SEA GRANT PROGRAM ANNUAL REPORT 1970-71

TAMU-SG-72-104

Texas A&M University Sea Grant Program

January 1972

CENTER FOR MARINE RESOURCES / Texas A&M University

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SEA GRANT PROGRAM OPERATIONS 1970 - 71

The Sea Grant Program at Texas A&M University began September 1968 as one of the first six institutional awards with a grant of $475,000, from the National Science Foundation. Since that time more than $5.8 million have been directed to the program through institutional contributions and federal funding, currently awarded by the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. It has been one of thirteen broad-based institutional marine programs in the nation and one of the first to become a Sea Grant College.

Modeled after the Land Grant Program, the Sea Grant Program of the university is aimed toward the development of marine resources through education, research and advisory programs. It has been established as a distinct major program of the university, under the supervision of a university vice-president, and has the strong backing of the university administration. The active support of the university administrators is demonstrated by the fact that contributory costs are allocated through existing budget channels. Appropriations from the Legislature amounting to $200,000 a year for 1970, 1971 and 1972 have been obtained for the Sea Grant Program as a line item in the state budget.

Its third year of effort was climaxed with the designation of Texas A&M University as a Sea Grant College by Secretary of Commerce Maurice H. Stans, September 7, 1971.

This past year's accomplishments contributed greatly toward this honor. They can best be considered through a review of the Sea Grant Program's relationship to:

1. The total university program in marine resources,
2. The statewide community,
3. Other educational institutions and industry and
4. Its internal organization.

The University Program in Marine Resources

Marine related activities are found throughout the ten colleges and many major organizational units. Three major components -- the College of Marine Sciences and Maritime Resources, the Center for Marine Resources, and the Department of Oceanography -- can be identified, however. On the Texas A&M campus the major portion of the

marine-related activities and 90 indirectly related were offered throughout the campus, an increase of 18 percent and 34 percent respectively over the 1970-71 academic year.

The total annual operations for marine-related programs at Texas A&M University are estimated at $5.1 million during 1970-71. Sea Grant funding alone for that same year amounted to almost $1.8 million.

College of Marine Sciences and Maritime Resources. Of the university's total marine program expenditures, approximately 30 percent are directed toward work in Galveston. Marine-related programs there have been grouped under the new College of Marine Sciences and Maritime Resources which was established September 1971 in Galveston. The new arm of the university was made possible through legislation introduced in the 62nd Legislature by Senator A. R. Schwartz of Galveston and Representative Bill Presnal of Bryan. It included the:

Texas Maritime Academy
Moody Marine Institute
(Galveston Marine Laboratory)
Coastal Zone Laboratory

The College is located on Pelican Island in Galveston on a 100-acre site given to the University by the George P. Mitchell family. It is the nation's first such installation on the Gulf of Mexico.

The Texas Maritime Academy, established in 1962, offers Bachelor of Science degrees in marine transportation, marine engineering and naval science to an annual enrollment of almost 100 cadets. Training vessel for the Academy, the only one on the Gulf coast and the newest of the nation's six accredited maritime academies, is the 15,000-ton converted ocean liner, *Texas Clipper*.

The Moody Marine Institute served as a focal point for coordination of work with other institutions and industries in the area and for the execution of interdisciplinary programs. The Galveston Marine Laboratory, a major component of the Institute, has offered during this past year resident work toward the Master of Science degree in marine biology as well as undergraduate training and technical training in fisheries biology and engaged in a variety of marine and biological research areas. Many students did thesis work in the Galveston laboratories or on vessels operating out of or in the Galveston area. Resident degrees on the Master's level will soon be available. Enrollment figures for the 1970-71 academic year are given below:

Fall 1970	17	(10 M.S.; 7 Ph.D.)
Spring 1971	28	(19 M.S.; 9 Ph.D.)
Summer 1971 (1st term)	70	
Summer 1971 (2nd term)	53	

Summer 1971 enrollment figures are the largest that the laboratory has experienced since the initiation of the resident teaching program in 1964.

Recently a plan for the reorganization of the activities of the Moody Marine Institute and the Galveston Marine Laboratory was approved by the President of the University and the Dean of the College. Those activities falling within the realm of the Galveston Marine Laboratory are to be assigned to two departments which are to be formed. New activities will be added, bringing the total to five within the soon to be created Moody School of Marine Affairs.

The Coastal Zone Laboratory is the first in what will become a chain of laboratories along the Texas coast, serving as centers for interdisciplinary applied research in bay and estuarine systems. In Galveston, the laboratory will focus on problems unique to this area, functioning in much the same way as agricultural experiment stations have served as regional research units.

The academic program of the College of Marine Sciences and Maritime Resources is now in the planning stage. Joint programs are being developed with many of the College Station campus units, including engineering, fisheries science, and oceanography.

Center for Marine Resources. The Center, based in College Station, was established in the spring of 1971 to administer broad programs of marine resource development, including the Sea Grant Program. It serves as a center for information on marine activities and includes the Department of Marine Resources Information and Department of Marine Advisory Services (see Figure 1).

The purpose of the Center is to provide a coordinating mechanism for marine programs which are interdisciplinary in nature, to identify potential program areas, to assist in proposal preparation and to advise on possible sources of funding. The major program administered by the Center is the Sea Grant Program.

Detailed descriptions of the activities of the Center are contained in the section on "Organization of the Program" presented on page 11 of this report.

The Department of Oceanography. The Department of Oceanography, established in 1949, is the fourth oldest in the nation with a complete academic program in oceanography. Texas A&M University is the only university in the state with ocean-going research capabilities operating four vessels ranging in size from 39 feet to 186 feet. A new vessel will be ready for operation in the spring of 1973. Called an AGOR (Auxiliary General Oceanographic Research/Utility) vessel, its overall length will be 165 feet and will accommodate 28 persons, including scientific party and crew. It is unique in that it is constructed to house any one of ten mobile laboratories constructed as vans which may be placed on the vessel as needed. Since its establishment, the department has granted approximately 192 graduate level

CENTER FOR MARINE RESOURCES

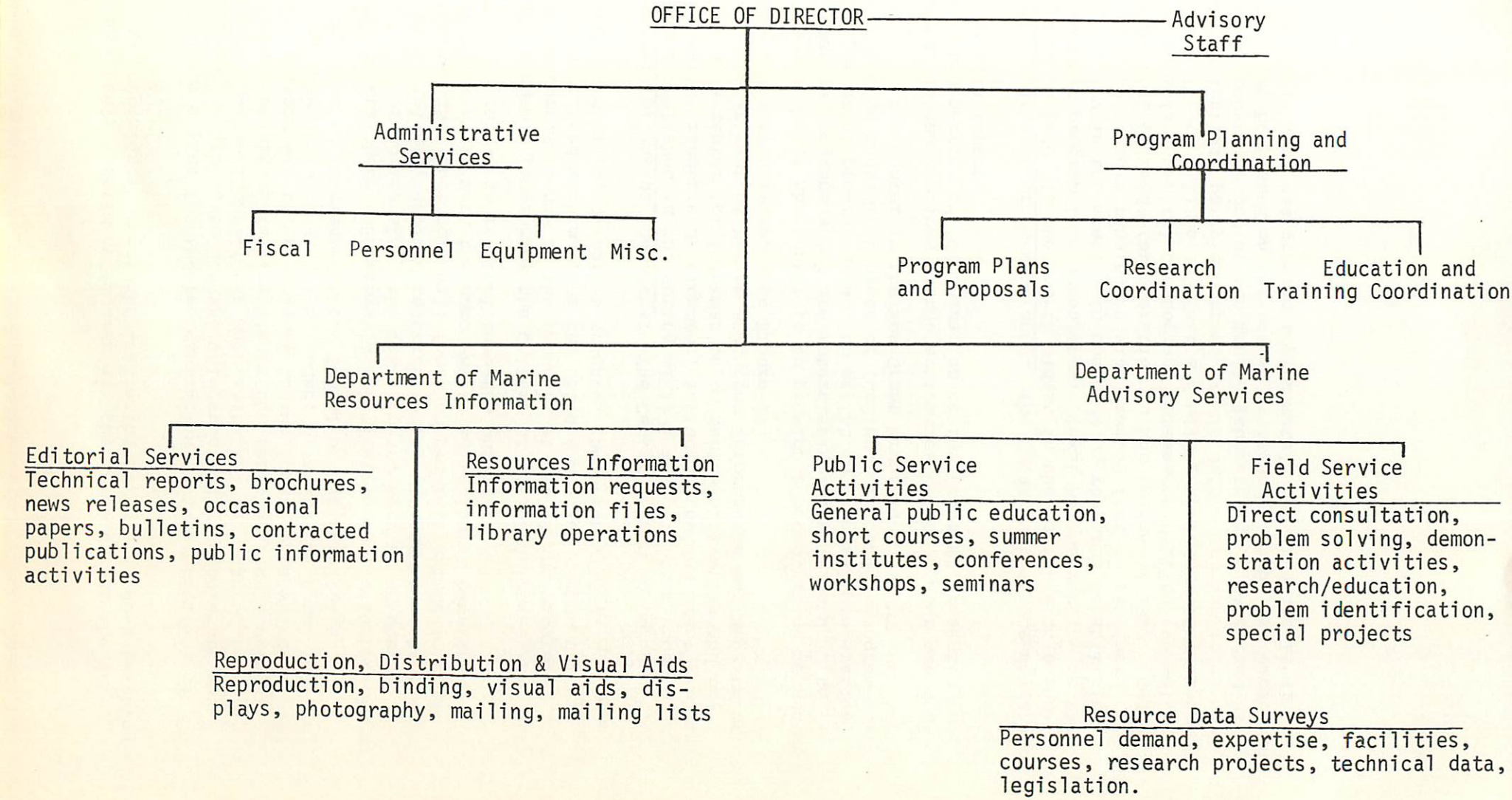

FIGURE 1

degrees. Construction has begun on an $8 million, 14-story oceanography and meteorology building on the College Station campus. It is expected to be completed in September 1972.

Other University Units. Organizational units on the campus which exist for non-marine reasons also have programs in marine affairs. In the College of Engineering, a number of divisions and departments have marine-related competence such as the fish protein pilot plant and the Morgan's Point Water Pollution Research Laboratory on the Houston Ship Channel. In addition, sophisticated equipment used in marine-related investigations are continually being developed. The College of Agriculture conducts a number of programs related to marine affairs, particularly in the fisheries and land-use areas. In Brazoria county, the Texas Agricultural Extension Service has developed a mariculture facility consisting of some 20 ponds, a mobile trailer laboratory, marsh buggies, and analytical laboratory facilities. These, along with 6 ponds located in Orange county, provide the largest array of ponds on the Gulf coast designed specifically to research and demonstrate the potential of shrimp culture. The Aquatic Animal Medicine Laboratory, operated by Texas A&M University's College of Veterinary Medicine, is investigating fish diseases that threaten aquaculture operations. The Department of Biology of the College of Science has a component which is oriented toward marine biology, although there is no specific degree offered in this field.

Within the College of Business Administration three projects were supported by the Sea Grant program this past year. In cooperation with the Department of Finance a degree program in the management of marine commerce and industry was developed; an analysis was made on the distribution of seafood products; and an experimental study of seafood merchandising practices among food retailers was conducted, the latter two through the Marketing Department.

A study regarding the feasibility of an offshore terminal for use by deep-draft superships which are unable to enter existing channels and harbors because of water depth limitations was also given support by the Sea Grant program during this third year through the Industrial Economics Research Division of the University. Through an agreement with the South Texas Regional Export Expansion Council specific areas of research and schedules of activities needed for development of such offshore facilities were identified. Funds for the study were supplied by the Sea Grant Program along with equal contributions from the ports of Freeport, Galveston and Port Arthur.

A summer institute for elementary and junior high school teachers interested in coastal zone problems was held at the Agricultural Research Station in Beeville, Texas through the joint efforts of persons from the Corpus Christi area and staff from the Department of Curriculum and Instruction. The Institute involved classroom lectures, workshops and numerous field trips of the surrounding area.

The Sea Grant program has produced a university-wide involvement;

it has created a campus-wide force that applies the maximum university resources on the Sea Grant goals. This is evidenced by the large number of ideas that are brought to the attention of the Sea Grant Office; by the joint working groups which have formed either for research or for educational programs; by the personal interest of every dean on campus; and by the willingness of operating units to recast their programs so that the Sea Grant contributory funding provisions can be met.

During the 1970-71 funding year more than 158 university staff and faculty members were involved in Sea Grant sponsored activities. Forty-five students were actively supported by Sea Grant in their research activities. The result has been a broad program which reaches into 22 departments of divisions in nine of the University's 10 academic Colleges. In addition, staff members and students from other schools and universities as well as industrialists have worked on Sea Grant supported projects.

The Statewide Community

Marine resources questions are very lively topics for discussion in Texas. The Sea Grant Program in the state has played an active and dominant role in the emergence of this subject as one of broad public concern. Public officials now see possibilities for program sponsorship in the area of marine resources. Virtually every prominent Texas State official has made a statement of public record on this matter.

The State Involvement. During the 61st Legislature, 1970, the Interim Committee of the House of Representatives, chaired by Rep. Ray Lemmon, was established to consider the needs of the State of Texas for an Institute of Oceanography. The Sea Grant Program had no formal ties to the hearing of this Committee, but individuals within the Program were called upon to supply background information. A project to the House Interim Committee was awarded by the Texas A&M University Sea Grant Program for funds to support dissemination of information resulting from its hearing.

At the Committee's first meeting, the members unanimously agreed that no decision regarding an Institute of Oceanography could be reached without a broad understanding of Texas involvement in marine-related affairs. Seven public hearings were held, at which time spokesmen from all areas of marine-related economy, from coastal towns and cities, and from academic institutions were provided an opportunity to communicate their thoughts and desires. Testimony indicated that Texas already has a critical economic dependency on the world oceans and, more specifically, on the Gulf of Mexico, and that proper preparation for the future could bring Texas far larger benefits from ocean and coastal development. Visits by Committee members to the coastal areas under study verified the magnitude of coastal

problems thus leading the Committee to the conclusion that the question of an oceanographic institute should be deferred in favor of the pressing priorities of coastal and marine-related development. They did recommend, however, the establishment of a Texas Council on Marine-Related Affairs to provide the Legislature, the Governor, and the people of Texas with a source of experienced judgment and advice. This Council would serve as a forum where lawmakers could join with experts in marine affairs to plan the State's future as the nation's leading coastal state.

The Committee called upon the Sea Grant Office for assistance in preparing its report which was presented to the 62nd Legislature. To further the efforts of this Committee a new committee was recently appointed in accordance with H.S.R. 57, called Coastal and Marine Resources Interim Study Committee. This committee will again be chaired by Representative Ray Lemmon.

As yet the Texas Council on Marine-Related Affairs has not been established although the Legislature passed a law to create it. A Sea Grant Advisory Council for Texas, however, was recently formed by Texas A&M University President Jack Williams. Recognizing the breadth of interests to be served by the Sea Grant Program, he invited 12 selected citizens of the state to serve. Members of the Council are:

William McIlhenny, Dow Chemical Company, Freeport
(Chairman)
Robert L. Armstrong, Land Commissioner, State of
Texas
Nick S. Campise, Division, Inc., Houston
Al Cisneros, Brownsville Navigation District,
Brownsville
Clarence Cottam, Welder Wildlife Foundation,
Sinton
Emmett Fields, University of Houston, Houston
Levan Griffis, Southern Methodist University,
Dallas
Frank Hildebrand, Texas Tourist Development Agency,
Austin
John A. Mehos, Liberties Corporation, Galveston
William Price, Central Power & Light, Corpus Christi
Albert K. Sparks, National Marine Fishery Service,
Galveston
Dow Wynn, Port of Port Arthur Navigation District,
Port Arthur

His statement of purpose said, "I am asking the Sea Grant Advisory Council for Texas to provide advice directly to me and to the Director of the Sea Grant Program at Texas A&M University concerning any aspect of the program which the Council may wish to consider. Of particular interest to us will be your estimate of the quality of the Sea Grant Program, its response to needs of the state, its relationships

with government agencies and industries, its use of worthy talents at other universities, and its administration. We would expect that the Council may wish to meet two or three times a year to hear presentations about the program or to discuss its progress."

The University has continued to work with the Office of the Governor and the Interagency Natural Resources Council in the State's Coastal Resources Management Program., Funded by the State for $100,000 in 1970-71, the Program defined several research areas critical to coastal zone management decisions. Three of these projects have been given to researchers at Texas A&M University to carry out. Center personnel have been active in stimulating interest in this area and have provided the means to identify key research personnel for implementation of the State's coastal zone management plan.

Center personnel have also been instrumental in the development of a state plan for environmental education. Staff members have met with representatives of the Governor's office and the Coordinating Board for Higher Education to provide university input into a statewide plan to create greater public awareness of the environment.

The State of Texas has been kept well-informed of the progress of the Sea Grant Program at Texas A&M University to include its function as a Sea Grant College.

At the local level, the Sea Grant Program has been actively involved with city and county leaders. In Galveston Sea Grant responded to the need presented by the Ocean Affairs Board for assistance on the Coastal model city plans. In Brownsville and Port Arthur Sea Grant researchers and advisory personnel have worked with port and trade leaders. In Brazosport, Sea Grant has encouraged private and municipal support for mariculture. In Houston Sea Grant made the first marine science and engineering awards to high school students. And all along the Texas Coast, Sea Grant has stimulated and promoted marine affairs.

This then is a clear indication of the significance of the Sea Grant Program and its role in the overall efforts of the State toward the development of its marine resources.

Other Educational Institutions and Industry

The emergence of the Sea Grant Program also has stimulated concern for marine resources programs among other educational institutions of the State. The Sea Grant Program Office of Texas A&M University has maintained an awareness of the development, has assisted some of them with project funds, and has initiated efforts to coordinate programs. The program has made definite progress in these respects.

The Institutional Involvement. During the third year of operation

of the Sea Grant, Texas A&M University agreements were executed with six institutions for programs in law and technician training. Existing cooperative projects at Texas State Technical Institute and the University of Houston were continued and new projects begun at Lamar State College of Technology, Brazosport Junior College, Del Mar College and Texas A&I University.

Shown below are the levels of funding and a brief description of the projects:

	Federal	Contributory	Description
Texas State Technical Institute	19,000	10,233	Technical Training
University of Houston	25,000	14,913	Law and Marine Resources
Lamar State College of Technology	21,023	14,587	Marine Sedimentation
Brazosport Junior College	12,000	6,630	Technician Training
Del Mar College	36,000	23,506	Technician Training
Texas A&I University	4,249	6,375	Summer Workshop (Marine Ecology)
	$117,272	$76,244	

As a cooperative project with Texas A&M University, Bates College of Law at the University of Houston is developing the Institute of Coastal and Marine Law. This consortium of Texas law schools is designed to be a vehicle for obtaining top legal minds to implement the state's Coastal Resources Management Program. 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 the development of a regular course in Environmental Law to be offered for the first time in 1972 and numerous publications.

The Industrial Involvement. Cooperative projects and support for Sea Grant activities involving industries have increased during this third year of operation.

A cooperative project concerning shrimp culture research with Dow Chemical Company was initiated with Federal funds amounting to $32,000, and institutional support of $16,000 totalling $48,000.

In mid-June an advisory committee composed of shrimping and shrimp gear experts, an electronic specialist and staff members of the Southwest Research Institute was established to perfect and demonstrate an electronic net monitoring device that will offer the continental shelf shrimp fisherman the same catch discrimination capabilities that the "Thumper string" gives the bay shrimper. This activity was initiated with Federal funds amounting to $12,100 and institutional support of $6,450 totalling $18,550.

During the year support was received from various industries and organizations amounting to over $130,000.

INVOLVEMENT OF INDUSTRY AND GOVERNMENT

Industrial Support	1968-69	1969-70	1970-71
Well Reconnaissance Inc. of Dallas (Dr. Arnold H. Bouma)	1,050	3,950	
Oceanonics, Inc. (Dr. Edmund Bailey)			1,400
J & J Marine Diving Co. (Dr. W. P. Fife)			4,000
A. B. Silchenstedt Shrimp Net Monitor (Dr. Phillip Oetking)			6,450
Electro Film, Inc. (Dr. Arnold H. Bouma)			10,000
Atlantic Richfield (Mrs. Leatha Miloy)			100
Nueces County Navigation District (Mrs. Leatha Miloy)			100
Chevron Oil Company (Dr. Richard Geyer)			
Gulf Oil Company "			
Mobil Oil Company "			
Phillips Oil Company "			
Superior Oil Company "			
Humble Oil Company "			
Marathon Oil Company "			
Sun Oil Company "			20,000
Other Support (Including Governmental Agencies)			
Galveston Community College	600		
City of Galveston			5,000
South Texas Regional Export Expansion Council			10,000
Interagency Natural Resources Council	3,500		
Interim Study Committee on Oceanography (Texas House of Representatives)			5,000
Brazos County Mosquito Control District		12,900	59,201
Regional Education Service Center			3,400
Governor's Office, State of Texas			1,500
Link Foundation			1,000
Moody Foundation			2,000
	5,150	16,850	129,151

Organization of the Program

The Center for Marine Resources Administers the Sea Grant Program. Essentially the Center for Marine Resources constitutes a renaming of the Sea Grant Program Office as described in previous annual reports. The new name reflects the general nature of the activities to be undertaken by the Center but the Sea Grant Program remains the primary responsibility.

The Center for Marine Resources carries out several functions on behalf of the program. Program management functions are headquartered here, under the direction of Mr. Willis H. Clark, Assistant Director of the Center. Mr. Allen Martin, Sea Grant Program Associate, performs general grant administration with emphasis on fiscal, personnel and facility matters. Coordination of education, research and advisory projects is also the responsibility of the Center. Research coordination is accomplished through the director and assistant director. Educational projects are coordinated by Mr. Roger Anderson.

Advisory services projects are supported by the Department of Marine Resources Information and coordinated by the Department of Marine Advisory Services.

The Department of Marine Resources Information is responsible for providing timely and useful information to marine resources developers and users. It is a major operation within the Center and is an important element of the Sea Grant Program. A comprehensive documentation project within the Department is concerned entirely with the preparation, printing, and distribution of the university's marine resource publications series, and for the coordination of information aspects of workshops, conferences, exhibits and similar functions. The Department operates as an originating source of publications and articles, and provides an editing service in connection with the documentation needs of all Sea Grant participants. Five professional staff members and five clerical personnel make up the Department.

Publications include general informational documents, technical reports, brochures and announcements, occasional papers, bulletins, technical papers, news releases and photo documentation. Reports and newsletters are distributed to special interest groups, state/national lay leaders and professionals and the mass media. Public schools and civic groups are also a prime target audience. In the General Information series, 5,000 persons receive material approximately 10 times a year. Three hundred persons receive specialized reports as they are prepared.

During the 1970-71 grant year, approximately 50 publications were produced and distributed through the Department. An additional 75-100 news releases and special features were prepared for the mass media. On

behalf of the national Sea Grant Program, the Department prepared a Sea Grant exhibit for the 1971 Offshore Technology Conference, and in October 1970, the State Fair of Texas devoted an entire pavillion to materials accumulated through Sea Grant efforts from various state and federal agencies as well as industry. This "Oceanus" pavillion was viewed by more than 300,000 persons and was held over for special showings to public school children and civic groups. A large three-dimensional display of the "Food Chain of the Sea", prepared by the Sea Grant Program for "Oceanus" is now on permanent display at the Junior Museum of Natural History in Bryan, Texas. In June, 1971 the Department sponsored a Marine Science Writer's Briefing in Galveston. Writers and journalists attending were present and with *Texas and the Gulf of Mexico* - a looseleaf compilation of facts and figures relevant to the Gulf and its impact on Texas. A unique documentary film, called *Seascape*, was recently completed and is available on a loan basis to civic organization, schools and staff and faculty of the university. To date the film has been shown to almost 2,000 viewers and has been presented on two television stations within the state. A review and documentation of activities of Sea Grant institutions across the nation is presented through *Sea Grant 70's* which also includes abstracts of recent Sea Grant publications.

The Department of Marine Advisory Services deals in public service activities such as short courses, summer institutes, conferences, workshops and seminars, resource data surveys and field service activities involving direct consultation, demonstration activities and special projects. To date workshops involving more than 1,000 persons were held preliminary to the state's first major ocean conference, *Goals for Texas in the Coastal Zone and the Sea*, which was co-sponsored with the Office of the Governor of Texas. This Department serves as a coordinating mechanism for marine advisory projects which, in the third year, were conducted in ten departments of the University, two other institutions and two non-university groups.

The process of organizing the Sea Grant Program has included the matters of defining marine resources, establishing the subject matter needs to be worked on, providing a structure under which the various program elements can be compared and evaluated, and creating administrative and service activities to support project workers.

The original approach to organization of the program has been essentially the same as that used in other institutions. A call was made for proposals and projects were initiated by faculty and staff members interested in marine resources, the new result being essentially a package of project ideas. As the program has grown, it has moved in the direction of a directed program made up of projects responsive to goals that have been enunciated. New projects of higher priority are replacing some of the initial projects. The program is evolving into a coherent attack on well defined problems.

Program coherency has not been achieved yet in the academic sense. There is no organized body of knowledge that can be called marine resources. The term does not have a standard meaning. Moreover, there are incompletely defined bodies of knowledge related to marine fisheries, marine transportation, marine recreation, and other component parts of marine resources. This lack of knowledge has been a deterrent to the organization of the Sea Grant Program. Solving this problem is one of the principle challenges facing the program. An academic identity for marine resources must evolve and organization of the Sea Grant Program will not be complete until the identity has been achieved.

Nor has coherency of the program been possible because of an identifiable community known as the "marine resource industry", a marine resource government entity or a unique professional society concerned with this subject. One of the first major tasks undertaken was that of identifying the several industries, state agencies, and other groups playing a role in this field. They were found to be many and diverse. Each has its own point of view. It is not surprising that each and every coastal region of the nation is different from any other with respect to the details of its marine community. This became obvious as more key persons in Texas marine resources were identified.

It has fallen to the Sea Grant Office itself, therefore, to enunciate the program organization and to develop a structure into which will fit the concerns expressed by resource users as well as the projects proposed by academic groups. This has been an evolutionary process leading to six major program areas:

Marine Fisheries	Marine Environmental Quality
Marine Commerce	Marine Engineering and Technology
Marine Sciences	Marine Resources Management

In addition to these areas, program management and direction activities have continued. During 1970-71, too, the basic plans for Coastal Zone Laboratories have been developed. Each of these programs has been developed and expanded during the 1970-71 year.

The eventual goal of each program is to obtain results that can be used for making decisions with respect to marine resources or for increasing the value of these resources in economic or other terms. The following sections of this report deal with these programs in greater detail.

Within each of the eight major program areas enumerated, there are specific projects identified in the educations, reserach and advisory service categories. In developing the Sea Grant Program, increasing attention has been paid to education and advisory projects. Research activities will have a resurgence when the need for new knowledge becomes better defined. In advisory services, better methods are being sought to transmit, organize and use the existing knowledge base.

The need for analysis, review and direction for the educational component has led to the creation of a position for a Coordinator for Education and Training. In June, 1971, Roger Anderson was hired by the Center to serve in this capacity. Education projects in the Texas A&M University's Sea Grant Program involve:

1. Instruction for science teachers of primary and secondary schools,
2. Technical and vocational training,
3. General and special courses for undergraduates,
4. General and special courses for graduate students, and
5. Special curricula areas.

Advisory services have been initiated with full-time advisory specialists in several subject matter fields:

1. For fisheries (located at Galveston),
2. For marine recreation (located at College Station),
3. For the marine transportation industry (located at College Station),
4. Oceanographic services (located at College Station), and
5. Marine small business activities.

The Sea Grant Program Office staff has been deeply involved in the coordination and organization of Advisory Services activities. Through 1970-71, in fact, most of the identifiable activities in this area have been the result of program office staff, particularly in the areas of workshops and publications.

In December, 1970, two departments were created with the Center to concentrate on advisory services activities. The Department of Marine Resources Information, headed by Mrs. Leatha Miloy, is responsible for published materials related to advisory services, while the Department of Marine Advisory Services is responsible for coordination, planning, direction and some execution of Sea Grant Advisory activities.

The percentage break-down by category of Sea Grant funds for 1970-71 is given in the accompanying table:

Sea Grant Funding for 1970-71 by category

Education	$366,500
Research	959,275
Advisory	220,325
Administration, Direction and Development	243,200
	1,789,300 (Federal funds: $1,166,000)

The broad subject of marine affairs is multi-faceted and at Texas A&M University acceptance of a Sea Grant College designation has been interpreted to include acceptance of a responsibility to explore and develop all avenues leading to better uses of marine resources available to the State. This means broad communication and coordination, enhancing the capabilities of existing institutions, and working in support of industry, commerce, State agencies, and local communities. The steps taken in the first three years of the Sea Grant Program give ample evidence that the role of Texas A&M in marine affairs is well understood.

PUBLICATIONS AND DOCUMENTATION

Boykin, Rosemary E. *Texas and the Gulf of Mexico.* Texas A&M University Sea Grant Program. College Station, Texas. June 1971. 300 pp.

Coastscripts- Distributed to one hundred and seventy selected people affiliated with Texas A&M University. It consists of periodical newspaper clippings of interest.

Lemmon, Ray (chairman). *Report of the Interim Study Committee on Oceanography.* Submitted to the Honorable Gus F. Mutscher, Speaker of the House, Texas House of Representatives and the Members of the 62nd Legislature of the State of Texas. Texas A&M University Sea Grant Program. College Station, Texas. TAMU-SG-71-105. February 1971. 22 pp.

Sea Grant Program, Texas A&M University. *Goals for Texas in the Coastal Zone and the Sea.* College Station, Texas. TAMU-SG-71-102. January 1971. 20 pp.

Sea Grant Program, Texas A&M University and Remote Sensing Center. *Proceedings of the Symposium on Remote Sensing in Marine Geology and Fishery Resources.* College Station, Texas. TAMU-SG-71-106. March 1971. 229 pp.

Sea Grant Program, Texas A&M University. *Sea Grant Program Activities. 1969-70.* College Station, Texas. TAMU-SG-71-104. December 1970. 97 pp.

Spilhaus, Athelstan. *Man's Return to the Sea.* Speech presented to the Marine Science Briefing, June 10, 1971, in Galveston, Texas. Center for Marine Resources, Texas A&M University. College Station, Texas. TAMU-SG-71-301. November 1971.

University and the Sea - Six page newsletter distributed bi-monthly to over four thousand subscribers. It contains interesting notes on various aspects of the Texas A&M University Sea Grant Program and other related oceanographic programs.

MARINE FISHERIES

Increasing the output and reducing costs of the world's marine fisheries are of the utmost importance. The variety of projects supported by the Sea Grant Program at Texas A&M University reflect this importance. As shown in the previous section these projects involve elements of research, education and advisory services, and in many instances, these are difficult to separate. The marine fisheries program encompasses work in fish diseases, pond culture, and seafood processing technology. Publications and documentation resulting from this program area will be found listed at the end of this section.

Mariculture Pond Demonstrations (Research)

Activity Leaders: Wallace G. Klussman, Agricultural Extension Service, Jack C. Parker, Wildlife and Fisheries Science Department

Demonstration and research efforts have established the potential of mariculture in Texas coastal lowlands. Emphasis has been placed on shrimp culture because this form of mariculture holds the highest expectations for commercial production and economic gain. Findings have indicated that both natural and reservoir ponds are suitable for culturing shrimp. However, poor survival and inconsistent supply of seed stock, as well as inadequate artificial feeds and inefficient harvest techniques, have prevented the establishment of economically feasible commercial practices. The significant support of this project by coastal-based agriculture and industry has dictated the need to expand efforts in this field. To satisfy these needs, it is necessary (a) to identify factors causing mortality in ponds, (b) to evaluate artificial feeds and shrimp stocking rates on a field-scale basis, and (c) to develop commercially suitable techniques for harvesting shrimp in both natural and reservoir ponds.

Project Description and Report of Work and Accomplishments

Pond Experiments. Since August 1970, the pond demonstration facility at Angleton has been expanded by ten additional 1/2 - acre

ponds and now includes 20 1/2 - acre ponds and three natural marsh ponds. These ponds were constructed by the Brazoria County Commissioners Court at the request of Mr. J. C. McNeill, IV, Director of the Brazoria County Mosquito Control District. This facility, along with the six 1/2 - acre ponds located in Orange county provide the largest array of ponds on the Gulf coast designed specifically to research and demonstrate the potential of shrimp culture.

Pond culture experiments this year at Angleton were designed to evaluate the feasibility of brown shrimp production using 35 and 45 percent protein rations in fertilized and unfertilized ponds and in new and 2-year old ponds. The arrangement of treatments was set up in a randomized-block design utilizing 16 ponds and is shown in Figure 1. Of the four remaining ponds, three were used for incidental experiments and one served as a blank for hydrological studies. Drought conditions prevented the utilization of the three natural marsh ponds.

Ponds 3-10 and 12-19 (see Figure 1) were stocked on May 7, 1971 with hatchery-reared postlarvae brown shrimp supplied by the Dow Chemical Company's hatchery at Freeport, Texas, and constitute the randomized-block design. The stocking rate was 10,000 shrimp per pond. Pond 2 was stocked with 30,000 postlarvae brown shrimp from Dow's hatchery to provide preliminary information on the feasibility of higher stocking rates. Ponds 1 and 11 were stocked with 10,000 juvenile brown shrimp from Galveston Bay to provide comparable data (a control) with that obtained last year on bay stocked shrimp. Pond 20 was utilized for hydrological studies.

During the previous year, a nine-pond study with juvenile brown shrimp stocked from Galveston Bay indicated that brown shrimp did not grow much above 90 mm under existing conditions. It did not appear as though these shrimp were eating the pelleted feed which was introduced. Further laboratory experiments conducted in cooperation with the Dow Chemical Company indicated that this feed was significantly inferior to a number of experimental rations which we assisted Ralston Purina in developing. Based on the findings of the pond and laboratory experiments, it was jointly agreed that the pelleted feed was inferior in both form and quality. In cooperation with Dow and Ralston Purina, new rations were developed, tested under laboratory conditions and found to be suitable feeds for brown shrimp. Based on these studies, two rations were produced, in quantity, by Ralston Purina and submitted to shrimp in all ponds. Both feeds were low energy rations with a 1:1 calcium-phosphorus ratio and differed only in that one contained 45 percent protein (Ration A in Figure 1). Both were prepared in a flake form which, when immersed in salt water under laboratory conditions, remained intact and attractive to shrimp for up to 24 hours. Both rations were equally replicated in the 16 pond experiment and Ration A was used in the incidental experiments.

Fertilizer (45-0-0:N-P-K) was applied on May 5 at a rate of 15 lbs./pond to those ponds so designated in Figure 1. Subsequent

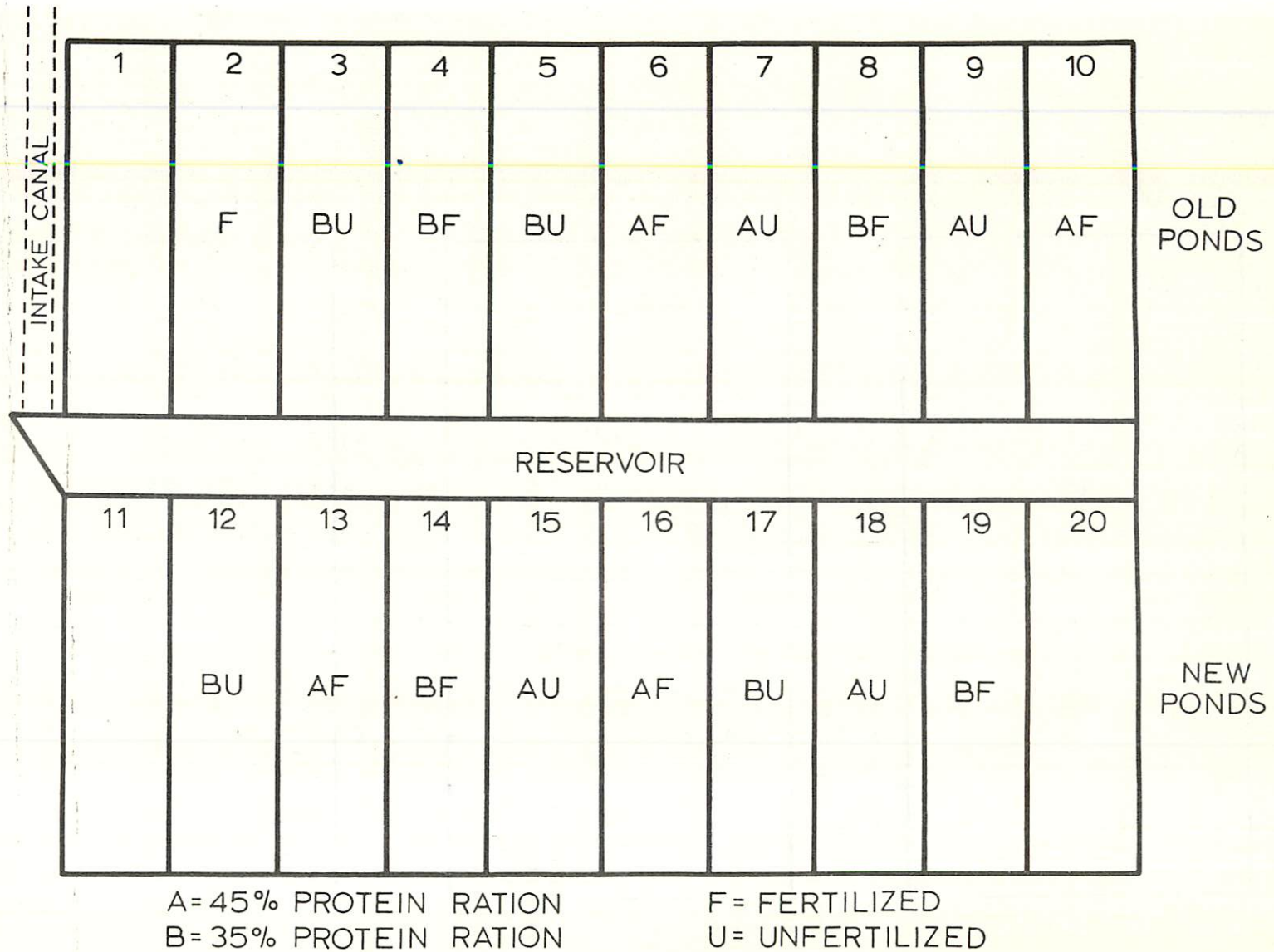

Figure 1. Arrangement of treatments in randomized-block design.

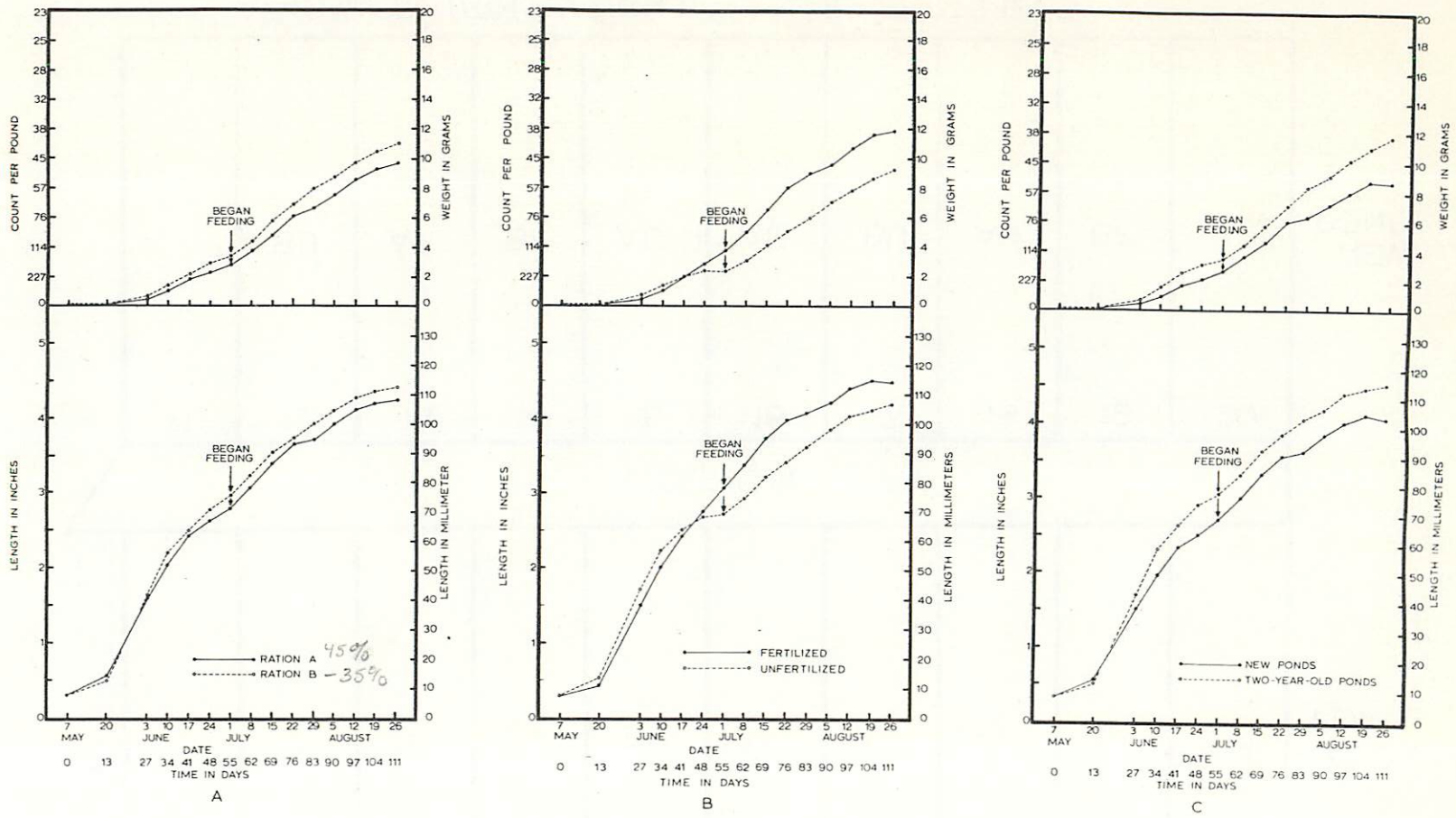

Figure 2. Growth of brown shrimp by comparable treatments.

treatments at two-week intervals consisted of 2.5 lbs./pond of 12-3-0:N-P-K and continued until feeding was begun. At that time, fertilization was discontinued to prevent overproduction of phytoplankton and the resulting oxygen depletion problems.

Salinity, dissolved oxygen and pH were monitored in all ponds three times each week. Additionally, ponds 16-20 were monitored once each week for total dissolved inorganic nitrogen, total phosphorus, sulfates, silicates and alkalinity together with plankton and benthic biomass and total carbon assimilation. Once each month, dissolved oxygen and pH were monitored at hourly intervals over a 24-hour period in ponds 16-20. A continuous record of bottom temperatures was made in pond 20. Growth estimates on shrimp were taken at two-week intervals over the first month and at one-week intervals thereafter. For these estimates, 25 shrimp were removed from each pond, weighed, and their total length (tip of the telson to the tip of the rostrum) measured.

Growth rates through August 26 under the treatments previously described are presented in Figure 2. Feeding was begun when it was evident that growth in the unfertilized ponds had ceased. Growth to that point in all ponds was the result of natural food production, and it was obvious that fertilization enhanced this production. Differences in growth between old and new ponds was probably the result of fertilization in the old ponds from decomposed feed submitted in previous studies. The addition of feed produced a significant increase in growth in the unfertilized ponds (see Figure 2-B). This experiment will be continued, barring unforeseen problems, until the middle of October,and a harvest demonstration will take place during the latter part of October.

The ponds in Orange County were stocked with white shrimp on August 1, 1971 and fed Ration B. Growth after 30 days appeared adequate,and it is anticipated that a harvest demonstration will be scheduled for November.

Demonstrations. Two field demonstrations of shrimp culture practices were held in November, 1970; one on the Wildlife Refuge of Mr. Sam Parish in Orange County and the other at the demonstration site in Brazoria County. A total of over 300 persons attended these demonstrations. Programs were presented to inform attendees of the present state-of-the-art in shrimp culture. These activities were covered in news releases by one TV station in Beaumont and two in Houston along with articles in 12 newspapers. Articles in the Orange Leader and Houston Post covering these demonstrations are enclosed.

Shrimp Culture Workshop. Over 30 Gulf coast shrimp culture experts participated in a workshop on April 13, 1971, at Texas A&M University. This workshop was planned and organized by Dr. Jack C. Parker and provided a forum for exchange of information among persons

actively engaged in shrimp culture research.

Pilot Study of Distribution Activities and Merchandising Practices Associated with the Seafood Industry in the Texas Gulf Coast Region (Research)

Activity Leader: Samuel M. Gillespie, Marketing Department, College of Business Administration

This research project consists of two separate studies: an analysis of distribution channel structure of seafood products and an experimental study of seafood merchandising practices among food retailers.

Project Description and Report of Work and Accomplishments

Distribution Channel Study. This study is the first organized attempt to describe the distribution channels for finfish species taken from Texas coastal waters and point out problem areas related to the performance of marketing functions, services, and activities within these channels.

During the study, twenty-seven of approximately two hundred and ten wholesalers of fresh saltwater finfish in the state of Texas were investigated. These wholesalers -- fifteen of which were located on the Texas Gulf coast, and the rest within the metropolitan areas of Houston, Dallas, Austin and San Antonio -- were personally interviewed and questioned.

It was shown that the predominant marketing channel for fresh saltwater finfish utilized by the Texas fishing industry: Harvesters → Coastal Wholesalers → Inland Wholesalers → Retailers → Ultimate Consumers. Seventy-eight percent of the volume of fresh finfish accounted for at the coastal wholesaler trade level was distributed to ultimate consumers through this channel. Other important marketing channels were shown to be: (1) Harvesters → Coastal Wholesalers → Ultimate Consumers, through which 14% of the finfish were distributed, and (2) Harvesters → Coastal Wholesalers → Retailers → Ultimate Consumers, through which the remaining 88% of the volume of fresh finfish accounted for at the coastal wholesaler trade level was distributed to ultimate consumers.

With respect to the retail trade level in Texas, it was shown that restaurants play the most important role in distributing fresh saltwater finfish to ultimate consumers relative to vertically

integrated retail markets, independent retailers, and institutions (schools, hospitals, etc.).

Approximately two-thirds of the finfish accounted for in this study was shown to be consumed in the coastal regions (including the Houston metropolitan area), while 15% was consumed in the San Antonio area, 12% in the Austin area, and 7% in the Dallas area. Of the total volume of saltwater finfish accounted for in the study, 15% was distributed out-of-state.

Finally, it was shown that the problem areas affecting the distribution channels and the entire Texas fishing industry could be categorized into four general areas: (1) difficulty in obtaining sufficient quantities of fresh finfish to satisfy the existing demand, (2) pollution problems, (3) state governmental regulations affecting harvesting of finfish, and (4) business "myopia" and lethargy among firms in the channel of distribution.

Seafood Merchandising Practices Among Food Retailers. This research study examines the effects of planned implemented merchandising strategies on the sales and profits of a retail fresh seafood market located within a local Bryan, Texas supermarket. Two major objectives of the study were to determine if:

1. Sales volume and profitability of fresh seafood products may be increased by planned merchandising strategies.
2. The increased sales volume and profitability may be accomplished without taking a disproportionate share or normal supermarket operating funds.

In addition to a period of observation, three planned merchandising strategies were implemented during the study; a low-cost merchandising plan involving only procedural changes; an average cost merchandising effort involving light promotional expenditures; and a high cost merchandising strategy consisting of heavy promotion of fresh seafood products.

It was shown that each successive experimental merchandising strategy produced greater sales and profits of fresh seafood items. In addition, incremental analysis showed that these increases did not take a disproportionate share of supermarket funds as each successive experimental merchandising effort showed sizeable incremental rates of return.

In addition to accomplishing the two major objectives, additional conclusions inferred from the analysis of the data were:

1. Fresh seafood products can be promoted with great success.
2. There appeared to be a favorable direct, but not necessarily proportional, relationship between promotion and customer services, and profits.
3. From all evidence, the full potential of the fresh seafood market was not reached.

4. While the full potential of the fresh seafood market was not reached, the effects of diminishing returns were felt.
5. Promotion and customer services were major factors in increasing sales and profits of fresh seafood.
6. While it is difficult to isolate the effects of the payday cycle on sales, it appeared as though payday weeks had little effect upon weekly profits.
7. Weekends remained a strong selling period for fresh seafood.

In both projects close cooperation was required from Mr. Bill Schwartz, Marketing Specialist, Texas Parks and Wildlife and Mr. Henry Boies, Fishery Marketing Specialist, National Marine Fisheries Service, Department of Commerce, Dallas, Texas Field Office. In the distribution channel study favorable personal contact among the leading coastal and inland finfish wholesalers was needed to provide input for the study. Special arrangements were made with Mr. O. T. McCullough, Quality Seafood, Austin, Texas to train two graduate students in the rudiments of fresh finfish processing. These individuals are a strong linkage between the academic/research staff of Texas A&M and the business environment.

Shrimp Culture Research (Research)

Activity Leader: W. F. McIlhenny, The Dow Chemical Company

The overall objective of this program is to develop economical pond culture methods for shrimp production. In this area, one of the most important factors preventing commercial pond rearing of shrimp is the lack of a highly efficient food. Dow's efforts during the period ending in September, 1971, were concentrated in the areas of nutrition and instrumentation. Postlarval shrimp were furnished from Dow's Freeport hatchery for use in the Texas A&M pond culture program.

The following tasks were to be performed during the grant period.

1. Candidate foods for shrimp were to be synthesized and preliminary tests run on the palatability.
2. Preliminary shrimp growth rate studies were to be made with the candidate foods.
3. The Texas A&M pond program was to be supplied with postlarval shrimp.

Project Description and Report of Work and Accomplishments

In the development of a supplemental diet for pond culture of shrimp during the 1970 - 1971 grant period, an attempt was made to determine the nutritional requirements for juvenile shrimp, to determine the effects of composition and physical form of the diet on palatability, and to evaluate the suitability of the diet by measurement of growth rates and survival during feeding trials.

Amino Acid Requirements in *Penaeus aztecus*. The single most important element of a shrimp diet is probably protein, and it is generally believed that the biological value of the protein depends upon its amino acid composition. Since protein is the largest and most expensive single constituent of a diet, it is economically important to determine which amino acids can be synthesized by the shrimp and which are essential. The essential amino acids, and amino acid composition of the protein contained in the tail of juvenile brown shrimp, Penaeus aztecus were determined in this investigation.

The tail muscle of 60 - 80 mm juvenile brown shrimp was removed, ground, homogenized in water and treated to remove carbohydrates, nucleic acids, and fats. The sample was then hydrolyzed by the method of Gehrke et al, and passed through a cation exchange column to remove the biological background. The trimethylsilyl derivatives of the amino acids were prepared and analyzed on a Model 1200 Varian FID gas-liquid chromatograph. The amino acids were identified by retention times, and quantified by area ratio to a phenanthrene internal standard. A standard amino acid mixture was used to determine response factors for the detector. The amino acid assay observed was similar to that reported by other investigators for Penaeus aztecus.

Juvenile brown shrimp were injected with 20 micro-liters each of an isotonic solution containing ^{14}C-glucose and incubated in an aerated tank for 24 hours. Following the incubation period, the shrimp were sacrificed and the tall muscle was treated to remove carbohydrates, nucleic acids and fats before hydrolysis. The amino acids were identified by two dimensional ascending thin layer chromatography, and the radioactive acids identified by scintillation spectrophotometry.

Those amino acids which were found to contain ^{14}C radioactivity (Table 1) were established as nonessential amino acids because they were synthesized by the shrimp from the metabolic fragments of the injected ^{14}C-glucose. The remainder of the amino acids found by the quantitative analysis of the shrimp tails were then considered essential. From the data presented in Table 1, it is possible to specify a minimum nutritional requirement, at least for the amino acids to be found in an acceptable diet.

Palatability of Synthetic Diets for *Penaeus aztecus*. The composition of a prepared diet and its physical form were suspected to

influence the palatability to juvenile brown shrimp. Six diets for palatability trials were prepared by the Ralston Purina Company, including a basal diet, compounded into light, medium, and heavy densities. In three other diets the amounts of the individual components of the diets were varied. Raw chopped fish was used as the control. A 16-day experiment was conducted in 10-gallon aquaria to determine the preference of brown shrimp for food of varying physical structure and composition. The shrimp were fed once daily. Observations were made on both the shrimp's initial reaction to the food, and continued feeding activity. Chopped fish was the most preferred food by almost a factor of two, followed by the high density basal diet. The basal diet, but with soybean meal substituted for fish meal,was least preferred. It was concluded that because a high density basal diet was most preferred of the artificial diets, future diets should be prepared as a high density flake, since this was the form that Purina could manufacture.

The Feeding of Synthetic Diets to *Penaeus aztecus*. Although the diets prepared in this investigation were meant to be used as pond-culture supplemental feeds, the growth and survival of juvenile brown shrimp fed only the experimental diets were measured for longer periods of time to determine which of the candidates had the best performance. A facility was prepared for conducting the feeding experiments under controlled environmental conditions in a temperature-controlled building housing a series of fifteen 40-gallon fiberglass tanks.

TABLE 1

AMINO ACIDS IN PENAEUS AZTECUS

Amino Acids	Specific Activity Counts/Min/u-mole of Carbon	Min. Dietary/Body Requirement/Composition Gms Amino Acid/Gm Tot. Body Wt*
(non-essential)		
Alanine	8,220	0.012
Aspartic acid	1,140	0.035
Glutamic acid	6,740	0.007
Glycine	1,200	0.029
Hydroxyproline	10,400	0.0007
Proline		0.007
Serine	2,210	0.011
(essential)		
Arginine	60	0.011
Histidine	20	0.007
Leucine	10	0.016
Isoleucine	10	0.005
Lycine	20	0.016
Methionine	10	0.007
Phenylalanine	10	0.012
Threonine	10	0.012
Tryptophan	20	0.002
Tyrosine	10	0.006
Valine	10	0.011

* Protein content of shrimp was 21.9% of wet body weight.

Seawater and river water were blended and treated to eliminate water-borne biological contamination, and a salinity of 27 o/oo ± 3 o/oo, a temperature of 27°C ± 3°C, and a flow of 1 liter/min. to each tank was maintained. Preliminary experiments indicated that no substrate should be used in feeding experiments as this introduced uncontrolled variability into the experimental conditions. The weights and lengths of the test animals were determined. Growth rates were calculated from the initial and final average individual weights, and the culture time, in days, by the equation:

$$r_g = \frac{\ln \frac{W_f}{W_i}}{t}$$

where:

W_i = initial average individual weight, gms.
W_f = final average individual weight, gms.
t = period of the experiment days
r_g = specific growth rate, days $^{-1}$

The number of animals surviving the experimental period divided by the number stocked was expressed as a percentage.

Four feeding experiments were performed. The first two were exploratory and no experimental design was used. In the last two experiments, replicated full-factorial experiments were performed.

In the first experiment three of the six artificial diets compounded by Ralston Purina were compared to a no-feed control. Twenty mm postlarvae brown shrimp were used as test animals, measured and stocked 80 to the tank, and fed the experimental diets once a day at 5-8% of body weight. After 30 days, the survivors were counted and measured for length and weight. All the artificial diets gave significantly higher growth rates and survival than the no-feed control. The dense structure-basal diet has the highest growth rate in this experiment.

A second experiment compared feeding rate of the dense basal diet and commercial pet foods. The test animals, 30 mm postlarvae, the survivors of the first experiment were measured and stocked, 60 to the tank, and fed once a day at 5% of body weight for 30 days. Again, the excess food was removed. The growth rate increased with feeding rate, based on body weight. The growth rates of the animals fed the commercial pet foods were equivalent to those fed high protein diets on an equivalent protein feeding rate basis. The survival of shrimp fed the pet food was better than that for shrimp fed the high density basal diet. Based on the success of the high density basal diet, the Ralston Purina Company was requested to prepare eight additional diets containing two levels each of protein content, calcium to phosphate ration and metabolic energy.

The third experiment was a replicated two level, three factor full-factorial experimental design using the compositional variations in the eight diets as experimental variables. Fifteen juvenile brown shrimp, 80 mm long, were measured and stocked in each tank. The diets were fed at 8% body weight per day and excess food and wastes produced were removed daily. The most significant feature of this experiment was the poor cohesiveness of the low calcium to phosphate diets which disintegrated in a matter of minutes. The effect of protein content and energy level was confused, indicating lower growth at higher protein contents. Survivals were all quite good (80 - 85%) for a 30-day period.

The fourth experiment used only the high calcium to phosphorus diets in an additional experiment of a replicated, two-factor, two-level, full-factorial design. The four experimental conditions were high and low levels of protein content and metabolic energy. Again, 15 juvenile brown shrimp, 80 mm long, were measured and stocked in each tank. As before, the feeding rate was 5 to 8% body weight per day. The excess food and waste products were removed daily. There was a significant interaction between protein content and metabolic energy. Protein content was significant in that a lower protein content resulted in an increased growth rate. Survivals were also found to be very good (85 - 100%) for 30 days.

Bacterial and Viral Diseases and Cell Cultures of Marine Fish and Shellfish (Research)

Activity Leader: G. W. Klontz, Department of Veterinary Microbiology

The continuing objectives of this report are to study the bacterial and viral diseases enzootic to wild and propagated fish and shellfish in the Gulf of Mexico. The program is broad-based to encompass the following:

1. Detection and characterization, *in vitro* as well as *in vivo*, of bacteria and viruses pathogenic for marine fish and shellfish,
2. Epidemiological studies to determine the significance of the isolated disease-producing agents,
3. Diagnostic services for private and governmental agencies,
4. Professional training at the graduate level for qualified students -- both veterinarians and fisheries biologists.

Project Description and Report of Work and Accomplishments

During this fiscal year, work efforts were directed along seven lines:

1. Establishment of the Aquatic Animal Medicine Laboratory,
2. Collection and maintenance of marine fish and shellfish,
3. Detection and identification of bacterial pathogens of fish and shellfish,
4. Development of cell culture methods to facilitate identification of viruses pathogenic for fish,
5. Investigation of reported fish-kills in bays along the Gulf of Mexico,
6. Extension and training,
7. Participation in professional organizations and committees.

The Aquatic Animal Medicine Laboratory. Building 1007, the old Anthrax Barn and also later known as the Leptospirosis Laboratory, on the College of Veterinary Medicine Research Farm was renovated. This consisted of closing in one side of the building, insulating the walls and ceiling, installing heating and air conditioning units, and painting the structure inside and out. Also, there were modifications to the electrical wiring to meet the increased demand for electricity.

The renovations were completed during the latter part of January 1971 and an open house was held on February 3, 1971. Since then the Aquatic Animal Medicine Laboratory has been the center of a great deal of activity. The first class in the new course on Diseases of Fish (V.Mi. 661) used the facility for the laboratory portion of the course. Also, there have been several short-term and on-going research projects conducted on the following subjects: bacterial diseases of shellfish, pollution-caused diseases of fish and shellfish, mycotic diseases of shellfish and geriatrics of marine fish.

Collection and Maintenance of Marine Fish and Shellfish. The studies conducted this fiscal year necessitated the collection and maintenance of 16 species of marine and freshwater fish and four species of marine invertebrates in closed water systems. To accomplish this, six types of closed water systems were developed. After certain modifications, all have maintained the fish and shellfish without difficulty. A manuscript describing the systems and their use is being prepared for publication.

Detection and Identification of Bacterial Pathogens. Continuing primary emphasis has been placed upon isolating and identifying bacteria causing disease among populations of propagated and wild marine fish and shellfish.

Immunofluorescent methods have been developed for detecting Aeromonas liquifaciens in carrier fish. Also, the capabilities of detecting specific antibody in fish serum by immunofluorescence

have been developed. This organism has been the cause of severe outbreaks of bacterial hemorrhagic septicemia in both freshwater and marine fish.

In addition, special cultural methods have been developed for processing fish tissues suspected of being infected with A. liquifaciens. A transport medium capable of maintaining the viability of 10-100 bacterial cells for up to eight weeks has been tested. This has alleviated the necessity of immediately processing samples obtained in the field and has allowed their being shipped to distant laboratory facilities for complete analysis.

A differential medium developed last year to distinguish A. liquifaciens from other bacteria was tested further. The results have been very encouraging.

Studies of the antigenic relationships of various isolates of A. liquifaciens is continuing. These studies when completed will provide a basis for:

1. Determining the origin and distribution of the "problem" strains of the organism,
2. Selecting strains appropriate for use as immunoprophylactic agents.

Studies of Vibrio anguilarum, a frequently isolated organism from marine fish, have been started. The course of these studies has been designed along that used in studying A. liquifaciens.

Electron microscopic techniques have been developed for ultrastructural studies of bacteria pathogenic for fish (Figure 1). These studies are valuable in identifying some bacteria.

A multi-point inoculator was developed to facilitate the biochemical processing several bacterial isolates (Figure 2). This instrument has been extremely valuable in bacterial taxonomy.

Cell Culture Methods. Studies to establish methods for growing and maintaining primary and continuous cell lines derived from marine fish species have produced only marginal results. Initial outgrowth of cells can be obtained frequently but reproducibility is lacking. Cell clusters degenerate spontaneously in spite of efforts to achieve cell division and growth. A number of growth and nutritional medias have been tested.

An Atlantic croaker (Micropogon undulatus) fin cell (MuF) is now at the fourth sub-culture level in a closed system at 25°C. A spot (Leiostromas xanthrus) fin cell (LxF) is now at the seventh sub-culture level in an open system at 25°C. Both cell lines are extremely slow-growing and the complete virus spectrum of the cells is unknown.

The LxF cells have been assayed for replication of suspect lymphocystis virus material. No virus replication was detected after three blind passages.

Virus spectrum studies of two cell lines derived previously from the Atlantic croaker x- MuF and MuSB (fin and swimbladder derived) - indicate that these cells will support the replication of several poikilothermic and homoiothermic viruses i.e., FV-3, IHN, IPN, vaccinia and herpes simplex. Similar results were obtained with the RTG-2 (rainbow trout gonad) cells. The following viruses replicated in first passage RTG-2 cells, but not in second passage: FV-3, IHN, IPN, REO-3, PI_3 BVD and herpes simplex.

The pathogenicity of IPN virus for suckling mice was studied. Suckling mice, 24 hours old, were inoculated with 0.01 ml. IPN virus suspension intracerebrally. No evidence of virus replication was detected after initial infection or subsequent blind passages.

Tissue suspensions of squid, garfish, mudfish, eel liver, eel eggs, flounder and Atlantic croaker were screened for viruses in grunt fin and rainbow trout hepatoma cell lines. No evidence of viral cytopathogenicity was detected after three serial blind passages incubated at either 25°C or 18°C.

Suspensions of lesions obtained from Atlantic croaker fingerlings with clinical lymphocystis virus disease were inoculated into bluegill (Lepomis macrohirus) subcutaneously and into LxF cells and into FHM (fathead minnow) cells. The virus was not isolated in the cell cultures and it did not produce clinical disease in the bluegill. These studies are continuing.

Investigation of Disease Outbreaks in Wild Fish. In late summer, 1971, water samples and fish were obtained from several stations on the Houston Ship Channel. This study was done in cooperation with personnel of the Civil Engineering Department. The primary purpose of the sample taking was to examine fish grossly and microscopically and to analyse the water chemically.

This information will be applied at a later date to samples obtained during a fish-kill. A manuscript will be published describing the guidelines for taking samples during a future fish-kill in the Houston Ship Channel.

Extension and Training. During the late spring an epizootic in postlarval shrimp being propagated near Freeport, Texas, was studied. A fungus resembling members of the genus Philophora was isolated. The genus could not be ascertained because spore formation could not be induced on artificial medium. When adult shrimp were exposed parenterally to the organism, black necrotic areas developed on the exoskeleton. Copper sulfate and Mycostatin were found to be effective controls of the disease in the postlarvae shrimp.

Two short courses in fish diseases were conducted by project personnel.

1. A one-day series of lectures on diseases of fish used as laboratory animals conducted for students

at the Air Force School of Aerospace Medicine in San Antonio.

2. A five-day series of lectures and laboratory exercises on the diseases of propagated fish for hatchery managers and assistant hatchery managers, Texas Parks and Wildlife Department.

Professional Organizations and Special Committees. The following is a list of professional organization committees in which members of the project served this past year:

G. W. Klontz:
- Member, American Fisheries Society Fish Disease Committee
- Member, Subcommittee on Aquatic Animal Health, National Academy of Science Committee of Animal Health
- Member, Program Committee, World Mariculture Society
- Chairman, Fish Disease Committee, World Mariculture Society
- Member, Marine Laboratory Advisory Committee, Texas A&M University

D. H. Lewis:
- Member, Marine Laboratory Advisory Committee, Texas A&M University

S. McConnell:
- Member, Fish Disease Committee, World Mariculture Society
- Member, Subcommittee on Fish Standards, ILAR Committee, National Academy of Science
- Member, Viral and Rickettsia Registry Committee, American Type Culture Collection
- Chairman, Committee on Animal Virus Characterization, U. S. Animal Health Assn., W.H.O.

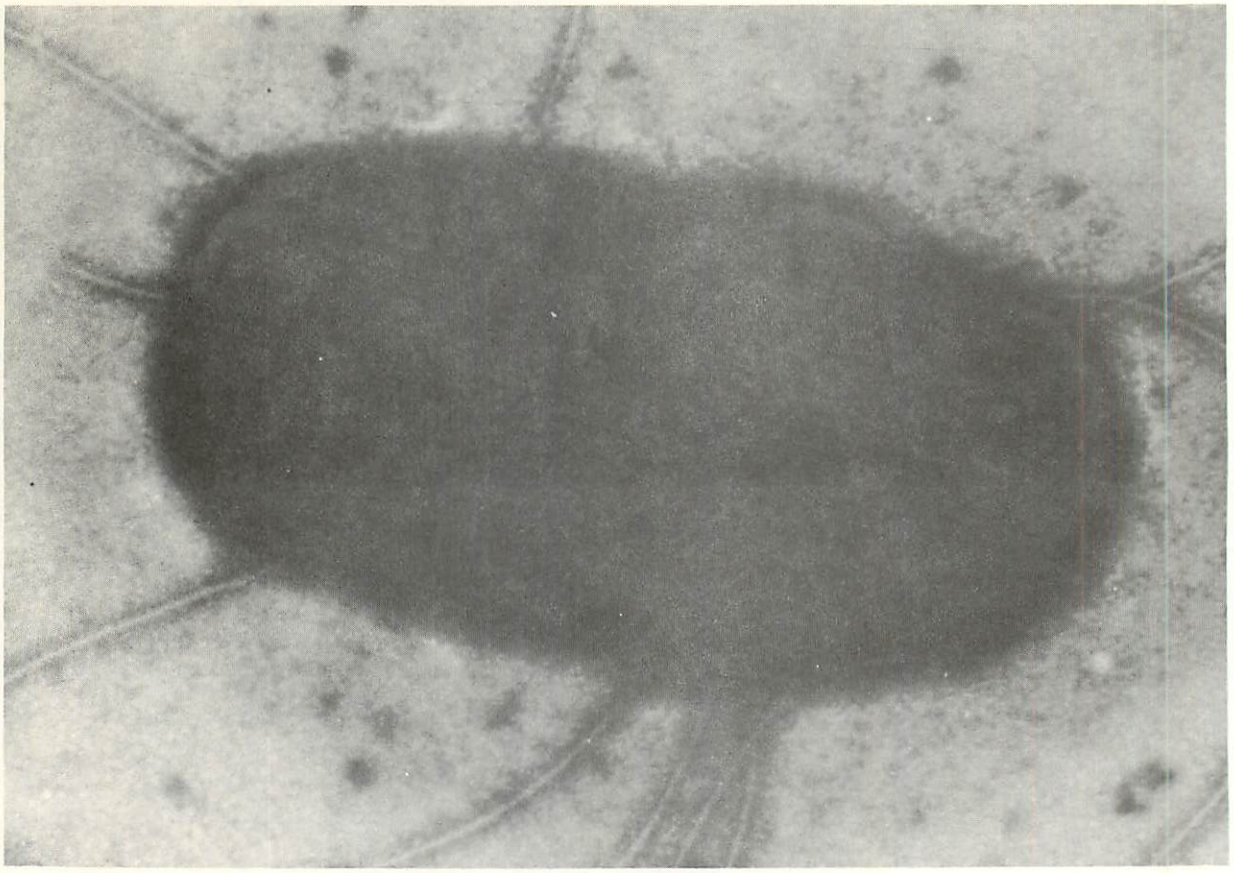

FIGURE 1

The addition of an electron microscope to the Department of Veterinary Microbiology provides another tool for studying marine bacteria and viruses. In the above micrograph, a bacterium is magnified approximately 50,000 times. The number and arrangement of flagella on the bacterial surface is demonstrated. This organism is peritrichous which distinguishes it from Vibrio anguillarium and other pathogenic monotrichous bacteria.

FIGURE 2

Multipoint inoculator for processing several bacterial cultures simultaneously. This involves transfer of bacterial cells from master plate (nearest the burner) into biochemical media in the wells of remaining plates. The inoculator tips (in hand) are dipped into the petri dish containing methanol (nearest bottom of photo) and flamed prior to transferring the bacterial cells.

Preliminary Study of the Fishery Potential of Deep-sea Shrimps in the Gulf of Mexico (Research)

Activity Leader: Linda H. Pequegnat, Department of Oceanography

The existing shrimp fishery in the Gulf of Mexico involves certain species of shrimps of the Family Penaeidae which, during some portion of their adult life cycle, are found close to shore in relatively shallow water. Shrimp fishing is therefore carried on now in shallow continental shelf waters - waters which increasingly reflect and concentrate man's pollution of the nearshore environment.

In contrast to this, there are certain untapped populations of deep-sea shrimp species from the penaeid, caridean and mysidacean shrimp groups which live at depths between 100 and 2,000 fathoms in the Gulf of Mexico. This is well offshore and beyond the continental shelf, where the waters are less influenced by pollution products from land.

The purpose of this study is to determine the possible fishery potential of these various deep-sea shrimp species in the Gulf of Mexico.

Project Description and Report of Work and Accomplishments.

It was decided that in order to determine the possible fishery potential of deep-sea shrimps, certain basic information needed to be acquired for each species. First an assessment of the kinds of shrimp species and their relative abundance needed to be made. Then information on population density, horizontal and vertical distributions, size ranges, feeding habits, and life history needed to be studied for each species.

In the limited amount of time available for support of this preliminary study of the problem (March 15 to August 31, 1971), the main efforts have been expended on the first basic assessment of the kinds and numbers of shrimp species available in the Gulf of Mexico below 100 fathoms. This was accomplished by the analysis of shrimp specimens and data from the R/V ALAMINOS deep-sea Gulf of Mexico collections since 1964 and supplemented by certain National Marine Fisheries (R/V OREGON) Gulf of Mexico material and data.

Preliminary population assessments based on habitats, relative abundance, vertical distribution, and horizontal distribution are given below for the following three groups of deep-sea shrimps: penaeid, caridean, and mysidacean shrimps.

Penaeid Shrimps. Of the 23 species of deep-sea penaeid shrimps known to occur in the Gulf of Mexico, the majority (17 species) are

benthic or bottom-living species, while the remaining six species are pelagic, i.e., living in the water column well above the bottom.

In tabulating records of abundance of the species from Gulf of Mexico trawl and dredge hauls and assigning relative designations of "rare," "sparse," "common," and "abundant," the six species of pelagic penaeids are reduced to the following two "abundant" or "common" species:

PELAGIC SPECIES	RELATIVE ABUNDANCE	DEPTH RANGE	AREAS OF GULF
Gennadas valens (Smith, 1884)	abundant	100 - 700	NE,NW,SE,SW
Bentheogennema intermedia (Bate, 1888)	common	above 500	NE,NW,SE,SW

For convenience in expressing geographical range, the Gulf of Mexico has been divided into four quadrants: northeast (NE), northwest (NW), southeast (SE), and southwest (SW).

Of the 17 benthic species of deep-sea penaeid shrimps in the Gulf, three were "common" and three were "abundant" as follows:

BENTHIC SPECIES	RELATIVE ABUNDANCE	DEPTH RANGE (fms)	AREAS OF GULF
Benthesicymus bartletti (Smith, 1882)	abundant	400-900	NE,NW,SW
Hymenopenaeus debilis (Smith, 1885)	abundant	250-600	NE,NW
Penaeopsis megalops (Smith, 1885)	abundant	100-400	NE,NW,SE,SW
Benthesicymus cereus (Burkenroad, 1936)	common	800-2100	NE,NW,SW
Hymenopenaeus robustus (Smith, 1885)	common	100-500	NE,NW,SE,SW
Parapenaeus longirostris (Lucas, 1849)	common	50-400	NE,NW,SW

It should be noted that Hymenopenaeus robustus (known commonly as the "royal-red shrimp") is the largest in size of the more common deep-water penaeids of the Gulf and occurs in sufficient numbers at 100-200 fathoms to be of possible commercial value. The National Marine Fisheries Laboratory at Pascagoula, Mississippi is experimenting with exploratory fishing gear and performing chemical analyses of tissues on this species.

Although not listed here as common in the Gulf of Mexico, the "scarlet prawn," Plesiopenaeus edwardsianus, has been taken in significantly large quantities in certain areas of the SE Gulf (Campeche Bank) and in other areas of the western Atlantic Ocean and Caribbean

Sea. This species is also being studied at the Pascagoula laboratory.

Caridean Shrimps. The deep-sea carideans are a diverse group with a total of 63 species in nine families known to occur in the Gulf of Mexico from below 100 fathoms depth.

The majority of species (41) are benthic. Of the remaining 22 pelagic carideans, none were considered to be "abundant" and only the following three species could be designated as "common":

PELAGIC SPECIES	RELATIVE ABUNDANCE	DEPTH RANGE (fms)	AREAS OF GULF
Acanthephyra purpurea (A. Milne-Edwards, 1881)	common	200-700	SW,NW,NE,SE
Acanthephyra stylorostrata (Bate, 1888)	common	500-1000	SW,NE,NW
Systellaspis debilis (A. Milne-Edwards, 1881)	common	150-500	SW,NW,NE,SE

In the above table, the quadrants into which the Gulf has been divided are arranged according to decreasing abundance for each species, as they are in the following table.

Of the 41 benthic species known in the Gulf, the 12 "abundant" and "common" species are as follows:

BENTHIC SPECIES	RELATIVE ABUNDANCE	DEPTH RANGE (fms)	AREAS OF GULF
Glyphocrangon aculeata (A Milne-Edwards, 1881)	abundant	400-800	NW,SW,NE
Glyphocrangon alispina (Chace, 1939)	abundant	300-500	NE,NW,SW
Glyphocrangon nobilis (A. Milne-Edwards, 1881)	abundant	500-1000	NW,NE,SW,SE
Nematocarcinus cursor (A. Milne-Edwards, 1881)	abundant	200-1000	NW,NE,SW,SE
Pontophilus gracilis (Smith, 1882)	common	200-800	NW,NE,SW,SE
Glyphocrangon longleyi (Schmitt, 1931)	common	150-450	SE,NE,NW,SW
Nematocarcinus ensifer (Smith, 1882)	common	900-2100	SE,NE,NW
Heterocarpus ensifer (A. Milne-Edwards, 1881)	common	120-250	SE,NE,SW
Heterocarpus oryx (A. Milne-Edwards, 1881)	common	400-1000	SW,NW,NE,SE
Parapandalus willisi (L. Pequegnat, 1970)	common	150-250	NE,NW

Plesionika holthuisi (Crosnier & Forest, 1967)	common	300-500	NE,NW
Plesionika longipes (A. Milne-Edwards, 1881)	common	190-220	SE,NE

Mysidacean Shrimps. The assessment of this group of "Opposum shrimps" in the Gulf of Mexico is not complete because not all of the collected material has been analyzed. A preliminary assessment indicates, however, that of the ten species of Mysidacea known to live in the Gulf of Mexico below 100 fathoms, only four species, all pelagic, could be considered to be "common." These are Gnathophausia ingens (Dohrn, 1870); Eucopia australis (Dana, 1852); Eucopia sculpticauda (Faxon, 1893); and Eucopia unguiculata (Willemoes - Suhm, 1875). The latter three species of Eucopia could probably be eliminated because of their small size, i.e., less than two inches body length. The Gnathophausia ingens is perhaps more promising, with adults ranging up to 7 or 8 inches in length and with the majority of the adults between 3 and 5 inches long. It is recommended that the biology and distribution of this species be studied in greater detail in order to predict its availability for harvesting.

Conclusions and Recommendations. We have shown, on the basis of relative abundance in the Gulf alone, that certain species of deep-sea penaeid, caridean, and mysidacean shrimps may be eliminated from contention as fishery potentials. It is recommended that more precise studies be made of size ranges and depth distributions for each species listed in order to further eliminate the species which are too small or too deep in distribution for feasible fishing. Finally, it is recommended that studies be made of feeding habits, life histories, and biochemical analyses of shrimp tissues for postmortem quality deterioration in the species selected as fishery potentials.

During the course of this study the Activity Leader traveled to the Harvard University Museum of Comparative Zoology and the U. S. National Museum of Natural History for comparative studies on the taxonomy of deep-sea shrimps. Arrangements were initiated for certain rare deep-sea shrimps from the Texas A&M collections to be deposited at these museums.

Arrangements have also been made for the Activity Leader to collaborate in a paper on the revision of the oplophorid caridean shrimps of the Gulf and Caribbean with Professor L. B. Holthuis, an international authority on Crustacea at the Leiden Museum in the Netherlands.

Occurrence and Significance of Parasites in Commercial Ocean Food Fish (Research)

Activity Leader: F. C. Faries, Jr., Department of Veterinary Parasitology

Much of the damage to fish due to parasites appears to be mechanical. Parasites may injure tissues and blood vessels by their burrowing or obstruct blood vessels entirely with their bodies or their eggs. Some actually ingest tissues, blood or body fluids. Some parasites are known to release toxic materials. Therefore, infections with parasites may contribute to mortality of fish directly by mechanical injury and indirectly by traumatic stresses that lower host resistance to environmental factors. Parasites reduce the value of fish as human food by producing pathologic conditions or by esthetic reasons.

There are a variety of agents found in fish and other food products taken from natural waters that may induce illness in the consumer. Fish and seafoods are known to be hosts of several parasitic diseases which involve man. The present scattered reports which incriminate fish as reservoirs of potential reservoirs of infections of man and domestic animals are sufficient justification, therefore for giving far greater attention to this group of animals in the future.

The objectives of this study are:

1. To determine the extent, seasonal occurrence, geographical location and identification of parasites of commercial food fish.
2. To evaluate the effect of the parasite on the fish as it affects the fish for human food.
3. To study the relationship of the parasites of commercial food fish to mammals and birds.

Project Description and Report of Work and Accomplishments

A 13 month survey of parasites of the Atlantic Croaker, Micropogon undulatus, and the Spot, Leiostomus xanthurus from Clear Lake, Texas was completed. In the survey over 1300 croaker and spot were examined for parasites. One new species of protozoan was discovered and named. Initial reports of four species of fish parasites from the Gulf of Mexico were made. A small museum of approximately 45 species of parasites from 10 species of marine fishes was collected. Of the parasites recovered, isopods were sent to Dr. T. E. Bowman (National Museum of National History, Division of Crustacea, Smithsonian Institution, Washington, D. C. 20560) for identification while Apocreadium manteri, a trematode, and Ergasilus lizae, a copepod, were sent to Dr. R. M. Overstreet (Gulf Coast Research Laboratory,

Ocean Springs, Mississippi 39564) and Dr. L. S. Roberts (Department of Zoology, University of Massachusetts, Amherst, Massachusetts 01002), respectively, for confirmation. Dr. P.A. Meglitsch (Department of Biolgoy, Drake University, Des Moines, Iowa 50311) has been kind enough to supply information regarding the genus Kudoa, a protozoan. The various species of marine fishes for parasite examinations were collected by making 20 trips to the Texas Parks and Wildlife Marine Laboratory at Seabrook, Texas and by accompanying a single cruise on the Western Gulf, docked at Rockport, Texas.

Under the supervision of the co-investigator, a graduate student, William W. Price, in the Biology Department identified species of trematodes for credit in a registered problems course.

In addition to those reports listed at the end of this section manuscripts describing two new species of myxosporidians (parasitic protozoa) are in preparation.

A presentation in a seminar on parasites of marine fish was given at the National Marine Fisheries Service (formerly the Bureau of Commercial Fisheries) in Galveston, Texas.

Post-Mortem Characteristics and Biochemical Properties Affecting the Organoleptic Quality of Fish Muscle (Research)

Activity Leader: Bryant F. Cobb, III, Department of Animal Science

Large quantities of fish are presently being wasted by the Texas fishing industry. Many fish are dumped overboard. A considerable amount of loss occurs in market channels. Much of this loss is due to mishandling, but a significant amount is due to post-mortem deterioration. Recently large numbers of fish from Galveston Bay have been reported by fish markets to have detectable petroleum and other off-flavors.

The fishing industry of Texas has specifically asked that we work on three projects:

1. Utilization of "trash" fish,
2. Loss of quality in shrimp and tests to determine spoilage,
3. Loss of weight of shrimp during processing.

All of these projects have considerable economic potential. Anywhere from 350 million to one billion pounds of fish are discarded by the Texas industry every year. Many of the shrimp reach the

market in a deteriorated condition resulting in loss of sales and too often the loss of product. About 25% of the weight of the shrimp tail is lost during the peeling, deveining operation.

Project Description and Report of Work and Accomplishments

Utilization of Trash Fish. Most of the trash fish discarded by the Texas shrimping industry are from the family Sciaenidae. Initial work with the Atlantic Croaker from this family indicated that strong fishy odors and flavors rapidly develop in any product made from the fresh fish flesh. Efforts to overcome this problem have resulted in a process to make an odorless, tasteless, dehydrated fish protein which can be readily incorporated into sausages, meat pastes, etc. The procedure also results in a high quality oil. This aspect of the research has been completed and is presently being written up for publication.

It should be noted that rats fed a diet containing 10% of the fish protein made from mercury contaminated fish from Galveston Bay had high levels (0.4 - 0.6 ppm in blood and liver, 0.6 - 0.9 ppm in kidneys) of mercury at the end of 4 weeks of feeding. Approximately 20% of the mercury in the diet was recovered in the kidneys and livers of the rats.

Loss of Quality in Shrimp. The effect of the area of catch on the subsequent quality deterioration of shrimp has been investigated. Shrimp were taken from different locations on the Texas coast from Galveston to Brownsville. Initial measurements were made on total volatile nitrogen (TVN), trimethylamine nitrogen (TMN), trimenthylamine oxide (TMAO), amino acids and bacterial counts. The shrimp which were handled aseptically, were placed on sterile ice and then kept until putrid odors were evident. Other samples, taken directly from the boats, were treated in the same manner.

Shrimp taken directly from the water kept as long as 40 days with an average time of 25-30 days. Shrimp taken from the boats kept on the average less than a week. This data indicated that the fisherman lowers the shelf life of the shrimp by at least 10 days. These results have already been incorporated into our "Food Handling Course".

During the period on ice, TVN content increased in most of the shrimp taken from Palacios to Brownsville, while decreasing or remaining constant in most of the shrimp taken from Galveston to Matagorda. Shrimp (taken from boats) with TVN contents of 15 mg/100g or greater spoiled very rapidly while those with lower TVN contents appeared to keep longer. No TMAO was detectable in any of the shrimp. This TMN presumably came from bacterial action on choline. Amino acid analyses are incomplete. Bacterial counts on shrimp taken directly from the water ranged from 10^3-10^4 per gram while those taken from the boats ranged from 10^6-10^9 per gram.

On the basis of this study and previous observations a study has been instituted to attempt to establish TVN levels in spoiled shrimp. National Shrimp Processors of Brownsville is cooperating in this project. TVN levels are being measured on shrimp as they enter the plant. These levels are being correlated with the condition of the shrimp. If the TVN level is near 30mg/100g the shrimp are spoiled or approaching spoilage. (The 30 mg level has already been accepted by Japan and Australia as a spoilage level).

Loss of Weight of Shrimp During Processing. This part of the study is in preliminary stages. Initial studies indicate that from 18-23% of the shrimp flavor agents are lost in processing and that TVN losses provide a method of rapid estimation of these losses. The magnitude of this loss is such that approximately 95 pounds of free lysine is lost for every 10,000 pounds of shrimp processed (this figure does not include lysine in peptides and proteins).

Photographic Assessment of the Standing Stock and Life Habits of Potentially Important Marine Species in the Gulf of Mexico (Research)

Activity Leader: Willis E. Pequegnat, Department of Oceanography

Biological sampling on the bottom of the Gulf of Mexico in substantially deeper waters than ordinarily harvested today by commercial fishermen has revealed several kinds of animals that may prove to be commercially valuable. For example, one of these is the Giant Red Crab (Geryon quinquedens), which is as large as or larger than most brachyuran crabs marketed today. Therefore, it may represent not only a delicacy, but a valuable source of sea-derived protein. As yet, however (and this exemplifies the condition for other species), we know too little about the life habits, population densities, reproductive capacities, and general distribution of this species to calculate whether or not it could sustain an intensive fishery. One of the principal objectives of this project is to obtain the ecological information about this and other promising species that is required to make intelligent decisions as to their commercial value. It is anticipated that much of the required data will be obtained through photographic and video techniques.

Project Description and Report of Work and Accomplishments

This project was activated at mid-year (March) 1970. During

the 6-month period ending August 31, 1970, significant steps were taken in designing and fabricating required instrumentation.

The paucity of information on the life habits and general ecology of marine organisms living in even moderately deep water is disheartening. It seems apparent that the most promising way to fill these glaring gaps in our knowledge involves photographic and video systems. Although still photographs have provided us with much useful data about deep-sea species, it is obvious that movie and television cameras with provision for video taping will be profoundly superior. Furthermore, important adjuncts to this investigative system involve inclusion of audio sensors and recorders and the supply of appropriate artificial light.

The first step of the project involved design of an in situ movie-video-audio system that could be lowered to the bottom on a large tripod and left for periods up to 24 hours. The following specifications for the system were laid down and implemented:

1. That the pressure housing would accommodate either a 16 mm Arriflex camera with a 1000-ft. film magazine or a television video tape system,
2. That the lights would be of such intensity and wave length characteristics as to properly expose Ektachrome color film at distances up to 10 feet, and
3. That the system would be collated so as to permit time-lapse photography, with the lights and camera being activated just enough to expose 1000 feet of film in 24 hours at the rate of 24 frames per second.

Design of the pressure housing for the camera and film magazine proved to be the stickiest problem. Deep-sea housings with a usable internal diameter of 24 inches and capable of withstanding 5500 lbs. per sq. inch are not available on the market. After several false starts that were abandoned primarily because of ridiculous estimates from outside suppliers for one-of-a-kind devices, we finally designed a case made up of eight wafers of 3-inch aluminum plate secured with four 26-inch bolts. The required opening in the case was achieved by milling out the center of each plate and fitting the doughnut-like plates together. Watertight integrity was achieved by securing O-rings between each pair of plates and the end caps. A viewing port was lathed out in one cap and was fitted with a cone of 3-inch plexiglass. The end result was a case that cost about $500.00 as compared with earlier estimates from industry that ran up to several thousands of dollars.

As a power source for lights, camera and electronic timers, we adapted ordinary 12-volt automobile batteries. The only modification required was a length of bicycle tubing that was attached to each

cell and filled with surplus acid to prevent implosion. The batteries functioned well at 4.5 degrees contigrade and supplied ample power to all units.

A Sony tape recorder was fitted into the case alongside the camera. It was mated with a deep-sea hydrophone. These units are powered simultaneously with the camera.

During July-August of this year, the entire unit was tested successfully at depths up to 1170 meters where the ambient pressure is about 1700 lbs. per square inch. The case maintained its watertight integrity for periods up to four hours.

Initial design of the project called for a free-fall self-retrieving system, but this plan was abandoned when it became evident that the entire system would weigh about 100 kilos in water. Instead the system will be lowered on a large tripod and the lowering cable fitted with a large buoy so that it can be left unattended and the ship put to other uses.

Prior to selecting drop-sites for the system, study has been made of known geographic and bathymetric distributions of relevant species. When ship time becomes available next summer, it is anticipated that several days will be devoted to use of this device. Tests already conducted indicate that the system will work reliably, that the light is adequate for good color balance, and that the sound system can be synchronized easily with the filming. Only one drawback exists, viz., the fact that the color film cannot (without considerable expenditure) be developed at sea. One obvious solution to this problem is to use a television-video tape system on all initial lowerings. Fortunately, the pressure housing will accept a Sony television camera and recorder. It is anticipated that tests of this device will be carried out this year.

The Inflammatory Response of the Speckled Trout (*Cynoscion nebulosus*) (Research)

Activity Leader: Richard M. Robinson, Department of Veterinary Pathology

This experimental project will provide basic research data on the histopathological changes involved in acute inflammation in the fish. The presently available data are not adequate and this study is imperative for pathological interpretation of lesions induced by various mechanisms as they relate to spontaneous and experimental diseases of fish. Eighty-eight fish are to be experimentally subjected to surgical, chemical and antigenic insult.

The histological response will be observed and recorded for future interpretations in spontaneous disease.

Project Description and Report of Work and Accomplishments

The technique for the maintenance of speckled trout (Cynoscion nebulosus) has been developed and they have been successfully adapted to aquarium environments. These animals have been successfully maintained in artificial sea water utilizing Gambusia affinis as a food source, and have been successfully used for the study on inflammatory reactions of fish. The first trial consisted of inoculation of sodium hydroxide subcutaneously and sequentially killing the experimental fish for histopathological analysis. This trial was completed and the reactions have been characterized by Dr. Bendele. Two additional trials were proposed but were not completed. The reason for this was the problem of obtaining the fish. This species apparently fluctuates considerably in abundance on the gulf coast, and the suppliers were not able to net sufficient numbers of the fish for the final two trials. The month of September was the only month in which sufficient numbers of C. nebulosus were available during 1970-71. Since no Sea Grant support is available for the fiscal year 1971-72, the project has had to be terminated.

Shrimp Net Monitoring System (Research)

Activity Leader: Philip Oetking, Southwest Research Institute, Corpus Christi, Texas

In the U.S. fishing industry, shrimp is the species most in demand, with current consumption being in excess of 400 million pounds per year. The dollar value of the shrimp market is more than twice that of salmon, the nearest competitor. Unfortunately, the U.S. shrimping fleet has been unable to keep pace with the rising demand, and more than half of the current consumption is imported. Until such time as technical improvements can be developed and implemented in the U.S. shrimping fleet, the consumer cost per pound and the import ration will continue to increase.

One of the basic problems in commercial shrimping is simply the time lost in locating a productive area for netting. Normally, a small net called a "try net", is towed and periodically raised to test the shrimp production of the area covered. However, the method is not completely satisfactory because of the time lapse between netting of the shrimp and inspection of the net. Often a boat will pass well out of a productive area before the identification

is made, leading to the problem of relocating the area.

In shallow waters, a "thumper string" is used to give the fisherman immediate knowledge of a productive area without having to raise the try net. One end of the thumper string, a light line, is attached to the net webbing and the other end is held by the fisherman. Shrimp hitting the net webbing cause a vibration in the line which is distinguishable from those caused by fish or other objects. The thumper string is ineffective in deep water because the resistance of the water on the light line obliterates the diagnostic signal.

The objective of this project is to perfect and demonstrate an electronic net monitoring device that will offer the continental shelf shrimp fisherman the same catch discrimination capabilities that the "thumper string" gives the bay shrimper.

Project Description and Report of Work and Accomplishments

This project was started in mid-June, 1971. Shortly thereafter, an advisory committee composed of shrimping and shrimp gear experts, electronic specialist and Institute staff members was established. The committee members furnished Southwest Research Institute with shrimping expertise, the test net and sled, shrimp boat usage and test tank facilities.

The system is composed of four major parts: a sled mounted net, a "strain gauge bridge" transducer, an amplifier and balance unit and a discrimination unit. Figure 1 is a photograph of the net and sled showing the amplifier and balance unit (fastened on the far side of the sled frame) and the transducer mount on the intermediate arm near the center of the net. The parts of the transducer and the encased amplifier and balance unit are shown in Figure 2.

The transducer, consisting of a small plastic beam with four strain gauges mounted in a bridge configuration, is connected to the net by a light line. The output of the bridge is amplified and sent to the discrimination unit aboard the vessel. A feedback circuit in the amplifier and balance unit continually keeps the strain gauge bridge in its most sensitive range regardless of the load on the transducer. The discrimination unit used on the vessel deck during the preliminary trials includes an oscilloscope and magnetic tape recorder but an alarm system will replace these instruments during the later demonstrations.

The monitoring device designed for deep water shrimp operations was first tried in a test tank in order to study the characteristic movements of shrimp as they strike the net and to recognize the electronic response resulting from this action. The second phase of the tests were conducted aboard bay shrimp boats where the fisherman's "thumper string" technique could be used to identify

the "catch" and to furnish a correlation between the various biological forms netted and the response of the transducer. An experienced bay shrimp fisherman can generally distinguish between the shrimp, fish or trash. The final demonstrations will be made on the continental shelf where confirmation of the "catch" will require raising of the net.

Adverse weather conditions and the scarcity of bay shrimp during the first several months of the project caused a delay in the onboard trial of the net monitoring system. None of the continental shelf tests has been completed. Several months extension of the project has been granted and the tests are scheduled in October and early November.

Conclusion. Although the shrimp net monitor has not been tested in the environment for which it was designed, the effectiveness of the system in shallow water has generated considerable enthusiasm among shrimp boat operators and has been extremely encouraging to the activity leaders. Different sea bottom conditions, wave action, fish varieties and shrimp size expected on the continental shelf may change the present optimism.

A magnetic tape recording of the output signal and the voice of the thumper string operator permits laboratory replay and photographic reproduction of specific events. An example of the type of results obtained by this procedure is shown in Figure 3. The voice track on the tape verifies that two shrimp were detected on the thumper string during the time interval recorded in the photograph. To date, more than 75% of the shrimp detected by the thumper string, a technique which includes some misidentification are recognized by the net monitor.

If it can be shown that a high percentage of the shrimp encountered on the continental shelf can be detected by this system with a relatively low occurrence of false alarms, it is reasonable to conclude that the system will significantly increase the efficiency of the Gulf shrimper. The system will inform the fisherman immediately when he is in a productive area and, just as important, when he leaves that area.

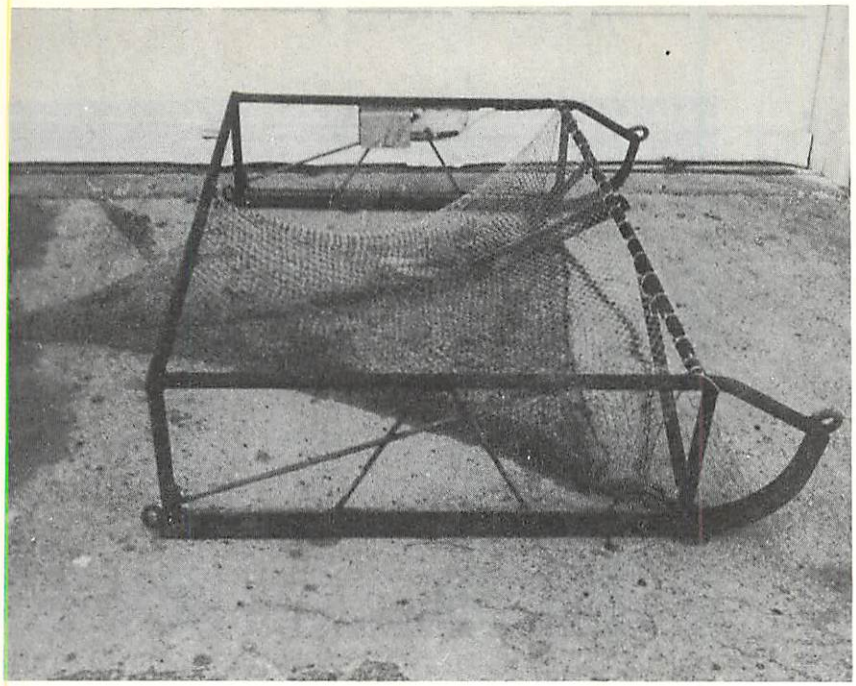

Figure 1

Sled mounted net showing amplifier and balance unit (far side of sled frame) and transducer (central intermediate arm)

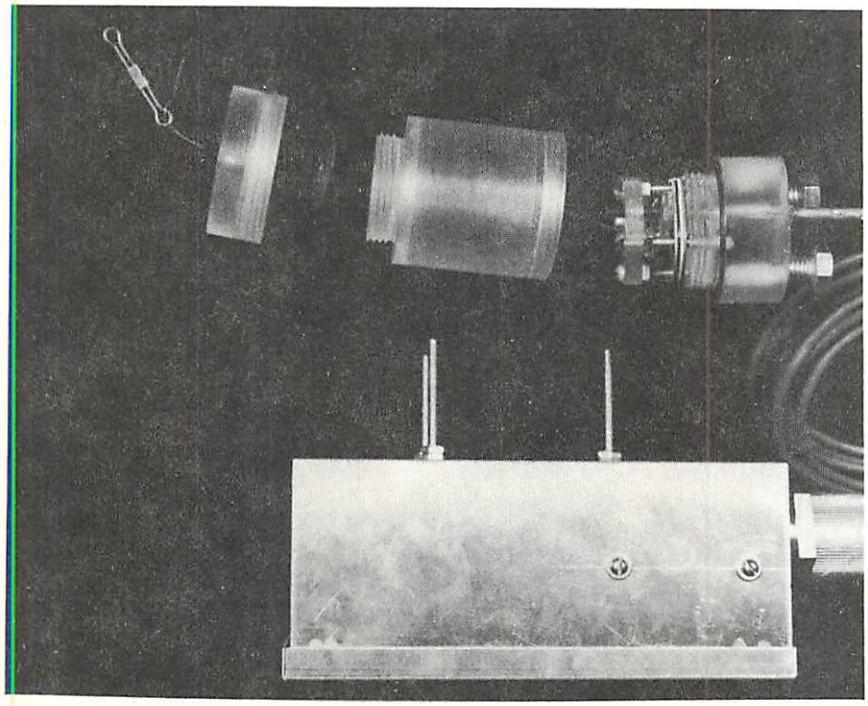

Figure 2

Shrimp monitoring system showing the parts of the transducer and the encased amplifier and balance unit

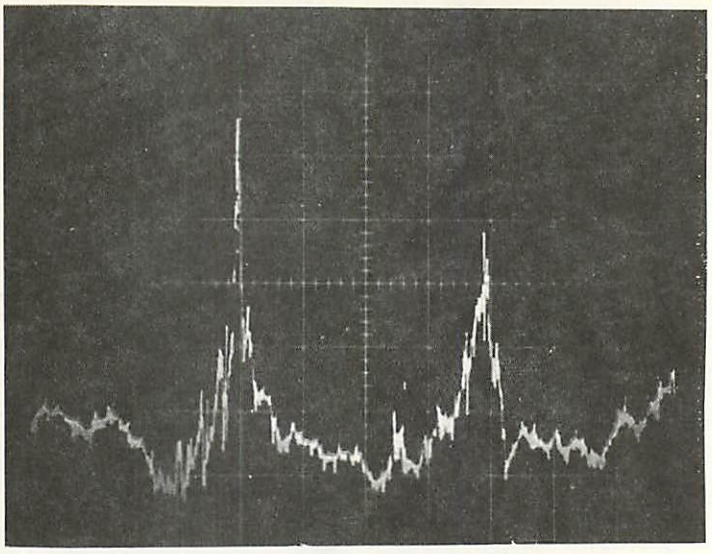

Figure 3

Photograph of the output signal of the Net Monitoring System showing the response of two shrimp

Histology of Marine Fish
(Research)

Activity Leaders: William E. Haensly and Raymond F. Sis, Department of Veterinary Anatomy

Attempting to solve the food shortage in the world, an increasing number of scientists are investigating the diseases of food producing fish. The proposed investigation will undertake baseline studies of the normal microscopic anatomy of fish. The normal microscopic structure must be determined before the pathology of fish diseases can be described. The proposed project will furnish vital information which is needed in fish disease research and will contribute to our knowledge of comparative histology, providing a collection of histologic material for future teaching and research.

Project Description and Report of Work and Accomplishments

Activities this year centered around the Gulf killifish, Fundulus grandis. Because this particular species is readily maintained under laboratory conditions it has the potential of becoming a laboratory animal. References are not available relating to the normal microscopic anatomy of this animal. Work this past year was in two parts: identification of the cardiovascular system, and collecting tissues and organs from the adult Fundulus grandis.

Cardiovascular System Identification. Prior to identification and histological study of the vascular channels it is first necessary to outline the blood vascular system by a dye injection technique. Techniques available for this same purpose in mammals were tried on this fish. None of the mammalian techniques were successfully applied to the fish. We are continuing to work on this problem, a vascular perfusing technique will provide, in addition to outlining the cardiovascular system, an optimal method for the preservation of tissues.

Collection of Organs and Tissue Samples. From a stock of Gulf killifish maintained at the Texas A&M University Aquatic Medicine Laboratory, 340 samples of organs and tissues were collected. These samples represent the following systems: digestive, circulatory, urinary, reproductive, nervous, respiratory, and endocrine. The tissues were preserved in one of four fixatives; formalin, Bouin's, Helley's, and glutaraldehyde in order to determine an optimal fixative for fish tissue. The microscopic observation and description of the organs and tissue samples is now being conducted.

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

Activity Leader: Robert R. Wilson, Department of Agricultural Economics

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 that can be applied by shrimp fishing farms. Theoretical models were developed during the first two years of 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 farms.

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 committments 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 Coast 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.

Mariculture of Commercial Crustaceans and Fishes on the Upper Texas Coast (Research)

Activity Leader: R. Kirk Strawn, Department of Wildlife Science

Sources of wild seafood are limited and mariculture is the best way to insure an adequate supply of favorite American food items such as shrimp. Temperature is a major factor in the production of these cold-blooded animals. Even on the Gulf Coast of Texas, natural water temperatures during over half the year are below the optimum level for maximum survival, growth and food-conversion rates of most animals. Electric power plants are a source of vast quantities of waste heat that cost much money to produce and that can be used for mariculture. Power plants will be sited on the coast in increasing numbers because of the vast amount of cooling water available and because they will be more and more excluded from freshwater sites. Freshwater that they would evaporate will be used instead for domestic purposes and to grow food.

The effects of power plants on the estuarine environment are of much concern to the public which has been informed that the number and size of plants will be greatly increased and that most of these plants will be atomic. Atomic plants as now designed are less efficient in converting heat into electricity and produce more waste heat per kilowatt generated than do fossil-fuel plants.

Waste heat for mariculture will be in abundant supply for mariculture during the rest of this century. Our studies yield data necessary for the use of waste heat for mariculture and data on effects of this heat on important organisms native to the Texas Coast. Our experiments supplement and are supplemented by our studies on natural populations living in heated areas of Galveston Bay.

Mariculturists with no access to heated water can use our data to determine safe temperature and salinity changes for organisms when stocked in a pond, for predicting survival, growth and food-conversion rates for organisms grown during the various seasons and for desirable temperatures to be achieved through pond design.

Project Description and Report of Work and Accomplishments

A temperature-choice tank was built and preliminary experiments were run on the temperature performances of shrimp and blue crabs. The refrigeration system was extended to cool all acclimation tanks in our laboratory at the Texas A&M Marine Laboratory.

Research was performed on growth, food-conversion, and survival rates of striped mullet at various temperatures and salinities.

Cages were constructed and painted to retard rust. These cages were placed in the intake canal of the P. H. Robinson Generating

Station of the Houston Lighting and Power Company and stocked with various species of fish. The fish were fed Purina Floating Trout Chow and they were measured periodically to determine survival, growth, and food-conversion rates. Pompano and pin fish are doing the best of the several species tested.

A companion project, Texas Agricultural Experiment Station Project 1869 financed by the Houston Lighting and Power Company, will provide 25 0.1 hectar ponds, a greenhouse containing 60 plexiglass tanks of approximately 80 gallons each and numerous cages for use in the intake and discharge canals at the Cedar Bayou Power Plant. The ponds will receive a constant supply of water from the discharge canal and the laboratory aquaria will receive a constant supply of refrigerated water and by heating the water temperature in the aquaria can be controlled to ±0.1 C. The primary purpose of this facility is to maintain crustaceans and fishes in water pumped through the Cedar Bayou Power Plant and to determine if this water has any detrimental effects on these organisms. All experiments will be designed so that they also yield information important to mariculture. These facilities can be used in many cases for experiments for our Sea Grant program in mariculture. At present they are being used for experiments in oyster culture under the supervision of Dr. Sammy Ray.

Moody Foundation Fellowships enabled us to support additional graduate students. These fellowships will not be available for future students on the project. One student proved unable to maintain live fish and was transferred to another project. Mr. Herbert Simmons received his M.S. degree and went to work for the Texas Parks and Wildlife Service and Dr. J. Selman Holland was graduated with a Ph.D. degree and went to work for the Institute of Marine Science at Port Aransas, Texas.

Field Guide to the Estuarine and Marine Fishes of Texas (Education)

Activity Leader: Wallace G. Klussmann, Agricultural Extension Service

Project Description and Report of Work and Accomplishments

Since the initiation of the project to prepare a Field Guide to the Estuarine and Marine Fishes of Texas in September, 1970, a preliminary key to the estuarine and marine fishes of Texas has been prepared for circulation among fishery biologists and other interested groups along the Gulf coast. Based on letters and phone calls received, interest in the key appears widespread among educational institutions, students and laymen and more than 500 copies have been circulated.

The present form of the key is being revised to include illustrations and life history annotations for all the species. It is anticipated that the final draft will be completed by January 1972.

Galveston Marine Laboratory (Education and Research)

Activity Leader: Sammy M. Ray, Texas A&M Marine Laboratory, Galveston, Texas

The Marine Laboratory's Sea Grant Program is primarily concerned with instruction, both undergraduate and graduate, and student research in areas related to exploitation and utilization of marine biological resources. Initially, the major objective of this project is expansion of the graduate instructional and research program so that students may complete in Galveston all or most course work and thesis research required for the Master of Science Degree in marine-oriented biological sciences such as marine biology, marine fisheries and biological oceanography. Courses and research programs will emphasize development and application of scientific information that may lead to more efficient utilization, as well as artificial cultivation (mariculture), of commercially important marine organisms. Moreover, the laboratory's instructional and research programs have become more involved in coastal zone problems such as estuarine ecology and pollution biology.

The research program of the Marine Laboratory has been greatly strengthened by sizeable grants from The Moody Foundation of Galveston. These funds provide stipends for postdoctoral and graduate fellowships in marine-related areas as well as undergraduate scholarships for summer study at the Marine Laboratory. Some of the Moody fellows are working on Sea Grant projects such as aquaculture of marine organisms.

The Marine Laboratory is also providing offices, classrooms and laboratories for other Sea Grant projects at Texas A&M University. These projects include:

1. Aquaculture Program of the Wildlife & Fisheries Sciences Department,
2. Marine Advisory Services.

During this year another academic entity of Texas A&M University, the Department of Veterinary Microbiology of the College of Veterinary Medicine, began participation in the Laboratory's instructional program. The Division of Environmental Engineering of the College of Engineering plans to participate in the instructional program during the 1971-72 academic year. Presently both state and out-of-state educational

institutions use the Marine Laboratory as a base for field trips to the coast and for short-term studies. It is anticipated that such use by students and investigators from other institutions will greatly increase with the expansion of space and facilities projected for October 1, 1971.

Project Description and Report of Work and Accomplishments

Educational Activities - Fall Semester 1970. Seventeen graduate students (10 masters and 7 doctoral level) enrolled for courses in biology, oceanography, wildlife and fisheries sciences and veterinary microbiology at the Marine Laboratory. A new course, Veterinary Microbiology 660 (Diseases of Marine Invertebrates), which was developed especially for offering at the Marine Laboratory as a part of its Sea Grant Program, was offered for the first time during this semester. The course was developed and taught by Dr. Albert K. Sparks, Director of National Marine Fisheries Service Biological Laboratory, Galveston.

Student Credit Hours:

1.	Masters	74
2.	Doctoral	60

Total number of students enrolled by course:

Biology 691 (Research)	1
Oceanography 691 (Research)	2
Veterinary Microbiology 660	12
Wildlife and Fisheries Sciences 685 (Problems)	1
Wildlife and Fisheries Sciences 691 (Research)	6

Spring Semester 1971. Twenty-eight graduate students (19 masters and 9 doctoral level) enrolled for courses at the Marine Laboratory. A new course, Wildlife and Fisheries Sciences 615 (Mariculture), which was developed especially for offering at the Marine Laboratory as a part of its Sea Grant Program, was taught for the first time during this semester. The course was developed by Dr. David V. Aldrich, who also taught the major portion of the course with special lectures provided by J. R. Kelly, S. M. Ray and W. B. Wilson.

Student Credit Hours:

1.	Masters	133
2.	Doctoral	92

Total number of students enrolled by course:

Biology 619 (Research)	3
Oceanography 623 (Zooplankton)	10
Oceanography 691 (Research)	2

Wildlife and Fisheries Sciences 615 (Mariculture)	17
Wildlife and Fisheries Sciences 691 (Research)	10

Summer Sessions 1971. The combined summer sessions showed the largest enrollment that the laboratory has experienced since the initiation of the resident teaching program in 1964. Seventy students enrolled for the first summer session and fifty-three registered for the second one. Twelve females attended the first session and seven attended the second one. Generally, the enrollment during the summer sessions consist of about 60 percent undergraduate and about 40 percent graduate students. In the summer of 1971, however, the percentages were reversed, i.e., 40 percent undergraduate and 60 percent graduate. The distribution of students according to classification is presented below:

	Undergrads TAMU	Undergrads Non-TAMU	Masters TAMU	Masters Non-TAMU	Doctorate TAMU	Doctorate Non-TAMU
First Session	19	8	16	13	14	0
Second Session	19	7	15	4	8	0

Although most summer students were from Texas A&M University, there were students in attendance from other colleges and universities including: University of Texas Medical Branch; State University College at Brockport, Brockport, New York; Stephen F. Austin State University; Baylor University; University of Alberta, Canada; West Texas State University; SUNY at Cortland, Cortland, New York; Oberlin College, Ohio; University of Cape Town, South Africa; University of Texas; University of Houston; Marine Biomedical Institute; and Galveston College.

Student Credit Hours (total for both sessions):

1.	Undergraduate	368
2.	Masters	180
3.	Doctorate	92

Total number of students enrolled by course:

Biology 435 (Marine Invertebrate Zoology)	11
Biology 440 (Marine Biology)	14
Biology 485 (Problems)	10
Biology 637 (Marine Botany)	9
Biology 662 (Biology of the Mollusca)	8
Biology 665 (Marine Invertebrate Zoology)	8

Biology 685 (Problems)	2
Biology 691 (Research)	9
EDCI 691 (Research)	1
Oceanography 685 (Problems)	1
Oceanography 691 (Research)	2
Statistics 406 (Statistical Methods)	20
Wildlife and Fisheries Sciences 312 (Marine Ichthyology)	27
Wildlife and Fisheries Sciences 400 (Fisheries Survey)	12
Wildlife and Fisheries Sciences 418 (Animal Population Dynamics)	15
Wildlife and Fisheries Sciences 485 (Problems)	3
Wildlife and Fisheries Sciences 685 (Problems)	6
Wildlife and Fisheries Sciences 691 (Research)	30

New Course Development. Two new graduate courses, "Mariculture" (Wildlife and Fisheries Sciences 615) and "Diseases of Marine Invertebrates" (Veterinary Microbiology) were developed and taught at the Marine Laboratory during the 1970-71 academic year. Diseases of Marine Invertebrates was developed by Dr. A. K. Sparks and Dr. D. V. Aldrich developed the Mariculture course.

During the period covered by the report, two undergraduate and four doctoral students were supported at least part of the year by working on the Wildlife and Fisheries Sciences Department's Aquaculture project supported by the Sea Grant Program. Students were also supported by a Moody Foundation grant. These funds supported five master's and three doctoral students, as well as 10 undergraduates for six weeks of summer study. One postdoctoral fellow (Dr. Emery A. Sutton) was partially supported by the Moody post-doctoral grant. Moreover, eight masters and one doctoral student were supported at least part of the time by the Houston Lighting and Power Company project that is being conducted by Drs. K. Strawn and D. V. Aldrich through the Wildlife and Fisheries Sciences Department and the Texas Agricultural Experiment Station.

Services Provided to Other Sea Grant Projects by the Marine Laboratory and its Personnel

Marine Advisory (Extension) Services. Mr. Johnie H. Crance, Area Marine Fisheries Specialist, maintains an office at the Marine Laboratory. The facilities and support personnel of the Marine Laboratory are made available to Mr. Crance.

Aquaculture Project of the Wildlife and Fisheries Sciences Department. Much of the Aquaculture project, which is under the direction of Dr. Kirk Strawn, is conducted at the Marine Laboratory.

Dr. David Aldrich of our resident staff devoted a quarter of his time to this project. A large space (2,200 square feet) has been converted to an aquarium room for this project.

Specimen Collection and Public Relations. Mr. William J. Wardle, Research Associate, has been most active in collecting biological specimens for several Sea Grant projects located in Galveston and on the College Station campus. The demand for specimens was so great that we had to provide Mr. Wardle with an assistant to aid him in the collection and maintenance of specimens. Mr. David Moore was employed for a period of two weeks, after which time he was offered a better paying job at the National Marine Fisheries Service Laboratory. Mr. Billy Fuls was employed as a replacement for Mr. Moore during March. Mr. Fuls resigned in May 1971 to return to school. Dr. Fred Conte was hired to assist Mr. Wardle on June 1, 1971.

In addition to providing specimens for Texas A&M University Sea Grant projects as well as teaching and research material for the Marine Laboratory's program, Mr. Wardle has provided biological material for Dr. A. J. Weinheimer's Sea Grant project at the University of Oklahoma Medical School. This project is involved in a search for anticarcinogenic agents from marine organisms.

Mr. Wardle assists the Director of the Marine Laboratory with public relations activities. He is also responsible for conducting tours of the Marine Laboratory as well as organizing field trips for classes and groups from various educational institutions, including both state and out-of-state organizations. The request for tours of the Marine Laboratory and guided field trips continue to increase. Since many of the requests for tours came during the regular school year, the tours generally are conducted on Saturday. This has worked a hardship on Mr. Wardle, but he has willingly assumed this extra duty. However, if the requests for tours continue to increase, some arrangements will have to be made to provide Mr. Wardle with some assistance for this week-end activity. Of course we could eliminate the Saturday tours; however, this would make it difficult for some out-of-town groups to attend.

The staff of the Marine Laboratory gave short lectures to several high school and college groups who wished to become acquainted with our program and to learn something of career possibilities in marine sciences. Large groups of Kansas State University and Stephen F. Austin State University used the laboratory's facilities for two-or three-day field trips on the Gulf Coast. Some biology classes from inland colleges and universities used the laboratory as a base for week-end field trips. We are receiving an increasing number of requests from high schools and institutions of higher learning from inland areas to provide tours and lectures in the general area of marine science. Such activities stimulate an interest and awareness of the importance of our marine resources.

A list of the various groups that have visited the laboratory during the 1970-71 academic year is presented in Appendix 1.

Miscellaneous Sea Grant Activities

The Marine Laboratory's resident staff and the Director in particular have engaged in frequent conferences with College Station staff members who are either conducting or are planning to conduct Sea Grant projects. Our familarity with marine and fisheries activities in the Galveston area has been useful in providing contact between personnel on the main campus and state, federal, and commercial fisheries organizations.

The Director served on a number of committees including: Oceanography, Education and Pollution Committees of the Galveston Chamber of Commerce; Moody Foundation Scholarship Selection Committee; Governor's Advisory Panel on the Safe Use of Agricultural Chemicals; and Texas A&M University Committees -- Marine Laboratory Advisory Committee and Moody Fellowship Committee (Chairman). Through such committee service by the Director, the Marine Laboratory maintains contact with educational, industrial, state, federal and philanthropic institutions in the Galveston area.

The Director served as Chairman of the marine toxins section of a "Conference on the Sanitary Quality and Microbial Safety of Fishery Products" sponsored by the U. S. Public Health Service in Mayaguez, Puerto Rico, September 8-10, 1970. The section of the proceedings on marine toxins was edited by the Director.

During December the Director served on an evaluation panel for fisheries and marine biology projects of the Texas A&M University Sea Grant Program and served as moderator for the fisheries section of the Sea Grant Workshop held in Galveston in May 1971.

Pilot Test of Feasibility of Suspended Culture of Oysters From an Offshore Oil Well Platform

In October 1970, S. Ray and W. Wardle began a pilot study to test the feasibility of suspended oyster culture from an oil well platform (Platform B, Atlantic-Richfield) about 10 miles offshore at High Island, Texas. The water is about 40 feet deep in this area. Adult and young oysters were placed in galvanized wire baskets and suspended at three depths: near the bottom (~30 feet), mid-depth (~20 feet), and near the surface (6-10 feet below mean low tide). A control station was set up in lower Galveston Bay at the U. S. Coast Guard Station pier (CGP).

During the fall, winter and spring the oysters grew well and showed little mortality and the problem of fouling was less than anticipated. However, during the summer months the experimental oysters on the platform and the controls on the Coast Guard pier suffered heavy mortality. Moreover, mortality near the bottom was greater than that at depths near the surface. The cumulative mortality after 10 months for this pilot study is presented in Table 1.

Table 1. West Bay Oysters After 10 Months

Platform B			Coast Guard Pier		
DEPTH	MORTALITY	MEAN LENGTH GAIN*	DEPTH	MORTALITY	MEAN LENGTH GAIN*
20'	30%	25%	6'	35%	23%
32'	65%	22%	12'	50%	29%

*Percentage increase in average length of surviving oysters over average length of the initial population of oysters used in this study.

The cumulative mortality and mean length gain of the surviving oysters at the platform and CGP was comparable and most of it occurred during the summer months. Since the initial population of oysters obtained from West Bay of the Galveston Bay System probably had a high level of Dermocystidium marinum (a lethal fungus parasite of oysters) infection, it is believed that mortality was caused primarily by this agent. Although the initial population of oysters was not assayed for D. marinum in October 1970, an oyster sample from the same area was assayed on December 17, 1970 and it showed an incidence of infection of about 50% and a weighted incidence of 1.6. Quite likely the parasite level was even higher in October.

It is also noteworthy that the bottom baskets showed a greater mortality than the upper ones. The cause for this difference is not known but there is a strong indication that predation by oyster drills (Thais) was responsible for the additional mortality in the lower baskets. Oyster drills were not observed in upper ones. It is not known how the drills entered the baskets since the strings were not touching the bottom. Perhaps they entered as free-swimming larvae. If so, the drills had a very rapid growth rate because some of the drills were an inch long.

In May 1971, another pilot study was initiated to determine the growth and mortality rate of oysters showing high and low incidences of D. marinum. Oysters from Red Fish Reef, Galveston Bay, with an incidence of 72% and weighted incidence of 1.6 were used as "high"-Dermocystidium oysters and oysters from Barts' Pass, Galveston Bay, with an incidence of 4% and weighted incidence of 0.04 were used as "low"-Dermocystidium oysters.

Fifty oysters of each group were suspended at three depths (near the bottom - 32'; mid-depth - 20'; and near the surface - 6-12'). Thus, there was a string of 150 low-Dermocystidium oysters and a string of 150 high-Dermocystidium oysters suspended from the platform. The oysters were suspended in baskets made from polyethylene mesh material instead of galvanized chicken wire. The use of plastic bags eliminates the corrosion problem experienced with the wire baskets, but there is some cutting of the plastic bags by the sharp

shell of rapidly growing oysters. A few oysters have been lost in this manner.

Also, 50 oysters of each group were suspended at two depths (near the bottom - 12'; and near the surface - 6') at the Coast Guard pier as controls. Thus there was a string of 100 oysters from each of the two groups suspended from the Coast Guard pier.

Unfortunately the lower-depth and mid-depth oysters (100 oysters) at the platform were lost some time between May and June 1970. The polyethylene lines had been severed, probably by abrasion on some underwater structure. In the future we shall use galvanized chain to avoid such mishaps.

The cumulative mortality and biomass gain for the upper baskets (50 oysters) after 3 months are presented in Table 2 (Redfish Reef Oysters) and Table 3 (Bart's Pass Oysters).

Table 2. Red Fish Reef Oysters After 3 Months

Platform B			Coast Guard Pier		
DEPTH	MORTALITY	MEAN BIOMASS GAIN*	DEPTH	MORTALITY	MEAN BIOMASS GAIN*
6-10'	36%	27%	6'		
			12'	32%**	-5%**

*Difference between air weight of entire population at beginning of study and surviving population after 3 months.

**Values represent combination of data from baskets held at depths of 6' and 12'.

Data presented in Table 2 indicate that about one-third of the high-*Dermocystidium* oysters were lost at both stations during the three summer months. There is little doubt that the intensification of residual *D. marinum* infection was the cause of this mortality. The lethality of *D. marinum* during the warm seasons (especially during late summer and early fall) has been documented on numerous occasions. The lower loss of biomass (-4.7%) at the CGP as compared with Platform B (-27%) is due to an anomaly. The surviving oysters at the CGP station had a heavy set of spat (year oysters). Such a set did not, as would be expected, occur at Platform B. The spat cannot be conveniently removed -- thus they resulted in added weight not related to changes in biomass of the original oyster populations.

The lack of appreciable oyster setting at the offshore platforms would have certain advantages in a commercial operation. This would alleviate the problems of competition of young oysters that become attached to market-sized ones. Moreover, additional labor may be required to remove under-sized oysters from marketable ones.

The Bart's Pass oysters (low-*Dermocystidium*) were strikingly different from the Red Fish oysters (high-*Dermocystidium*) in showing no mortality at either station during the 3-month period. Moreover, oysters at both stations showed about a 20% gain in total biomass. The gain in biomass of adult oysters during the summer is contrary to data generally obtained in such studies. Adult oysters tend not to grow during the summer months in the Gulf of Mexico. Some authorities attribute the lack of growth in summer to spawning activities and paucity of suitable food. Others blame the stress of disease organisms such as *D. marinum*. The data obtained in this study to date tends to support the latter view since the low-*Dermocystidium* oysters lived and gained biomass during the summer months.

Table 3. Bart's Pass Oysters After 3 Months

Platform B			Coast Guard Pier		
DEPTH	MORTALITY	MEAN BIOMASS GAIN*	DEPTH	MORTALITY	MEAN BIOMASS GAIN*
6-10'	4%**	21%	6'	None***	22%***
			12'		

*Same as indicated in Table 2.

**Two oysters missing from baskets; oysters probably were lost by passing through stretched mesh of basket, thus there was probably no mortality *per se* at this station.

***Data for baskets at depths of 6' and 12' combined.

The conclusions to be drawn from these preliminary studies with regard to the biological feasibility of using nearshore, offshore platforms for suspension culture of oysters are:

1. Oyster drills (*Thais*) may present a problem. Data from this study suggest that problems may be ameliorated by not utilizing the lower levels of the water column and also by not placing the baskets in the water until late spring or early summer (after the peak of drill spawning).
2. In order to avoid mortalities due to *D. marinum* during summer months, seed stocks with no or low residual infection of this fungus parasite must be utilized if oysters are to be grown through the warm season.
3. Fouling of the oyster baskets with sessile flora and fauna seems to be less than anticipated.
4. Although this study was concerned primarily with biological feasibility, there remain several mechanical problems which must be investigated.

APPENDIX I

September 1, 1970 - August 31, 1971

September 11	Lovenberg Middle School, Galveston, 30 sixth graders
October 15-17	Kansas State College, Biology Department, 29 students, Emporia, Kansas
December 5	Charlton-Pollard High School, Beaumont, 135 students
December 12	Boy Scout Explorer Post 603, League City, 9 scouts
December 12	Queen of Peace School, La Marque, 20 students
January 14	Texas A&M University Academic Year Program, 29 students
January 27	Louisiana State University, 9 students
February 13	McArthur High School, North Houston, 35 students
March 4	University of Houston biology class, 40 students
March 19	Noble High School, Noble, Oklahoma, 20 students
March 30	Our Lady of Lourdes Elementary School, Hitchcock, 52 fifth and sixth graders
April 4	Brazosport Museum curator and assistant (2 in party)
April 6	West Texas State University, 4 students
April 12	Carthage High School, Carthage, 14 students
April 15	St. Patrick's School, Galveston, 32 fifth graders
April 19	Kinkaid High School, Houston, 11 students
May 1	Anson Jones High School, Bryan, 35 students
May 1	Stephen F. Austin State University, Nacogdoches, 11 students
May 7	Alamo Elementary School, Galveston, 29 fourth graders
May 15	Texas City High School, Texas City, 16 students
May 15	T. H. White Science Club, Dallas, 15 high school students
June 4	Bible School, Hitchcock, 13 grade school children

June 29	Richland Elementary School, Houston, 20 third - sixth graders
July 1	Trinity School, Galveston, 15 fourth - sixth graders
July 2	Went to Trinity School to give talk and movie to 30 fifth - sixth graders
July 21	Moody Methodist Church, 25 seven - nine years old -- went to show film and give talk
July 29	Universal Presbyterian Church, Houston (day camp), 20 grade and high school students
August 9	Explorer Scouts, Washington, D. C., 25 scouts 15 - 18 years old

Mariculture and Invertebrate Pathology (Education)

Activity Leader: Sammy M. Ray, Texas A&M Marine Laboratory, Galveston, Texas

The objective of this project was to develop graduate courses in "Mariculture" and "Diseases of Marine Invertebrates" for offering at the Marine Laboratory.

Project Description and Report of Work and Accomplishments

Courses were developed and offered for the first time during the 1970-71 academic year. Dr. Sparks developed and taught the "Diseases of Marine Invertebrates" course during the fall semester of 1970. Twelve students enrolled for this course.

The "Mariculture" course was developed by Dr. Aldrich, who was also the major instructor. He was assisted with special lectures provided by Drs. J. R. Kelly, S. M. Ray and W. B. Wilson. Seventeen students were enrolled in the course. This was one of the largest enrollments that we have had in a graduate course taught at the Marine Laboratory.

The objectives of this project were met during the time alloted.

Development and Presentation of a Graduate Course on the Bacterial and Viral Diseases of Fish (Education)

Activity Leader: G. W. Klontz, Department of Veterinary Microbiology

Increasing interest and activity in raising fish for human consumption has created a need for qualified personnel to detect, diagnose, treat and control infectious and noninfectious diseases of food fish.

The objective of this project is to develop and subsequently present a graduate level course in the bacterial and viral diseases of propagated and wild fish species. It is intended to be a three credit-hour course (two lectures and one laboratory per week) for graduate students in veterinary medicine and fisheries biology. There will be detailed presentations on the cause(s) of each disease, including the factors affecting the susceptibility to infection -- on the symptomatology, diagnosis (both in the laboratory and in the field), treatment regimens, and methods of preventing subsequent occurrences of the disease where practical or possible.

Project Description and Report of Work and Accomplishments

During the spring semester, 1971, a four credit-hour course (three lectures and two 2-hour laboratory sessions) on the diseases of fish was offered as Veterinary Microbiology 658 - Problems. Eight graduate students enrolled.

The following course outline was submitted through the appropriate channels in Texas A&M University for approval:

THEORY (Lectures):	2	Introduction - Scope of Course Economics of Fish Industry History of Fish Husbandry Techniques of Fish Culture
	2	Anatomy and Physiology of Fish
	1	Host Response of Fish
	4	Epidemiology of Fish Diseases
	2	Diagnostic Techniques
	1	Treatment of Fish Diseases
	20	Bacterial Diseases of Fish
	9	Viral Diseases of Fish
	2	Mycotic Diseases of Fish
	1	Idiopathic Diseases of Fish
LABORATORY:	2	Handling Fish in the Laboratory Necropsy Techniques Anesthesia Blood Sampling Inoculation of Exogenous Material

6	Diagnostic Techniques Electrophoresis Hematology Serology Bacteriology Virology
14	Bacterial Diseases of Fish Aeromonads Pseudomonads Myxobacteria Others
10	Viral Diseases of Fish Infectious Pancreatic Necrosis Infectious Hematopoietic Necrosis Channel Catfish Virus Disease Lymphocystis Others

The proposal was approved and Veterinary Microbiology 661 - Diseases of Fish, a four credit-hour course is scheduled for the spring semester. The lecture and laboratory material is being readied for publication as "A Syllabus of the Diseases of Fish" during the 1971-72 year.

Extension Food Handling and Processing Course for Fishermen, Fish Handlers, and Fish (Shrimp) Processing Plant Personnel (Advisory)

Activity Leader: Bryant F. Cobb, III, Department of Animal Science

One of the major problems in the fishing industry is the lack of good sanitation. This has resulted in several seizures of shrimp by the U. S. Food and Drug Administration. In addition, large quantities of shrimp are lost or reduced in quality due to poor handling.

Project Description and Report of Work and Accomplishments

1. An extension course has been developed and was presented on April 19, 1971 in Brownsville, Texas to 45 supervisory personnel from fish processing plants.
2. A trip encompassing one week was taken in December 1970 for the purpose of directly talking to various representatives of the fishing industry on their sanitation problems. Almost 100 people, including boat captains were contacted during the trip.

Representatives from Brownsville to Galveston were contacted.

3. With the State Department of Health, a manual for self-evaluation of sanitation conditions is now being devised.
4. A formal course was presented in Port Lavaca on September 25, 1971 to approximately 40 fishing personnel.

Marine Fisheries and General Extension (Advisory)

Activity Leader: Wallace G. Klussmann, Agricultural Extension Service

Historically, there has been little effort to extend and interpret accumulated research information to the commercial fishing industry. Thus, specific emphasis was given to the development of an extension information program designed to extend maritime informational services to the people who stand to benefit from its application. The Cooperative Extension Service reaches into all communities of the state. In each county, there is a resident professional staff of Extension agents who maintain and operate the County Extension office. This office serves as a local point of contact where local people can tap the total resources of Texas A&M University to help solve their problems. With the development of audience acquaintance and trust, the local Extension office can become the focal point for information and assistance for people concerned with and dependent upon marine-related reasources.

The underlying functions of this project are evaluative research and the interpretation and dissemination of research findings to the users of marine resources to facilitate accelerated but wise use of both renewable and nonrenewable resources. The specific objectives of this project are:

1. To improve the life of the fisherman by attempting to make his work easier and more profitable and
2. To increase the understanding and appreciation of marine resources and their contribution to the quality of life along the coastal zone.

Project Description and Report of Work and Accomplishments

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1. To improve the life of the fisherman by attempting to make his work easier and more profitable and
2. To increase the understanding and appreciation of marine resources and their contribution to the quality of life along the coastal zone.

Activities in the general Extension and Marine Fisheries Project focused upon a wide array of subjects including educational meetings and seminars, publication development, individual assistance and project planning.

Briefly, all efforts were focused upon the identification of real problems of the fisheries industry and upon assistance responses to these problems. Guidelines for tax programs, required radio changes and sanitation devices have been developed and distributed to fishermen. The feasibility of an electric shrimp trawl has been tested and evaluated. A modified electric shrimp trawl has been used commercially by several Texas fishermen. An environmental education program has been initiated. Slide sets and bulletins on estuarine relationships have been completed. One hundred ten employees of seafood processing plants participated in fish food handlers schools. A guide to sport fishing in Texas is 25 percent complete and a field guide to the marine fishes of Texas is 75 percent complete. Publications describing and documenting the coastal fisheries of Texas have been completed.

Personnel assigned to the project organized or participated in a number of educational activities. These activities included:

1. Preparation and presentation of a paper on an Extension program for marine fisheries in Texas at the annual meeting of the Texas Shrimp Association and The Gulf States Marine Fisheries Commission;
2. Presentation of a discussion on the use of the electric trawl at the annual meeting of the Freeport Shrimpers Association;
3. Participation in seminars on Marine Extension Programs at the annual meeting of the Extension Specialists in Portland, Oregon;
4. Appearance as a witness before the State Legislative Committee on agriculture;
5. Conduction of several programs for youth including high school career days, science fairs and 4-H clubs;
6. Assisting the Parks and Wildlife Department and KPRC-TV in preparation of TV films on waterfowl identification; and
7. Conduction of fish food handlers schools in two counties which was attended by 110 employees of seafood processing plants.

Significant effort is always required for individual assistance. However, these efforts are valuable in establishing the two-way communication concept with a new audience. Conferences were held with some key representatives of the fisheries industry to identify problems and to further developments of an advisory committee composed of industry leaders. Problems of major concern identified in these conferences with industry leaders include the need for handling, processing and marketing fishery products, cheaper boat construction costs and insurance rates, interpretation of marine laws, more and better crew training programs, utilization of unexploited species, and a more effective method of assessing and predicting abundance and location of fisheries stocks.

As a result of published information on a new tax program for commercial fishermen, fisheries specialists provided further individual assistance to a number of fishermen interested in the tax saving program. A publication describing this opportunity was developed with the assistance of the Extension personnel in the Department of Agricultural Economics.

A publication describing and documenting the coastal fisheries of Texas was developed, printed and distributed. A copy of the publication is attached. This publication should provide valuable information to the resource planner, educators and public agencies and institutions concerned with the fisheries resources.

Project personnel also participated in the Governor's Conference on Marine Resources in Houston and the World Mariculture Society workshop in Galveston. Wallace Klussmann was elected Secretary-Treasurer of the World Mariculture Society during the annual meeting. This duty will require a great amount of time during the 1971 calendar year. Preparation of newsletters and related correspondence require almost a full-time person.

A detailed and well-illustrated publication on the importance of the estuary was developed and is now in press. This publication is aimed at the general public, conservation education agencies, school teachers and mass media in an effort to promote understanding of this marine resource. The manuscript was prepared by Johnie Crance with the assistance of the Department of Agricultural Communications.

Results of field testing new designs of an electric trawl were published and distributed in the first of a series of bulletins on subjects relevant to marine fisheries. An electric trawl, modified according to the findings of this field testing, is now being used commercially by a leading Texas fisherman.

Efforts to assist the marine sports fisherman have also been initiated. A printed guide to coastal sport fishing is 25 percent complete. The guide will include maps, facilities and suggestions for improving fishing success. County agricultural agents are providing local contacts and assistance in the development of the detailed statewide guide. The proceedings of the Coastal Land Use

Conference were completed and printed.

A display relating to mariculture was prepared for the state fair of Texas. More than 600 requests for information were received and handled as a direct result of the display. It is estimated that 800,000 persons viewed the exhibit.

Role of Microorganisms in the Quality Deterioration of Seafoods (Advisory)

Activity Leader: Bryant F. Cobb, III, Department of Animal Science

Samples of seafoods from the Gulf of Mexico including fish and shellfish, both crustacean and molluscan will be examined for level and types of microorganisms during various stages of handling, processing and storage. These studies will be carried out under both commercial and laboratory conditions. Special attention will be given to the effect of the plating conditions on the total number and distribution of the various species isolated from the samples. In this respect major emphasis will be placed on the role of the composition of the plating medium and temperature of plate incubation. The objectives of this project have been extended to include the microbiology of pond-reared shrimp and the incidence of Vibrio parahaemolyticus among seafoods of the Gulf of Mexico.

Project Description and Report of Work and Accomplishments

During 1970-71, research was carried out in the following specific areas:

Role of microorganisms in the quality deterioration of shrimp. Results indicated that the microbial flora of Gulf shrimp was dominated by coryneform bacteria and species of Pseudomonas, Moraxella, and Micrococcus. Refrigerated storage usually caused an increase in Pseudomonas species. The microflora of pond shrimp differed greatly from that of Gulf coast shrimp. The former contained fewer of the typical spoilage bacteria than Gulf coast shrimp. These research data are probably the most extensive investigations on the microbiology of Gulf coast and pond-reared shrimp. They were published in the Journal of Milk and Food Technology.

The effect of individual species on quality deterioration was determined by inoculating "sterile shrimp" with individual bacterial species. Changes in the protein and amino acid patterns have been determined. The results of this work indicated that Pseudomonas species were most active in breaking down the protein of shrimp.

The results of this work have been accepted for publication. Other studies indicated that the pH of shrimp can be used as a simple screening test to evaluate degrees of freshness. The results of this investigation are in a paper "Comparison of Extract-Release Volume, pH, and Agar Plate Count" which has been published in the Journal of Milk and Food Technology.

Microbiology of pond-reared shrimp. Bacterial counts on pond shrimp were lowest in August when water temperature and salinity were high. Coryneform bacterial and to a lesser extent Vibrio species were the most predominant isolates from fresh pond shrimp. Pseudomonas species, which usually cause problems in refrigerated Gulf shrimp, were not important in pond shrimp. Pond shrimp stored at 3-5C for 7 days were acceptable by appearance and odor. The results of this investigation are published in a paper "Microbial Flora of Pond-reared Brown Shrimp" in Applied Microbiology.

Isolation and enumeration, pathogenicity, and distribution in seafoods of Vibrio parahaemolyticus. V. parahaemolyticus, a major cause of gastroenteritis in Japan was isolated from white shrimp. The organism was pathogenic for brown shrimp from the Gulf of Mexico. Results of this study were published in a paper "Isolation of Vibrio parahaemolyticus from Gulf Coast Shrimp". Studies have been completed on the development of isolation procedures incorporating fluorescent antibody techniques. A review entitled "Vibrio parahaemolyticus" has been accepted for publication in the Journal of Milk and Food Technology.

Quality deterioration of microbial origin in frozen breaded raw shrimp. In cooperation with National Shrimp Processors, Inc., Division of Ralston Purina, a study is underway to determine the loss in quality of frozen breaded raw shrimp during transit from processing plant to consumer. This study was requested by industry and is considered of great importance. In one phase of this study, samples of the frozen food are submitted to various "defrost patterns" to determine the conditions which will result in chemical and microbiological changes. This study has been in progress for 1 year and will be completed in December 1972.

Oceanic and Marine Technology Program (Training)

Activity Leader: E. D. Middleton, Jr., Brazosport College, Lake Jackson, Texas

Along with burgeoning activities in oceanography, comes a vital

demand for the development of supporting technology and the production of skilled oceanic and marine technicians.

Off-shore industry, marine petro-chemical operation, sports and recreational water activities, commercial fisheries, oceanographic exploration and research companies and many others are searching for trained man-power in the area of vessel and equipment operations, in order to cope effectively with the tremendous growth of marine technology now in progress.

With this picture and these needs in mind, Brazosport College has established a new program in Oceanic and Marine Technology. This program will train young people for ocean-associated careers with industry.

The program will offer a basic training period of one year in oceanic and marine technical skills, leading to a certificate from the college and preparation for United States Coast Guard licensing examinations.

After successful completion of an industrial practicum, working in the field of oceanic-marine activity, the student will have the option of continuing into a two-year program. The second year of this program, culminating in an Associate of Applied Science degree, will provide advanced training in the several career fields in oceanic and marine technology applications.

Among the varied and interesting subject and activities to be included in the new program are seamanship, navigation, ship and boat handling, sailing, diesel engines and power plants, ship and boat maintenance and housekeeping, nautical rules of the road, fire fighting and damage control, safety and first aid at sea, SCUBA diving, towing and salvage, search and rescue, shipyard and construction applications, yacht and sport-boat operations, oceanic technology, port, harbor and plant security, marine electronics, marine welding, and marine resources and economics.

Training vessels and boats of various types and design will be available for student training, as will commercial vessels and installations during the summer industrial practicum.

Concurrently with an education in the fascinating realm of oceanic and marine technology, the graduating student is equipped with valuable skills, enabling him immediately to enter the industrial marine career field. In addition, many of the credits offered by this program may be transferred to oceanography or marine courses at one of the ever increasing numbers of colleges and universities which provide these programs.

Project Description and Report of Work and Accomplishments

Major accomplishments during the period may be summarized in the following categories.

1. Planning
2. Initiation and Development
3. Implementation
    a. Student Recruitment
    b. Teacher Procurement
    c. Equipment
    d. Vessel Operations
    e. Curricula Development
    f. Special Programs
    g. Program Monitoring
    h. Future Planning

The planning phase of this program was implemented during the reporting period. Considerations affecting the planning of this program involved ultimate program objectives, subject material to be presented, necessary equipment, classroom facilities, training aids, curriculum, student input, instructor requirements, textbooks and reference materials.

Curriculum and textbooks were recommended and adopted.

A training vessel was leased and scheduled classes were begun on August 30, 1971.

Student input calculated as necessary for program start was fifteen persons; actual input exceeded 200% of minimum requirement with thirty-seven students enrolling in program courses, including thirty-four full-time, full-program individuals.

PUBLICATIONS AND DOCUMENTATION

Work carried out under the Marine Fisheries Program has been presented in several forms. The following list includes technical and general reports, professional journal publications, and conference presentations which have resulted from the 1970-71 program.

Technical and General Reports

Crance, Johnie H. *The Coastal Fisheries of Texas.* Sea Grant Publication TAMU-SG-71-107. 12 pp. June 1971.

Crance, Johnie H. *The Estuarine Zone -- Uses and Concern.* Sea Grant Program and Texas Agricultural Extension Service. In press.

Conte, F. S. and J. C. Parker. *Ecological Aspects of Selected Crustacea of Two Marsh Embayments of the Texas Coast.* TAMU-SG-71-211. 184 pp. June 1971.

Firth, Richard W., Jr. and W. E. Pequegnat. *Deep-sea Lobsters of the Families Polychelidae and Nephropidae (Crustacea, Decapoda) in the Gulf of Mexico and Caribbean Sea.* Texas A&M University Technical Report. Reference 71-11T. College Station, Texas. 1971.

Gregory, Layne. *A Study of the Marketing Channels for Fresh Finfish in the Texas Fishing Industry.* Submitted in partial fulfillment of Master of Science Degree. Texas A&M University. TAMU-SG-71-220.

Harrington, David L. *Progress in Electric Shrimp Trawl Development.* Marine Advisory Bulletin -- Fisheries. TAMU-SG-71-501. October 1970.

Holland, J. Selmon, Jr. *Effects of Temperature and Salinity on Survival and Growth of Blue Crabs.* Submitted August 1971 in partial fulfillment of the Doctor of Philosophy Degree in Wildlife and Fisheries Sciences. Texas A&M University.

Holland, J. Selman, David V. Aldrick and Kirk Strawn. *Effects of Temperature and Salinity on Growth, Food Conversion, Survival and Temperature Resistance of Juvenile Blue Crabs, Callinectes sapidus Rathbun.* Texas A&M Sea Grant Program. College Station, Texas. TAMU-SG-71-205.

Johnson, Alan M. *Deterministic and Stochastic Models for Bioeconomic Control of a Commercial Fishery.* Submitted in partial fulfillment of Doctor of Philosophy Degree in Statistics. Texas A&M University. College Station, Texas.

Klussmann, Wallace G. and Johnie H. Crance. *Pollution and Foreign Vessels Should be Reported.* Marine Advisory Bulletin -- Fisheries. TAMU-SG-71-510. July 1971.

Loomis, Steven. *An Experimental Study of Seafood Merchandising in a Supermarket.* Submitted in partial fulfillment of Master of Science Degree. Texas A&M University. TAMU-SG-71-221.

Mathews, Daniel W. et al. *A New Tax Program for Commercial Fishermen.* Marine Advisory Bulletin -- Fisheries. TAMU-SG-71-508. July 1971.

Parker, J. C. *Biology of the Spot, Leiostomus xanthurus Lacepede, and Atlantic croaker, Micropogon undulatus (Linneaus), in Two Gulf of Mexico Nursery Areas.* TAMU-SG-71-210. 182 pp. May 1971.

Parker, J. C. *A Study of the Length-Weight Relationship and Condition of Spot, Leiostomus xanthurus Lacepede, and Atlantic croaker, Micropogon undulatus (Linnaeus).* 17 pp. In review.

Parker, J. E., et al. *Distribution of Aquatic Macro-fauna in a Marsh on West Galveston Bay, Texas and Possible Effects Thereon Resulting From Impoundments for Shrimp Culture.* TAMU-SG-71-208. 32 pp. May 1971.

Parker, J. C., et al. *Effect of Fish Removal on the Growth and Condition of White Shrimp, Penaeus setiferus (Linnaeus), in Brackish Ponds.* 7 pp. In review.

Pequegnat, W. E. and L. H. Pequegnat. *New Species and New Records of Munidopsis (Decapoda: Galatheidae) From the Gulf of Mexico and Caribbean Sea.* Supplement to Vol. 1. Texas A&M University Oceanographic Studies. Gulf Publishing Company. Houston, Texas. 1971.

Simmons, Herbert. *Acclimation to Temperature at Various Salinities of Cyprinodon variegatus.* Submitted June 1971 in partial fulfillment of Master of Science Degree in Wildlife and Fisheries Sciences. Texas A&M University.

Simmons, Herbert B. *Thermal Resistance at Various Salinities in the Sheepshead Minnow (Cyprinoclon variegatus Lacepede.* Texas A&M Sea Grant Program. College Station, Texas. TAMU-SG-71-205.

Wiesepape, Larry M. and David V. Aldrich. *Effects of Temperature and Salinity on Thermal Death in Postlarval Brown Shrimp, Penaeus aztecus.* Texas A&M Sea Grant Program. College Station, Texas. TAMU-SG-71-201.

Professional Journal Publications

Cobb, B. F., III. *The Use of Mariculture to Produce a Quality Food Product: A Challenge for the Future.* Proc. World Mariculture Society. (In press).

Cobb, B. F., III. *The Utilization of Trash Fish.* Accepted for publication in Proc. Gulf States Marine Fisheries Comm.

Cobb, B. F., III, and C. Vanderzant. *Biochemical Changes in Shrimp Inoculated with Pseudomonas, Bacillus and a Coryneform Bacterium.* Accepted for publication by J. Milk & Food Technology. 1971.

Holway, J. E. and G. W. Klontz. *A Procedure for Testing the Antigenicity of Vaccines for Immunization of Fish Against Furunculosis.* Fish - Cult. 33 (1):42. 1971.

Joy, James E. *Geographical Distribution and Host Records for the Genus Crassicutis (Trematoda: Allocreadiidae) with a New Locality Record for Crassicutis archosargii.* Submitted to Folio Parasitologia.

Joy, James E. *New Locality Records for Diplomonorchis leicostomi Hopkins, 1941 (Trematoda: Digenea) and Macrovalvitrematoides micropogoni with Notes on Their Geographical Distribution.* Submitted to Texas Journal of Science.

Joy, James E. *Parasites from the Spot, Leiostomus xanthurus Lacepede, in Galveston Bay, Texas.* Submitted to Journal of Fish Biology.

Joy, James E. *Spirocamallanus pereirai (Nematoda: Camallanidae) from the Croaker, Micropogon undulatus, in Texas.* Journal of Parasitology, 57:390. 1971.

Lewis, D. H. and T. C. Allison. *An Immunofluorescent Technique for Detecting Aeromonas liquifaciens in Fish Utilized in Lunar Exposure Studies.* Trans. Am. Fish. Soc. 100(3): 575-578. 1971.

Nickelson, R., and C. Vanderzant. *Vibrio parahaemolyticus: A Review.* J. Milk & Food Technology. 34:Sept. 1971.

Parker, J. C. *Distribution of Juvenile Brown Shrimp (Penaeus aztecus Ives) in Galveston Bay, Texas, as Related to Certain Hydrographic Features and Salinity.* Contributions in Marine Science. Vol. 15. pp. 1-12. 1971.

Ray, Sammy M. *Paralytic Shellfish Poisoning: A Status Report.* Current Topics in Comparative Pathobiology. Vol I. (In press).

Vanderzant, C., and R. Nickelson. *Comparison of Extract-Release Volume, pH, and Agar Plate Count of Shrimp.* J. Milk & Food Technology. 34:115-118. 1971.

Vanderzant, C. , E. Mroz, and R. Nickelson. *Microbial Flora of Gulf of Mexico and Pond Shrimp.* J. Milk & Food Technology. 33:346-350. 1971.

Vanderzant, C., et al. *Microbial Flora of Pond-Reared Brown Shrimp (Penaeus aztecus).* Appl. Microbiol. 21:916-921. 1971.

Conference Presentations

Brown, C. D. and G. W. Klontz. *Texas A&M University's Role in Aquatic Animal Medicine.* Proceedings of 1971 Meeting of the International Association of Aquatic Animal Medicine. 1971.

Crance, Johnie H. *A Marine Fisheries Extension Program.* Annual Meeting of the Texas Shrimp Association and The Gulf States Marine Fisheries Commission. Brownsville, Texas. March 1971.

Klontz, G. W. *Aquatic Animal Medicine.* Presented at the American Association of Avian Pathologists Meeting. Trenton, New Jersey. October 1970.

Klontz, G. W. *Aquatic Animal Medicine - An Overview.* Presented at the American Veterinary Medical Association Meeting. Detroit, Michigan. July 1971.

Klontz, G. W. *Aquatic Animal Medicine at Texas A&M University.* Presented at the University of California. Course in Perspectives in Veterinary Medicine. Davis, California. November 1970.

Klontz, G. W. *Aquatic Animal Medicine - Where are we now?* Presented at the faculty meeting. Department of Veterinary Anatomy. Texas A&M University. February 1971.

Klontz, G. W. *Biology and Fisheries.* Presented at the Marine Science Reporting: Briefing Session. Galveston, Texas. January 1971.

Klontz, G. W. *Diseases of Propagated Fishes: A Challenge for the Veterinarian.* Proceedings of Eleventh Poultry Pathologists Conference. 1970.

Klontz, G. W. *The Effects of Agricultural Pollutants on Aquatic Life.* Presented at the American Veterinary Medical Association Meeting. Detroit, Michigan. July 1971.

Klontz, G. W. *Fish and Marine Mammals in the Laboratory.* Presented at the Marine Biomedical Institute. Galveston, Texas. January 1970.

Klontz, G. W. *Fish Diseases.* Presented at the Annual Workshop Meeting of the World Mariculture Society. Galveston, Texas. February 1971.

Klontz, G. W. *General Epizootiology of Diseases of Feral Fishes.* Presented at the Wildlife Disease Association Meeting. Fort Collins, Colorado. August 1971.

Klontz, G. W. *Hatchery Management and Fish Diseases.* Presented at the American Veterinary Medical Association Meeting. Detroit, Michigan. July 1971.

Klontz, G. W. *Hematological Techniques and the Immune Response in Rainbow Trout.* Presented at the Symposium on Diseases of Fish. London, England. May 1971.

Klontz, G. W. *Immune Response in Fish.* Presented at the Armed Forces Institute of Pathology course on Pathology of Diseases of Laboratory Animals. Washington, D. C. September 1970.

Klontz, G. W. *Mariculture Work at Texas A&M University.* Presented at the Fish Farming Seminar. Inverness, Scotland. May 1971.

Klontz, G. W. *Post Mortem Techniques for Fish.* Presented at the American Veterinary Medical Association Meeting. Detroit, Michigan. July 1971.

Klontz, G. W. *Some Respiratory Diseases of Fish.* Presented at the Armed Forces Institute of Pathology course on Pathology of Diseases of Laboratory Animals. Washington, D. C. September 1970.

Klontz, G. W. *The Use of Fish in Biological Situations.* Proceedings of the Symposium on Remote Sensing in Marine Biology and Fishery Resources. January 25-26, 1971. College Station, Texas. TAMU-SG-71-106. Sea Grant Program. Texas A&M University. College Station, Texas. March 1971.

Klontz, G. W. and D. P. Anderson. *Oral Immunization of Salmonids: A Review.* Symposium on Diseases of Fish and Shellfish. S. F. Snieszki, (Editor). pp. 16-21. Spec. Publ. No. 5. American Fisheries Society. 1970.

Lewis, D. H. *Bacteria Infecting Man and Fish -- Vibrio parahemolyticus and Aeromonas hydrophila (liquifaciens).* Presented at the 21st Annual Southwest Conference on Diseases in Nature Transmissible to Man. Houston, Texas. February 1971.

Loomis, Steven. *Experiment in Retail Fresh Seafood Merchandising.* Presented at National Fisheries Institute - Retail Seminar. September 1971. Chicago, Illinois.

McConnell, S. and G. W. Klontz. *Virus Diseases of Fish.* Proceedings of the XIX World Veterinary Congress 2: 506-508. 1971.

McConnell, S. and G. W. Klontz. *Virus Diseases of Fish.* Presented at the XIX World Veterinary Congress. Mexico City, Mexico. August 1971.

Ray, Sammy M. *Current Status of Paralytic Shellfish Poisoning.* Presented at the Third International Congress on Food Science and Technology (SOS/70). Washington, D. C. August 9-14, 1970.

Texas Sea Grant Program and Texas Agricultural Extension Service. *Coastal Land Resources Conference.* Proceedings of the Coastal Land Use Conference. TAMU-SG-71-101. 111 pp. September 1970.

Thompson, Russell G. *Some Limitations to the Development of a Bioeconomic Theory of the Fishery.* Presented at the National Marine Fisheries Services Supply Conference. November 1970. To be published in Proceedings.

Thompson, Russell G. and Melvin D. George. *A Stochastic Investment Model for a Survival Conscious Firm.* Presented at the Econometric Society. December 1970. Abstract in Econometrica. July 1971. To be published in Proceedings.

Thompson, Russell G. et al. *An Extension of a Stochastic Investment Model for a Survival Conscious Firm.* Presented at the National Marine Fisheries Services Supply Conference. November 1970. To be published in Proceedings.

Trieff, N. M. et al. *Isolation of Gymnodinium breve toxin.* Presented at Second International Symposium on Animal and Plant Toxins. Tel-Aviv, Israel. February 22-28, 1970. To be published in Proceedings.

Wilson, Robert R. and Richard W. Callen. *Computerized Analysis of Shrimping Vessel Investments.* Presented at the Gulf States Marine Fisheries Commission and Texas Shrimp Association. March 1971. To be published in Proceedings.

Wilson, Robert R. et al. *Optimal Investment and Financial Strategies in Shrimp Fishing.* Presented at the Twenty-third Annual Gulf and Caribbean Fisheries Institute. November 1970. To be published in Proceedings. Also published as TAMU-SG-71-701.

MARINE COMMERCE

The development of our coastal harbors and channels have played an important role in the Nation's commercial and industrial growth. Current trends in the shipping/transportation industry along with the increasing numbers of super-sized vessels has prompted the initiation of Sea Grant supported projects dealing with associated problems. Because of their social and economic implications, projects concerned with tourism and recreational development, land use analysis of coastal areas and the development of a master plan to assist Galveston in attaining the goal of model coastal city are also under study by Sea Grant personnel. Publications and documentation resulting from this program area will be found listed at the end of this section.

Comprehensive Land Use Analysis of the Texas Gulf Coast (Research)

Activity Leader: John Miloy, Industrial Economics Research Division

This project is the initial phase to develop a comprehensive land use analysis of the 36 countries comprising the coastal zone of Texas. Primary goal will be to assess the current and projected acreage demands along the Texas coast by marine resources industries, mining and mariculture, agriculture, tourism and recreational activities, marine-oriented research facilities, fisheries and residential activities. Identification of these competitive land users is required to pinpoint problem areas and opportunities for growth. Such a study will provide the framework for future development and comprehensive planning in the coastal zone of Texas.

Project Description and Report of Work and Accomplishments

In support of this initial phase, statistical data for this area has been collected and gathered from primary and secondary sources to pinpoint the present situation and changes occurring in the coastal zone. Major trends are being documented by tabulation and analysis of population and employment characteristics over an extended period of time. Comparative statistics from the latest

census reports are being developed.

At the beginning phase of the project, an extensive literature search was conducted to collect published materials relating to land use development. Although the literature search has been completed, additional sources of pertinent material are being pursued as the investigation proceeds.

Communications and visits have been made with appropriate Federal, state and local agencies concerned with land use development. Also, considerable correspondence has been developed with Federal and state agencies, business leaders and personnel of universities interested in land use activities.

In addition, the project leader attended the third annual Offshore Technology Conference in Houston, Texas, on April 19-21, 1971, in which marine coastal problems were discussed. Project leader also attended the National Security Industrial Association/National Oceanographic Association Symposium in Washington, D. C., on June 2-3, 1971, in which organizations and Federal agencies presented individual goals, problems and current research activities.

Factors Affecting Industrial Location on the Texas Gulf Coast (Research and Advisory Services)

Activity Leaders: John Miloy and Arthur Wright, Industrial Economics Research Division

Primary objectives in this study were to determine the factors affecting industrial locating along the 36-county Gulf Coast area and to assess the influence of marine related activities on industrial location in this area. Funding for the study was derived from the funds allocated to the project "Comprehensive Land Use Analysis of the Texas Gulf Coast."

Project Description and Report of Work and Accomplishments

The basic analysis of the study is comprised of two parts. One part is a descriptive inventory of the coastal zone on a county-by-county basis over a period of years, and the second part consists of primary data gathered from a questionnaire developed and sent to 245 new firms which have located in the area within the last two years. Results from the questionnaire identify and rank the most important location considerations, clarify advantages and disadvantages of the region to new firms, indicate the comparative size of each new firm in terms of employees and gross revenue, delineate the

types of labor required, show the type and relative importance of transportation used to receive raw materials and distribute end products, and to indicate percent of material coming from various distances and percent of products being shipped various distances.

Of the 245 questionnaires distributed, 65 were returned by the firms, or approximately 27 percent. These questionnaires were tabulated and analyzed for inclusion in the study.

Evaluating the role of marine and non-marine related industries, including an analysis of the changing physical, social, and economic characteristics of the area, should be helpful in making strategies for the future economic development of the Texas coastal zone.

Offshore Port Study (Research)

Activity Leader: James R. Bradley, Industrial Economics Research Division

The objective of this project is to establish the feasibility of an offshore terminal for use by deep-draft superships which are unable to enter existing channels and harbors because of water depth limitations. The project is being conducted in two phases: Phase I is the work plan for the feasibility study and Phase II is the feasibility study itself.

Project Description and Report of Work and Accomplishments

Phase I was begun on January 1, 1971 and was completed on August 31, 1971. The Phase I report, entitled "Work Plan for a Study of the Feasibility of an Offshore Terminal in the Texas Gulf Coast Region," was published in July, 1971 and has received national distribution to interested persons in the industry.

Phase II will be started on September 1, 1971. A number of meetings and other milestones, leading to full start-up of this phase have already occurred, and others are scheduled for the first quarter of the 1971-72 fiscal year.

The program of work during the first phase of this project was broadbased and comprehensive. Activities included an exhaustive survey of literature both in the library and among the trade in the field. Coincident with the literature search, on-going developments in the area of study were assessed through contact by mail, telephone and personal interviews with consultants, business firms and government agencies. In all, approximately 75 telephone calls, 100

letters and 33 personal contacts were undertaken in the development of data considered adequate for Phase I.

In addition to the contacts enumerated above, work was initiated with individuals representing six different areas of expertise on the Texas A&M University campus and inputs usable in the work plan report were received from four of them.

An offshore study trip was made aboard the United States Army dredge "McFarland" during the spring.

Three conferences were attended. These were the Offshore Technology Conference on April 19-21 in Houston, the Japanese Technology Seminar on April 22nd and the National Research Council regional conference on Transportation of Hazardous Materials, held August 18 in Houston.

During the reporting period, several presentations before groups were held. On June 9th, approximately 40 members of the Ports and Waterways Committee of the Houston Chamber of Commerce were given a report on the progress of the port study. On July 21st, the completed study was presented to the South Texas Regional Export Expansion Council and to the news media at two separate meetings in Houston.

Since publication of the Phase I report, 575 copies have been supplied to various persons in the field who requested them and, also, approximately one-third of this number have been sent out on an unsolicited basis.

A good start has been made on building an Industrial Economics Research Division library of port-related literature.

Tourism and Recreation Development (Research)

Activity Leader: Clare A. Gunn, Department of Recreation and Parks

This project is a first attempt to relate overall tourism-recreation development to the marine and coastal environment. The sea-land interface is becoming an extremely important area for leisure use. Because of the many social and economic implications it now deserves careful and professional examination. It is experiencing greater growth pressure than inland areas. Such growth brings problems -- conflicts within recreation uses, conflicts with other marine and land uses, less-than-satisfactory experiences for participants, lowered levels of profits and often erosion of the resource base. This project is directed toward establishing relationships

between development and the resource base so that wiser and better use can be made of coastal areas. It will serve as a guide for exploiting these resources in ways that can more efficiently reach tourism-recreation goals.

This is an interim report for a three-year project having as its objective the development of a system of environmental evaluation of a coastal region for the planning and development of tourism-recreation. The system is to include:

1. Identification of natural and man-made resource factors important to the support of tourism-recreation activities;
2. Creation of a typology of tourism-recreation activities and their degree of dependency upon the natural and man-made resources;
3. Development of a means of identifying the propensity for tourism-recreation growth as seen by a panel of knowledgeable persons in the region; and
4. The delineation of zones best suited to basic categories of tourims-recreation development.

While the study involves the entire Texas Gulf coast, its primary scope involves the Corpus Christi area.

The goals for the first year were to make some progress on all objectives because they are to tightly interlaced. It is not feasible to set them up in a programmed sequence. Therefore, degrees of accomplishment vary but all objectives have been given some attention. The following is a summary of highlights of progress to date.

Project Description and Report of Work and Accomplishments

Report of Work. Following is a brief summary of this year's activities. These activities were not planned to be terminated within the first year; therefore reports are now in process rather than completed.

Review of Studies. Review of environmental evaluation studies and previous research shows related efforts but none that encompasses the full range of tourism-recreation development. Studies within several disciplines were investigated and have been documented: geography, land economics, ecology, regional planning, agriculture, computer technology, systems analysis, landscape architecture. Studies in tourist business location and resource allocation were sought but few were located. The search for studies that will assist this project is continuing.

Reconnaissance. Reconnaissance of the coastal region is revealing characteristics of the resource base that both limit and make it peculiarly attractive for tourism-recreation development.