Touring
   C. Vacation Home Use

Thus, the range can be narrowed to the following five categories: RESORTING, SIGHTSEEING/TOURING, OUTDOOR RECREATION, VACATION HOME USE, and ATTENDING EVENTS. These categories are being correlated with resource characteristics. Obviously some activities within each are heavily dependent upon man-made development and others relate closely to natural resources.

Student Involvement. In the Spring Semester, 1971, a class of 13 graduate students (3 Ph.D. and 10 Master students) in RP 607 -- a class devoted to regional resource design for tourism-recreation development -- researched the Corpus Christi area.

The project encompassed research of the factors listed above (Reconnaissance). This was performed primarily by library search of existing literature but also included field trips to the area. One field trip included a symposium by leaders of the City Planning Department, City Recreation and Parks Department, and the National Park Service, site visits to the main environmental segments of the area, and site interviews with two leading private vacation home and resort developers: Padre Island Investment Corporation and Key Allegro Development.

This has provided valuable teaching input that future resource managers would not otherwise obtain. Furthermore, it assisted materially in data collection.

Mr. Allan Worms, a Ph.D. student in Recreation and Resources Development is doing a major account of research for this study which will form the basis of his dissertation. Mr. James Melton, a student in the Recreation and Resources Developments Masters of Agriculture program is preparing a professional paper on the topic of his research -- coastal recreation vehicle use.

In March, 1971, 12 graduate students in Recreation and Resources Development, RP 636, The Dynamics of Travel and Tourism, visited a coastal region generally considered competitive with the Texas Gulf coast -- the New Orleans, Louisiana area. This field trip included meeting with officials of state agencies, such as the Highway department, parks forests, and fisheries, planning, and the Louisiana Tourist Commission. It also included inspection of the Vieux Carre segment of the city of New Orleans and meeting with officials there: director of restaurant association, planning department, Vieux Carre Commission, City Park, and the County Extension Service.

It was evident that tourism and recreation there was heavily dependent upon the man-made resource base: historic background, tradition, ethnic origins, establishment of specialized food services. The resources do not foster the beach and waterfront development possible along the barrier islands and coasts of Texas.

Further student involvement by students and faculty in the Marketing Department, Texas A&M University. Much of the typology work and dependency effort was accomplished by Lane Gregory and Steve Loomis, MBA students in Marketing and Eugene Clark, an undergraduate student in Marketing. Dr. Sam Gillespie, professor of marketing, has made considerable contribution to the relationships of business and the resource base. His consultation has been and continues to be a valuable input to the study.

Environmental Description. One portion of this project includes an environmental overview of the characteristics of the Texas Gulf coast as they relate to tourism-recreation. This phase is revealing 5 major subregions of the coast, based upon both natural and man-made resources. Other characteristics tend to be common throughout the region, such as land relief, relative humidity, winds, and geologic age. This phase is approximately 20% completed.

Meetings and Conferences. Thus far, several conferences and meetings have been made an integral part of the study and have proven to be of great value. From the total research project, elementary planning concepts for coastal tourism-recreation were derived and presented at two conferences: "Ocean '71 -- The First National Conference and Exhibition on Marine Recreation and Conservation," held at Long Beach, March 12-14, 1971 and "The Travel Research Association Annual Conference," Aspen, Colorado, August 15-18, 1971. Input from other panelists are being utilized in the project.

In June, 1971, an inspection, observation, and interview trip was made into the Pacific Northwest. The coastal recreation and tourism development in the vicinity of Portland, Olympia, Victoria, Vancouver and Seattle contains many environmental implications adaptable to Texas. Adaptation to differences of climate and tourist origin were also observed.

Galveston Model Coastal City Project (Research)

Activity Leader: Dan M. Bragg, Industrial Economics Research Division

The objective of this project is to develop a work plan which defines the area of study and provides general guidelines for follow-

on projects and studies leading to an ultimate master plan to assist Galveston in attaining the goal of a model coastal city.

Project Description and Report of Work and Accomplishments

In the development of a program of work to achieve such an objective, a plan is needed to establish goals, to provide direction and to program activities in an orderly sequence. The development of a work plan for Galveston involves a number of interrelated considerations that must be identified, organized and analyzed if maximum benefits are to be forthcoming. Determination of procedural steps and subject areas to be covered is an essential ingredient in the effective use of time, money and manpower in such an effort.

The work plan study was begun on June 1, 1971 and concluded on August 31, 1971. The report that resulted from this study will be published about October 1, 1971.

The program of work during this study has been broadbased and comprehensive. Activities have included an exhaustive survey of literature in the various fields involved; contact by mail, telephone and personal interview with a number of key people having information applicable to the study; and, on-the-ground surveys of the local Galveston scene. In all, approximately 39 personal interviews, 23 telephone calls and 25 letters have been generated in developing data suitable for use in the study.

A team made up of Texas A&M University faculty and staff personnel was formed on June 1 and was added to later in the study period. The final team consisted of persons representing the following disciplines:

Coastal and ocean engineering
Industrial economics
Urban planning
Civil engineering
Business analysis
Recreation and tourism
Oceanography education
Building construction
Port and harbor research

A presentation on the purpose and scope of the study was made to the Ocean Science Institute committee of the City of Galveston on July 21, 1971 in Galveston.

Three meetings of the full Texas A&M University team were held on the Texas A&M campus during the study period and, a number of informal meetings between two or more team members were held during the same period.

Port and Harbor Development System
(Research)

Activity Leader: Russell L. Stogsdill, Architecture Research Center

Opportunities exist in port and harbor facilities for the design professions, as a result of current trends in the shipping/transportation industry. New vessel size has brought a problem of functional obsolescence to a majority of the existing port and harbor facilities. In order to capitalize on the many benefits of supersized vessels, it is imperative that the port and harbor facilities be as technologically advanced as the vessels they serve.

The objectives of this study are:

1. Analyze regional port transportation requirements.
2. Establish basic design criteria for port and harbor facilities.
3. Develop concept solutions for port and harbor facilities as well as supporting waterfront development.

Project Description and Report of Work and Accomplishments

The project was initiated with a literature search, site visits and correspondence. The intent being to collect all available published material on ports and harbors as well as support and transportation facilities. Port and Harbor Information was categorized into ten general headings:

1. Port types
2. Port locations
3. Port administration
4. Port transportation modes
5. Cargo handling
6. Labor
7. Support industry
8. Port safety
9. Port finance
10. Trends

Each of these headings had more detailed breakdowns.

The literature search included local libraries, public and private. Site visits were conducted throughout the data collection phase to:

1. Port of New Orleans, Louisiana
2. Port of Houston, Texas
3. Port of Galveston, Texas
4. Port of Beaumont, Texas
5. Port of Corpus Christi, Texas
6. Port of Port Arthur, Texas
7. Port of Los Angeles, California

8. Port of Oakland, California
9. Port of Long Beach, California

Government offices contacted were:

1. The Executive Director of Civil Works, Corps of Engineers, Washington, D. C.
2. District Director, Corps of Engineers, Galveston, Texas
3. Project Manager, Port and Cargo Systems Committee, Maritime
4. Transportation Research Board, National Academy of Sciences, Washington, D. C.
5. Science Advisory, U. S. Coast Guard, Washington, D. C.
6. Governor's Office, State of Texas

Other groups and industries contacted were:

1. The American Association of Port Authorities, Washington, D. C.
2. The Truck Trailer Manufacturers Association, Washington, D. C.
3. The Atchison, Topeka, and Santa Fe Railway Co., Amarillo, Texas
4. Brown and Root, Inc., Houston, Texas
5. Lykes Brothers Steamship Co., Inc., New Orleans, Louisiana
6. Port Directors of approximately 75 selected ports all over the world
7. Frederic R. Harris, Inc., New Orleans, Louisiana
8. Todd Shipyards Corp., Galveston, Texas
9. Fruehauf, Corp., Detroit, Michigan

These listings are designed to indicate a cross-section of sources which contributed information for this study.

After the analysis phase, the material collected was synthesized. All redundant material was deleted. The remainder of the information was condensed and illustrated in order to make it easier to understand.

The planning section of the referenced report outlines a step by step procedure for port and harbor design and construction. This section will familiarize the reader with complex requirements necessary to competently design and plan a port.

Various trends were evident in all major breakdowns from the analysis section. A trend section is included in the report. The trends listed are only the major trends that appear to be affecting ports and harbors of the future.

The concept section of the report is a schematic application of the analysis, planning and trends section to three different port conditions.

The format of the report is designed to serve as an initial

procedural guide to the several disciplines involved in port and harbor planning.

There has been a unanimous request by all groups providing information for a copy of the final report.

Members of this project team attended two major conferences in pursuit of information:

1. Annual Marine Technology Society Conference - Washington, D. C.
2. Offshore Technology Conference - Houston, Texas.

Three students participated on this project throughout the year (one graduate student and two undergraduates). Their interest has been stimulated by the involvement in the marine environment to the point that they have joined the student section of the Marine Technology Society and are presently planning to initiate a student chapter at Texas A&M University.

Commodity Flow Study (Research)

Activity Leader: G. Sadler Bridges, Texas Transportation Institute

The purpose of this study is to develop the methodology and determine the feasibility of implementing a program for the continuous collection of transport flow statistics for the Texas Gulf Ports. The study includes a careful investigation of the means, agencies and costs of implementing a continuous transportation study. One criteria for the design will include the possibility of integrating connecting land transportation data with currently collected waterborne data. The investigation will be limited to the domestic origin of exports and the domestic destination of imports and will not be designed to show the economic impact of waterborne commerce.

Project Description and Report of Work and Accomplishments

The initial work on this study was begun in December 1970 with the major effort being made during June, July and August 1971. During the first phase the necessary background research and data collection was accomplished and interviews conducted with a number of interested agencies and organizations. The second phase to be accomplished during the 1971-72 period will complete the work.

Major activities accomplished during this first phase include the following:

1. Defined a marine commodity flow statistics program and specified the requisite data element.
2. Documented existing marine related commodity flow statistics collection programs.
3. Identified potential users and uses of a comprehensive marine commodity flow statistics program.
4. Interviewed the major Texas ports, Corps of Engineers, and Bureau of Customs on source documents, availability of data, disclosure restrictions, and feasibility of a continuint marine commodity flow statistics program.

Marine Commodity Flow Statistics Program. Transportation results from the interplay of specialized activities in different geographic locations. Three distinct aspects of the total transportation process are activities, residences, warehouses, factories, etc., flows, the actual movement of goods between activities, and channels, the actual networks of facilities including terminals, transfer points etc. The data elements used to describe flows are shipper information, receiver information, shipment information, transportation information and routing information. Each of these elements is in turn made up of several specific items of information.

Existing Marine Related Commodity Flow Statistics. Waterborne transport flow data are collected by several federal agencies to meet various statutory requirements and for other operating needs. In addition, state and local agencies and organizations collect some waterborne transportation information for special needs. Federal programs are administered by the Department of Commerce, Bureau of the Census, Bureau of International Commerce and Maritime Administration, Department of Defense, Army Corps of Engineers, Department of Transportation, and the Interstate Commerce Commission. At the present time only a minimum amount of coordination and comparability exists among these programs. No programs are presently administered by the State of Texas. However, several navigation districts compile and publish statistics in cooperation with the program of the Army Corps of Engineers.

Users and Uses of Marine Commodity Flow Statistics. Major uses of marine commodity flow statistics would be ports and navigation districts, state and local government agencies, industry and research organizations and federal government agencies. The broader uses of these statistics include, administration and regulation of transportation services, local, regional, state and national transportation planning analysis of capital improvement needs, market studies, and contingency planning for natural disasters or other disruptions such as strikes.

Interview Marine Related Organisms. Interviews were conducted with the major Texas ports, Corps of Engineers and Bureau of the Customs. Initial analysis of the results of these interviews indicates wide spread interest in transport flow statistics on either a continuing or periodic basis. However, disclosure restrictions, availability and completeness of source documents, and the sensitive nature of the markets for imports and exports suggests that a comprehensive transport flow statistics program is not now feasbile. Further study of alternative approaches will be done in the coming year with more emphasis on providing improved presentation and dissemination of presently available information.

Technical Development Services (Advisory)

Activity Leaders: John Miloy and Norman Whitehorn, Industrial Economics Research Division

Providing information and technical assistance to marine oriented commercial and small business firms to accelerate economic growth and expansion is the major objective of this project.

Project Description and Report of Work and Accomplishments

In order to identify specific firms that were interested in receiving assistance of this kind, a mailing list was compiled in September, 1970. The list was compiled from the 1970 Directory of Texas Manufacturers, telephone directories, and organizational membership lists to be used for initial contact and later for mailing advisory bulletins, brochures, and miscellaneous announcements. Only those firms directly involved in some form of marine activities were listed. Included were manufacturers, contractors, service organizations, and retail outlets. Selection of firms to be surveyed was made on the basis of employment size and standard industrial classification (SIC) number.

On October 8, 1970, a questionnaire was mailed to 312 firms with 90 responding by returning a completed questionnaire showing interest in the project. Approximately 96 percent of 86 of the firms responding to the questionnaire had an employment of less than 250. No firm with more than 500 employees was surveyed. Profile sheets with information taken from the questionnaire have been completed and are on file for current reference.

A visit was made in early December to the Small Business Administration and to the U. S. Department of Commerce Business Service Field Office, both in Houston, to determine the nature of problems and areas of information that could be referred to them for assistance to the firm. Personal visits have also been made to 75 of the 90 firms having an interest in the project. In each case, the president, manager, or another high ranking official of the firm was contacted. Problems were identified, discussed, and in most instances assistance was given within a very few days. The assistance ranged from the supplying of a firm's name that manufactured a product or provided a service to that of an engineering specialist visiting the plant, making a study of the problem, and suggesting a solution.

The project leader attended the third annual offshore Technology Conference in Houston, Texas, on April 19-21, 1971, in which some of the problems of offshore explorations, pollution control, arctic transportation, food and drugs from the sea, and coastal zone management were discussed.

He also attended a marine extension workshop at Oregon State University August 30 - September 3, 1971. The workshop provided instruction in the methodology of marine extension work. Discussions and activities centered around the establishment of priorities, audience identification, sources of information, use of media, and program planning and execution.

Advisory bulletins prepared on the following subjects were mailed to the firms during the past year:

February	Advisory Services for Coastal Firms
March	Availability of Services
April	What's Available in Domestic and Overseas Marketing Assistance
May	Markets for New Products
July	New Ideas in Products, Processes, and Services.

These bulletins have proved to be an excellent communication system in providing not only general information, but also in announcing conferences, workshops, and other meetings and serving generally as a medium of contact between the Industrial Economics Research Division and industry.

The information found in this report was obtained and compiled during the period September 1, 1970 through August 31, 1971, and should be interpreted as of that time period.

Requests for Assistance. A small entrepreneur was interested in developing a shrimping fleet. Not wanting to invest by chance, he contacted the Industrial Economics Research Division for assistance in obtaining information as new technical methods in locating shrimp at all depths in all seasons and suggestions on vessel hull

layouts, rigging and equipment. He also wanted to know the projections on the demand for shrimp for the next ten years and the location of fisheries training schools as a source for skilled labor.

Much of the information requested has been published in journals, technical reports and advisory bulletins. The published material was accumulated and delivered to him. He was also referred to the following individuals for additional help:

Mr. Johnie H. Crance, Texas A&M Fisheries Specialist
Dr. Robert R. Wilson, Texas A&M University, Department of Agricultural Economics
National Fisheries Training Center, Freeport
National Fisheries Training Center, Aransas Pass
Rockport Yacht & Supply, Rockport
Kelso Marine, Inc., Galveston
Marine Mart, Inc., Port Isabel.

Recent contact with the firm indicates that it has begun shrimping operations on a limited basis.

One request came from Mr. A. A. Hughes, Vice President of Camco, Inc., Houston. He needed to know how far upstream the Brazos and Colorado Rivers are navigable for a self-propelled, flat bottom barge, 20 feet by 400 feet, which draws four feet of water and has legs extending 40 feet high. The Brazos River Authority, the Lower Colorado River Authority, and the United States Corps of Engineers were contacted. The information was obtained and forwarded to him.

Waste disposals and pollution control are topics of great concern to most firms. Mr. Terry Orr, Bauer Dredging Company, Inc., Port Lavaca, needed general background information on various topics which were a part of his company's operation.

A literature search was conducted and technical articles were forwarded to him. Their gratitude for the information was expressed this way. "We certainly appreciate your fast and thorough response to our request for information. Your office is the first link we have found which is attuned to the need of industry to have access to information depositories and obtain data with a reasonable length of time."

Mr. R. A. Durham, President of the Corbitt Marine Ways, Inc., Freeport, Texas had a problem due to the instability of his barge-type dry dock during the lowering operation.

Referral was made to the Department of Mechanical Engineering, Texas A&M University. Dr. Harry Sweet made an on-site visit to the dry dock location. An analysis was made of the mechanics of the system during the lowering and raising operations and the causes of the instability were determined. Mr. Durham was then provided with recommendations for "fixes," including specifications and sources for water level gages and better valves.

An additional study is presently being made of the marine

railway at the same location to redesign and build more adequate facilities to meet the increased marine repair activity.

Mr. H. C. Owens, Diamond Point Company, Houston, needed published data, if available, on contaminants found in the Texas Coast bays. After discussing this problem with Dr. Roy Hann of Texas A&M's Environmental Engineering Division, the Texas Water Quality Board, United States Geological Survey, and Texas Parks and Wildlife were contacted. Data from each of these agencies were received and forwarded to Mr. Owens.

Mr. R. B. Stanberry, Chemola Corporation, Houston, asked two questions concerning oil pollution. "What happens to oil when dispersants sink oil to the bottom of the bay or ocean? Are any chemicals available to keep from further polluting or contaminating the area?"

This problem was also discussed with Dr. Roy Hann of the Environmental Engineering Division. Dr. Hann had no knowledge of any research of new chemicals to aid in further reducing pollution when dispersants had been used. However, with the possibility of Dr. Hann conducting future research in cooperation with the Gulf Coast Waste Disposal Authority, Mr. Stanberry was referred to Dr. Hann for further assistance in this area.

Mr. W. Lee Lockerby, Houston's Fisherman's Wharf, Houston, requested information on pasteurization of shrimp. Copies of published reports on the subject were sent to Mr. Lockerby. Referral was made to Dr. Bryant Cobb of Texas A&M University, who is conducting research in related fields, for further assistance.

Technical Development Services (Advisory)

Activity Leader: Dan M. Bragg, Industrial Economics Research Division

This project was established to provide information and assistance to firms engaged in engineering, port facilities and transportation activities. A continuing goal of the project is to furnish information and assistance to accelerate economic growth and expansion of these firms.

Project Description and Report of Work and Accomplishments

To obtain maximum effectiveness of such an endeavor requires an intimate knowledge of existing ports and other water transportation facilities along with an established working relationship with key

persons in each port administration as well as in other areas of the water transportation field. In addition, a working knowledge of the state-of-the-art technology in the enumerated areas, along with an up-to-date awareness of on-going developments in ports and water transportation, is needed to permit meaningful contributions to these areas.

Contact with persons by telephone, letter and personal visit, along with a certain amount of travel to view on-going projects, are the essential ingredients necessary for the accomplishment of the goals of this project. Other necessary factors include attendance at conferences, conventions and seminars, and membership in key professional and trade organizations.

During the reporting period covered by this summary, trips were made to five ports in Texas. Telephone or letter contact was established with three others for a total of eight out of the eleven major ports in the state contacted during the past two quarters.

Also, meetings were held with Corps of Engineers personnel and with representatives of several consulting firms engaged in port development work. These meetings concerned such subjects as: channel dredging, breakwater and dock modifications, offshore facilities, financing of port improvements, harbor waste disposal and port redevelopment.

Several conferences related to water transportation were attended. These included the Texas Transportation Conference at College Station, the Offshore Technology Conference at Houston, the Japanese Technology Seminar at Houston and the National Research Council regional meeting on shipping of hazardous materials.

A presentation was made before the Ports and Waterways Committee of the Houston Chamber of Commerce in June. Approximately 40 attendees at this meeting heard a discussion concerning the need for deepwater port facilities in Texas.

On the Texas A&M University campus, a working relationship has been established with persons in several different disciplines allied with the areas of water transportation, harbor construction, water pollution and ship design. These contacts are expected to become quite useful as this project blossoms fully during the coming year.

A fair-sized library of information has been collected and materials are still coming in. This collection includes bathymetric charts of the Texas Gulf coast area, maps of shipping fairways, "Rules of the Road" for the Texas Gulf, facility layouts of several ports and a number of reference papers on harbor development and shipping practices. In addition, issues of a number of port magazines are being received regularly and subscriptions to several outstanding trade journals have been opened up.

One specific request has been received from a port for a study of a problem common to all ports -- pollution of harbor waters from waste disposed from ships. An investigation has been started on this problem and it is anticipated that this could develop into a sizeable research effort.

Contact has been established with personnel in several governmental agencies involved in the areas that this project covers. Such agencies include Maritime Administration, Corps of Engineers, Coast Guard, American Association of Port Authorities, Texas Ports Association, the Texas Interagency Transportation Council and the Coastal Resources Management Program of the State of Texas.

Publication of the first advisory bulletin in the area of ports and transportation is anticipated for the early part of the coming year.

Technical Development Services
Recreation and Tourism
(Advisory)

Activity Leader: Kathryn M. Delaune, Industrial Economic Research Division

The outdoor recreation and tourism industry today is the most vigorous growth industry in America, tanking third both nationally and in the State of Texas. Indications are that the seventies will see an intensified drive toward more leisure time as a result of a shorter work week, more paid holidays, job sabbaticals, and earlier retirement. The tourist industry will be a principal beneficiary of the trend.

Since outdoor recreation and tourism are big business, the problems that develop are similar to the problems of any other kind of business. It takes good management, sound judgment, experience, and imagination. The objective, then, of this project was to provide technical information and assistance to companies and organizations engaged in recreation and tourism activities in order to promote growth and expansion of the firms within the designated 36-county area.

Project Description and Report of Work and Accomplishments

In order to achieve the objective of the project, the technical associate utilized data from human and documentary sources. Human resources were personnel in public and private agencies as well as individual owners and operators of firms engaged in water-oriented recreation and tourism activities. The documentary sources consisted

of books, periodicals, bulletins, theses, dissertations, and reports of research related to the project.

Initial efforts were directed to companies and organizations within a 36-county area of Texas. Since no directory of companies engaged in marine recreation and tourism was available, a mailing list of 480 firms in the coastal zone was compiled from area telephone directories, Chamber of Commerce listings, etc. On October 21, 1970, contact was made with each firm by letter of explanation, enclosing a questionnaire for the purpose of obtaining information which would assist in identifying problems and needs. A follow-up letter was mailed approximately three weeks later to companies which had not responded. One hundred and seventy-eight (37 percent) were completed and returned.

Visits and consultations were conducted with 53 Chamber of Commerce offices, 25 governmental agencies and 86 private recreation and tourism enterprises to further identify and aid in the solution of problems. Detailed explanations of the program were given to management and technical personnel, and requests for specific information and assistance were solicited from each firm.

On May 12, 1971, a survey was made of the 178 respondents in an attempt to measure their interest regarding seminars on topics of mutual interest and the season of the year when it would be most convenient for them to attend. Of the population surveyed, 57 percent indicated they preferred winter, 15 percent preferred fall, 15 percent preferred spring, and 13 percent preferred summer. Plans are being made to conduct four hour seminars in areas of interest. Competent lecturers will be selected from a variety of sources including university faculty and research staff, governmental agencies, industrial consultants, and knowledgeable private individuals.

Individual needs for information were given personal attention through mail correspondence and additional visits. These are as follows:

1. Requests for assistance in management, marketing, advertising, wholesale purchasing, and collection of delinquent accounts.
2. Requests for available financial assistance for municipal recreational facilities.
3. Requests for copies of Texas shrimping laws.
4. Requests for information as to state agencies responsible for tourism development.
5. A request for plans for wet and dry marinas.
6. Requests for information regarding user preference -- wet or dry marinas.
7. A request for information and assistance in the development of a municipal recreation program for the City of Friendswood, Texas.

At the invitation of the recreation committee of the city council, the technical associate met on six occasions with the committee and/or the council to delineate the benefits of an organized municipal recreation department to the community.

Four conferences were held with personnel in public and private agencies responsible for recreational activities.

A recreational survey of the residents of Friendswood was undertaken; responses were tabulated; and results were analyzed.

A presentation was made to the Chamber of Commerce at a noonday luncheon outlining the proposed master plan, explaining short-term and long-range goals.

Applicants to fill the position of director of recreation and parks were interviewed and screened.

Recommendations concerning facilities, program, and personnel were submitted to the recreation committee and city council.

In order to keep abreast of the current techniques utilized by professionals in the field of recreation and tourism, the project leader attended the following conferences:

1. Texas Recreation and Parks Society Annual Conference (Fort Worth, Texas) which highlighted cooperative agreements between public agencies, the promotion of commercial recreation, and ecology and the public. Approximate attendance -- 325.

2. Oceans 71 -- Marine Recreation and Conservation National Conference (Long Beach, California) which delved into areas of national environment control policy planning and its impact upon selected areas, coastal zone management legislation, recreation and leisure use of the sea, and major trends and future uses of recreation in the ocean. Approximate attendance -- 75.

3. Governor's Conference on Tourist Development (Austin, Texas). Discussion and Panel Topics included: Package Tours, Financing, Matching Funds, City Hotel/Motel Room Tax, and the program of the Beautify Texas Council. Approximate Attendance -- 400.

4. National Recreation and Park Association Institute (Denver, Colorado) which dealt with development of public outdoor recreation areas and facilities, neighborhood facilities, historic preservation, beautification, etc. Approximate attendance -- 500.

Other conferences and workshops related to the Sea Grant program included:

1. A meeting with personnel of the Brownsville Navigation District, Brownsville, Texas.

2. A meeting of Sea Grant project leaders in Galveston, Texas.

3. The Marine Science Writer/Editors Meeting in Galveston, Texas.

In addition to the above conferences and workshops, the project leaders made a two-day trip aboard the Texas A&M University vessel EXCELLENCE from Corpus Christi to Morgan's Point via the Intracoastal Waterway for the purpose of viewing the potential of the waterway for recreation and tourism.

PUBLICATIONS AND DOCUMENTATION

Work conducted through the Marine Commerce program has been published in general and technical reports, professional journals and periodicals, and has been presented at conferences and seminars.

Technical and General Reports

Bragg, Dan M. and James R. Bradley. *Work Plan for a Study of the Feasibility of an Offshore Terminal in the Texas Gulf Coast Region.* Sea Grant Program and Industrial Economics Research Division. College Station, Texas. TAMU-SG-71-212. 30 pp. June 1971.

Gunn, C. A. *Coastal Resource Characteristics for Tourism in Texas.* A paper in process that will describe the general characteristics of the Texas Gulf coast that relate to tourism-recreation.

Melton, James. *Winter Recreation Vehicle Use on the Texas Gulf Coast.* A paper being prepared as a partial fulfillment of his requirements for the Masters of Agriculture Degree in Recreation and Resources Development.

Stogsdill, Russell L. *Port and Harbor Development System.* Texas A&M University. College Station, Texas. TAMU-SG-71-216. November 1971.

Whitehorn, Norman C. *Advisory Services for Coastal Firms.* Sea Grant Program and Industrial Economics Research Division, Commerce Marine Advisory Bulletin. Texas A&M University. College Station, Texas. TAMU-SG-71-503. 2 pp. February 1971.

Whitehorn, Norman C. *Availability of Services.* Sea Grant Program and Industrial Economics Research Division. Commerce Marine Advisory Bulletin. Texas A&M University. College Station, Texas. TAMU-SG-71-504. 4 pp. March 1971.

Whitehorn, Norman C. *Markets for New Products.* Sea Grant Program and Industrial Economics Research Division. Commerce Marine Advisory Bulletin. Texas A&M University. College Station, Texas. TAMU-SG-71-507. 6 pp. May 1971.

Whitehorn, Norman C. *New Ideas in Products, Processes, and Services.* Sea Grant Program and Industrial Economics Research Division. Commerce Marine Advisory Bulletin. College Station, Texas. TAMU-SG-71-509. 4 pp. July 1971.

Whitehorn, Norman C. *What's Available in Domestic and Overseas Marketing Assistance.* Sea Grant Program and Industrial Economics Research Division. Commerce Marine Advisory Bulletin. Texas A&M University. College Station, Texas. TAMU-SG-71-505. 5 pp. April 1971.

Worms, Allan. *A Procedure for Analysis of Regional Tourism Characteristics By Use of Local Knowledgeables.* In process.

Wright, Arthur L. and Warren T. Matthews. *Economic Development and Factors Affecting Industrial Location on the Texas Gulf Coast.* Sea Grant Program and Industrial Economics Research Division. Texas A&M University. College Station, Texas. TAMU-SG-71-214. 72 pp. June 1971.

Professional Journals and Periodicals

Gunn, C. A. *A New Approach to Coastal Tourism Development.* A paper submitted for publication in Landscape Architecture and the Journal of Leisure Research.

Conferences Reports Presented

Gunn, C. A. *Coastal Tourism -- Meeting the Needs of the 70's.* A paper presented at the conference entitled, "Ocean '71," the first national conference and exhibition on marine recreation and conservation. Long Beach, California. March 12, 1971.

MARINE SCIENCES

The Texas A&M Sea Grant Program has supported a broad range of projects in marine sciences. Five of these were in basic research, four in education and two in advisory services. A listing of publications and documentation resulting from this program will be found at the end of this section.

Electrical Logging in Aquatic Environments (Research)

Activity Leader: Arnold H. Bouma, Department of Oceanography

The "Electrical Logging in Aquatic Environments" project deals with the development of hardware and methodology-application-comparison of electrical resistivity logging on extruded cores, as well as in situ, in unconsolidated sediments. This type of electrical logging on cores will help to detect zones of interest otherwise overlooked during visual observation and serial sampling, while the electrical logs are compared with laboratory results on structural, textural and engineering parameters with the idea of being able to reduce the number of time-consuming laboratory analyses. The in-situ electrical logging system is primarily intended to correlate sedimentary strata thus reducing the number of cores to be taken, while it also will be of an indicative nature for any one area once the logging characteristics of that area are known.

Project Description and Report of Work and Accomplishments

During the years previous to the 1970-71 funding period, the well-known industrial electrical logging techniques were modified and adopted to unconsolidated marine sediments. The instrumentation and techniques developed on this project were unique because at that time industrial logging personnel were unable to visualize logging procedures in an environment where no borehole existed, and where unstable platforms such as rolling ships were used.

Initial measurements with primitive self-made equipment, together with borrowed and/or modified equipment, proved that the

concept of applying electrical logging to unconsolidated sediments was valid. The logger from Well Reconnaissance, Inc., Dallas, Texas, was extensively used for nearly two years before building our own device.

The next step was the construction of a logging rack to electrically log extruded core sections. The measurements were relative, but the method provided an ideal scanning technique for detecting variations within a core which were not visible to the naked eye, or were missing during serial sampling. Several improvements were made in the mechanics of the instrument, the electronics and the electrodes, during the course of this project.

The original logging probe built on this project was designed with electrodes at the end so that a continuous resistivity measurement was recorded during pull out. The constant motion of the ship combined with a fixed, rapid rate of withdrawal, in addition to a slow chart recording speed, rendered this version of the probe impractical. A moving, magnetic indexing device also required considerable modification and improvement. Consequently, an entirely new design based upon slightly different principals was decided upon.

The present electrical logging equipment consists of two new instruments: core scanner and in-situ probe. The core scanner is a better version of our core resistivity logging rack. It displays the log at a 1 to 1 scale compared to the core. Also, the measurements are absolute and not relative as they were with the older devices. Several combinations of electrodes were tested. Prior to this time all cores logged showed a resistivity high at each end due to a lack of mass beyond the core. This effect has been eliminated by placing brass discs of the same diameter as the core at each end of the core and connecting them to ground. The entire length of the core was grounded to prevent biasing. If mechanically possible, we will substitute carbon for the brass to avoid polarizing effects.

The core scanner worked beautifully and several plugs of sediment were removed with large syringes and the absolute resistivity was measured on calibrated resistivity bank for control purposes. Dr. George L. Huebner, who designed and built the scanner, assisted with all these experiments. The samples extracted with the syringes were saved for further laboratory sediment analyses. Separate samples were collected from the same intervals for water content, specific gravity, porosity and calcium carbonate analyses. The results are presently being used to determine which parameters correlate with resistivity.

The in-situ probe is a completely new design consisting of a 10-foot probe with 100 electrodes placed at equal distances in a spiral arrangement. The probe, made from fiber glass, was inserted into a metal pressure housing which contained two stepping switches.

The apparatus was lowered on a wire line and the signals were transmitted through a 5 conductor cable to the ship. The use of two separate cables is a cumbersome and risky process. However, the situation was economically dictated as stressed multiconductor cable is expensive and we were able to borrow the conductor cable.

The electrical signal from the probe was monitored by a VCO unit and displayed on a Mosley recorder-borrowed from Dr. G. Franceschini from the Texas A&M meterology department. The advantage of this new unit over the old one is that the resistivity profile is obtained while the probe is at rest in the sediment instead of during pull out. Measuring during pull out was inaccurate due to ships motion and poor winch speed control at very low speed. The SACLANT group in La Spezia, Italy, solved that problem at very high costs and ended up with a huge instrument that not only was difficult to handle but also was vunerable due to exposed electronics.

In-situ measurements were obtained during an R/V ORCA cruise in early August 1971 at a location 5 miles south of the Galveston outer sea bouy. The results were highly satisfactory and accurate comparison of the resistivity log, obtained by the core scanner on cores collected from the same anchor station, will be done later as soon as the readings from the in-situ log are corrected by baseline measurements and both logs can be drawn to the same scale.

The in-situ probe was also used in Galveston Bay. The ship was anchored but because of a squall line the ship was swinging widely on the anchor. When the probe was finally retrieved, it was found to have broken in half. The precise reason for the break has not been determined but a combination of factors may be responsible including a weakness in the fiber glass pole.

Although the cruise was beset with mishaps, it must be considered a success. Prior to breaking, the in-situ probe was working well proving that the design principal was correct.

At the time of writing this report a new in-situ probe is being constructed to be used on an R/V ALAMINOS cruise during the first week of October 1971. Again, cores will be taken, measured on the core scanner and then further processed.

Close contacts were being held with Electrofilm, Inc. in Hollywood, California until about February 1971 at which time the company had to take this R&D program off their activity list resulting from a decrease in contracts. Electrofilm, Inc. worked with us on the development of coatings with high resistivity characteristics that would allow the use of "cheap" materials for the construction of logging devices.

Well Reconnaissance, Inc. in Dallas, Texas provided the project again with consulting and instrumentation at no costs. We have used their resistivity, gamma ray and caliper probes together with the

electronic packages such as amplifier and recorders. Their co-operation has saved the project large amounts of funds otherwise necessary for rent or purchases during initial trials.

Dr. S. J. Pirson from the University of Texas in Austin, Department of Petroleum Engineering, lent us two Eh devices and gave us considerable consulting help. Lack of funds prohibited sufficient sea trials with this instrumentation as no proper winch capabilities and conducting cables could be purchased.

Dresser Atlas built for us a connector head for towing experiments and gave us the help of one of their top technicians for two days to assemble the probe. Experiments were carried out in the Gulf of Mexico without much success due to the small size of the area investigated. Rough seas during cruise 71-A-4II of the R/V ALAMINOS in the southern Caribbean off Columbia prevented the use of many experiments.

Woodward-Envicon, Inc., Clifton, New Jersey, provided funds to build a core scanner for them which now is rented to us on a matching basis. They also provided considerable consulting time: Dr. Frank B. Chmelik.

In addition to these industrial contacts and the presentations and publications listed, the electrical logging technique forms part of course Ocn 635, "Techniques and Procedures used in Geological Oceanography."

Reports and Project Documentation. This Sea Grant project has been orally reported on during the last two Offshore Technology Conferences, 1970 and 1971, in Houston, Texas, as well as during the Geological-Geophysical Oceanography Information Seminar for industries held last year in the Ramada Inn, College Station, Texas.

Based on these oral presentations and the various papers published, a significant interest has developed within several industries, universities and government agencies, such as the oil industry, logging industry, consultants, University of Rhode Island, University of Kiel (Germany), National Oceanic and Atmospheric Administration, Navy, U.S.G.S. and also NATO (Saclant, Italy).

We have been invited to participate in the next OTC meeting in 1972.

Shear Strength Determination of Marine Sediments by Means of Wave Energy Ratios (Research)

Activity Leader: William R. Bryant, Department of Oceanography

The design of adequate foundations for offshore structures and underwater installations requires the determination of the bearing capacity of the sea floor. The effectiveness of certain anchorage systems depends upon the holding capacity of the sediments. Submarine slope stability and potential danger areas susceptible to mass movements such as slumping are related to the compatibility of the sea floor topography with the engineering properties of the sediments.

The mechanical response of sediments to loading is usually analyzed for two conditions, considered independently. First, stresses imposed by loading should not cause the sediments to break or fail along surfaces of rupture: this is a condition related to sediment shear strength. Second, compression settlement or decompression upheaval should not be great enough to damage the structure and/or its function: this is a condition related to sediment compressibility. Shear strength and compressibility can be determined either directly or indirectly.

The direct methods rely on current technology developed by soil engineers: undisturbed samples are tested in the laboratory for their engineering properties. In the shallow water of the coastal shelves, boring depths can be of several hundred feet. In deep water, sediment investigations are limited by the shallow penetration depths from which samples can be obtained by coring or dredging.

Although indirect methods are still in the experimental stage, seismic methods appear to be the most promising, because they enable the investigation of engineering properties of sediments over large water-covered areas economically. However, a direct theoretical relationship between seismic properties cannot be anticipated and must be determined empirically, because seismic properties are defined within a limited range of small stresses compatible with the propagation of elastic waves causing small, transient and recoverable deformations in the sediments; whereas, engineering properties deal mostly with large, permanent and irreversible deformations resulting from the application of the much larger pressures imposed by engineering structures.

The purpose of this project is to determine empirical relationships between the generation and propagational characteristics of elastic waves and the engineering properties of marine sediments. The objective is to relate (1) compressional body waves characteristics

to sediments compressibility as defined in Geotechnique, and (2) shear waves characteristics to sediments shear strength.

Project Description and Report of Work and Accomplishments

Compressibility of Marine Sediments. Testing of marine sediments with the high pressure Anteus back pressure consolidometer used in conjunction with a velocimeter has shown that a seismic determination of the compressibility of marine sediments is possible. In the laboratory consolidation test, a cylindrical clay sample is encased in a ring and sandwiched between two porous stones. A loading ram is placed above the upper stone. The bottom porous stone is seated in a base plate. A vertical pressure, applied to the sample, first places the water in compression so that initially the pore water carried all the vertical pressure. As water leaves the voids, the pore pressure decreases and the intergranular pressure increases, causing a compression of the sample. When the compression of the sample has virtually ceased, all the applied vertical pressure is carried by the soil particles. The vertical pressure is then doubled and this is repeated for the range of pressures under investigation. The Anteus consolidometer, used in this research, allows complete saturation of the samples by the application of back pore pressure.

The electronic instrumentation was designed to measure the compressional wave travel time in the axial direction of the samples. Air-backed transducer housing assemblies were attached to the center of the base plate and the loading ram, through the porous stones. A power amplifier driven from a variable frequency oscillator operating at 165 kHz and gated by a tone burst generator was used to excite the transmitting transducer and one channel of a two-channel oscilloscope. The output of the receiving transducer, amplified by a pre-amplifier, was displayed on the outer channel of the oscilloscope. The oscilloscope was externally triggered by a gated voltage output from the tone burst generator. The compressional-wave velocities were computed by dividing the samples thickness by the wave travel time between transducers. Using the relationship between the coefficient of compressibility, determined by consolidation tests, and the velocity of compressional waves, a system has been developed to estimate the compressibility of a marine sediment via its compressional wave velocity. This relationship resulted from the analysis of laboratory measurements made of the coefficient of compressibility, compressional-wave velocity, density and void-ratio of marine sediments obtained by the R/V ALAMINOS, Texas A&M Oceanographic Research Vessel, in the Gulf of Mexico. The relationship is different from the suspension equation in which the bulk compressibility is the result of two components: the particle and the water compressibilities. The difference lies in an additional component of the bulk compressibility: the "frame compressibility" which was found to be related to the coefficient of compressibility.

The relationship is therefore applicable only to sediments possessing a frame rigidity. It does not apply to suspensions (porosity greater than 80%), nor to indurated sediments (porosity smaller than 15%), which behaves as a solid.

It was also found that clay muds with a void ratio greater than 2 ± 0.5 do not consolidate according to the "classical" virgin curve, which is linear in the void ratio-log pressure diagram. High void ratio marine clay sediments exhibit a linear void ratio-pressure relation, more typical of suspensions.

Shear Strength of Marine Sediments. The laboratory model of a seismic system capable of determining the shear strength of marine sediments consists essentially of a cavity energized by resonance. A pattern of standing waves has been generated in the resonant cavity containing the sample of sediment. The readings indicated that there is a relationship between the propagation characteristics of elastic waves and the shear strength of marine sediments.

The instrumentation was built in accordance with a theoretical study on the analogy between the wave-guide theory and the Mohr's Circle theory. It was designed to generate and receive compressional and shear waves in a sample of sediment placed in a cylindrical aluminum container.

According to the Mohr's Circle theory, a square element of sediment subjected to equal and opposite principal stresses should be in pure shear at 45° from the principal directions. By analogy with the wave guide theory, it was assumed that the desired oscillating stress field could be generated by establishing resonance or a standing wave pattern of the $T_{2,1,1}$ mode in the cylindrical sample.

For a wave velocity of approximately 5000 ft/sec, the optimum conditions were computed to occur at a frequency of 30,000 H. in a cylindrical sediment-filled 5.25-in. diameter cavity, 2.5-in. deep.

To generate the compressional waves, four transmitting transducers were placed at the N, S, E and W positions around the cavity. These transducers are 1/16-in. diameter steel rods inserted into the resonant ring and hence into the sediment. At the end are 1/2-inch steel spheres for introducing a spherical wave.

The 2.5-in. long steel rods are maintained in the container's wall through a system of small "O" rings which also provides the necessary acoustical insulation.

A system of convertible drivers (Electro-Voice, Model 188C) generates the vibrational energy in the steel rods. Two stereo power amplifiers (DYNACO Model 120 A) capable of 60 watt output, driven by a variable frequency oscillator (202 C Hewlett Packard) are used to excite the transmitting transducers (sphere-rod system

driven by convertible driver). A very accurate frequency counter (5216 A Hewlett Packard 12.5 MHZ Electronic Counter) is used to monitor the exciting frequency.

To monitor the energy received at 45°, four receiving transducers (sphere-rod systems similar to those used for transmitters) were placed at the NW, SW, SE and NE positions around the cavity. A stereo-magnetic pick-up (888 Series Empire Cartridge) in contact with the end of the steel rod monitors the energy received by the sphere located in the sample. This mechanical energy changed into an equivalent electrical energy is amplified by two stereo preamplifiers (Dynaco PAT-4 Solid State) and monitored by a Tektronix Oscilloscope (Type 561 A).

A Polaroid camera mounted on the CRT records the final data.

Testing indicated that the wave energy ratio of sediments, defined as the ratio of vibrational energy transported by shear waves to that transported by compressional waves, is related to sediments shear strength. The energy ratio of an Ottawa sand increases when pressure is applied to the sample. The same phenomenon occurs in a sample of overconsolidated Beaumont clay, whereas no response was observed in a bentonitic mud of high void ratio. This appears to support the difference in compressional behavior found in our compressibility studies, however, no quantitative relationship could be determined because the noise level in the laboratory apparatus is quite high and obscure some of the desired results.

The field system is presently being prepared in the Marine Environment Simulator at Lamar University. The simulator consists essentially of a covered 25 by 30 ft. excavation, 3 ft. in depth, in the outcropping overconsolidated Beaumont clay. The excavation is filled with high void ratio bentonitic mud. The electronic instrumentation is identical to that of the laboratory apparatus with the exception that the mechanical (vibrating spheres) transducers have been replaced by Edo-Western ceramic transducers, built for this purpose.

Flower Garden Feasibility Study (Research)

Activity Leader: William P. Fife, Department of Biology

This project was designed to study the feasibility of establishing a research facility on the so-called "Flower Gardens," a tropical reef located about 100 miles off the coast of Galveston, Texas. This reef is reported to be the northernmost reef in this country. It was

intended to determine if the scientific need for such a facility could be justified, and if so, what sort of facility it should be, who would be able to make use of it and in general terms, what would be its cost of installation and operation.

Project Description and Report of Work and Accomplishments

An ad hoc committee consisting of Dr. R. Rezak, Dr. W. Fife, Dr. J. Caruthers and Dr. T. Bright developed a study in which the feasibility of a Flower Garden Facility was evaluated. It was, in general, concluded that such a facility should consist of a stable platform rather than an anchored ship (a Texas-type tower was considered). It was determined, however, that such a facility would not be able to be financially self-supporting, and it is doubtful if any one research project could justify the costs involved. Indeed, it was noted that if the State of Texas supported such a venture, it would not receive financial returns commensurate with its investment for the foreseeable future. It was concluded that such a facility should be installed, however, for three reasons. Firstly, it is apparent that leaders in marine affairs within the State of Texas wish such a facility. Secondly, there would be a number of valuable scientific problems which could be undertaken, both in the fields of biology, engineering, and physical oceanography. Thirdly, such a venture would assist this University in developing the technical and operational competence which is necessary to place facilities in much deeper water both in the Gulf and in the deeper ocean. It would seem that there will be a need for such activities in the near future.

As a part of this study, two cruises were made to the Flower Garden area to conduct preliminary research, both in biology, engineering, and geology. Studies were carried out on currents, temperature, salinity, erosion, fouling, and bottom structure. A penetrometer experiment was conducted to determine if such a device could be used to assess the nature of the ocean bottom at that location. A substantial collection and identification of marine life was begun. This collection has since been used by several other institutions and still is being enlarged.

Before its termination, this project involved 5 departments from 3 colleges, two major educational institutions, and one government agency, all participating in planning or conducting research connected with this program. It also included six scientists of this University, three scientists from a government agency (Sandia Corporation AEC), eight graduate students and a number of technicians.

Use of Hydrogen-Oxygen for Deep Sea Diving (Research)

Activity Leader: William P. Fife, Department of Biology

As man dives to deeper depths it has become apparent that there is a need for another inert light gas with which to dilute oxygen in the breathing mixture. There are three main reasons for this need. Firstly, there is a question as to whether helium, which now is being used as a diluent for oxygen in deep dives, causes neurological problems at depths below 1000 feet of sea water. Secondly, even if helium can continue to be used at these great depths, there is a need for another inert gas so that during decompression it will be possible to shift breathing gases and thus increase the inert gas gradient between the body and the breathing mixture. Such an increased gradient will greatly increase the rate at which a diver can be decompressed to the surface after an extended deep dive. Thirdly, a number of knowledgeable people both in the U. S. Navy, as well as elsewhere, believe that helium gas will become less available in the future, even in this country. The use of a cheap light inert gas in place of helium would be desirable from the economical standpoint.

The idea of using hydrogen-oxygen breathing mixtures for deep diving is not new. It was originally suggested in 1941 by Case and Haldane, and in 1943 Zetterstrom made four short dives with such a mixture. His untimely death (not related to the use of hydrogen-oxygen) brought such research to a halt.

Project Description and Report of Work and Accomplishments

Recently, Edel and Fife have been conducting preliminary studies both on animals and man to determine the feasibility of using non-explosive mixtures of hydrogen and oxygen. The principal purpose of this work was to develop the techniques for mixing and handling hydrogen and oxygen and to determine if there were obvious physiological contraindications to the use of such mixtures in man.

The present program supported a long-term deep dive in which a dog was taken to an equivalent depth of 1000 feet of sea water, and allowed to breathe a 97% - 3% hydrogen-oxygen mixture for 39 hours. The total dive required five days. To date, this is the longest dive to that depth in which an animal has breathed such a mixture.

The results of this work indicate that hydrogen-oxygen breathing mixtures for deep diving is feasible. So far, no physiological evidence of damage or deterioration related to the use of this mixture has been found.

Work supported by this grant was the basis for three proposals to outside agencies for additional funds for further work.

Marine Geochemical Analysis (Research)

Activity Leader: William M. Sackett, Department of Oceanography

The expertise developed in several programs in chemical oceanography at Texas A&M University has valuable implications in so far as the present emphasis on environmental awareness is concerned. Early in 1970, the directions of our efforts were changed to take practical advantage of our capabilities. These new directions were to initiate programs:

1. To study the distribution of dissolved light hydrocarbons, dissolved organic carbon, radiocarbon and tritium concentrations in near-shore areas to assess man's influence on the coastal environment and
2. To fingerprint oil and tar occurrences by their stable isotope composition. All of these programs but the monitoring of light hydrocarbon concentrations were discontinued at the termination of GH59 on August 31, 1971.

Project Description and Report of Work and Accomplishments

The Distribution of Organic Carbon in the Brazos River Basin. The distribution of organic carbon in the Brazos River basin was found to be significantly influenced by man's activities. The DOC concentration in the Brazos River ranged from 2.8 mgC/l to 7.0 mgC/l. The POC concentration ranged from 1.0 mgC/l to 16 mgC/l. The DOC values were found to be the best indication of organic water pollution. The POC from domestic pollution is generally broken down before it reaches the river, but the DOC is more resistant to degradation. The high DOC concentrations were found in the upper middle basin of the Brazos River and near the mouth. The high values were the result of domestic and industrial pollution. Organic pollution was detected in other parts of the river during certain periods.

It was found that the DOC concentrations in the lower basin were considerably more independent of flowrate than the POC concentrations. The POC concentrations were directly related to river

discharge. The DOC/POC ratio of the Brazos River ranged from 0.24 to 6.0. The high values were found in the middle basin where the POC values were low. The low ratios were obtained at periods of high river discharge in the lower basin. In the lower basin this ratio ranged from 0.24 to 2.81, with the majority of the values from one to two.

Organic carbon values were determined for several tributaries in the Brazos River basin. It was found that the POC concentrations in the tributaries were generally similar to those in the Brazos River. The DOC concentrations were generally lower than those in the Brazos River for tributaries above Waco, but the opposite was true below Waco. Little River had similar organic carbon concentrations as the Brazos River.

It was found that there probably has been a considerably increase in the organic carbon level in the Houston Ship Channel over the last two years.

Contemporary Tritium Geochemistry of the Gulf of Mexico. The reaction 14/7N(n,T)12/6C has been studied and the activation cross section measured at about 40 millibarns. This cross section was applied to tritium production in the Texas A&M University MTR-type nuclear reactor. An estimated tritium inventory of the reactor pool water indicated that at least 98% of the tritium produced was lost from the reactor pool to the environment.

Water, and water from plant samples, collected near the reactor showed no correlation with the tritium activity of reactor pool water. These water samples reflected the aftereffects of the annual spring leak of tritium for the year 1967; i.e., the tritium activity decreased slowly during the sampling period (June through December).

A system was developed for the low-level counting of aqueous tritium samples by liquid scintillation spectrometry. To optimize conditions for low counter background, shielding was important both above and below the counter. Plastic vials gave the best all-around performance for the low-level counting of aqueous tritium samples, and the methods of handling and moving the vials are extremely important. A toluene-based counting solution was studied that is in many ways superior to those used previously for this type of work.

A procedure for screening rapidly the tritium activities of natural water samples was studied. Direct counting of water, which requires negligible processing time for samples, is adequate for samples containing tritium activities as low as about 400 T.U. In the tritium activity range of 100-400 T.U., an isotope exchange technique that requires about 3 days of sample processing time is adequate. Electrolytic enrichment techniques are necessary for lower tritium activities, especially those of sea water samples -- the processing time for such samples is on the order of 20 days. The screening procedure can be used to determine quickly the desirability of degree of sample enrichment that is necessary for a given

suite of water samples.

The electrolytic enrichment technique has been evaluated thoroughly, and several innovations added:

1. A flow of argon gas is led through the enrichment cells to preclude possible contamination of the sample undergoing electrolysis and to sweep from the cell the explosive, electrolytically-generated mixture of hydrogen and oxygen,
2. The electrodes have been anchored rigidly in place by means of nylon bolts and nuts, with extremely reproducible geometry, and
3. In addition to the normal electrodes, large surface-area electrodes were built and placed in specially enlarged electrolysis cells.

A constant current density was maintained on all electrodes during electrolysis runs. When the efficiency of electrolysis was used to analyze the performance of electrodes the results indicated that the enrichment of tritium is extremely reproducible over a wide range of volume reductions, regardless of electrode size, and that all electrode pairs behave in an identical manner.

The oceanographic phase of the research showed that the Subtropical Underwater is the major source of tritium in the western Gulf of Mexico. This water mass carries the tritium to the Yucatan Strait and then to the western Gulf. The physical properties of the water mass that extends from the surface to the depth of the Subtropical Underwater and the tritium content are modified by mixing processes as the water moves westward.

The integrated tritium content of the water column, to a depth of 150 m, is higher in the western Gulf than in the Yucatan Strait. This excess is due to the input of tritium from runoff and rainfall. A 2-box model was developed for the mixing and exchange of water masses in the upper layers of the Gulf of Mexico. This box model was used to derive a formula from which the residence time of water in the upper 150 m of the western Gulf can be calculated. The estimated residence time calculated from this formula, through a short series of approximations, was 3.5 to 6 years.

Methane, Ethane and Propane Concentrations in Gulf of Mexico. The concentrations of the low-molecularweight hydrocarbons in the Gulf of Mexico were measured. The ranges of methane, ethane and propane were found to be $(6\text{-}125)\times10^{-5}$, $(1.6\text{-}37.3)\times10^{-6}$, and $(1.2\text{-}38.6)\times10^{-6}$ ml/liter seawater, respectively, for depths ranging from zero to 3,742 m. For a given water column, these values were found to be in the same range as, but more variable than, those previously reported. These results suggested that one method of offshore petroleum-seep detection is to survey and map the concentrations of hydrocarbons in near-bottom waters.

Organic Carbon as a Pollution Parameter in the Brazos River Estuary and the Gulf of Mexico. The distribution of dissolved organic carbon (DOC) in the Brazos River basin in Texas was found to be significantly influenced by man's activities. The DOC concentrations in the Brazos River ranged from 2.8 mgC/l to 7.0 mgC/l. Particulate organic carbon (POC) concentrations ranged from 0.4 mgC/l to 16 mgC/l. The POC from domestic pollution is generally removed from suspension and/or broken down in creeks before it reaches the river, but the DOC is more persistent. An inverse linear relationship between salinity and DOC for coastal waters was observed. Extrapolation to zero salinity gave a predicted DOC concentration in runoff for 7 to 10 mgC/liter. This is about twice the mean value for the Brazos River above Freeport and suggests that about one half of the DOC being added to the Gulf of Mexico may be due to man's activities. A considerable increase (over 100%) in the organic carbon level in the Houston Ship Channel over the last two years was observed.

Terrestrial Contribution of Organic Carbon to the Gulf of Mexico. An evaluation of the various sources of terrestrial and near shore derived organic carbon has been made for the Gulf of Mexico. The Brazos River was studied in detail in order to gain an understanding of the effects of topography, river discharge and man's activities on the organic carbon levels contributed to the Gulf. The Mississippi River and the Coatzacoalcos River, Mexico were also sampled. The annual input of dissolved organic carbon (DOC) into the Gulf is about equally divided between that generated by primary production in the open Gulf and from terrestrial sources, approximately 0.9×10^{13} g from each. The latter source includes estuary and near shore generation which is about double that introduced by river runoff. Industrial sources in the vicinity of Freeport, Texas, alone contribute about 1% of the total terrestrial input into the Gulf. Domestic and agricultural derived organic carbon noticeably increase the DOC concentrations in certain streams and rivers but appear to be quickly reduced by biological oxidation or dilution to natural levels. The natural DOC level contributed to the Gulf appears to be about 3 mgC/L.

Coastal Zone Problems Institute for Elementary and Junior High Teachers (Education and Advisory)

Activity Leader: Earl Jones, Department of Curriculum and Instruction

Project Description and Report of Work and Accomplishments

Following the approval of funding for the proposed pilot pro-

ject, work was begun preparing for the summer institute. Professors contacted and approved for the two sessions included Mr. Glen Harrell, Consulting Geologist in the Corpus Christi area for Geology 685 and Dr. Delmar Janke, Professor in Educational Curriculum and Instruction, Texas A&M University, for EDCI 638.

Provision was made to hold the course at the Agricultural Research Station in Beeville, Texas.

Various slide units were prepared dealing with various coastal problems. Among these were "Progress" a slide and music presentation which dealt with water and noise pollution. Another of the units was one dealing with the socio-economic effects of pollution on the fishing industry.

Materials Collected

"Port of Galveston" - magazines
Manual for Still Cameras
"The Shrimp Fishery"
"The Texas Oyster Fishery"
"Food and Game Fishes"
"Teachers Curriculum Guides"
"Guide to Teaching of Conservation"
"Eighth Grade Earth Sciences"
"Effects of Slope Roughness"
"Law and the Coastal Margin"
"Sea Grant Project Activities"
"Design of an Automatic Corer"
"The University and the Sea"
Hydrology of Coastal Waters
"Compilation-Goals for Texas"
"Keep it Fit to Support Life"
"Environmental Conservation"
"The Coastal Fisheries Program"
"Texas Industry and the Ocean"
"On Man in His Environment"
"Texas Gulf Coast" - annotated bibliography
"Set up of Oil on Water by Wind"
"Interim Study Committee on Oceanography"
"Sea Grant Program Operations 69-70"
"A Checklist of Texas Fresh-Water Fish"
"Economic Impact of Texas Marine Resources"
"Interaction of Man & The Biosphere"
"Fish & Wildlife of Willapa Bay"
"Interim Study Committee on Oceanography" - miscellaneous periodicals
"Crabs of Texas"
"Stop Killing Our Oceans
"Texas A&M"
"Goals for Texas"
"1970 School Catalog"
"Environmental Study Unit"
Coastscripts
"Technical Report"
"Marine Resources"
Conservation Education
"Conservation Units"
"Conservation Guide"
"Psychology Today"
"Modern Life Science"
"Crisis Oregon Estuaries"
"Coastal Land Resources"

Scheduling of various proposed activities was begun and personnel from the various industries, national parks, and other governmental agencies were contacted resulting in the following schedules of events:

June	21, Monday	Registration and Introduction.
	22, Tuesday	Lecture - Definition and branches. Introduction to rocks and minerals.
	23, Wednesday	Lecture - Geomorphology - Structural Geology - Hydrologic Cycle Meterology - process of degradation and aggradation.
	24, Thursday	Field trip to Padre Island to study barrier island structures by trench method.
	25, Friday	Dr. Price - Field trip to study Nueces and Corpus Christi Bays and Pleistocene Ingleside barrier island.
	28, Monday	Lecture - Straigraphy and Paleontology.
	29, Tuesday	King Ranch Trip.
	30, Wednesday	Field trip to collect shells and examine their environment.
July	1, Thursday	Field trip to seine for specimens for aquaria.
	2, Friday	Dr. Price - Field trip - Flour Bluff fault, clay dunes, Pleistocene oysters.
	5, Monday	Holiday
	6, Tuesday	Dr. Price - Field trip - Padre Island, migration and history of tidal delta.
	7, Wednesday	Dr. Price - Field trip - Padre Island Development Corporation's environmental impact studies and conservation practices.
	8, Thursday	Lecture - Discussion of course and questions.
	9, Friday	Summation of course and review. (Final Examination)
	12, Monday	Lecture - Dr. Janke - Beeville - Key Concepts of Environmental Education.
	13, Tuesday	Lecture - Dr. Janke - Beeville - Key Concepts of Environmental Education and materials available.
	14, Wednesday	Field trip by man from Parks & Wildlife - Mr. Dick Harrington.
	15, Thursday	Lecture - Representative from Oil Resources - Beeville.
	16, Friday	Padre Island Investment Corp. on site lecture.
	19, Monday	and presentation - Mr. Gene Graham.
	20, Tuesday	Field trip - Welder Foundation - Sinton.
	21, Wednesday	Field trip - Representative from Texas Air Quality.
	22, Thursday	Lecture - Dr. Janke - Beeville. Field trip - King Ranch - Humble Oil & Refining - Mr. Jud Miller.
	26, Monday	Field trip - Padre Island National Park.
	27, Tuesday	Seashore - Derek Hambley - Chief Naturalist.
	28, Wednesday	Flour Bluff Museum; Lecture (Games & Summation in Environmental Education).

July 29, Thursday — Review and evaluation - Beeville.
30, Friday — Review and evaluation - Beeville.
Lecture - Actions individuals can take in preserving qualities environment.

The participants, their school, units produced, levels and purposes are listed below:

Barnett, Mrs. Genevieve, Chapman Ranch, A TRIP TO PADRE ISLAND, fourth grade.

Objectives:
- To introduce the unit on PLANTS AND ANIMALS OF PADRE ISLAND.
- To help the children "see" the beautiful and exciting opportunities that are available to them with plants and animals close to home.
- To learn the common names of some birds, animals, plants and shells.
- To plan a field trip with a purpose.
- To help the children think conservation.

Bartling, Dave, Flour Bluff High School, OUR ENDANGERED EARTH, Junior High through adult.

Objectives:
- To create an awareness of environmental quality.
- To move the viewer to some action against pollution.
- To get students to join SCOPE in its fight against pollution.
- To get students in class to think before they damage our environment through pollution and litter.
- To introduce a unit on ecology in junior high or high school.

Broad, George, Flour Bluff Junior High, THE OCEAN ON YOUR TABLE, eight grade.

Objectives:
- To interest students in marine aquaria as both a classroom activity and absorbing hobby.
- To create awareness of the Gulf Coastal Bend's diversity of marine organisms.
- To teach the value and concept of ecology and ecosystems.

Fischer, Johnny, West Oso, COASTAL ZONE: POLLUTION, Fifth and sixth grade science.

Objective:
- To arouse an interest to protect our coast through environmental education.

Gooris, Mrs. Darlene, Tuloso-Midway Junior, eighth grade Earth Science,

Objectives:
- To develop an appreciation of the esthetic values of the natural resources of the Texas Coastal Zone.
- To explain some of the problems inherent in man's interaction with the environment of the Texas Coast.

To develop an awareness that conservation means the wise use of our natural resources by man living in harmony with nature.

Garza, Mrs. Celia R., Corpus Christi Allen Elementary, Plant and Animal Neighbors in and Around Corpus Christi, third grade.

Objectives:
To acquaint children with Texas wildlife.
To teach children some kinds of plants.
To show the inter-dependence of plants, animals, and people.
To instill in them awareness of things around them.

Gibson, Robert L., West Oso J. F. Kennedy Elementary, The Construction, Setting-Up, and Maintenance of the Salt Water Aquarium.

Objectives:
To create an interest in the world around us.
To stimulate an interest in classroom activities.
To show the advantages of an all glass aquarium.
To prove that the proper maintenance of an environment must be maintained in order for plants and animals to survive.

Harrison, Mrs. Miriam C., Corpus Christi Moore Elementary, Recognition and Preservation of the Flora and Fauna of the Coastal Bend Area, third grade science.

Objectives:
To familiarize the children with some of the most common forms of plant and animal life in the Coastal Band Area.
To make students aware of the interdependence of living things.
To alert children to the situations and conditions which can endanger wildlife.

Robinson, Doreen V., Flour Bluff Elementary, FLORAL LIFE OF THE GULF COAST AREA, Fourth Grade Science.

Objectives:
To acquaint the students with a variety of floral life in our local area.
To create an awareness that floral life succeeds in definite zones and regions where conditions are favorable for their survival.
To show that some animals depend upon plants.
To make the students aware of the aesthetic value of nature through flowers.

Spurlin, Mrs. Dorothy, Flour Bluff Elementary, THE VALUE OF DUNES ALONG A COAST, Fourth Grade.

Objectives:
To create an awareness of the importance of island dunes to the mainland.
To show how dunes can be damaged or destroyed through careless use.
To show how dunes can be both enjoyable and protected.

Swanson, Mrs. Mary Frances, Corpus Christi South Park Jr. High, UNIT FOR LIFE-EARTH SCIENCE.

Objectives:
- To prepare students for a field trip to Padre Island.
- Field study of the geological feature, the barrier island, and the subenvironments it creates.
- To observe the dynamics of the interfacing of the lithosphere, hydrosphere, atmosphere and resulting effect on the biosphere.
- Evaluate man's alterations of this environment.
- Project future plans, control and enhancement of Padre Island.
- Make text book materials and classroom activities vital to the students via contact and observations in the field.

Wyscarver, Allan D., Robstown Jr. High, COASTAL BEND FISHING, eighth grade Social Studies.

Objectives:
- To show the universality of fishing as recreation.
- To demonstrate that fishing is a form of recreation especially suited to the Coastal Bend Region of Texas.
- To stress the need for personal awareness of pollution control of our fishing waters.

Barker, Mrs. Jerrie V., Corpus Christi Martin Jr. High, Different coastal water environments have different characteristics, 7th and 8th grade science.

Objectives:
- To introduce the students to differences in coastal water environments.
- To prepare the class for a field trip to these different environments, showing them what to observe at each environment.
- To use as a prelude for a closer study of each type of water environment ending the whole unit with an indepth study of estuaries and how important they are to the state's marine and wildlife ecology.

Davis, Billie L., Guadalupe and Cross Elementary, Victoria, "ALONG NATURE'S PATHWAYS", eighth grade.

Objectives:
- To expose students to many of the natural beauties of the Texas Gulf Coast and to contrast the beauty and naturalness to the ugliness and unpleasant situations which involve every individual in deciding what his stand will be in the preservation of nature as it should be while living in our world as it is today and will be tomorrow.

Norris, Gail Joyce, Shields Elementary, Victoria, GULF COAST NATIVE TREES, Second Grade.

Objectives: To start an awareness and appreciation of our native trees.
To promote pride and care of things about us.
To explain how we recognize and use some trees and plants.

Wickline, Dorothy Walker, Ed Downs Elementary, San Benito, Plant and animal life in and around Harlingen and Corpus Christi, Fourth Grade.

Objectives: To be aware of ones surrounding, starting close at home and to live in harmony with animal and plant life.
Learn reproduction, respiratory, and general study of plants. Use textbook as guide.
Study different animals and their behavior patterns, their reproduction, and to man and contribution to ecology.
Learn natural balance of animal and plant life.
Study ecology, but in specific subjects, as industry and pollution; water pollution, etc.
Realize that flowers, animals, trees, as well as humans are a part of our universe and have the right to live.

Portis, Sherry H., Cuero Jr. High, RECREATION ON THE COAST, Seventh and eighth grade physical education.

Objectives: To show the wide range of recreational activities available on the Texas Gulf coast.
To make the students aware that even fun activities can result in pollution and/or injury if proper caution is not practiced.
To stress the need for personal awareness of pollution control.

Portis, Glenn, Cuero I.S.D. (principal) (5th grade physical education), TOURISM ON THE COAST, Fifth Grade Social Studies.

Objectives: To illustrate to students what life is like on the Gulf coast.
To relate how people depend on the tourist trade in order to make a living.
To show what people do when they go to the Gulf coast.
To show the kind of housing available on the Gulf coast.

Romanczyk, Lois Miller, Flour Bluff Primary, The Life-Style of the Whitetailed Deer, primary.

Objectives: To develop an appreciation of deer.
To show the economic importance of deer to early settlers.

To show that deer are important for an entirely different reason today.
To encourage appreciation and conservation of our wildlife.

At the closing of the institute, general evaluation was made by the personnel who were closely involved (Janke, Harrell, Becker, and Ward). It was felt that:

1. The reception was very favorable and that the information gotten in the institute will be retained as a result of the various field trips and other outings more so than would have been the case if the institute were confined to the classroom.
2. A better understanding of the mechanics involved in a project of this type which in turn would facilitate a better organization of any successive project.
3. It was felt that the participants gleaned many ideas which can be used in the classroom when dealing with coastal problems.
4. Personal thanks be extended Mrs. Mildred Norris, Dr. Tope and Karl Vincent at the Region II Service Center. Thanks also to Dr. Earl Jones, Roger Anderson and Allen Martin at Texas A&M University.

Below are various recommendations posed for possible improvement of successive workshops.

1. That succeeding workshops be conducted for resident credit as was this one.
2. Regarding the time period it was felt that being the last three weeks of the first summer term and the first three weeks of the second summer term with a possible extension of 1 or 2 weeks, either at the beginning or the end. This would enable the participants to be exposed to more of the Educational Aspects of environmental education, i.e. materials and classroom activities. In addition to this, the extension of the time period would allow for more work on unit development and refinement of the required A/V units which were a part of the workshop. If the time period were extended it might also be of a benefit to the participants if 7 hours credit instead of the 6 which were given in this institute just completed.
3. It was also felt that perhaps the order of the course offerings be inverted. Instead of offering Geology first and Education second, the reverse offered instead.
4. If possible it was felt that perhaps the southwest research vessel which is docked in Corpus Christi be used in the next workshop for one of the proposed trips. The equipment available for full-range monitoring including dissolved oxygen meter, gauge,

bottom profiler, sub-bottom profiler, and radio direction position finder, salinity and pH meter and temperature. It is felt that due to the cost of somewhere in the range of $350 to $400 this would perhaps not be feasable for our program.

5. More emphasis be placed on developing units and research papers in order to develop more professional materials.
6. If possible to acquire the use of a vehicle, preferably a bus to be used on field trips.

Evaluations of the participants included:

1. Better understanding of the Geology of the area (unanimous)
2. Better understanding of the Gulf Coast Problems (unanimous)
3. Six reported very interested in the use of A/V's in the classroom.
4. Four reported enjoying the chance to share with other teachers their ideas.
5. Almost all liked the informality.
6. Five felt the chance to learn about and collect shells for one project was very useful.
7. Seven reported many new ideas and suggestions for private individuals to help improve the environment.
8. One reported considerable insight into how "weary and deep" was her teaching technique rut and expressed need of and suggestions for improving it.
9. Four stated they were going to have more field trips -- One other individual agreed but suggested the trips be handled during the cool of the day.
10. Two suggested that more group work be done among the participants.
11. One person thought 1 or 2 weeks longer would be profitable.
12. All generally agreed that driving to Beeville daily was tedious.
13. Several liked the idea of each teacher presenting his or her particular slide unit at the end of the workshop.
14. Several made suggestions as to their idea of the best and worst field trips which will be taken care of in setting up any successive workshops.

Marine Diving Training for Underwater Applied Science (Education and Advisory)

Activity Leader: William W. Schroeder, Department of Health and Physical Education

The rapid increase in both the interest and requirement by individual scientists and technicians as well as marine oriented programs to carry out marine research projects "in situ" using conventional SCUBA diving techniques is recognized. It is also recognized that nearly all of the non-fatal accidents and fatalities which occur each year in SCUBA diving are due to inexperience, lack of proper training, and failute to observe certain safety precautions.

In order to assist in safe and successful scientific and technical exploration of the marine environment it is necessary to have a SCUBA training program of the highest quality continually available to appropriate personnel. This training consists of a 100 Hour Program divided into a basic 50 hour phase and an advanced 50 hour phase. Graduates have both theory and practice. He is able to participate in underwater programs and is potentially capable of extending his underwater range and proficiency by individual experience.

It is also essential to provide a central office where management and secretarial services can administer the program, as well as an equipment storage area. The Office of Diving Health and Safety fulfills the former need by maintaining accurate records on the training, experience, and competence of all University divers to be sure that only diving personnel who are qualified will be used for University sponsored scientific dives. These records also make it possible to assist principal investigators to find divers who are available to conduct their underwater research. The University diving locker satisfies the latter need by providing proper maintenance and monitoring of all diving equipment. In this way diving safety can be assured. This also permits more economical use of equipment since the same equipment can be used by various groups and projects.

Two other objectives are:

1. To support any official University underwater research or training project and any other group, institutions, industry, or state or national government sponsored programs requesting assistance by providing either trained divers, equipment, or technical advice,

2. To revise and up-date the University Guide for Diving Safety. More than 500 copies of this guide have been requested throughout the country. It is now the basic reference guide for safety at a number of institutions.

Project Description and Report of Work and Accomplishments

Since September 1, 1970, this project has carded 97 individuals and is currently training 63 additional individuals in the first 50 hours of the Texas A&M University 100 Hour Basic Marine Diving Training Program. Twenty-eight individuals, including faculty, staff, and graduate and undergraduate students, are presently completing the second 50 hours of the 100 Hour Course, which consists primarily of marine environmental diving. Thirty-two individuals, all qualified 100 Hour Basic divers maintained or increased their Environment/Depth Certification through project and/or training dives. The following is a breakdown of the 831 dives totaling 266 man hours logged underwater through the auspices of this project:

	Training	Project
	(number of dives/number of man hours underwater)	
Freshwater	328/89	25/12
Marine	308/101	170/64

In addition, this project has lent support in the form of either trained divers, equipment, or technical advice to the following programs of underwater projects:

1. August 31 - September 3, Texas A&M University/Sea Grant multidisciplinary investigation of the Flower Garden Reef.
2. September 29 - October 12, Texas A&M University geological investigation of the Flower Garden Reef.
3. October 3 - October 7, Texas A&M University biological/acoustical survey of the Flower Gardeen Reef.
4. October 26 - October 29, Texas A&M University biological investigation of the Flower Garden Reef.
5. November, Texas A&M University Florida Keys trip for bio-acoustical studies.
6. December 16 - December 18, NASA/GE/MBI Texas Tektite survey, Flower Garden Reef.
7. December, Texas A&M University marine biology field trip, Isla Mumeres, Yucatan, Mexico.
8. December, Texas A&M University biology field trip, Florida Keys, Florida.
9. May 12 - May 14, NASA/GE/MBI Texas Tektite survey, Flower Garden Reef.
10. May 24 - May 29, plus diving trips throughout summer, Sea Grant 100 Hour Marine Diving Training Course, Marine Laboratory, Galveston, Texas.

11. May 30 - June 15, Mexico natural oil seepage study, Veracruz, Mexico.
12. June 1 - June 15, Matagorda Bay Project, archaeological survey by the Institute for Underwater Research, Inc. for the State of Texas, Matagorda Bay, Texas.
13. June 23 - June 27, Texas A&M University/Sea Grant multidisciplinary investigation of the West Flower Garden Reef.
14. June - July, Houston Museum of Natural History, Gulf of Mexico mollusc study, Stetson Bank, Clay Piles, Gulf of Mexico.
15. August 28 - September 4, National Association of Underwater Instructors Industrial Orientation Course, San Diego, California.

Finally, during the past year, arrangements were completed which allow a working reciprocity between our program and the scientific diving programs at Scripps Institution of Oceanography, University of California at Los Angeles, University of California Irvine, University of Michigan, National Marine Fisheries Laboratory, and National Parks Service. Other programs currently being considered for reciprocity are Oregon State University, Santa Ana City College, University of Houston, Rice University, and University of Texas.

NSF Development of a New Biology Graduate Course (Education)

Activity Leader: Jack W. Anderson, Department of Biology

There has been a need for a course at Texas A&M which will prepare students for research and teaching in the field of physiological ecology. This is an especially important subject area, since the basic aim of such a course is to become aware of the present evidence and latest techniques concerning the effects of the environment on organisms. In this new biology graduate course, "Biology of Estuarine Organisms", the students will be involved in the study of natural and man-made stress agents and their affects on estuarine and marine organisms.

Project Description and Report of Work and Accomplishments

During the spring semester of 1971, when the above course was being taught for the first time, several inter-related activities

were conducted. Supplies and equipment were obtained and made available to the students for their individual research projects. Information was presented regarding the present knowledge of effects of the environment on the biology of estuarine and marine organisms. Analytical methods for such determinations were reviewed and the design of more sophisticated techniques were discussed. After the presentation of background information, students gained experience with physiological apparatus as they conducted independent, original research projects. The results of their studies were presented to the class and the methods and conclusions critically discussed.

In a few cases, the research conducted in connection with the course project will be included as a portion of the students dissertation. A portion of another project combined with the research of Dr. Anderson has been submitted for publication; results of other studies have suggested the direction of research which is now underway.

Summer Workshop in Marine Ecology (Education)

Activity Leader: Allan H. Chaney, Department of Biology

In 1968 the Welder Wildlife Refuge contacted the Biology Department of Texas A&I University about the possibility of offering course credit for a summer workshop for teachers that they had been giving for several years on the Refuge. As a result of several conferences, two three-week courses entitled Workshop in Biology were placed in the catalog and first offered during the summer of 1970. The first three weeks was devoted to the marine environment and the second to the fresh water and terrestrial environment. Participants received three hours of undergraduate or graduate credit for each course. Twenty-five undergraduates, graduates and teachers received credit for the first three weeks work and twenty-three for the second. Partial funding was provided by the Caesar Kleberg Foundation.

The two courses were so well received that the staff decided to offer them in 1971. However, funding was not available from the Caesar Kleberg Foundation and aid was solicited from the Sea Grant Program. This aid was provided but came too late to advertise the program. Also, because of the greater interest shown in the marine environment the program was modified to include only marine or marine related communities.

Because the students that were enrolled were teachers or future teachers the plan was to present a cumulative look at the marine environment through a study of different communities in our immediate area. Most public school teachers receive no training in this field in their college education. Through this program our teachers would derive the training needed to develop in their students the realization that:

1. Man's future environment depends upon his manipulations,
2. His environment is something to be lived with, respected and concerned about,
3. All living things are interrelated and interdependent,
4. The marine environment is complex, beautiful, to be appreciated and can be destroyed, and
5. Succession through change is inevitable.

Project Description and Report of Work and Accomplishments

To satisfy the aforementioned objectives, classes were designed so that students personally contacted the communities studied. Areas investigated were the Texas A&I Biological Station on Baffin Bay, Stedman Island in Redfish Bay, the Port Aransas jetties, the Padre Island National Seashore, the Welder Wildlife Refuge and Oso Creek in Corpus Christi. At each site water quality determinations and qualitative and quantitative samples of the biota were taken. References, texts and local keys were used for identification and information pertaining to life histories and environmental adaptations. Each student was required to maintain a notebook in which all observations, techniques learned, and interpretations were recorded. Classes were scheduled to meet from 9:00 a.m. to 6:00 p.m. five days a week from June 3 through July 8, 1971. Sixteen students registered for the first 3 weeks and 13 of these for the second. The following itinerary was met with the indicated results:

June 2-3 - Orientation, aims and objectives of the course and a discussion with the class of what they would like from the course. Students were exposed to the available literature and were given hand-outs in the form of keys to various animal and plant groups common to this area. A rapid survey and review of the Plant and Animal Kingdom was given. The students were instructed in the use of the keys, the function and use of a refractometer for salinity determinations, the preparation and inoculation of agar plates, the methods involved in pressing and storing plants including the flotation method for algae, the preservation and storing of animals, the establishment and maintenance of a salt marine aquarium.

June 4 - A lecture conducted by Dr. Richard David, Professor of Biology and occupant of the Caesar Kleberg

Chair in Wildlife Management, on "Biology as a Religion" - Evolution deals with the why's of the world and ecology is the handmaiden of evolution. This was followed by an open discussion.

June 7 - A lecture by Dr. Talmer Peacock, Professor and Head of the Biology Department, on "What Ecology encompasses and how it fits into the levels of organization." Included were definitions of common ecological terms and concepts, with emphasis on energy flow and community ecology. This was followed by questions, answers and discussions conducted by the project leaders.

June 8 - A lecture on marine ecology and marine communities conducted by Dr. Carl Wood, Assistant Professor of Biology and marine ecolcgist. The afternoon was spent in preparation for a field trip.

June 9-10 - Overnight trip to the Texas A&I Biological Station on Baffin Bay. Rotating teams of students ran diurnals every four hours on the following: water quality (methods and techniques demonstrated by Dr. Carl Wood); 300' trammel net; plankton net; and 30' seine. Samples were taken from each. Algae and shore plants were collected and properly preserved for future identification. Morphological adaptations of the plants for the hypersaline environment were discussed by Dr. Williges. During off-periods plankton counts and species identifications of both plants and animals using the provided keys with the aid of the project leaders were made. All information was pooled and discussions were conducted.

June 11 and 14 - Compilation of data, examination of samples and identification of species taken at Baffin Bay. Discussions with the students about the productivity of the hypersaline environment.

June 15-16 - Overnight trip to the Welder Wildlife Refuge to inspect their facilities and expose the students to Dr. Clarence Cottam, Director and noted conservationist and ornithologist. The refuge was toured, seine and plankton samples were taken and examined. Special emphasis was placed upon bird identification.

June 17 - Class discussion of the Welder trip, examination and identification of samples. Preparation for field trip the next day.

June 18 - All day trip to Stedman Island in Redfish Bay, with arrival at 9:00 a.m. The same procedure was followed as at Baffin Bay except the period involved was only 12 hours.

June 21 - Examination in class of samples and discussion of the differences between the hypersaline community (62 ppt) and a bay community in normal sea water (35 ppt). Preparation for overnight trip.

June 22-23 - Overnight trip to the Port Aransas Jetties. Special emphasis on algae and soft rock communities. Seine and plankton samples were taken but trammel netting was eliminated. Two one-meter square plots were dug and fiddler crabs were counted. Estimates were made of the population and sex ratios. A variety of living material was returned to the laboratory for introduction into the marine aquaria.

June 25 and 28 - Examination and identification of samples, observations on living material and discussions of the jetty community.

June 29 - Boat trip aboard the A&M research vessel EXCELLENCE. Received an explanation of its function and the operation of its gear. Observed some of the gear in operation during the trip in the Corpus Christi harbor.

June 30-July 1 - Overnight trip to the Padre Island National Seashore. Mr. Derek Hambly, Park Naturalist, conducted the group on a transect nature-tour from the water's edge to freshwater ponds on the land side of the barrier dunes. He also gave the history of the island, its future and the role of the National Park in that future. Plankton, seine and plant samples were taken. Counts were made of coquinas and the magnitude of their number was calculated for Padre Island. A 100' x 300' area was established and all ghost crab holes were counted. That night all crabs within the area were caught, sexed, marked with individual numbers and released. This procedure was repeated later and all holes were closed. The holes were again counted the next morning and discussions were conducted pertaining to information derived from this data. Set small Sherman traps and caught kangaroo rats during the night.

Observed and identified shore birds and collected lizards the next day. Stopped at Oso Creek on the return, observed the birds and discussed the effects of a land fill and housing project on this productive area.

July 2 and 5 - Class work pertaining to the sea shore and the Gulf.

July 6-7 - Overnight trip to the Texas A&I Biological Station on Baffin Bay. Systematically identified and counted plants and trapped marked rodents in a 135 x 135 meter established plot on the shore of Baffin Bay. The 125 traps were examined at three hour intervals throughout the night by different teams. Discussions were conducted pertaining to the data and vegetation and rodent movement maps were drawn.

July 8 - Final Exam Day - Notebooks were turned in and a round table discussion was held pertaining to the overall picture and the merits of the course. A critique was given by the project leaders. Students were asked to evaluate the course on paper. Hopefully we evoked in these students through the enormity of their observations an awareness of the goals set forth in the beginning of this report. To us, this is the best method of enhancing the nation's capability; not an exploitation of the resources of the marine environment.

Marine Acoustics Short Course (Advisory)

Activity Leader: Jerald W. Caruthers, Department of Oceanography

Along the entire Gulf Coast, as well as in certain inland regions of the Gulf States, are industries and research and educational institutions that engage in ocean-related technologies. Underwater acoustics plays an ever increasing role in those technologies. To meet the needs of the Gulf States in providing people with a knowledge of underwater acoustics, we presented an intense one-week course in underwater acoustics. The course was held on the Texas A&M University campus from June 28 to July 2, 1971.

Project Description and Report of Work and Accomplishments

The course was designed to present both basic and selected advanced topics in Marine Acoustics and to provide additional graduate education for scientists and engineers. Emphasis was placed on environmental aspects and civil uses. The course was especially recommended for scientists working in related areas who desired a knowledge of Marine Acoustics, and for engineers who design instrumentation for use in the marine environment.

One lecture was held each morning so as to provide continuity for the course and present the fundamentals. Three other lectures each day presented advanced topics.

A total of twelve professionals engaged in various aspects of underwater acoustics presented one or more lectures. Six of these were from Texas A&M University and six from outside the University.

There were 31 participants in the course. Some of the statistics of their background are given below.

Government		University		Industry
Military	Non-Military	TAMU	Other	
8	3	8	9	3
U. S.		Non-U. S.		
29		2		
Gulf Coast		Non-Gulf Coast		
16		15		
BS		MS		PhD
12		9		10

Lecture notes in two bound volumes and a copy of National Academy of Sciences' Present and Future Civil Uses of Underwater Sound were given to each participant at the beginning of the course. A recommended supplementary text was Principles of Underwater Sound for Engineers by R. J. Urick.

Course Officers:

Director, Marine Acoustics Course
Jerald W. Caruthers, Ph.D.
Assistant Director
Jorge C. Novarini, Licenciate
Head, Department of Oceanography, Texas A&M University
Richard A. Geyer, Ph.D.
Director, Texas A&M University Sea Grant Program
John C. Calhoun, Ph.D.

Lecturers:

Thomas J. Bright, Ph.D., Biological Oceanography, Texas A&M University, 1968. Assistant Professor, Department of Oceanography, Texas A&M University. Special research interest: acoustical behavior or coral reef animals.

William R. Bryant, Ph.D., Geology, University of Chicago, 1966. Associate Professor, Department of Oceanography, Texas A&M University. Special research interest: acoustical and geotechnical properties of marine sediments.

Jerald W. Caruthers, Ph.D., Physics, Texas A&M University, 1968. Special research interest: Acoustics and ocean wave theories, especially in terms of stochastic processes.

Ira Dyer, Ph.D., Physics, M.I.T., 1954. Senior Lecturer, M. I.T., Author of numerous papers in underwater acoustics. Considerable industrial experience in acoustics and R&D in ocean technology.

Davis A. Fahlquist, Ph.D., Geophysics, M.I.T., 1963. Associate Professor, Departments of Geophysics and Oceanography, Texas A&M University. Special research interest: Crustal structure and seismic refraction and reflection studies in oceanic areas.

Anthony F. Gangi, Ph.D., Physics, UCLA, 1960. Professor, Department of Geophysics, Texas A&M University. Considerable work in electromagnetic and seismic array systems. Special research area: theoretical seismology.

Claude W. Horton, Sr., Ph.D., Physics, University of Texas, 1948. Professor of Physics and Geological Sciences, University of Texas at Austin. Author of a book of signal processing in numerous papers in underwater acoustics. Present research interest: reverberation.

Theodor F. Hueter, Ph.D., Physics, Munich Tech., 1948. Marine System Center, Honeywell Inc., Consultant National Academy of Sciences. Author of text on transducers, expert in field of information systems and sonar transducers.

Ed B. Neitzel, M.S.E.E., University of Texas, 1952. Director of Engineering, Services Group of Texas Instruments, Inc. Holds numerous patents in power transducers for petroleum exploration, acoustic sensors, and data collecting systems.

Jorge C. Novarini, Licenciate in Physics, University of Buenos Aires, 1967. Research Scientist in Acoustics at Hydrographic Service of the Argentine Navy. Field of interest: Sound propagation and echo detection in shallow water.

Stephen Riter, Ph.D., Electrical Engineering, University of Houston, 1968. Assistant Professor, Electrical Engineering, Texas A&M University. Research interests: Communication theory, estimation and detection of stochastic processes, and underwater acoustics.

Robert J. Urick, M.M., Physics, California Institute of Technology, 1939. Physicist, Naval Ordance Laboratory. Numerous publications in acoustics, author of text in Under-

water Sound Engineering.

Course Outline:

June 28 - AM - Welcome (Calhoun)
Opening Address (Geyer)
Fundamentals of Acoustics (Caruthers)

PM - Telemetry and Signal Processing (Riter)
Wave Theory (Novarini)

June 29 - AM - Acoustics in the Sediments (Bryant)
Fundamentals of Acoustics (Caruthers)

PM - Marine Bioacoustics (Bright)
Sonar Equations (Urick)

June 30 - AM - Sound Propagation in the Sea (Urick)
Fundamentals of Acoustics (Caruthers)

PM - Scattering and Reverberation (Horton)
Seismic Profiling (Fahlquist)

July 1 - AM - Generation and Reception (Huetner)
Fundamentals of Acoustics (Caruthers)

PM - Civil Uses I (Neitzel)
Arrays and Signal Processing (Gangi)

July 2 - AM - Civil Uses II (Dyer)
Fundamentals of Acoustics (Caruthers)

Oceanographic Advisory Services (Advisory)

Activity Leader: T. K. Treadwell, Department of Oceanography

In spite of a seeming need for oceanographic advice by ocean-oriented industry, the utilization of oceanographers by industry is far lower than by universities or government. This project is designed to investigate the reasons for this limited utilization and suggest corrective actions. We will look into the specific needs for oceanographic advice by two classes of ocean industry on the Gulf Coast: offshore oil and pollution control companies. Their actual requirements for assistance will be evaluated, the potential value of oceanographic inputs explained to the industry personnel, and the reasons for non-use of ocean scientists and engineers sought. Alternative methods of providing oceanographic assistance, such as marine advisory services or short courses, will

be evaluated. Recommendations concerning improved placement services, setting up of marine advisory services, or establishment of short courses, will be made. An estimate of the potential benefits of expanding this study into other types of industry, or geographic areas other than the Gulf, will be made.

Project Description and Report of Work and Accomplishments

During the brief initial period covered by this report, I provided general advisory services to the Sea Grant Program Office. These included, inter alia, the following:

Reviewed and made suggestions for changes to "Texas and the Gulf of Mexico".

Participated in and made presentation to science writers workshop at Galveston.

Reviewed and made suggestions for changes to proposal concenrning an offshore marine terminal.

Reviewed past actions and proposals concerning oceanographic advisory services. Formulated and submitted proposal for study for coming year. Commenced making contracts with industry and university representatives in line with the advisory service study.

PUBLICATIONS AND DOCUMENTATION

The following publications reflect the broad range of projects in marine sciences.

Technical and General Reports

Brooks, J. M., *The Distribution of Organic Carbon in the Brazos River Basin.* Masters Thesis. Texas A&M University. August 1970.

Caruthers, Jerald W. *Lecture Notes on Marine Acoustics, Vol. 1: Fundamentals of Marine Acoustics.* Texas A&M University. TAMU-SG-71-403. 156 pp. June 1971.

Caruthers, Jerald W. *Lecture Notes on Marine Acoustics, Vol. 2: Selected Advanced Topics in Marine Acoustics.* Texas A&M University. TAMU-SG-71-404. 213 pp. June 1971.

Chmelik, F. B. *An Investigation of Changes Induced in Macrostructures in Pelitic Sediments During Primary Consolidation.* Texas A&M University Technical Report, 70-8-T. 1970.

Chmelik, F. B. and A. H. Bouma. *Electrical Logging of Recent Marine Sediment Cores.* In: Topics and Techniques, Gulf of Mexico, Texas A&M Technical Report, 69-5-T. 1969.

Deridi, V. *(Title not Available).* Masters Thesis. Lamar University. Beaumont, Texas. (in preparation).

Kincaid, G. P., Jr. *Contemporary tritium geochemistry of the Gulf of Mexico.* Doctoral Dissertation. Texas A&M University. August 1971.

Patel, Mafabhai. *Report on Projected Work.* EGR 631. July 1970.

Rezak, Richard et al. *West Flower Gardens Research Facility.* A Report by The Flower Gardens Feasibility Committee. Texas A&M University. TAMU-SG-71-103. 23 pp. December 1970.

Schroeder, William W. and Thomas J. Bright. *Passive and Experimental Bio-Acoustical Studies on Marine Organisms in Their Natural Habitat.* Tektite II Report, Department of Interior, Mission 4-50. January 1971. (in press).

Schroeder, William W. and Phyllis Anne Schroeder. *Selected Bibliography on Snorkel and SCUBA Diving.* Published in conjunction with Man's Underwater Activities Committee of the Marine Technology Society. 4 pp. December 1970.

Schroeder, William W. and William P. Fife. *University Guide for Diving Safety*. Texas A&M University. TAMU-SG-70-602. May 1970.

Trabant, P. K. *Theoretical Analogy Between Electro-Magnetic Wave and Seismic Wave Propagation*. Masters Thesis. Texas A&M University. (in preparation).

Professional Journals and Periodicals

Bouma, A. H. et al. *Sediment Transport Along Oceanic Density Interfaces*. Abstracts with Programs for 1969, part 7. Geological Society of America. pp. 259-260.

Chmelik, F. B. and A. H. Bouma. *Electrical Logging of Recent Marine Sediment Cores*. Trans. American Geophysical Union, Vol. 50. pp. 201. 1969. (Abstract).

Chmelik, F. B. and A. H. Bouma. *New Logging Technique Will Speed Ocean Bottom Surveys*. Ocean Industry Magazine. pp. 56-59. May 1970.

Chmelik, F. B. et al. *Comparison of Electrical Logs and Physical Parameters of Marine Sediment Cores*. Trans. Gulf Coast Association Geological Societies. Vol. 19, pp. 63-70. 1969.

Conference Reports Presented

Bouma, A. H., et al. *Shipboard and in-situ Electrical Resistivity Logging of Unconsolidated Marine Sediments*. OTC 1351, Preprints. Offshore Technology Conference. April 19-21. Houston, Texas. 1971.

Brooks, J. M., W. Sackett, and A. Fredericks. *(1971) Organic Carbon as a Pollution Parameter in the Brazos River Estuary and the Gulf of Mexico*. 161st National ACS Meeting. Los Angeles, California. April 1, 1971.

Brooks, J. M., W. Sackett, and A. Fredericks. *Terrestrial Contribution of Organic Carbon to the Gulf of Mexico*. (submitted for publication to Limnology and Oceanography).

Bryant, William R. *(Title not available)*. Geological Oceanography Seminar. Texas A&M University. College Station, Texas. October 1970.

Bryant, William R. and Andre P. DelFlache. *Geotechnical Charts of the Deeper Portion of the Gulf of Mexico*. OTC 1468, Preprints. Offshore Technology Conference. April 22-24. Houston, Texas. 1970.

Chmelik, F. B. and A. H. Bouma. *Electrical Logging in Recent Sediments*. OTC 1147, Preprints. Offshore Technology Conference. April 22-24. Houston, Texas. 1970.

DelFlache, Andre P. and William R. Bryant. *Compressional Behavior of High-Void Ration Marine Sediments*. OTC 1148, Preprints. Offshore Technology Conference. April 22-24. Houston, Texas. 1970.

DelFlache, Andre P., et al. *Determination of Compressibility of Marine Sediments from Compressional Wave Velocity Measurements*. OTC 1328, Preprints. Offshore Technology Conference. April 22-24. Houston, Texas. 1970.

DelFlache, Andre P. and William R. Bryant. *Compression Exponent of Marine Sediments as Related to Settlement Studies.* (in preparation). To be presented at Offshore Technology Conference. May 1971. Houston, Texas.

Fife, William P. *The Future of H_2O_2.* January 19. Medical Problems of Deep-Sea Diving presented by MBI and American Petroleum Institute. 1971.

Fife, W. P. and P. O. Edel. *Preliminary Experiments with Hydrogen-oxygen Breathing Mixtures.* Presented to Aerospace Medical Association Scientific Meeting, 1971.

Fife, William P. *Medical Aspects of Diving.* February 26-28. Southwest Council Instructors Program National SCUBA Instructors Course. Baytown, Texas. 1971.

Frank, D. J., W. M. Sackett, R. Hall and A. D. Fredericks. *(1970) Methane, Ethane and Propane Concentrations in Gulf of Mexico.* AAPG, 54(10) 1933-38. Also presented at INTEROCEAN '70. Dusseldorf, Germany.

Frank, D. J., W. Sackett, R. Hall and A. Fredericks. *Methane, Ethane and Propane Concentrations in Gulf of Mexico.* INTEROCEAN '70. Dusseldorf, Germany.

Schroeder, William W. *Aspects of Deep Diving.* February 26-28. Southwest Council Instructors Program National SCUBA Instructors Course. Baytown, Texas. 1971.

Schroeder, William W. *Aspects of Deep Diving.* May 15-22. National SCUBA Instructors Certification Course, National Association of Underwater Instructors. Houston, Texas. 1971.

Schroeder, William W. *Basic Oceanography.* May 15-22. National SCUBA Instructors Certification Course. National Association of Underwater Instructors. Houston, Texas. 1971.

Schroeder, William W. *Conservation and the Recreational Diver.* May 15-22. National SCUBA Instructors Certification Course. National Association of Underwater Instructors. Houston, Texas. 1971.

Schroeder, William W. *Guidance and Standards for Research Personnel Engaged in Diving Activities Through Sea Grant and Other Programs.* April 4-5. AAHPER National Convention. Presentation on "Guidance and Standards for Research Personnel Engaged in Diving Activities Through Sea Grant and Other Programs". Detroit, Michigan. 1971.

Schroeder, William W. *Results of Mission 4-50.* May 3-5. Final Report of the TEKTITE II Project. NASA. Huntsville, Alabama. 1971.

Schroeder, William W. *The Scientific Diving Training Program at Texas A&M University.* August 28 - September 4. Industrial Orientation Course. National Association of Underwater Instructors. San Diego, California. 1971.

Schroeder, William W. *Marine Diving Training Programs at Colleges and Universities*. October 23-25. Second International Conference on Underwater Education. By National Association of Underwater Instructors. Santa Ana, California. 1970.

Schroeder, William W. *The Scientific Diving Training Program at Texas A&M University*. September 10-13. Southwest Council Instructors Program National SCUBA Instructors Course. Longview, Texas. 1970.

Schroeder, William W. *The Tektite II Project*. September 10-13. Southwest Council Instructors Program National SCUBA Instructors Course. Longview, Texas. 1970.

Schroeder, William W. *The Tektite II Project*. February 26-28. Southwest Council Instructors Program National SCUBA Instructors Course. Baytown, Texas. 1971.

Schroeder, William W. *The Texas A&M University Diving Program*. February 26-28. Southwest Council Instructors Program National SCUBA Instructors Course. Baytown, Texas. 1971.

Schroeder, William W. *A University Guide for Diving Safety*. November 2-3. Technical Symposium "Professional Diving Safety National Programs". Presented by the Committee on Man's Underwater Activities. Marine Technology Society. New Orleans, Louisiana. 1970.

MARINE RESOURCES MANAGEMENT

The effective use and management of our marine resources are among the most pressing problems facing the Nation. The President's Commission on Marine Science Engineering and Resources (1969) called for the institution of an improved system for the rational management of our coastal and estuarine zones and the Great Lakes regions. On the state level the Sea Grant Program at Texas A&M University is supporting many interdisciplinary projects with the common purpose of assisting in the planning and managing of the state's marine resources. Projects in this program area include education, research, and advisory services activities. Publications and documentation resulting from these projects are listed at the end of this section.

Law and Marine Resources (Research)

Activity Leader: Eliezer Ereli, Sea Law Program, Bates College of Law (University of Houston)

The Sea Law Program started as a means of filling a void in the legal-administrative framework relating to the Texas Management of Coastal and Marine resources. Hence the program aims at initiating a comprehensive and continuous program of courses, research and information services linked to the needs and goals of the state, the legal profession and federal-state harmonious cooperation.

Project Description and Report of Work and Accomplishments

Starting with these aims, the Program achieved a remarkable success in its first year of operation.

Most important, the Program was instrumental, through conferences, discussion and cooperation among law schools, the Governor's Office and the Legislature, in establishing the Texas Law Institute of Coastal and Marine Resources. Funded by the Legislature, the Institute functions were defined by the Governor in his report to the Legislature as "legal analysis of institutional authority and responsibility necessary for the proper implementation of a Coastal Resources Management Program." As Chairman of

the Interagency Natural Resources Council, the Governor pointed out that the Council should work directly with the Institute "in legal problems of coastal resource management". The Governor's recommendations were enacted into legislation on May 26, 1971 by Senate Concurrent Resolutions Nos. 8 and 9, 62nd Legislature, 1st Session.

The Sea Law Program also initiated a seminar in Environmental Aspects of Marine Activities, coordinated with the needs and goals of the Texas Coastal Zone Management Program. The seminar generated other activities including:

1. Student papers on the problems and control of oil pollution resulting in
2. A Law Review article,
3. A handbook for use of industry, bar and government,
4. The development of a regular course in Environmental Law to be offered for the first time in 1972,
5. A case book on the legal regime of the sea and activities herein for use by students in the course on Environmental Law,
6. Materials available for a conference to be held in November, 1971 on recent environmental developments in maritime and offshore activities.

Marine Information Services (Research)

Activity Leader: Eugene B. Smith, Business Analysis and Research Department

The objective of this project was to collect, store and disseminate information and research data to marine related industries in Texas. The primary area under study was personnel expertise in the field of marine resources.

Project Description and Report of Work and Accomplishments

In order to establish a large data base of marine oriented expertise, a survey, covering all colleges and universities in the state of Texas, was conducted.

Data collection techniques consisted of a questionnaire mailed to an official of the institution. For large institutions or those thought to have a number of marine personnel, a personal visit was

made to facilitate a better coverage of qualified individuals. Once the data was collected it was edited and converted to punched cards for later computer processing. Selected data items were coded to facilitate the preparation of various indices.

A computer program was developed to prepare a variety of lists which would make the available information readily accessable to users. These lists were prepared according to the following formats:

1. Detailed Personnel Listing - A list of all data on each individual in the file arranged in alphabetical order.
2. Alphabetical Listing - An alphabetical list of each individual including name and institution code.
3. Organizational Listing - An alphabetical list of names ordered by department within organization.
4. Resource Specialty Listing - An alphabetical listing of names within institution codes grouped within broad marine oriented categories.
5. Expertise Listing - A listing of names with institution codes ordered by descriptor terms supplied by each respondent. (Note: Each respondent was requested to list up to six terms which could be used to describe his particular marine expertise).

Work on this phase of the project consisting of the data collection and final printing of the directory was accomplished in conjunction with Mr. Norman C. Whitehorn of Industrial Economics.

An additional major portion of the project involved the maintenance of two major information dissemination files. These files, containing a total of about 8,600 names and addresses, were initiated by the Department of Marine Resources Information Services to facilitate the distribution of information to the marine resources community. Approximately 120,000 mailing address labels were prepared during the past year.

Other activities included the preparation of published technical information in microfiche form and the distribution of this material to the three local microfiche files.

Marine Resources Management
(Education)

Activity Leader: Clinton A. Phillips, Department of Finance

The purpose of this project is to develop a degree program in the College of Business Administration in the management of marine commerce and industry. The degree will be multi-disciplinary with about half the work to be in the departments of the College of Business. The remaining hours will be selected by the student from courses in science, geosciences, and/or engineering. As a part of this program, four new courses will be developed: Planning, Programming, Budgeting Systems, Coastal Zone and Ocean Law, Natural Resource Accounting and Marine Resource Management. As an integral part of the degree program, students will spend up to three months in a marine resource related business or governmental organization analyzing a problem and preparing a case study for integration into classroom materials.

Project Description and Report of Work and Accomplishments

The work involved in this activity has involved several components. First, a major component has been the design of several courses for the College of Business Administration's portion of the curriculum. Two stages have been involved in this effort. The first stage consisted of preliminary design resulting in a description sufficiently detailed for purposes of getting the courses approved through the University Graduate Committee and ultimately by the Academic Council. Of the four courses originally proposed, three have been fully approved and are listed in the General and Graduate Catalogues of the University. These are Finance 670, Planning, Programming, Budgeting Systems, Management 661, Marine Resource Management, and Management 662, Marine and Coastal Zone Law. The latter, Management 662 was taught in the Second Summer Session, 1971 and is currently being taught in the Fall Semester, 1971. Finance 670 is also being taught in the Fall Semester, 1971, while Management 661 is scheduled to be taught in the Spring Semester, 1972.

The second stage of course design has involved a detailed search of available information and the preparation of teaching materials which synthesize fragmented and widely scattered information. The two courses posing significant problems in this regard have been Management 661 and 662. Matching funds were used to secure the services of a visiting professor, Walter J. McNichols during the three summer months to assist in the design of the course and to offer it. Preparation of the second course has been conducted by the Activity Leader and has involved surveying a vast quantity of literature with the aid of graduate assistants. This has involved a survey using a detailed questionnaire sent to each

coastal state to elicit information concerning their current legislation and institutional arrangements relevant to coastal zone management. In this regard we are particularly interested in identifying various patterns of development. The data from the questionnaires are currently being analyzed and a report is being prepared. All of this information plus other gleaned from reviewing relevant literature will be consolidated into a text for the course, Marine Resource Management. Also included will be a series of case studies for student analysis. Ten such cases have been written to date.

The second major component of the activity has been the development of interdisciplinary relationships with other departments on this campus which, by virtue of their focus, are logical candidates for participation in the program. These include Biology, Civil Engineering, Economics, Geography, Geology, Oceanography, Political Science, Recreation and Parks, Urban and Regional Planning and Wildlife Science. A mechanism for coordinating this interdisciplinary curriculum is being devised and excellent cooperation has been received to date.

A third component of the activity has been the preparation of "A Proposal for a New Instructional Program in Management" which has been approved by the College of Business Administration and is now in process of securing approval at appropriate levels in Texas A&M University for ultimate approval by the Coordinating Board, Texas College and University System.

Numerous discussions have been held with students interested in the program. Initial response to date suggests this curriculum will prove to be very attractive not only to students at Texas A&M University but also to others at other institutions.

Finally, a series of five Marine and Environmental Law Seminars was conducted by Visiting Professor Walter J. McNichols during the summer of 1971. These were co-sponsored by the Center for Marine Resources and the College of Business Administration. The topics together with the dates were as follows:

The High Seas	June 30
The Outer Continental Shelf	July 12
The Territorial Seas and the Contiguous Zone	July 19
Fisheries	July 26
Pollution Control	August 9

Professor McNichols served as banquet speaker for the Coastal and Ocean Engineering Short Course on August 11, 1971.

The overall development of the program is proceeding on schedule.

Reports and Project Documentation. Preparation in process of a survey text in marine and coastal zone law to be published by the Center for Marine Resources.

Preparation in process of a survey text in marine resources management. It is hoped this will also be published by the Center for Marine Resources.

Preparation of a survey and analysis of current developments in marine and coastal zone management in coastal states of the U.S. to be distributed as an occasional paper by the College of Business Administration.

Investment - Financial Analysis for the Shrimp Fishing Firm (Research)

Activity Leader: Robert R. Wilson, Institute of Statistics

It is well known that the shrimp fishery is a very important national industry and by an overwhelming margin the most important fishery resource to the state of Texas. Perhaps the most important and farthest reaching economic decisions that managers of shrimp fishing firms must make are those concerning investments in the fishing fleet. The objective of this study has been from the outset to develop dynamic financial strategies that reflect industry conditions and can be applied by shrimp fishing firms. Theoretical models were developed during the first two years of the study. Two approaches were devised for obtaining financial strategies:

1. A dynamic deterministic model and
2. A stochastic survival model.

During the third year, the research as proposed had two basic objectives:

1. To refine parameter values for the deterministic model to make them reflect a more exact image of industry conditions and
2. To make an application of a stochastic survival model for financial strategies to investments by shrimp fishing firms.

Project Description and Report of Work and Accomplishments

All work outlined in the Sea Grant Project Proposal for 1970-71 has been completed. The deterministic model has been extended in its reflectiveness of industry conditions and the application of a stochastic survival model of investment has been made for the shrimp fishing firm as outlined.

Furthermore, ground-work has been laid that should make it possible to obtain sufficient data to refine the method much further than originally expected and to make it available on an advisory basis to all shrimp fishing firms, large or small.

It seems evident that three modifications of each model, not visualized in the 1970-71 proposal, must be completed before either can be used in a general advisory capacity. These modifications include:

1. Consideration of strategies for selling or trading vessels in addition to purchase (non-purchase) strategies;
2. Consideration of strategies for alternative vessel sizes and riggings; and
3. Consideration of strategies that take into account the indivisibility of a fishing vessel as a unit of capital.

Mathematical modifications of the deterministic model have been made which incorporate strategies for selling and trading and for alternative sizes and riggings.

Data that appear to be adequate for empirical application of these modifications has been offered to the project by many interested shrimp fishing firms. Although we have collected and processed data from several of these firms the data base is not yet adequate to support empirical applications.

In the case of vessel indivisibilities, we have apparently perfected our methods for the deterministic model. Models developed during 1968-69 and 1969-70 under this project allowed complete divisibility of vessels as a unit of capital. Knowledgeable industry people have indicated that for investment purposes the ownership of vessels cannot commonly be divided among firms in small irregular components. Difficulties encountered in modifying the deterministic model to incorporate indivisibilities have been in computer methods and available software. It appears that we have successfully overcome these difficulties.

There is yet a controversy as to whether or not the population dynamics of the shrimp is affected by fishing effort and thus by vessel investments. However, there is much evidence that fishing effort can effect the population dynamics of most other species. To generalize our methods so that they might apply to fisheries other than shrimp, we have incorporated a population growth equation into the deterministic model and obtained decision rules for optimal investment strategies. Data from the New England cod fishery have been used to estimate parameters in the model and the resulting decision rules. The first report on this effort will be in the forthcoming doctoral dissertation of Mr. Alan Johnson.

An effort was made to reduce the mathematical notation in presentations and other papers arising from this project. At the same

time explanations were presented more in an accounting framework. A series of nontechnical advisory leaflets has been planned with which to better describe the work and its uses to potential users in the shrimp fishing industry.

A considerable amount of rapport with the industry has been developed during this year. In addition to our cooperators at Aransas Pass, we either have commitments of data or have received data in the form of financial records from shrimp firms in Brownsville, Rockport, Fulton, Port Lavaca, Galveston, and Freeport. We have received encouragement and offers of assistance for our work from supporting industries such as marine maintenance suppliers, gear suppliers, marine engine manufacturers and suppliers, boat builders, and bankers. We have developed and maintained a close liaision with the National Marine Fisheries Service national headquarters in Washington, D. C. and College Park, Maryland, Southern region headquarters at St. Petersburg, Florida, Dallas office, and at the Galveston Marine Lab. We have cooperatively assisted NMFS in the development of a data bank on costs and returns for the operation of shrimping vessels in the Gulf of Mexico. Such a data source will expedite their research as well as our own. Close relationships have been developed with economists and others working in marine subjects at the University of Texas, University of Florida, the University of Miami and the University of Missouri. Relationships have also been developed with the Texas members of the Gulf States Marine Fisheries Commission and with the Texas Parks and Wildlife Department.

The project leader participated in the following conferences and meetings:

1. Conference with Bureau of Commercial Fisheries, Economic Research Division on Shrimp Research, College Park, Maryland, August 27-30, 1970.
2. Marine Fisheries Supply Conference, Sponsored by National Marine Fisheries Service (NMFS) Economic Research Division, Baltimore, Maryland, November 4,5,6, 1970.
3. Gulf and Caribbean Fisheries Institute, 23rd Annual Meeting, Curacao, N.A., November 8-12, 1970.
4. Southern Marine Economics Coordinating Conference, sponsored by NMFS Southern Regional Office, December 14-16, 1970, St. Petersburg, Florida.
5. 1970 Winter Meeting at the Allied Social Sciences Association, December 27-30, 1970, Detroit, Michigan.
6. 1971 Meeting of the Southern Agricultural Economics Association, February 1-3, 1971, Jacksonville, Florida.
7. Conference on Cost and Returns Data Base for the Gulf Shrimp Fishing Fleet, University of Florida,

February 4, 1971, Gainesville, Florida.

8. Meeting of Gulf Fisheries Research, NMFS Southern Regional Office, February 5, 1971, St. Petersburg, Florida.
9. Meeting on Proposed Shrimp Research, NMFS Marine Laboratory, March 12, 1971, Galveston, Texas.
10. Gulf States Marine Fisheries Commission and Texas Shrimp Association Meeting, March 18-20, 1971, Brownsville, Texas.

Marine Information Services (Advisory)

Activity Leader: Norman C. Whitehorn, Industrial Economics Research Division

The objective of this project is to collect, store, and disseminate statistical information and research data to marine related industries in Texas. General areas included are facilities, activities, and personnel expertise of ports and academic institutions over the State of Texas.

Project Description and Report of Work and Accomplishments

The initial phase of the project began in September, 1970, in developing plans to conduct a survey of Texas ports to identify the available expertise in marine activities. After a visit on October 1, 1970, with Mr. Richard B. Swenson, President of the Texas Ports Association, the general consensus of the Texas Ports personnel was that a survey of this kind was not necessary.

A second phase of the project was to conduct a similar survey of all colleges and universities in Texas. Contact with Texas A&M University was made with the deans of the respective colleges in a letter dated November 3, 1970, from the Director of the Sea Grant Program Office stating the objectives and benefits to be derived from such a personnel file and to solicit names of individuals that should be listed. Visits were made in early December to Rice University, Lamar State College of Technology, University of Texas at Austin, Brazosport Junior College, Del Mar College, University of Corpus Christi, Texas A&I University, Texas Christian University, University of Texas at Arlington and the University of Houston to explain the survey in detail and to request assistance in identifying personnel from each institution. A questionnaire accompanied by a letter of explanation was mailed November 24, 1970, to the presidents of all other academic institutions in the state to ask assistance in making the survey.

Marine related personnel in each institution were identified and requested to return the questionnaire giving pertinent information reflecting their expertise. Four hundred forty-eight completed questionnaires were returned by May 15, 1970. The information was edited and transferred to a machine readable format. It is now stored on punched cards to provide ease of success and quick retrievability.

The information has been published in a bound volume entitled, Marine Resources Capabilities in Texas, Directory of Personnel in Educational Institutions. The directory is cross-referenced in five areas to enhance its usability and is now available for distribution. Supplements and annual updatings are anticipated to keep the information current.

The information found in this report was obtained and compiled during the period September 1, 1970, through August 31, 1971, and should be interpreted as of that time period.

PUBLICATION AND DOCUMENTATION

The following reports and papers resulted from Sea Grant work in Marine Resources Management during the 1970-71 reporting period.

Technical and General Reports

Ereli, Eliezer. *Legal Regime of the Sea, Its Resources and Activities Therein.* University of Houston Press. 700 pp. December 1971.

Ereli, Eliezer and G. E. Hopkins. *International, Federal and State Response to Oil Spills From Ships and Platforms: Evaluation and Recommendations for State Action.* Vol. 9, Houston Law Review. (in press).

Johnson, Alan M. *Deterministic and Stochastic Models for Bioeconomic Control of a Commercial Fishery.* A doctoral dissertation in preparation for the partial fulfillment of the requirements for the Ph.D. Degree in Statistics.

Thompson, Russell G. et al. *An Extension of a Stochastic Investment Model for a Survival Conscious Firm.* Texas A&M University Sea Grant Program. TAMU-SG-70-218. 22 pp. July 1970.

Whitehorn, Norman C. and Eugene B. Smith. *Marine Resources Capabilities in Texas, Directory of Personnel in Educational Institutions.* Texas A&M University Sea Grant Program. TAMU-SG-71-602. 221 pp. July 1971.

Wilson, Robert R. et al. *Optimal Investment and Financial Strategies in Shrimp Fishing.* Texas A&M University Sea Grant Program. TAMU-SG-71-701. 49 pp. December 1970.

Conference Papers Presented

Thompson, Russell G. *Some Limitations to the Development of a Bioeconomic Theory of the Fishery.* National Marine Fisheries Services Supply Conference. Baltimore, Maryland. November 5, 1970.

Thompson, Russell G. and Melvin D. George. *A Stochastic Investment Model for a Survival Conscious Firm.* 1970 Winter Meeting of the Econometric Society. Detroit, Michigan. December 30, 1970. Abstracted in Econometrica, July 1971.

Wilson, Robert R. and Richard W. Callen. *Computerized Analysis of Shrimping Vessel Investments.* 1971 Spring Meeting of Gulf States Marine Fisheries Commission and Texas Shrimp Association. Brownsville, Texas. March 19, 1971.

MARINE ENGINEERING AND TECHNOLOGY

Sea Grant projects in the Marine Engineering and Technology program cover a wide variety of areas. Included are projects concerned with acoustical studies, scour of Gulf coast beaches, instrumentation and hardware, and technician training. Reports and documentation resulting from these projects are listed at the end of this section.

Development of Acoustic Nonlinearity as a Means of Sediment Characterization (Research)

Activity Leader: Jerald W. Caruthers, Department of Oceanography

The structural properties of the sediments are of great importance to ocean technology, and the capability to measure these properties in situ is of considerable significance. Intermodulation distortion in acoustic propagation is strongly dependent upon the physical properties of the medium. The research and development of probes and techniques for measuring the nonlinearties which produce the intermodulation distortion and the collecting of data necessary to relate the nonlinear properties to the physical properties will be carried out under this project.

Project Description and Report of Work and Accomplishments

During the past year transducers, additional electronic devices, and a sediment container were designed and built. The transducers have been partially tested the calibration has begun.

The present system is illustrated by the block diagram given in figure 1. The experimental procedure will involve the progagation of two high frequency acoustic beams of slightly different frequencies into the sediments and the magnitude of intermodulation distortion produced by acoustic nonlinearity in the medium will be measured in terms of the strength of the difference frequency signal. The level of the difference frequency is expected to be a measure of certain properties of the medium (e. g. porosity, viscosity, higher order

coupling coefficients). Exactly what properties will be involved is not yet known because no mathematical theory presently exists for the problem. An analytical formulation for the problem is not presently tractable. Therefore, our approach has been to first demonstrate that it exists, collect data, and form empirical relations which include physical properties of the sediments.

Rapid advancement in this research has been impeded by low funding and personnel problems. The latter has been rectified; two new and apparently enthusiastic and capable students have replaced the former student. One student is a Master's candidate with a physics background and will develop the instrumentation and mathematics. The other is a Ph.D. candidate with a geological background and will be concerned with the sediment properties. This combination is working well, and we are meeting regularly to insure that progress is made this next year.

One industrial corporation, Schlumberger Corp., was informally contacted about a possible interest in this research; since we had no definite results at that time our effort was premature and fruitless. But, still, we contend that nonlinear acoustic propagation affords a unique possibility for developing a technique for measuring sediment properties remotely. To develop additional techniques for making such measurements is highly desirable. Presently, the only acoustic technique for doing this is the refractive method for sound velocity measurements.

Acoustic Communications (Research)

Activity Leader: Stephen Riter, Department of Electrical Engineering

Two underwater acoustic communications techniques are particularly attractive for local marine activities; they are pulse position modulation telemetry and acoustic transmission techniques for controlling underwater equipment. In this study the effects of disturbances peculiar to the underwater acoustic channel, such as fading, dispersion, and nonwhite ambient sea noise on these types of systems will be investigated. The results of these investigations will be used to determine the structure of practical systems which minimize these effects and to develop useful engineering design criteria.

Project Description and Report of Work and Accomplishments

Pulse Position Modulation Telemetry. Pulse position modulation

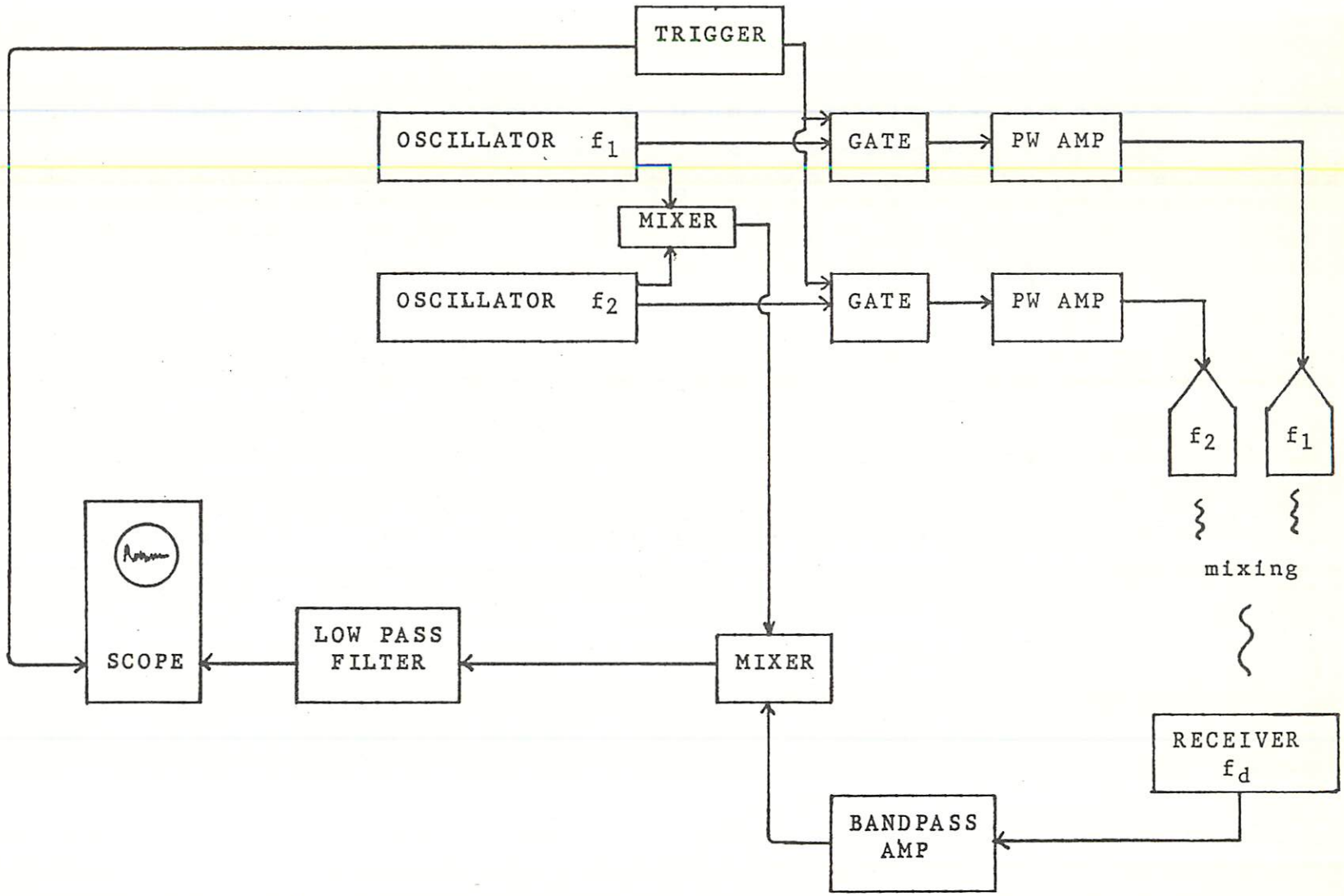

FIGURE 1: Block diagram for acoustic nonlinearity experiment.

(PPM) telemetry is a simple and effective technique for transmitting information via the underwater acoustic channel. A PPM system operates by transmitting a short acoustic tone once in every time frame. The time of transmission is a linear function of the value of the signal to be sent.

The underwater acoustic channel is a complex, randomly time-varying media whose exact mathematical description is currently the subject of much active research by scientists and engineers. The effects which most influence the design of an acoustic communication system are attenuation, multipath, time dispersion, and the addition of background noise. The receiver observes the output of the channel in the presence of its own internal noise. The signal is filtered by the receiver and applied to an envelope threshold detector or slicer which produces a pulse whenever the envelope of the received signal exceeds some predetermined level. If the noise plus other disturbances are small compared with the received signal, then there are slight perturbations in the slicer's estimate of the exact position of the waveform due to the additive nature of the background noise and the time spread of the received pulse. If the noise or other disturbances are large compared with the received signal, then anomalies occur due either to the noise exceeding the slicing level when no signal is present or concelling out the signal. We define the signal-to-noise ratio, where anomalies begin to have a high probability of occurrence, as the threshold point. It is observed that operation at lower signal-to-noise ratios gives unsatisfactory performance, while operation at higher signal-to-noise ratios gives only slightly improved performance for increased values of transmitter power. As part of this years effort we developed techniques for choosing system parameters so that operation of a practical system in the vicinity of the threshold point is possible. To verify the validity of the analysis laboratory simulations were conducted, and a prototype PPM system whose design and construction had been begun in FY 1969 was completed. This system was tested at sea during a cruise of the R/V ORCA.

Frequency Shift Keyed Telemetry. Many commercially available acoustic command and control systems use bandpass limiters to minimize the effect of amplitude fading and to provide an easily instrumented form of automatic gain control. In many cases performance at sea has not been satisfactory. In order to explain this we investigated the performance of fading telemetry systems with bandpass limiters and developed mathematical techniques for predicting their performance when used with fading acoustic signals. The analysis performed explains the phenomena observed with commercial systems and suggests methods for optimizing the performance of practical systems.

Industrial Contacts. Discussions of the results of our work have been held with representatives of Humble Oil Co., AMF Electro-

products, and the Raytheon Co. Dr. Riter participated in a meeting of the ASME Study Committee for the Exchange of Offshore Information to discuss the use of underwater acoustics in offshore oil fields.

Acoustical Detection of Marine Organisms (Research)

Activity Leader: Thomas J. Bright, Department of Oceanography

Our project strives to relate sound production to daily patterns of activity and behavior in marine organisms, particularly fishes. Ultimately, we hope to apply the information gained during our study to the location of populations of important sport and commercial fishes, tracking localized movements of significant sound producers, and assessing the effects of grazing and browsing by fishes on hard substrates.

Ancillary activities include development of diver held listening and recording devices and pioneering techniques for utilization of underwater habitats in bio-acoustical research.

Project Description and Report of Work and Accomplishments

Much of our time during the past year was devoted to analysis of data collected during a twenty day saturation dive in the Tektite II underwater habitat off St. John, Virgin Islands. Cyclical patterns of sound production were easily demonstrable and we detected and described several types of purposeful fish sounds previously unrecorded. Sounds were most frequently associated with aggressive behavior chasing and territorial defense. Some of the loudest however were apparently spontaneously produced by certain fishes wandering about the reef during early evening hours. The results of this phase of our study are in press.

The principal investigator has given approximately ten talks describing the Tektite II effort to organizations such as Rotary Clubs, Former Students Associations, Naval Reserve Groups, Wives Clubs, student-faculty seminars, etc. The scientific results were presented as a paper during the 1970 session of the American Society of Ichthyologists and Herpetologists. Certain information derived from our activities was incorporated into the subject matter for a Sea Grant sponsored short course for which Dr. Bright prepared notes to be published, and delivered one lecture.

During July and August, Dr. Bright and four students, John Sartori, Dan Taylor, Thomas Burke and Raymond Mathews, participated

in the Hydro-Lab Underwater Habitat Program. Bright, Sartori and Taylor lived for seven days in the habitat in 50 feet of water off Lucaya, Grand Bahama Island. Sound production and associated behavior were observed in the Reef Squirrelfish, Adioryx coruscus, the Squirrelfish, Holocentrus rufus, and the Blackbar Soldierfish, Myripristis jacobus. The last two were inhabitants of a cave. Cyclical data on sound production were acquired as were many significant observations on aggressive behavior. Mr. Sartori studied adventitious sound production by grazing parrotfishes. He was able to relate certain types and patterns of feeding sounds to size and perhaps, species. Limited observations on the acoustical behavior of the Dusky Damselfish were also carried out.

Results of our efforts in the Bahamas are being assessed and some will be submitted for publication by December 1971.

Effect of Fluid Viscoscity on Cavitation of Dredge Pumps (Research)

Activity Leader: John B. Herbich, Department of Civil Engineering

The objectives of this project are to evaluate cavitation characteristics of dredge pumps while handling solids-water mixtures. The cavitation of pumps is a function of material size (silt, clay sand, gravel) material gradation, suction head, pump speed, suction side geometry, and other variables.

Once the cavitation characteristics of the three pumps under study are known, modifications to inlet geometry will be made and the effect of changes on cavitation determined. Recommendations regarding the optimum suction side geometry will be made and this information disseminated to industry through publications and direct contacts.

Unfortunately, the continuation of the project has not been authorized by the Sea Grant Office, although the project objectives have only been partially achieved. It is hoped that the project will continue with support from industry or with future support from the Sea Grant Program. It is felt that substantial contribution to knowledge of cavitation of pumps will be made.

Project Description and Report of Work and Accomplishments.

Many activities along the coast, in the estuaries require either repeated or continuous dredging. Such activities involve dredging

of new ship channels, maintenance of existing channels, burying oil and gas pipelines, beach replenishment, etc. Other activities include offshore mining; it is generally agreed that the most economical methods of mineral recovery offshore will be by suction dredging.

The purpose of this project is to improve the cavitation performance of dredge pumps.

The first year of the project initiated in September 1968 was devoted to construction of the testing facility, the construction continued through the first part of the second year and was completed by December 1969. Since January 1970 the work has been continuing on evaluating cavitation performance of the dredge pumps specially donated to the Center for Dredging Studies. The first pump studied was the Morris Pump (6 inch suction and 6 inch discharge), the second pump being studied is the Pekor Pump (8 inch suction and 6 inch discharge). Since the Pekor Pump required a power supply greater than the installed 200 HP motor, the test stand facility required a modification to increase the power of the prime mover. Modifications involved replacement of the 200 hp motor with a 300 hp motor. Also a higher capacity torque meter was installed (20,000 in-lbs). It was also found desirable to install a nuclear density meter manufactured by Robertshaw. This device permits readings of the slurry density. It is hoped to resume testing again by June 15, 1971. After testing resumes, it is planned to continue with the Pekor pump performance tests at higher speeds and torque ranges. These tests will include slurry cavitation tests with a 30-40 fracture sand. A 10-20 fracture sand will also be studied using the Pekor pump. At this time it will be necessary to again change pumps to a Thomas Pump (8 inch suction and 6 inch discharge). This pump is comparable in size to the Pekor pump. For this reason, no further modifications of the test stand are anticipated. In the remaining summer months, slurry cavitation tests will continue using material up to the size of 1 inch mean diameter.

Test Stand and Instrumentation. The test stand consists of three major components:

1. Vacuum tank
2. Pump and Drive Unit
3. Instrumentation

The vacuum tank is 11 ft. in diameter and 15 ft. tall with a maximum volume of 800 cubic feet. It was designed to withstand a vacuum pressure of 29 inches of mercury. A Beach-Russ, type RP Model 50, Rotary Piston Vacuum Pump has been installed to pull the vacuum on the tank. The pump has a displacement of 80 cfm and is equipped with a vapor purge system to remove water vapor from the air pumped. The tank pressure is measured by a 40 in. absolute pressure mercury manometer, which also reads barometric pressure when the tank is open to the atmosphere (Figure 1).

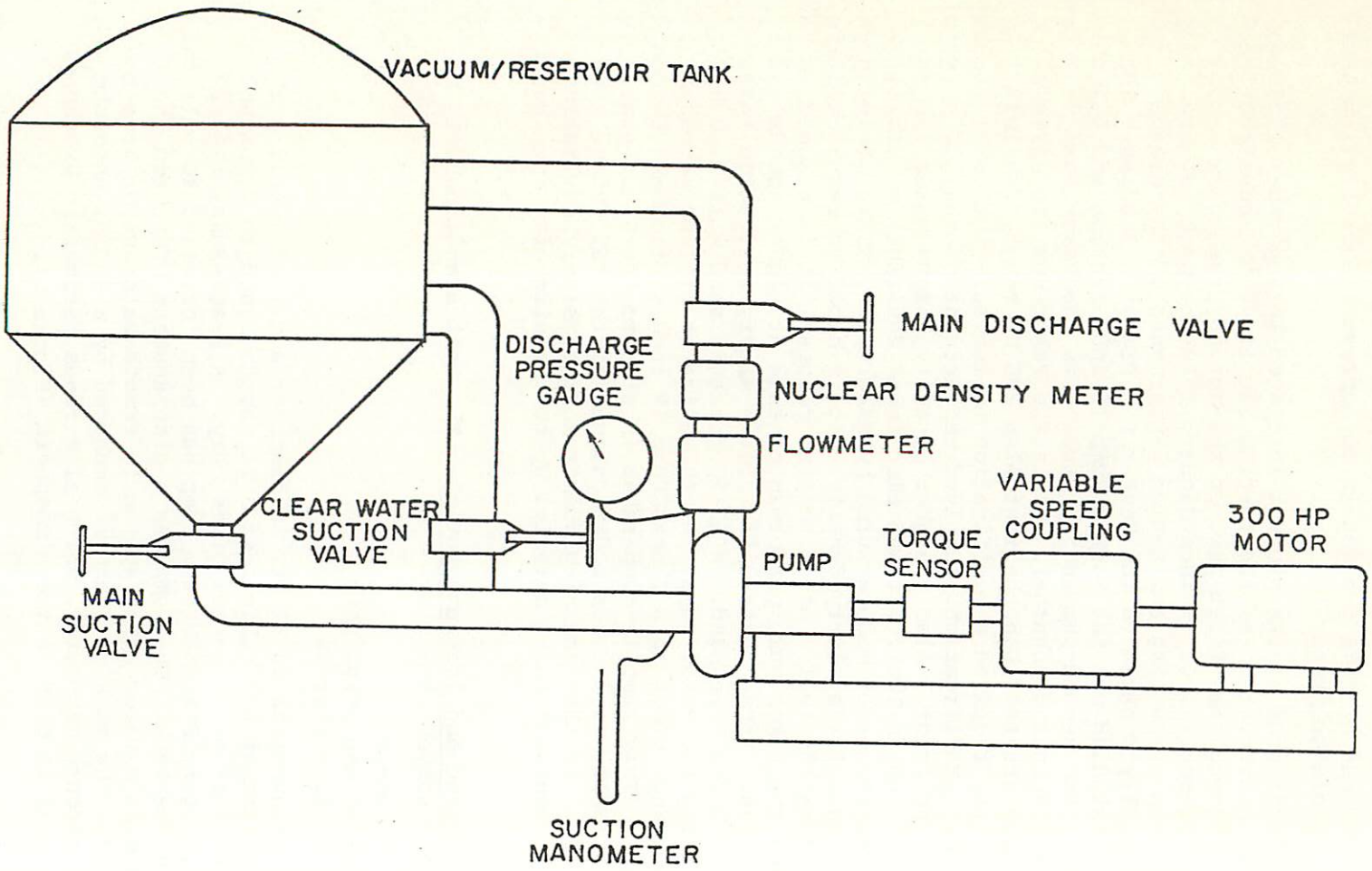

Figure 1

Schematic Diagram of Test Loop

The drive unit consists of a constant speed electric motor and a variable speed coupling. The motor is a 300 hp, 440 volt, 1785 RPM Louis Allis Electric Induction Motor. The variable speed coupling is a Dynamic 50-1750 RPM, constant torque, eddy current coupling. A Pekor Iron Works Model PW slurry pump is presently being studied. The pump is rated at 900 RPM with a capacity of 2200 GPM.

The instrumentation for the system includes:

1. Suction side pressure by mercury manometer.
2. Discharge side pressure by gauge.
3. Discharge by a Fischer & Porter 6" magnetic flow meter.
4. Temperature by taking a sample and measuring with a thermometer.
*5. Density of the fluid by a Nuclear Density meter located on discharge side of pump.
6. Shaft horsepower to pump by use of a Lebow (20,000 in-lbs) in-line shaft torque sensor.
7. Shaft speed by magnetic pickup.
8. Plexiglas suction side cover to be used when high speed movies are taken during testing with water.

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* Prior to installation of nuclear density meter measurements were taken by obtaining a sample through a pitot tube located on discharge side of pump.

An Analytical Solution for the Dynamic Response of a Laterally Loaded Pile (Research)

Activity Leader: Harry M. Coyle, Department of Civil Engineering

In recent years there has been a steady increase in the use of offshore structures for petroleum exploration and production. Most of these structures are supported on piles driven into the ocean bottom. One of the critical factors in the design of these structures is lateral loads from wind and waves. These loads are time-dependent and in most instances impulsive in nature. Very little attention has been given to the dynamic response of these structures.

During the first year (1968-1969) of this study, a mathematical model was developed which represents the dynamic characteristics of the interaction between individual piles and their soil-water environment. A numerical method of analysis was formulated and adapted for use with a high speed computer. During the second year (1969-1970) of this study, the dynamic response of laterally loaded model piles in stiff clay was investigated. Instrumented model piles of various diameters and embedded lengths were driven into stiff clay and tested laterally under free vibration conditions. The measured field response was compared and correlated with the response predicted by the numerical method developed during the first year of this study. Thus, the soil parameters required to achieve satisfactory agreement between field and predicted response of the model piles embedded in stiff clay were evaluated.

Project Description and Report of Work and Accomplishments

During the third year (1970-1971) of this study, the dynamic response of laterally loaded model piles in sand was investigated. Three model piles of standard steel pipe with nominal diameters of 1.25 inches, 2.00 inches, and 3.00 inches were used. All model piles were tested at a depth of embedment of 8 feet, and the 2.00 inch diameter pile was tested at a depth of embedment of 6 feet, 8 feet, and 10 feet. Each model pile was instrumented with 4 strain gage bridges and 2 accelerometers. The strain gage bridges were located 6 inches, 2 feet, 4 feet, and 6 feet below the ground surface. The accelerometers were located at the top of the pile and at the ground surface. The model piles were driven with a drop hammer in order to simulate actual driving conditions. Each pile was tested by applying a lateral load and measuring the initial displacement, then the pile was released and allowed to vibrate freely. Accelerations and bending moments were measured at the instrumented points along the pile during the vibration period. In this manner, experimental field data consisting of acceleration and bending moment versus time were obtained.

The analytical computer solution developed during the first year (1968-1969) of this study was used to predict the response of the model piles in sand. A modified Voight-Kelvin rheological model was utilized in the analytical solution to simulate the non-linear load-displacement characteristics of the soil. The predicted response of the model piles was correlated with the experimental field data. Using these correlations and laboratory data obtained from tests on soil samples taken at the test site, the soil parameters required to simulate the dynamic field response of the model piles were evaluated. Soil parameters evaluated were the soil spring constant, the soil quake, and the soil damping. It was found that the soil spring constant and soil quake greatly influence the magnitude and distribution of bending moment with depth, and soil damping is a function of pile velocity or frequency of vibration.

Funds have been allocated for the continuation of this study for one additional year. The objectives for the fourth year of this study are as follows:

1. To make full use of the computer program, limited parameter studies will be made to determine the "sensitivity" of the solution to various input data. This will insure that data which does not significantly influence the solution will receive no future research attention. It will also give the practicing engineer immediate information as to which direction and to what extent various input data can be expected to influence the solution.
2. A method for modeling the actual structure supported by the pile will be sought. To date, no work has been done on determining how this relatively important input data should be determined.

Dynamic Balance of Tidal Inlets (Research)

Activity Leader: R. M. Sorenson, Department of Civil Engineering

Most of the Texas coastline consists of barrier beaches backed by bays that are connected to the Gulf by natural and/or artificial tidal inlets. These bays are important to Texas for recreation, sport and commercial fishing, oyster farming, etc., so satisfactory connections with the Gulf are needed to provide water exchange for control of hypersalinity and assimilation of partially treated liquid

wastes, navigation routes, and passes for migrating fish. Many of the inlets on the Texas coast (e.g. Corpus Christi Pass, Brown Cedar Cut, Rollover Pass, Yarborough Pass) have had a history of silting up, rapidly eroding and/or migrating alongshore in response to the tides, wave climate, hurricane surge, longshore drift of sediment, etc. The aim of this project is to increase the level of understanding of Gulf coast inlet mechanics by field and laboratory investigations. This will lead to improved location, design and level of necessary maintenance of inlets.

Project Description and Report of Work and Accomplishments

The objective of the first year's study was to select a natural inlet on the Texas Gulf Coast and to conduct the field and laboratory studies necessary to an understanding of the behavior of this inlet. In particular, this includes the determination of the hydraulic and geomorphic characteristics of the inlet, the identification and establishment of the relative importance of the various natural processes that influence the behavior of the inlet; the evaluation of the stability of the inlet; and application of theories concerning tidal-induced flow and inlet stability to conditions prevailing at the inlet for comparison with the experimentally determined behavior of the inlet.

A survey of the literature pertaining to coastal inlets in general as well as available material on Texas Gulf Coast inlets was conducted. From this survey, Brown Cedar Cut, a natural barrier beach inlet on the east end of East Matgorda Bay was selected for detailed study. The organizations listed below were contacted to obtain specific information on Brown Cedar Cut (e.g. old maps, tide data, air photos, reports describing historical behavior, personal accounts of the inlets history). Of particular interest was information on the inlets response to specific hurricanes.

1. Parks and Wildlife Department, Austin
2. Army Corps of Engineers, Galveston District
3. Bureau of Economic Geology, University of Texas, Austin
4. U.S. Geological Survey, Corpus Christi
5. Lockwood, Andrews and Newnam, Consulting Engineers, Houston
6. NASA, Clear Lake City

Fieldwork at Brown Cedar Cut commenced during October, 1971. The field work was aimed at documenting the physical changes in the inlet in response to the wind, waves, tidal currents, longshore drift and surface runoff of precipitation. Field and laboratory work included:

1. Installation of recording tide gages at the inlet entrance and in E. Matagorda Bay and the recording of tide levels for over a two-month period;

2. Surveys of inlet hydrography on a bi-weekly basis to document changes in inlet geometry;
3. Sampling and size distribution analysis of bottom sediment samples in the inlet, the bay and offshore;
4. Measurements of tidal velocities at two-hour intervals over a complete tidal cycle (25 hours) to evaluate flood and ebb discharge and bed shear stress;
5. Drift card surveys to evaluate paths of water motion on flood and ebb tides;
6. Preliminary sand tracing studies (using flourescent tagging procedures) to evaluate critical shear stress and level of transport for different flow velocities for a sand sample from the study area.

Littoral drift rates were estimated in three ways:

1. From dredging records at Freeport harbor;
2. From wave hindcasts at Caplan, Texas in conjunction with the Coastal Engineering Research Center formula; and
3. From shoreline recession data up and down coast obtained from U.S. Coast and Geodetic Survey maps dating back to 1915 and Corps of Engineers beach surveys.

Wave data were not available so wind records for Freeport, Texas were used to estimate wave conditions.

The data from these field and laboratory studies as well as the historic and environmental data were used to develop an understanding of the behavior of this natural inlet and the relative importance of the various factors that control the inlets behavior.

The tracing studies conducted at Brown Cedar Cut were supported in part by a "seeding funds" grant from the A&M Research Council. Also, upon hearing of our inlets research activity, the Army Corps of Engineers asked us to conduct similar studies in conjunction with the cutting of a new fish pass on Matagorda Island near Corpus Christi. A proposal for support from the Corps of Engineers was submitted in August, 1971 and is currently under review.

At least twelve graduate students in Coastal and Ocean Engineering, Geology, and Oceanography assisted in various phases of the field work completely on a voluntary basis and without pay.

Scour of Gulf Coast Beaches Due to Wave Action in Front of Sea Walls and Dune Barriers (Research)

Activity Leader: R. E. Schiller, Jr., Department of Civil Engineering

The purpose of this project is to investigate scour and scour

patterns due to wave action in front of sea walls and natural beaches for conditions simulating Texas Gulf Coast beaches. During the second year of the project (Sept. 1, 1970 to Aug. 30, 1971) the objectives included:

1. Procurement and setting up of an ultrasonic distance meter to measure bottom configuration and water wave characteristics in the 3' deep x 2' wide x 120' long glass sided wave channel.
2. Equilibrium scour tests in the small (18' deep x 8" wide x 40' long) wave channel with a 40:1 beach slope and 3 seawall slopes in addition to the natural beach.
3. Equilibrium scour tests in the large (3' deep x 2' wide x 120' long) glass sided wave channel with 70:1 and 100:1 beach slopes and with 3 seawall slopes in addition to the natural beach tests. Several different waves were used in both wave channels.
4. Additional literature review after completion of equilibrium scour tests.
5. Initial transient scour tests to be made after completion of equilibrium scour tests.

Project Description and Report of Work and Accomplishments

Initial equilibrium scour tests were carried out in the small (18' deep x 8" wide x 40' long) wave channel using a 40:1 beach slope and beach sand from the beach near the mouth of the Colorado River near Matagorda, Texas. Eventually, tests in the small wave channel included seawalls with inclinations of 15°, 30°, and 90° with the horizontal as well as the natural beach tests. In the seawall tests, the seawall was located at the point of the breaking wave and tested under 4 wave conditions. Tests were also run for one wave condition with the seawall location being varied.

Tests in the large (3' high x 2' wide x 120' long) glass sided flume included beach slopes of 100:1 and 70:1 with sea walls having inclinations of 15°, 30°, and 90° with the horizontal as well as the natural beach tests for one wave condition. The seawalls were located at the point of the breaking wave in all cases. Each equilibrium test required operation of the wave generator for a period varying from 24 to 48 hours.

The ultrasonic distance meter which was procured using Sea Grant funds ($3200) was received during August, 1970, and was checked out initially during that month. Tests in the large flume were initiated in October of 1970, and additional electronic assistance was required from J. M. Bornhorst and representatives from Automation Industries, Boulder, Colorado to get the device working properly.

The device appeared to give accuracy of about 1/2% of the full range or about 0.01 feet on the 0 to 2 foot range. This device has also been used on other research projects at Texas A&M and is a much needed equipment item whenever simultaneous bottom configuration and water surface profiles are needed.

Mr. Charles Chesnutt was employed as a graduate assistant on the project until May 1971 when he completed the requirements for a Master of Science degree in Civil Engineering and was subsequently employed by the Coastal Engineering Research Center, Washington, D.C., 20016.

Mr. Won O. Song has been employed on the project since June 1, 1971, as a graduate assistant and has been engaged in a literature review and an initial series of transient scour tests in the small flume. Mr. Song is a Ph.D. candidate in Coastal Engineering.

Ocean Engineering (Education)

Activity Leader: John B. Herbich, Department of Civil Engineering

The objective of the project has been to strengthen the graduate curriculum in coastal and ocean engineering and to develop new graduate courses in this field.

The second objective of the project is to develop an undergraduate program in ocean engineering leading to a B. S. degree.

One of the significant and important objectives of the National Science Grant Program is training of qualified manpower. The well-trained and qualified manpower is essential if we are to accelerate development of marine resources. There is at present a shortage of qualified coastal and ocean engineers as based on (a) contacts with industry, (b) salary needs offered to graduates in coastal and ocean engineering.

The specific objectives of the project was to continue development of three new courses:

1. C.E. 682 - Coastal Sediment Processes
   Dr. R. M. Sorensen
2. C.E. 683 - Estuary Hydrodynamics
   Dr. R. Dominguez
3. C.E. 688 - Shallow and Deep Water Dredging
   Dr. J. B. Herbich

C.E. 682 and C.E. 683 were offered during the Spring Semester of 1971.

One new course is being developed, entitled "Engineering Aspects of Coastal Zone Development." It was offered for the first time during the spring semester of 1971 under C.E. 685 - Problems.

The following courses were modified and strengthened:

1. C.E. 675 - Coastal Engineering I
2. C.E. 677 - Coastal Engineering II
3. C.E. 676 - Ocean Engineering
4. C.E. 686 - Design and Analysis of Offshore and Coastal Structures
5. C.E. 687 - Marine Foundation Engineering

Several of the graduate students who were not participating in a sponsored research project conducted thesis research in coastal and ocean engineering as part of this program.

Project Description and Report of Work and Accomplishments

Graduate Curriculum. A major effort was directed toward further development of a graduate curriculum in coastal and ocean engineering. A program has now been firmly established and is becoming nationally known. Eight educators of professional rank are now teaching in this program on part-time basis.

Undergraduate Curriculum. A University Committee was established to investigate the possibility of offering a separate new program in ocean engineering. A sub-committee has now developed and agreed upon a curriculum in ocean engineering leading to a B.S. degree. The graduate program has also been outlined and a proposal for establishing a B.S., M.S., M. Eng. and Ph.D. degree programs is in the final stages of preparation. The proposal will be sent through the administrative channels to the Coordinating Board of Texas.

Presentations at High Schools. Dr. Herbich spoke at the Career Day at Duncanville High School about coastal and ocean engineering, and Dr. Sorensen made a presentation on ocean engineering at the JETS meeting at South Houston High School.

In addition, tours for high school students were conducted through the Hydromechanics Laboratories.

Seminars. Several seminars were presented by invited speakers from industry, these included a talk by Mr. W. F. Manning, Mobil Research and Development Corporation, Mobil Oil Company, Dallas, titled "Remarks on Some Offshore Structure Problems" and a talk by Dr. L. R. Russell of Fluor Ocean Services, Inc., Houston, on "Probability Distribution for Hurricane Effects."

Ocean Engineering Curriculum. Three surveys were conducted concerning the ocean engineering educational programs:

1. Ocean engineering programs (existing, or under development),
2. Industry's interest in ocean engineering education programs, and
3. Manpower needs in marine resources.

All of these surveys proved to be of great value in curricula development.

Course Notes. The course notes for new courses were prepared and assembled by several faculty members. Some of the notes will be published as textbooks. There has been a shortage of published notes or textbooks in coastal and ocean engineering and this effort is aimed at remedying this situation.

Development of an Automatic Marine Coring Unit (Research)

Activity Leader: E. I. Bailey, Department of Mechanical Engineering

Upon request of several geophysical organizations, a program was initiated at Texas A&M University under the Sea Grant Program to design a self-contained automatic seafloor setting corer. Work on the project began in February, 1970, and the first phase was completed in August 1970.

The Texas A&M Automatic Marine Corer Design, which resulted from this effort, will extract 49.5 ft. of 3 in. diameter core in eleven sections. The unit will be octagonal in cross section measuring 6 ft. side to side and 12 ft. in height. The unit will weigh 10,000 pounds dry, displace 2,000 pounds of water, and will be lowered to the ocean floor by a single power-tension cable. An automatic control system will be contained in the unit with shipside manual control available at any time.

Beginning in September, 1970, refinements were made to the existing designs of elements with the coring unit to facilitate construction and to increase the life and reliability of the unit. Some of the critical parts within the unit were machined and tested with modifications being made where necessary. The designs and specifications of support equipment were made to complete a usable system for obtaining long, undisturbed cores. Maintenance procedures were developed and lubricants were recommended for use in the seawater environment.

Upon completion, this coring unit will provide a heretofore unavailable service to all geophysical concerns desiring cores of the ocean floor, whether it be for mining, geological, or soil mechanics interest.

Project Description and Report of Work and Accomplishments

Upon request of several geophysical organizations, a program was initiated at Texas A&M University under the Sea Grant Program to design a selfcontained automatic seafloor setting corer which would:

1. Extract up to fifty feet of continuous undisturbed core.
2. Core in both hard and soft material.
3. Operate in depths of up to 1,000 feet of water.
4. Be as compact as possible to facilitate shipboard handling.

Work on the project began in February, 1970, and the first phase was completed in August, 1970.

The Texas A&M Automatic Marine Corer design, which resulted from this effort, will extract a 3 in. diameter core 49.5 ft. long in eleven sections. The unit will be octagonal in cross section measuring 6 ft. side to side and 12 ft. in height. When the unit reaches the ocean floor, four legs will fold down and level the unit on slopes up to 15°. The unit will weigh 10,000 pounds dry, will displace 2,000 pounds of water, and will be lowered to the ocean floor by a single power-tension cable. An automatic control system will be contained in the unit with shipside manual control available at any time.

A drill pipe fitted with a ring type core bit will be rotated under a considerable thrust load while water is pumped down the center of the drill pipe to wash the cuttings back up the annulus. The water will be routed through the double-walled bottom joint around the core barrel so that the sample will not be washed. A square rod extending from the top of the coring unit will retain the rotation of the core barrel, and will provide the means for retrieving the sample for storage. The square rod will also support a piston in the core barrel thus affecting "fixed piston" coring.

Hydraulic power will be supplied within the unit by a 10 horsepower electric motor driving two pumps. One pump will operate a hydraulic powerhead to produce 1,000 ft-lb. of torque on the drill pipe string. The other pump will operate all of the hydraulic cylinders on the unit plus the hydraulic winch which will provide 6,000 lb. of thrust or pull on the powerhead.

The preliminary design was completed in August, 1970. Much of that design showed principle only, as intended, and did not represent

a final design effort. Some of the parts required a complete design. A thorough review of the preliminary design was required to insure that all of the parts would fit together and that the various mechanisms would not interfere with one another. Designs and specifications of systems and equipment external to the coring unit were also needed to present a complete coring system design. This work was done during the second phase of the project.

Phase II was mainly concerned with the refinement of the existing design-making modifications and additions which would facilitate construction and increase the life and reliability of the unit. It included the construction and testing of one each of multiple parts to minimize the possibility of multiple errors in the construction of the prototype. Efforts were also made to incorporate design changes which would reduce the machining and fabrication time of the unit. Additional detail drawings were made to complete the set of shop drawings needed for construction.

The preliminary design of a winch and A-Frame assembly for handling the coring unit was included in Phase II of the project. The establishment of design parameters was of primary importance since much of the detail design work will be done by the suppliers of the various pieces of equipment to be used in the system. The equipment required includes:

1. A power-tension cable,
2. A self-powered winch with a line tensioning device,
3. An A-Frame complete with skidded foundation for supporting the coring unit and the winch.

Other work done during Phase II included the specification of lubricants and maintenance procedures to be used in the operation of the unit.

Short Courses in Coastal and Ocean Engineering (Advisory)

Activity Leader: John B. Herbich, Department of Civil Engineering

The objectives of this report are to provide continuing education to practicing engineers engaged in coastal and ocean engineering field. There is a continuing need for practicing engineers to refresh their knowledge and to be informed of new developments. This is particularly true of those working in coastal and ocean engineering, since the majority of engineers working in the field received their training and their degrees in an engineering field

other than coastal or ocean engineering.

Project Description and Report of Work and Accomplishments

The course notes for short courses given by the Coastal and Ocean Engineering division, or by the Center for Dredging Staff are prepared and are made available to short course participants. This information is not available in any given reference book, but it is scattered in many research publications, technical reports, or generally not available.

Two short courses were given.

1. Dredging Theory and Applications, a course of one week duration (January 11-15, 1971). Sixty-five participants were accepted to attend this course. Dr. R. M. Sorensen of the Coastal and Ocean Engineering Division was the short course director.
2. Coastal and Ocean Engineering, a course of two weeks duration (August 2-13, 1971). Forty-one participants attended this course. Dr. J. B. Herbich of the Coastal and Ocean Engineering Division was the faculty member in charge of this short course.

Dredging Theory Application. Four coastal and ocean engineering division faculty, Drs. Basco, Herbich, Schiller and Sorensen were involved in lectures and laboratory demonstrations. They were joined by two invited lecturers: Mr. T. M. Turner, vice president of Ellicott Machine Corporation, Baltimore, Maryland and Mr. R. A. Denning, Assistant Chief Marine Division, North Atlantic Division, Army Corps of Engineers, New York, New York. A course outline is appended to this report.

Coastal and Ocean Engineering Short Course. The short course instructors included the following faculty: Drs. Basco, Dominguez, Herbich, Schiller, and Sorensen (coastal and ocean engineering division), Drs. Bailey and Sweet (mechanical engineering department), Dr. Franceschini (meterology and oceanography departments), Dr. Bryant and Mr. Reid (oceanography department), Drs. Lowery, Martinez and Ross (structural engineering division, and Dr. L. D. Webb (materials engineering division). The invited lecturers included Mr. W. H. Bauerschlag, Executive Staff, Marine Division, Brown and Root, Inc., Houston; Mr. B. C. Gerwick, Jr., Executive vice president, Santa Fe-Pomeroy, Inc., San Francisco; Mr. G. E. Graybeal, Earth Observation Division, Manned Spacecraft Center, NASA; and Mr. B. McClelland, President, McClelland Engineers, Inc., Houston.

Complete course notes were prepared for the course. One set of course notes of the Dredging Short Course and of the Coastal and Ocean Engineering course has been submitted to the Sea Grant Office for its library.

Training of Marine Science Technicians at Del Mar College (Training)

Activity Leader: R. J. Williams, Del Mar College, Corpus Christi, Texas

This project provided the freshman year of training for a "trailer" group of Marine Science students. The initial group was funded through Sea Grant Project Support by the National Science Foundation under a charge to develop a Marine Science Electronics curriculum and train a pilot group of students.

The objectives of this project have been:

1. Provide continuity of Marine Science technicians training at Del Mar College.
2. Analyze the curriculum and revise where indicated by knowledge obtained by experience.
3. Provide "work experience training" for the Marine Science student.
4. Provide marine science training opportunities for U.S. Navy personnel in the ADCOP program.
5. Screen, interview, and test applicants and Marine Science students by professional counselors to ascertain any personality patterns of applicants and students.
6. Join with Corpus Christi area educational institutions and public agencies in the interchange of information pertaining to marine related activities.
7. Seek cooperation with other Sea Grant supported activities for the joint use of facilities (including vessels).
8. Demonstrate support of the regionally coordinated Sea Grant effort concept by cooperating with Texas A&M University.

Project Description and Report of Work and Accomplishments

There was not any publicity that this program would be offered in the fall of 1970 because of a delay of authorization on the part of Del Mar to proceed. Prospective students for the program who did apply could not be given a definite decision on whether the project would proceed. The authorization to proceed was given on the second day of registration for the fall semester, 1971. Despite the delay there were twenty-three (23) acceptable applicants to the program which indicates strong community interest in the program.

A change in curriculum concept was conceived and initiated. The previous Marine Science-Electronics curriculum was rigid and specified all courses to be taken over a two year period and provided for 16, 17, or 18 credit hours each semester. This allowed no latitude for reduced student course load or a "make-up" slot for a missed or failed course. Also, the marine science electronic opportunities in the Corpus Christi region are rather limited, whereas there is diverse activity in the biological and geological sciences. The new curriculum was flexible in the sense that the student was given minimum hour requirements in various disciplines. To be eligible for the Associate Degree, the student must complete 29 semester hours out of the 33 hours offered in Marine Science. He must also select a minor in the natural sciences/engineering technology and complete 28 hours in the chosen minor. Other requirements included 9 hours in college mathematics, 6-9 hours in English, 3-12 hours in history/government. The total hours required for the Associate degree was reduced to 78 hours. The need for a coordinated, unified program was satisfied by requiring the student to submit a "degree plan" for approval before the beginning of his second semester. Twenty-one (21) students filed degree plans. The flexible curriculum concept is considered a success.

Professor T. J. Lambertson, P.E. was assigned full time faculty duties with the Marine Science program. The beneficial effect of providing a full time, qualified Marine Science Technology professor was evidenced by the successful completion of the first semester by twenty-one (21) students.

Two laboratories in the Flato Technologies Building at Del Mar College have been designated as "Marine Science Laboratories." One is specified as a Marine Science Chemical Laboratory and includes, besides standard chemistry hardware, a digital readout pH meter, a gas chromatograph, and a polargraph. The other laboratory has been specified as an Instrumentation Laboratory and includes an instrumented twenty-four (24) foot-two dimensional wave tank and three (3) salt water acquariums for the support of marine life collected by students on field trips.

Field trips for the purpose of gathering marine life specimens and water analysis were conducted aboard the R/V EXCELLENCE in cooperation with the Civil Engineering Department at Texas A&M University. The cooperation of the two institutions was outstanding, and these field trips are considered a success.

Arrangements were made for a visit to the R/V EXCELLENCE by the Marine Science classes from four (4) area high schools. The students displayed a high degree of interest.

A continued effort has been made in the area of public relations by the release of news items to the local media. The local radio,