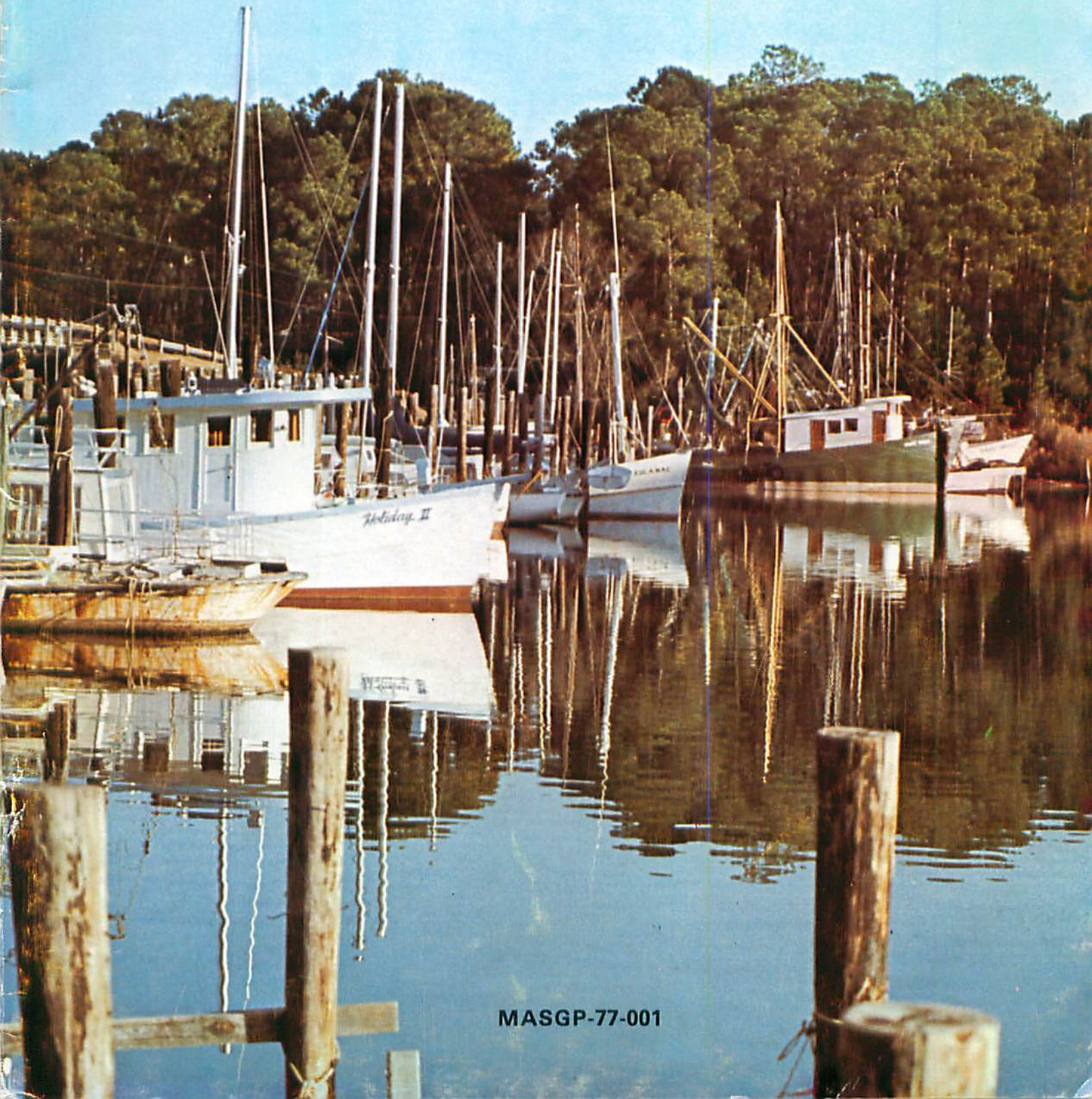
1975 ANNUAL REPORT

MISSISSIPPI-ALABAMA SEA GRANT CONSORTIUM

JANUARY 1, 1975 — JUNE 30, 1976



MASGP-77-001

THE MISSISSIPPI-ALABAMA SEA GRANT CONSORTIUM

PARTICIPATING INSTITUTIONS

Auburn University

Gulf Coast Research Laboratory

Mississippi State University

Tuskegee Institute

University of Alabama

University of Alabama in Birmingham

University of Alabama in Huntsville

Uni··_sity of Mississippi

University of South Alabama

University of Southern Mississippi

THE MANAGEMENT COMMITTEE

Robert P. Glaze, Ph.D. University of Alabama in Birmingham

Harold D. Howse, Ph.D. Gulf Coast Research Laboratory

Kenneth E. Johnson, Ph.D. University of Alabama in Huntsville

J. Chester McKee, Ph.D. Mississippi State University

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E. Roger Sayers, Ph.D. University of Alabama

E. Wayne Shell, Ph.D. Auburn University

Courtney J. Smith, Ph.D. Tuskegee Institute

Robert T. van Aller, Ph.D. University of Southern Mississippi

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EDITING AND LAYOUT:
Joe E. Seward, Jr.

EDITORIAL ASSISTANTS:
J. Baron McIlwain
Debbie Gautier

PHOTO CREDITS:
Joe E. Seward, Jr., cover
and pp. 1, 2, 5, 11, 17, 23, 33, 37, 39
University of Mississippi, p. 10

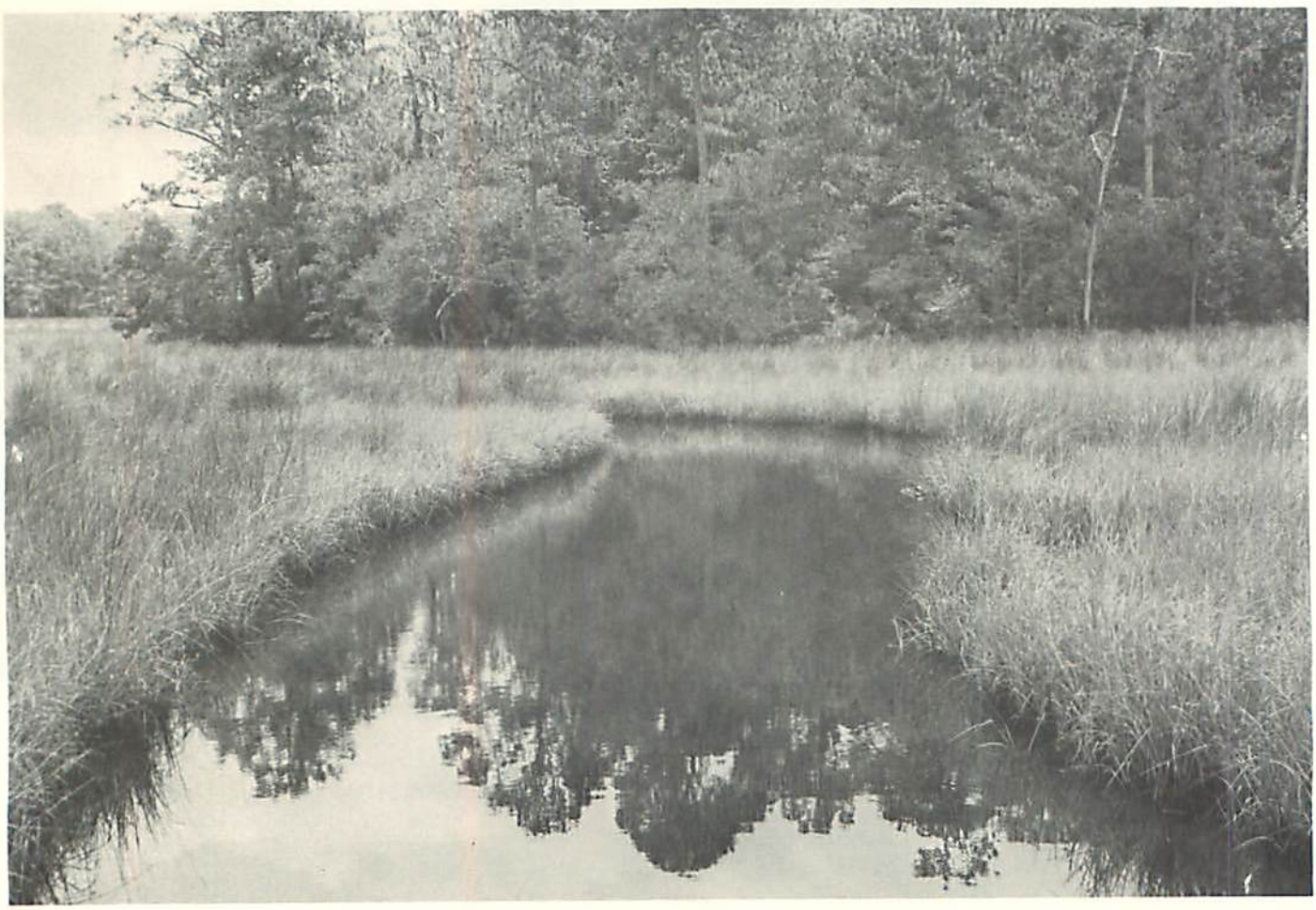
MISSISSIPPI-ALABAMA SEA GRANT CONSORTIUM
P. O. Drawer AG
Ocean Springs, Mississippi 39564
601-875-9341

FOREWORD

This year of activity had its share of achievement, frustration and disappointment but represented an important landmark for the Mississippi-Alabama Sea Grant Program. Several major projects survived the first year of development and have achieved a degree of productivity which was originally aspired to, intermittently given up on, invariably doubted but never totally abandoned. It has been a year of training for everyone, training that was truly satisfactory because visible products were appearing, goals were being achieved and real efforts were made to meet deadlines.

As most Program Directors would admit, the difficulties of limiting funds at the national level are magnified within the smaller projects. There is always a "bottom-line" below which the effort can rarely succeed and the individual projects presented in this report have seldom operated far from that marginal level. But in a sense that has become routine and may become more common throughout the Sea Grant program and the lessons of survival are always valuable. This could emerge as a most important factor when critical analysis is applied to the program as a whole.

The spirit of cooperation continued to grow during the pursuit of the various multidisciplinary studies and it is a credit to Sea Grant that departmental, institutional and now even state boundaries have disappeared. Sea Grant has provided the catalysis and communication link for workers in natural resources, coastal zone management, governmental structure, advisory services of all kinds and certainly in academic research. This has been a gradual process throughout the years but in 1975-76 these individuals began seeking each other rather than being pushed or glued together with Sea Grant dollars. A degree of mutual respect has replaced distrust and a genuine effort to produce has replaced competition. This too must be viewed as a tangible product from these early years of the first multi-state consortium and one which will ultimately pay off for the people of Mississippi and Alabama.



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PROGRAM MANAGEMENT AND DEVELOPMENT 79(1)

Bruce W. Mattox **Mississippi-Alabama Sea Grant Consortium**

1975 was a time of transition and change for the Mississippi-Alabama Sea Grant Consortium. Experience gained from previous years dictated that a new approach be taken toward fulfilling the stated goals of improving the quality of life in the coastal area and accelerating the development of marine resources.

Significant progress was made during the early years of the Consortium, and a number of goals were achieved, but the normal process of growth and maturation soon revealed that some of the procedures and assumptions that served well only a year before could not meet the needs and demands imposed by changing conditions.

A new and dynamic approach had to be developed that would provide the strength and flexibility to permit rapid response to the many problems that arise in the coastal area. This new approach had to establish a logical progression into which all foreseeable problems, or potential problems, could be placed.

The new concept, developed to fulfill the major Sea Grant objectives of research, education, and advisory services, uses the proved problem solving approach--Identification, Investigation and Development, and Application. In the first step of this approach, problem areas are identified and possible solutions are suggested through the efforts of the Sea Grant Advisory Service, principal investigators, and other personnel. The second step stresses the development of hardware, techniques, information, or processes necessary to solve the identified problems. The third step involves implementation of these solutions for the benefit of the marine community. The value of this concept has been demonstrated in the development of the 1975 Program of the Mississippi-Alabama Sea Grant Consortium.

Inherent in all Sea Grant activity is the two-way communications channel provided by the Advisory Service. The feedback generated by this system serves to evaluate, refine, and often to redirect research activity to insure the responsiveness of the overall Sea Grant Program. Such has been the case in several situations where information and experience gained from established projects were extended into new or related areas of investigation.

Faculty Advisory Committees, whose members were selected from the institutions of the Consortium, have provided a major contribution to the Director in determining the areas in which Sea Grant research, education, and advisory service activities may be of the greatest benefit. The interdisciplinary committees, in addition to evaluating potential research projects and acting in an advisory capacity, functioned as review panels to determine areas where Sea Grant involvement would be most beneficial.

The 1975 Mississippi-Alabama Sea Grant Program is comprised of 21 projects, and the goal of equal involvement for both states is coming closer to reality. Alabama has a total of five projects, one of which is a comprehensive two-state venture for the development of Gulf Coast artificial reefs. This involvement represents a significant increase over previous years, and plans are being made to involve the total research capability of the Consortium in an even greater number of cooperative efforts.

The Mississippi-Alabama Sea Grant Consortium played an increasingly important role in the development of coastal zone management plans for Mississippi and Alabama. These activities were concerned with the vital functions of disseminating information relative to the need for such programs and securing public participation in the preliminary planning processes. The Coordinator of Coastal Zone Management Activities worked closely with the Mississippi Marine Resources Council and the Alabama Coastal Area Board in planning and conducting five public meetings on coastal zone boundaries in both Mississippi and Alabama, in addition to a Coastal Leaders Conference on coastal zone management in both states. The proceedings of these meetings were published and distributed throughout the United States and several foreign countries. Descriptive brochures on coastal zone management were written and published for Mississippi and Alabama, and more than 10,000 were distributed in each state. Slide presentations were prepared for both the Mississippi and Alabama coastal zone management planning efforts, and they were shown to a number of civic clubs and general audiences throughout both coastal areas. A portable, lighted exhibit was designed, constructed, and used at a number of public gatherings to help emphasize the importance of coastal zone management to the future of the coastal areas of the two states.

Sea Grant provided valuable assistance to the Mississippi Marine Resources Council by identifying expertise in the various Consortium member institutions. This expertise was needed to perform the contractual services necessary for the Council to conduct its programs and activities.

The Consortium is definitely on the move. The intensive research activities of the principal investigators were documented in 39 new publications, which brings the Consortium total to 152. The outstanding cooperation among the participating institutions is a matter of record, and the planned increase of two-state and multi-institutional projects will further increase the productivity and importance of Sea Grant in Mississippi and Alabama.

RESEARCH

MARINE RESOURCES DEVELOPMENT

DEVELOPMENT OF GULF COAST ARTIFICIAL REEFS 07(1)

George F. Crozier — University of Alabama in Birmingham
Lewis R. Brown — Mississippi State University
David M. Dean — University of South Alabama
Edward E. Jones — University of South Alabama
Thomas D. McIlwain — Gulf Coast Research Laboratory
Robert L. Shipp — University of South Alabama

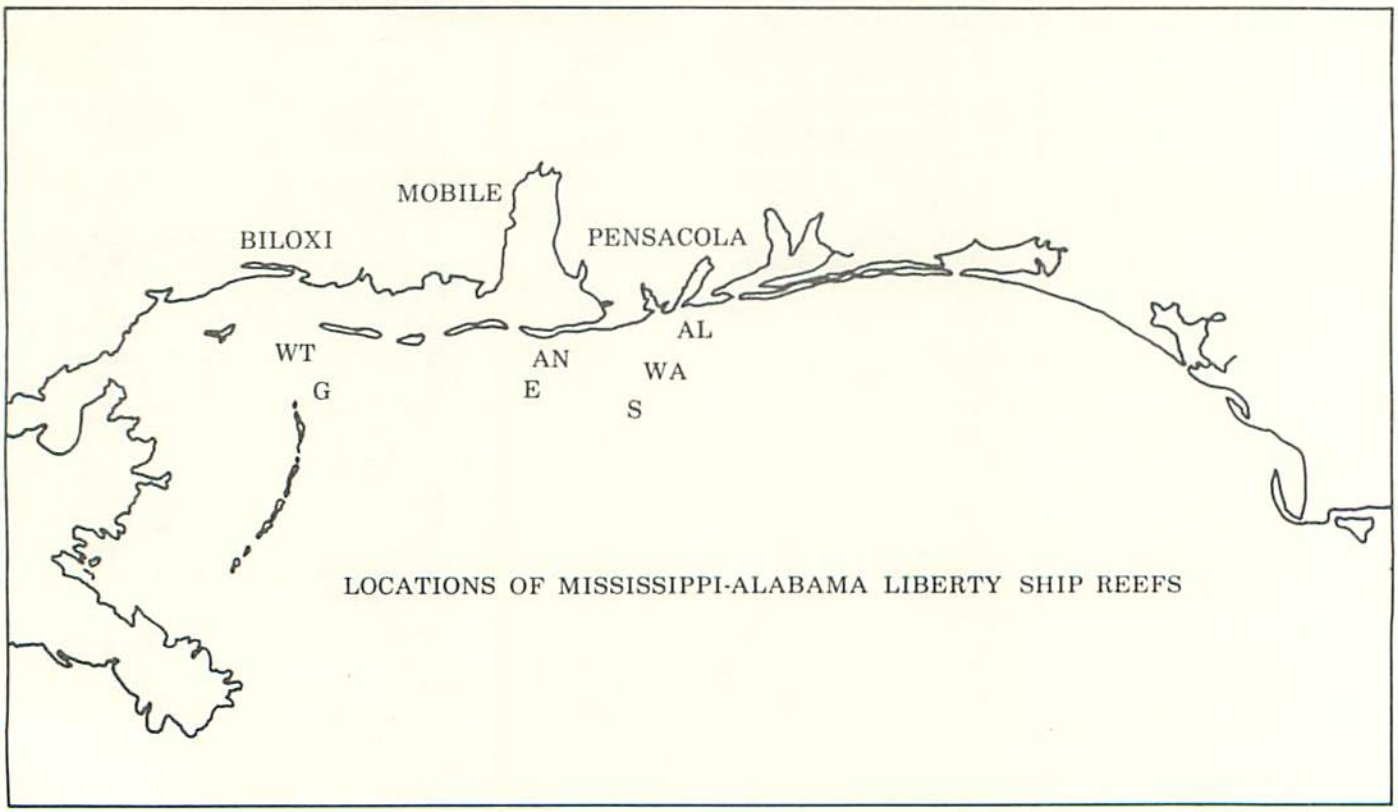
Since May of 1974, 10 Liberty Ships have been sunk in Mississippi and Alabama coastal waters to serve as artificial fishing reefs. These reefs were intended to create new habitats for game fish populations important to the recreational fisheries of the two states. The goals of this project have been to determine the success of these reefs in attracting and supporting populations of desired species and to study the general structure of the artificial reef community.

Observations of the artificial reef icthyofauna have been carried out by teams of divers using standard SCUBA techniques. Whenever tentative species identifications were made, additional members of the questionable species were collected on subsequent dives. A number of identifications have been confirmed in this manner. On site collections were made by use of hand nets and slurp guns. Upon surfacing, divers were debriefed and a species list was compiled. Information relating to the locations of

Sinking Dates of Mississippi-Alabama Liberty Ship Reefs

Alabama:
Wallace (WA)--May, 1974
Sparkman (S)--August, 1974
Allen (A)--February, 1975
Edwards (E)--December, 1975
Anderson (AN)--March, 1976

Mississippi:
Waterhouse (WT)--June, 1975 (2 hulls)
Gershwin (G)--December, 1975 (3 hulls)



LOCATIONS OF MISSISSIPPI-ALABAMA LIBERTY SHIP REEFS

fish and species abundance was included. Night dives were conducted to determine differences in diurnal and nocturnal species. When possible, photographs were taken of reef fish with an underwater 35 mm camera. Efforts also were made to obtain game fish specimens for gut analysis. Trawl and plankton collections were made throughout the reef areas and east to the head of the De Soto Canyon, which may be a major recruitment area for the reef communities.

Beginning in February of 1975, the invertebrate community of the reefs was sampled by means of scrapes, VanVeen grabs, and general observation/collection of larger fauna. Encrusting epifaunal organisms and associated species were scraped from 100 cm^2 quadrats at four random locations on Wallace Reef. The remainder of the scrape samples consisted of 400 cm^2 quadrats collected from the other reefs. Material was scraped by hand directly into sealable plastic bags and preserved with 10 percent formalin immediately after collection. The organisms were separated, identified, and stored in 70 percent alcohol. The 1975 samples have been identified at least to phylum, and the 1976 scrapings have been sorted.

The February bottom grab samples were collected by 0.14 m^2 VanVeen grab in the immediate vicinity of Wallace, Sparkman, and Allen Reefs. Wallace and Allen Reefs were sampled again in June, and Wallace again in September. The infaunal organisms (primarily Polychaetes) were separated, identified, and preserved in 70 percent alcohol. Beginning in the summer of 1976, routine dives were made to observe and collect by hand the macroinvertebrates present on the reefs but not represented in scrape or grab samples. These observations were made on Anderson, Gershwin, and Waterhouse Reefs.

Observations at Waterhouse Reef began at the time the hulls were sunk in June 1975, and the first sampling trips provided a good indication of initial recruitment of fishes to a new habitat. This aspect of the project is important, for seasonal trends in populations have become apparent. During the summer and early fall months there is a small tropical component which seems to disappear with the advent of colder water temperatures. The pelagic population also disappears during the winter months. The species list of fishes has grown from 21 in December 1975 to 53 in 1976. A 50 m transect area is being used to make quantitative evaluations of the species diversity of Waterhouse Reef.

An ENDECO Model 110 recording current meter was installed near Anderson Reef to obtain a better understanding of the water mass movement in the general area. Seventy-five days of continuous recording revealed a current range of 0 to 1.2 knots which was entirely tidal in nature. There was no evidence of a sustained current from any direction. This is the first tidal data collected from this part of the northern shelf of the Gulf of Mexico.

Copepods have been the major component of the zooplankton, but during the summer months a mixture of crustaceans-cladocerans, amphipods, and substantial numbers of copepods has been present. Because of the important role which copepods play in the transformation of primary production to consumers, and the amount of time required for identification, only the copepods were analyzed systematically. All other groups were sorted to phylum and preserved for further investigation.

The dominant copepods appear to be species which have wide tolerance to salinity and temperature such as *Centropages hamatus, Labidocera aestivia, Temora turbinata, Undinula vulagris,* and species of the genus *Corycaeus.* These species were present in samples taken from the entire area. In addition, some species appear only in the higher salinities to the east. These species include *Pontellina plumata, Sapphirina* sp., *Rhincalanus* sp., and others which appeared only once. These data would tentatively indicate that the water column changes from a more warm temperate, less saline muddy water off Mobile Bay to a subtropical clear water off the coast of Florida.

All invertebrates identified thus far comprise some 255 species, but the list is by no means complete. A number of scrape samples have yet to be sorted, and sampling efforts have been unequal at the various reefs. Due to the proximity and presence of a buoy, Anderson Reef has been visited more frequently than the other reefs. Scrapes are the only sample type which have been collected from all seven reefs. Data from bottom grabs are complete only for Wallace and Allen Reefs. General observation and collection of macroinvertebrates have occurred only at Anderson, Gershwin, and Waterhouse Reefs. The particular areas of faunal expertise of the divers making the observations is likely to have introduced a bias concerning the general observations.

The data indicate that polychaetes represent the most important macrofaunal constituent of the sediments, whereas molluscs and decapod crustaceans comprise important groups of larger invertebrates inhabiting the surface of the reefs. Encrusting organisms consist primarily of barnacles, hydroids, serpulid polychaetes, bryozoans, corals, and sponges to a lesser extent. Sparkman, second oldest of the reefs, was quite overgrown with encrusted fauna and supported extensive colonies of large bryozoans, with their own communities of associated fauna. It was observed that the Mississippi reefs harbored large numbers of the arc clam, *Anadara,* clinging to the sides of the hulls, along with many small crustaceans. However, the large numbers of asteroids seen on Anderson Reef were completely absent from the Mississippi reefs.

Given a more equalized sampling program with continued frequent observations and analysis of samples already taken, many of the gaps in the species list will undoubtedly be filled and a more adequate picture will be attained of faunal distributions among the reefs.

Collections made on trawl cruises have increased the total species to 110, representing 46 families, and diver observations have confirmed 54 species on the reefs. The ability to sample Anderson Reef with some regularity will allow the development of a seasonal occurrence profile.

It is apparent that high species diversity develops rapidly. Twenty species appeared at Anderson Reef within ten weeks and 41 within six months. Based on observations made on the Mississippi reefs, there is a clear impression of an east to west change in species composition and abundance of reef fishes.

Sufficient information is now available from this continuing project to prepare two advisory pamphlets. One would be addressed to sport fishermen and would contain information on the locations of the artificial reefs with illustrations and notes on the various game fish found there. The other would be addressed to the sport diver with information on spearfishing, aquarium fish collecting, and photographic opportunities.

PARASITES IN MARINE ANIMALS IN THE NORTHERN GULF OF MEXICO 08(1)

Robin M. Overstreet — **Gulf Coast Research Laboratory**

Many parasites in the northern Gulf of Mexico remain undescribed or poorly understood. Little is known about the biology, ecology, geographical distribution, and effect most of the commonly encountered species have on hosts. Some of these species affect either the sport or commercial fisheries, and others endanger human health. A better understanding of when, where, and how these infections originate will allow the people involved in fisheries or public health to adjust with the circumstances.

Parasites of finfishes and shellfishes, and those that infect or are potentially capable of infecting man, deserve increasing amounts of attention as more people eat seafood and occupy coastal areas. Information is needed concerning infectivity, pathogenicity, and control of selected parasites that infect reared and commercially valuable hosts. Life histories, pathogenicity, and treatment for selected parasites are of great importance, along with the seasonality or tolerances towards some environmental parameters of selected parasites that cause human skin rash. An immediate and pressing need is the identification and biology of some parasites infecting marine organisms in and adjacent to the northern Gulf of Mexico.

Microsporidosis, a readily transmitted disease affecting the economically important blue crab, is caused by the microsporidian *Nosema michaelis.* Most of the muscle tissue of crabs infected by this protozoan is replaced by microscopically-sized spores causing a chalky white appearance and a cotton-like texture when eaten.The drug buquinolate has been shown to control the infection in the majority of crabs tested. Multiple administrations of both drug and spores were analyzed. Commercial bleach or an iodine-containing disinfectant also will satisfactorily rid a system of infective spores.

The importance of rearing fish for food, bait, research, or other purposes is becoming more apparent. The dinoflagellate *Amyloodinium ocellatum* is capable of causing mass mortalities among fish in closed systems. Continuing research has shown that the majority of the fishes from the Mississippi Sound tested for this disease succumbed in aquaria. In attempts to control this dinoflagellate, baths of fresh water have been shown to be the most effective method; however, stages remaining in host mucus can remain infective. Most chemical treatments are either detrimental to the fish or make it unfit for consumption.

Lymphocystis is another disease that gives fish an aesthetically displeasing appearance. Most fish affected by this disease have numerous solitary tumors, occasionally united to form large conspicuous masses, distributed on the fins and body. Internal tumors also are present in silver perch. Studies of the ultrastructure of some internal infections were completed, as were studies on the annual prevalence of infections. Out of several hundred silver perch examined, only six were found to have naturally occurring lesions of lymphocystis in the heart. An electron microscopic examination of these hearts revealed viral particles in the interstitial space of the myocardium, further supporting the view that lymphocystis disease has a systemic phase. The examination also revealed various structures not previously found in lymphocystis-infected cells.

Attention also has been given to visible parasites or diseases that affect sport and commercial fisheries. There are a few species of tapeworms whose larvae infect the musculature of numerous economically important fishes. The most common, and consequently the most displeasing of these, is *Poecilancistrium caryophyllum.* This worm, typically about 4 cm in length, occurs most frequently in the spotted seatrout. Trout less than 14 cm in length generally are not infected. The original infection apparently causes a resistance to additional infections. Although harmless to man, fish infected by the parasite should be cooked, since other worms are potentially dangerous.

Mullet from both the United States and Israel were found to harbor parasites that can or do affect their hosts when maintained in culture. A review of these and most other parasites, diseases, and stresses afflicting mullet was completed, including comments on host-parasite relationships and methods to control some parasites. Mullet in the northern Gulf of Mexico developed tumors considered to be malignant fibrosarcomas, possibly associated with unidentified pollutants. Benign tumors occurred in the sea catfish and southern flounder.

Digenetic trematodes were described from cephalopods, and some roles of these hosts in their ecosystems were compared with those of fishes. Other worms were also described, including leeches which, even though not always parasitic, can act as hosts for blood parasites.

This ongoing project also has been examining a schistosome cercaria implicated in human dermatitis.

CIGUATERA FISH POISON 08(2)

Norman J. Doorenbos

University of Misssissippi

Ciguatera fish poison has presented a serious problem in tropical fisheries throughout recorded history. There are more than 400 species of ciguatoxic fish which include both herbivores and carnivores, as well as cartilaginous and boney species. These species include some of the more prized food fish such as groupers, jacks, eels, flounders, snappers, croakers, and barracudas. Without exception, fish of ciguatoxic species are nontoxic in some waters and highly toxic in others. In some cases only a few miles separate ciguatoxic and safe fish of a given species. Each of the ciguatoxic species is a bottom feeder or includes bottom feeding species in its diet. This fact has led researchers to conclude that these toxins or their precursors originate in the benthic flora of a reef.

Fish seem to tolerate the ciguatera toxins, but humans who eat the fish become very ill. Toxic symptoms may include abdominal pain, nausea, vomiting, diarrhea, numbness and a tingling sensation around the mouth, headache, numbness in the extremities, metallic taste, muscular weakness, muscle aches, reversal of the sensations of hot and cold, and itching. Death sometimes results, especially if the poisoning occurs in the Western Pacific. Recovery is often slow and may require weeks or even months for the neurological syndrome to disappear.

Although many reports of ciguatera fish poisoning have been documented in the Caribbean and lower Gulf of Mexico, and some 100 species of fish have been implicated, little research has been done in this area before the initiation of this project in 1973.

Preliminary work was accomplished on six specimens of ciguatera fish, totaling forty pounds, which were obtained from the Island Resources Foundation, St. Thomas, Virgin Islands. Extracts from these fish were separated into several fractions for biological and chemical study. When injected introperitoneally into mice, the more toxic fractions produced abdominal irritation, mydriasis, piloerection, diarrhea, vasodilation, a curious springing behavior, a disassociation from the environment, hypothermia, and labored breathing. The toxicity of the various fractions was similar to those reported on toxic Pacific fish.

In 1974 officials of the Cayman Islands Government made the Mosquito Research Control Unit Facility of Cayman Brac available for these research studies. Since that time more than 1,000 specimens have been collected, examined, and processed for shipment to the laboratories at the University of Mississippi to be screened for the presence of ciguatera.

Gut contents of three local surgeonfish species were examined, for this bottom feeding species is suspected of being near the beginning of the ciguatera food chain. Procedures were refined for examining and identifying food materials, along with procedures for isolating under sterile conditions microorganisms from the gut contents. These microorganisms were preserved by freeze drying and shipped to the University of Mississippi under vacuum. Subsequently, cultures of the microorganisms were grown and examined for production of toxins. Only one toxic fish and no toxin producing microorganisms were found in the Cayman Islands. However, a number of new techniques were developed that should prove invaluable during further research.

Three new bioassays were developed using tadpoles, a *Photobacterium* species, and *Artemia salina*, a species of brine shrimp. Each of these bioassays offer advantages over the previous use of mongooses, cats, or mice. The brine shrimp assay is the most useful of these because it is simple and more sensitive than the mouse assay.

Quantities of algae growing on or near surfaces containing copper were collected, freeze dried, and brought to the University. Copper and copper derivatives have been implicated in the development of fish toxins. The algae, however, did not contain any toxin.

Toxic fractions from the St. Thomas fish were compared with a sample from the Pacific. The effects on mice and brine shrimp were similar, and chromatographic behavior, although similar, differs sufficiently to indicate that the Pacific and St. Thomas toxins are not identical but probably very similar. Ciguatera fish poison may consist of a family of closely related chemical toxins.

Thin layer chromatography was used to isolate four alkaloids from the St. Thomas fish. These alkaloids appear to be different from those found in the Pacific ciguatera toxins, and three of the four were toxic to brine shrimp.

A field station for ciguatera research was constructed, equipped, and put into operation on Virgin Gorda, in the Virgin Islands, which is one of the ciguatera hot spots in the Caribbean. Funds for the construction and basic support of this field station, known as Bitter End Field Station, were provided by Century Steel Corporation of

Chicago, Illinois. The total investment is estimated to have exceeded $100,000. This facility will provide support for field studies essential to the investigation of ciguatera fish poison. It was originally built to house two investigators, but in 1976 it was enlarged to accommodate three.

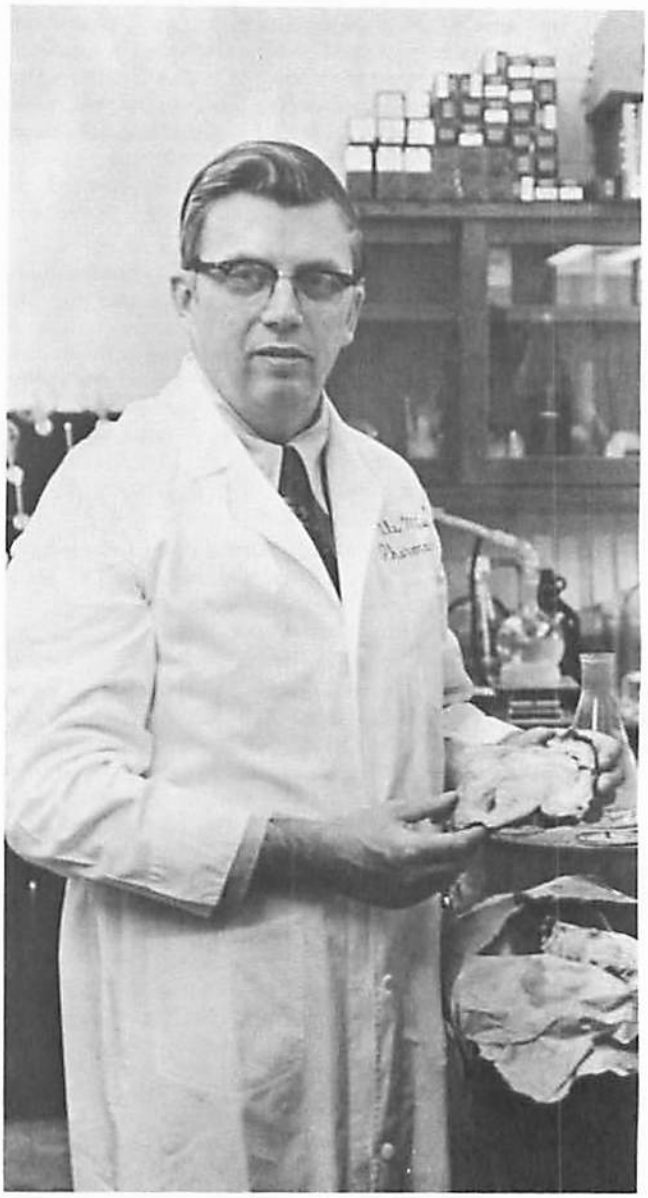
New bioassays for ciguatera toxins were developed using cultures of beating chick heart cells and an isolated rat heart atrium. The heart cells and the atrium beat more rapidly in the presence of ciguatera fish poisons. This effect is reversed by tetrodotoxin, the puffer fish toxin, because these two toxins have opposite mechanisms of action. Ciguatera makes cell membranes more porous to the passive transport of sodium ions; tetrodotoxin blocks their passage. It was demonstrated that the hypothermic effect observed earlier in mice treated with ciguatera toxins is a characteristic of both the Pacific and Caribbean strains and may be used as a sensitive bioassay. The brine shrimp bioassay has been refined and can be used to detect microgram quantities of ciguatera poisons.

The grayanotoxins of *Rhododendron* species closely resembles the ciguatera toxins in each of these assays, and tetrodotoxin reverses these effects in all of the bioassay systems except brine shrimp. This discovery has been most helpful, since very little ciguatera poison is available for research. The *Rhododendron* toxins were studied in several biological systems in the hope that the new information could be applied to ciguatera poisons.

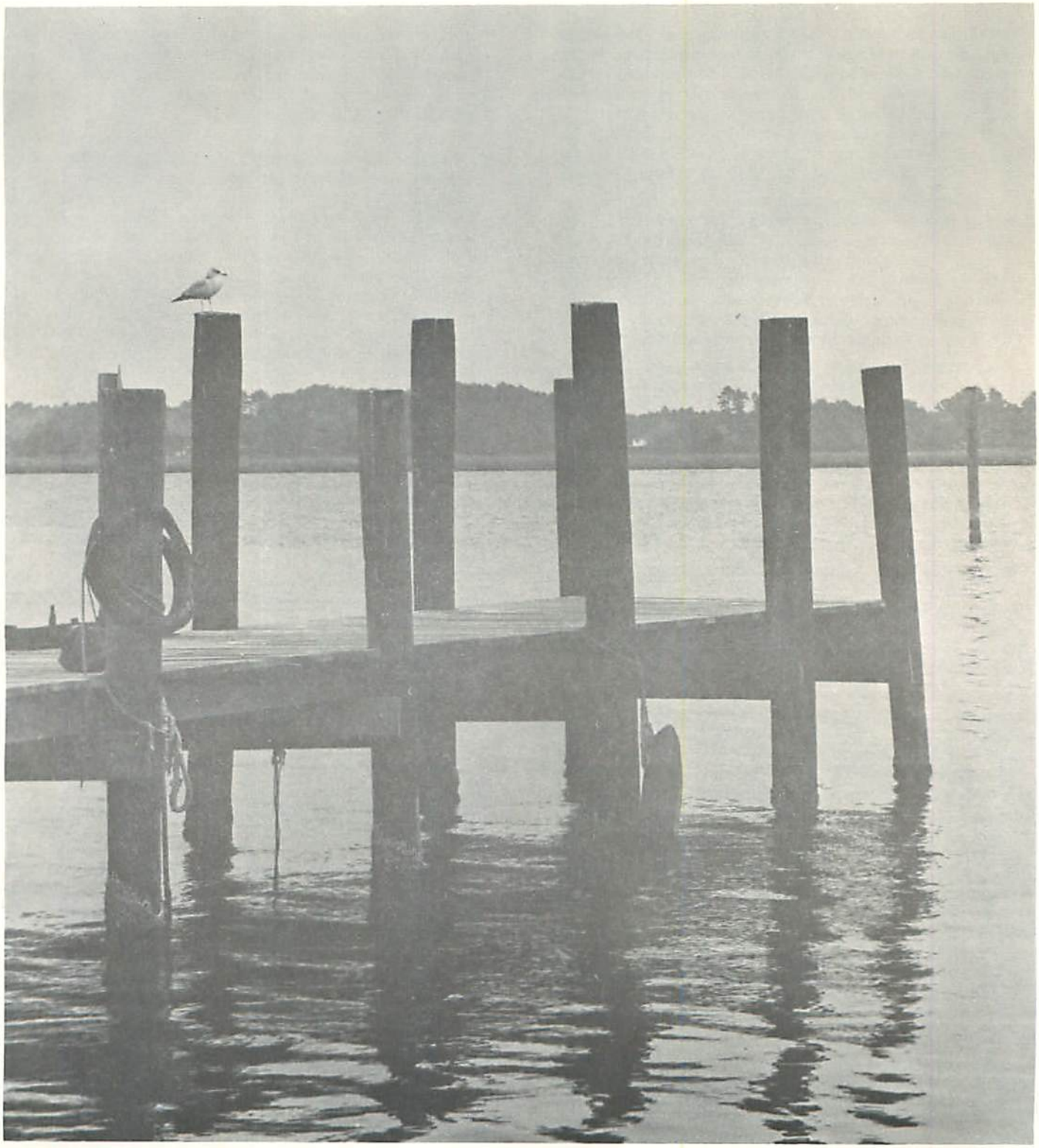
Techniques were developed for the isolation and culture of gut microorganisms under field conditions and for safely transporting these cultures to the laboratory for further study. The microorganisms are isolated under sterile conditions. Some are cultured on marine agar plates and others are freeze dried and sealed in ampules under vacuum for shipment. Upon receipt, subcultures are made, individual species are isolated, and cultures of the isolates are subsequently grown, extracted, and tested against brine shrimp and mice for the presence of ciguatera-like toxins.

Eight microorganism cultures isolated from the gut flora of surgeonfish collected from hot areas in the Virgin Islands were shown to elaborate highly toxic substances in culture media. Four of these microorganisms elaborate a toxin which closely resembles ciguatera in all of the bioassay procedures. Thus, the source of ciguatera reef fish may have been discovered. This is the most significant discovery made to date, for the source of ciguatera toxins has eluded the many investigators who have conducted previous research. If it can be proved that these microorganisms are the source of ciguatera, experiments can be designed to discover the various factors responsible for the development of the problem in some reef waters and not in others. It will also be possible to produce ciguatera toxins in quantity in the laboratory for needed chemical and biological studies.

Although this research project is not yet complete, tangible results already have been obtained. A fish shipped to the laboratory by a World Health Organization physician in Bermuda was examined and found to contain ciguatera toxin, confirming that ciguatera, not fish spoilage, was the cause of an outbreak of fish poisoning. This research effort continues in 1976.



SOCIO-ECONOMIC AND LEGAL STUDIES



AN ECONOMIC ASSESSMENT OF BOAT WASTE TREATMENT PROCESSES 14(2)

Leo R. Cheatham — **Mississippi State University**

On June 23, 1972, the Environmental Protection Agency adopted a series of no-discharge regulations for all types of boats equipped with toilets. The proposed certification procedures and design and construction requirements were published in the Federal Register on March 1, 1974. Finalized regulations were published on January 30, 1975, and were to become effective on January 30, 1977 for new vessels, and on January 30, 1980 for existing vessels.

These regulations eventually would have required no-discharge marine sanitation devices for all vessels. New vessels would have come equipped with these devices from the factory, and the discharge type devices on existing vessels would have been replaced. Most no-discharge systems require some type of holding tank, and these tanks require pump-outs. Consequently, pump-out stations would be necessary to implement the regulations.

Prior to the beginning of the project it was theorized that few pleasure craft and small commercial vessels operating along the Mississippi Coast would be in compliance with regulations. In addition, limited pump-out facilities would make the use of boat holding tanks difficult. These conditions would require the installation of large numbers of no-discharge systems on boats and the addition of many new pump-out stations. The possibility existed that the required expenditures might alter boating activities and reduce marina profits.

The no-discharge regulations will not become effective as scheduled, but have been superseded by performance standards published January 29, 1976. The revised regulations will permit U. S. Coast Guard certified discharge type devices to be used in place of no-discharge devices on the scheduled dates.

To obtain the information necessary to conduct this research project, marina operators were contacted and asked a limited number of general questions about their operations. A detailed questionnaire was left with them to be filled out and returned at their convenience. These questions concerned the type of business ownership, size of land and water area of establishment, services offered, number of berthing spaces by size and occupancy rate, number of customers, number of customer craft with toilets, number of customer boats, business problems, sources or revenue, and no-discharge regulation impact on the marina.

Boat dealers were interviewed to gather information on boat prices, holding tank prices, and the prices of marine sanitary devices. They were also asked for information concerning the type of sanitation devices they recommended to boat purchasers and what types of devices were generally bought.

A limited number of marinas with pump-out facilities were located on the state's land-locked lakes. Some of these marinas were visited to gather specific data on costs and maintenance of pump-out systems. Marina owners were interviewed and provided with a questionnaire requesting the following information: type of motor, type of pump, capacity of system, method of storage and disposal, period of time in use, initial cost of equipment, maintenance costs, total yearly operating costs, fees and revenue, profitability, and problems.

Questionnaires were sent to a random sample of 544 owners of boats more than 22 feet in length. The mailing list was compiled from the registration records of the Mississippi Boat and Water Safety Commission and U.S. Coast Guard documentation records. Each owner was asked for information as to type of boat, capacity, cost, name and location of home marina, names of other marinas visited, services used at marinas, frequency of boat use, length of boat trips, destinations of trips, family income, and opinions of no-discharge regulations. Owners also were asked if their boats were equipped with toilets, food preparation facilities, marine sanitation devices, or holding tanks.

Extensive efforts were directed toward compiling information on marine sanitation devices, holding tanks, and pump-out equipment. The Environmental Protection Agency was contacted on several occasions for data from related research projects. Copies of findings from marina industry studies conducted in the states of New York, Rhode Island, Vermont, Massachusetts, Texas, New Hampshire, Washington, and Connecticut provided much useful information.

A list of marine sanitation devices and holding tank manufacturers was acquired from the U. S. Coast Guard. Each manufacturer was contacted and asked to supply specific information on his products such as detailed descriptions, prices, capacities, and availability. These data were used to evaluate system alternatives. Copies of boating equipment wholesale catalogs were obtained for additional marine sanitation devices, holding tank models, and price information.

Both manufacturers were contacted to obtain information on sales policies relating to marine sanitation devices and holding tanks. Information was obtained on the availability of different sanitation devices on new boats, prices of the equipment, and prices of boats.

Boat count data and estimates of the numbers of small craft equipped with toilets were prepared for the three coastal counties of Mississippi. Data were compiled for different length classifications.

Boat owner questionnaires produced data for estimating the numbers of toilets and holding tanks. Poor response from owners of vessels in excess of 40 feet severely limited the information available in this category. Boats from 23 to 40 feet in length represent 80.9 per cent of all craft in excess of 22 feet registered on the Mississippi Coast.

No-discharge regulations would require devices which totally disintegrate sewage, such as incinerators or holding tanks to retain treated or untreated waste. Today only 290 of the estimated 1,671 boats equipped with toilets

would meet the no-discharge requirement with a holding tank. A limited number of the 218 boats equipped with other devices such as portable units would qualify. Even compliance with certified discharge device regulations will require installation of devices in at least 1,163 vessels under 40 feet, plus an estimated 275 units in vessels between 40 and 100 feet.

A technique was developed to measure sewage disposal requirements for different size groupings of boats. A measure combining the number of people, times the number of days of boat usage, times the number of boats in each group produces a figure indicative of total sewage potential from each group of boats.

The average occupancy rates ranged from 3.5 persons for 23 to 25 foot boats to 5.7 persons for 36 to 40 foot boats. Owners were asked to state the number of days between pump-outs with two people on board. Estimates on a 10 gallon tank ranged from 1 to 10 days. The average was .77 day per gallon. At this rate 3.5 persons could go 2.2 days on a 10 gallon tank. The capacities of holding tanks on boats so equipped ranged from three to 25 gallons. The most common size for 23 to 40 foot boats was 10 gallons.

Most of the small craft in excess of 22 feet in length were normally docked or stored at a marina in the coastal area when not at sea. Survey percentages of boats in each classification left at marinas were 70 per cent for 23 to 25 feet, 82 per cent for 26 to 30 feet, 80 per cent for 32 to 35 feet, and 100 per cent for 36 to 40 feet. The remainder were either moored at private docks or were trailerable and kept at home. On the average, boats equipped with toilets were used approximately 49 days per year with 60 per cent of these days on weekends.

Travel outside of the local coastal area by boat owners was very limited. Most of the longest cruises consisted of trips to the barrier islands located approximately 14 miles off the Mississippi Coast. The average length of these cruises in recent years was 104 miles and took an average of one to five days. Mississippi marinas provided the nearest available services to island travelers. Most of the travel outside of the Mississippi coastal area consisted of trips down the Florida Gulf Coast. Approximately 13 per cent of the boat owners had made at least one trip of this type in the last three years.

Surveys of marina operators, boat owners, and boat dealers revealed pump-out stations to be almost nonexistent along the coast. The marina survey indicated only one of the 23 full service marinas had a pump-out station and only one other marina had plans for one in the future. More than 80 per cent of the operators believed that fees from pump-outs would not be sufficient to cover costs of the equipment and its operation under either present conditions nor under conditions of no-discharge regulations.

Boat owners attempting to use holding tanks have become disgruntled with the pump-out situation. Those surveyed rated the difficulty of acquiring the service as very difficult or impossible. For many the nearest station is more than 100 miles from the home marina. Consequently, many are bypassing their tanks. A few boat owners have constructed homemade pump-out systems. One or two cases were cited where septic tank cleaning trucks were used, but the fee was $15 to $25 per pump-out. Boat owners think it is ridiculous to enact no-discharge regulations without making provisions for pump-out services.

All boat dealers interviewed were discouraging customers from buying holding tanks on new boats. Many were not attempting to sell any type of marine sanitation devices. Most cabin cruisers come standard equipped with a toilet, but holding tanks and marine sanitation devices are optional items that increase the price of a boat.

Small electric siphon pumps were being used at all the marinas contacted during the pump-out equipment survey. Capacities were from 8 to 20 gallons per hour. Pumps were located dockside and pumped directly into municipal sewage systems. Generally, the services were slightly profitable, primarily because of small initial investments of from $1,200 to $2,000. Maintenance and labor costs were small. Service ranged from $1.50 to $3.00 per pump-out. The secret to profitability lies in purchasing only equipment necessary to handle the load. Care must be exercised not to purchase more expensive equipment than needed. In an area where several stations are located, price per pump-out is determined by the market. Consequently, the marina operator's key to profit is to minimize cost.

State-of-the-art data on marine sanitation devices, holding tanks, and onshore treatment facilities were compiled. Holding tanks and incinerators are the most common no-discharge systems, while units containing macerators and chlorinators are common discharge devices. Other discharge systems may include biological and physical-chemical treatment systems. A technique for ranking different types of systems was developed which takes into consideration the cost of equipment, installation costs, cost of operation, imposed vessel load, operator skill requirements, expected device life, and the ability of the device to meet future discharge requirements.

A simple holding tank has the lowest initial cost of all alternatives other than some portable heads. For small pleasure craft the cost represents 0.5 to 3 per cent of the price of a new boat. When compared to pump-out fees and the cost of chemicals to control bacteria and reduce odor, the total cost of some incinerator devices may be less expensive in the long run.

Problems may be encountered at onshore bacterial treatment plants because of bacteria-destroying chemicals added to holding tanks. The contents of a tank may need to be diluted as much as 20 to 1 to permit reactivation of the bacteria.

Evidence suggests that no-discharge regulations may result in owners using their boats less than before. The major portion of owners are in the middle or low family income brackets. Mean average annual income before taxes for owners of 23 to 25 foot boats was $23,470. Incomes ranged from below $8,000 to more than $57,000, but more than 78 per cent were below $32,000 and more than 31 per cent were below $17,000. Income levels were only slightly higher for the classifications of larger boats. More than 28 per cent of the owners of 23 to 40 foot boats said they used their boats less in 1975 than in previous years, compared to 11 per cent who used theirs more, and 61 per cent who used theirs the same. Inflation and high operating costs were the most frequently cited reasons for using boats less. The requirement to purchase and maintain marine sanitary devices may increase the cost of operation to such an extent that boat usage may be reduced even more.

POTENTIAL INTERNATIONAL MARKETS FOR MULLET 14(3)

Giovanni B. Giglioni — **Mississippi State University**

Mullet is an underutilized but plentiful fishery resource in the Mississippi-Alabama coastal zone. Although recognized locally as a valuable food fish, marketing and processing problems have restricted its use in other geographic regions. Because of the recent increase in demand for fish and seafood, foreign marketing of mullet may be feasible and profitable for coastal fishermen and processors.

Italians consume more than 1 billion pounds of seafood a year, or about 18 pounds per capita. With the significant exception of tuna canned in olive oil and a few local specialities, most seafood is consumed fresh.

One of the fresh fish considered delectable is mullet of *cefalo* in Italian. This preference is neither of recent origin nor superficial. Quality mullet, fresh and weighing approximately 1.5 pounds each, is sold as quickly as it is brought to market.

Production of fresh fish in Italy has increased from 444.9 million pounds in 1951 to 830.3 million in 1974. The average annual increase in production, 2.85 per cent for the 24 year period, has declined since 1967 to 1.5 per cent, indicating a significant slowdown.

The future of Italian fresh fish production appears to be dependent on a series of negative factors including: the substantial increase in fuel cost; the trend toward extending territorial water limits, which results in longer and less productive fishing trips for Italian vessels; reduction in the fishing fleet; a new government regulation which prohibits fishing for mullet within 2 miles from the coastline; the continued depletion of seafood in the Mediterranean; and the competition from Japan and, in recent months, Russia.

With these factors in mind, it appears that production of fresh fish in Italy can only remain at present levels through great expense and government subsidies. Most likely production will continue to decline. This pessimistic forecast is shared by shipowners and importers who have halted the construction of trawlers. Longer trips and smaller payloads have caused concern about investments.

From 1958 to 1973 the production of Italian mullet has increased from about 8,960,000 to 16,128,000 pounds. Production has increased at an average annual rate of 4.5 per cent. In recent years it has been relatively stable, but since 1968 it has increased at a slower rate, only 2.3 per cent annually, pointing again toward a drop in production. From 1951 to 1973 the per capita consumption of fresh seafood has grown at the average annual rate of approximately 2 per cent. According to the standard demand theory, this growth has taken place because per capita incomes have increased at a rate of about 4.6 per cent per year, because of price changes in other goods, and despite an average 2 per cent per year rise in fresh seafood prices. Based on past market performance and other economic indicators, it is possible to calculate the increase of future seafood consumption at approximately 2.8 per cent per year.

It is not possible to calculate the actual consumption of mullet for lack of data. It can be noted, however, that this consumption must exceed domestic production because wholesalers import mullet from France, Spain, Portugal, and Mauritania. Italy has been a new importer of seafood. In 1951 imports amounted to 222.9 million pounds while exports were only 2.6 million, for a net import balance of some 220 million pounds. In 1974 imports were 279.3 million pounds while exports were 175.3 million, for a net import balance of 104 million pounds. The 1974 import figure is considerably lower than the values for most of the 1960's and 70's and represents a drop in imports of more than 71 million pounds of seafood from the previous year.

As indicated by these data, Italians prefer to eat fresh seafood. In 1951 the amount of fresh seafood consumed was more than twice as much as the amount of seafood that was canned, dried, or preserved. This ratio increased substantially in 1974 to 3.4 to 1, indicating an even stronger preference for fresh seafood.

The analysis of historical data on production, consumption, and exports-imports can be summarized as follows:

1. Italy, while producing a substantial amount of the seafood it consumes, must rely on imports to make up the difference.
2. The growth rate of seafood production is decreasing, and production is likely to decline further in the future.
3. Italy most likely will continue to be a net importer of seafood.
4. Other seafood — canned, preserved, frozen — accounts for a decreasing percentage of the total consumption. Therefore, the preference for fresh seafood is increasing.
5. Consumption of fresh seafood is likely to increase at the annual rate of 2.8 per cent.
6. Mullet is both produced and consumed in large quantities.
7. The quantity of mullet produced is not sufficient to satisfy domestic consumption.

Interviews with importers and wholesalers have revealed that they are eager to import fresh mullet in large quantities. The prices they would pay range from $.42 to $1.10 per pound. Most prices average about $.50. Also, fresh mullet must be whole, "in the round." There is very little interest for frozen mullet.

Most importers want photos, samples, and price quotations. Samples, especially, will allow them to establish the type and quality of the fish to evaluate its desirability and price.

The question was raised as to whether importers would be interested in buying croakers. These fish are completely unknown to the Italian market and the reaction of the importers ranged from total disinterest to qualified interest. Those who were not interested stated that markets are traditional and that years of advertising would be necessary before the public would accept a new fish product. Some stated that they had imported rock bass. It looks good and it tastes good, but was rejected by consumers, probably because of its dark meat, and had to be discontinued.

According to the Food and Agricultural Organization of the United Nations, the United States mullet catch in 1973 amounted to 34 million pounds, a considerable decline from 44 million in 1963. In 1974 the five Gulf States landed 30.51 million pounds. Mississippi and Alabama accounted for 1.5 and 7 per cent of the total, respectively. According to these data Mississippi produced 457,650 pounds and Alabama 2,135,700 pounds of mullet in 1974.

A number of Mississippi producers stated that fishermen are not equipped for commercial mullet fishing. This is substantiated by a statement of a NOAA marketing specialist. An Alabama producer said he could supply 30,000 pounds per week during October, November, and December; 15,000 pounds per week during January; and 10,000 pounds per week during the rest of the year.

The overall production in the Mobile area could be tripled, and mullet could be packed and delivered to Mobile Airport for $.24 per pound. The price may be lower in November due to a larger supply. The fresh mullet would be packed in 50-pound boxes lined with high-density polyliner. Thirty pounds of ice in each box would guarantee a six day shelf life. Medium size mullet would average from 3/4 to 1 1/4 pounds. Large mullet would average from 2 to 2 1/2 pounds.

Another Alabama producer said he could supply 20,000 to 30,000 pounds per day during September, October, and November, and 10,000 pounds per week the rest of the year.

Other producers in Mississippi and Alabama provided preliminary price figures for fresh mullet in the round, packed in wet ice in 50-pound boxes and delivered either to the Gulfport or Mobile airport. The estimates range from $.20 to $.30 per pound.

Mississippi and Alabama account only for a small percentage of the mullet caught in the Gulf of Mexico. This catch is probably consumed in the domestic market, and sufficient quantities for export must result from increased production or reallocation of present supplies, if justified by higher prices. At the present time, however, it appears that a few Alabama producers could easily develop the capacity to supply 2.8 million pounds of fresh mullet per year. Many fisheries experts believe that mullet is in the Gulf just waiting to be harvested. Quotations on the selling price range from $.24 to $.28 per pound during the less productive months, to $.18 per pound during the fall when supplies are more plentiful.

Air freight appears to be the only feasible means of supplying fresh mullet to the Italian market, especially since the product has a short shelf life and must be distributed to thousands of small retailers. There are three alternative ways of transporting mullet to the importer: scheduled commercial air freight; trucking to New York-Kennedy airport and chartering an airliner to Italy; or chartering an airliner from the Gulfport or Mobile airport to Italy.

The first alternative entails trucking the cargo to the airport in St. Louis, Missouri, or New Orleans, Louisiana, to connect with commercial air freight service. The cost would be about $.03 per pound for trucking and $.46 per pound air freight to Rome, or about $.49 per pound from producer to destination. This rate includes insurance coverage. The rate is lowered to $.42 per pound for 66,000 or more pounds. The rates are $.02 lower to Milan. Thirty-eight hours are required to ship a load from St. Louis to Italy, including all loading and unloading.

The second alternative consists of trucking the cargo to New York-Kennedy airport and then flying it to Rome on a chartered airliner, for a total transportation time of 62 hours. The costs of this alternative are $.464 per pound in 75,000 pound lots, and $.393 per pound for 90,000 pounds.

The third alternative, a full charter from the Gulf, requires the producer to deliver the mullet to the Gulfport or Mobile airport. The airline will then fly the cargo directly to Rome or Milan. According to a Seaboard World Airlines representative, the cost for chartering a Boeing 707 for such a trip is about $30,000, which equates to $.50 per pound for 75,000 pounds and $.42 per pound for 90,000 pounds. Approximately 15 hours would be required for the trip.

A comparison of the three alternatives is as follows:

	Cost	Time	Schedules Flexibility	Probability of Delay
Alternative 1	$.42/pound	38 hours	None	Largest
Alternative 2 (75,000 pounds)	$.464/pound	62 hours	Some	Medium
Alternative 2 (90,000 pounds)	$.393/pound	62 hours	Some	Medium
Alternative 3 (75,000 pounds)	$.50/pound	15 hours	Most	Smallest
Alternative 3 (90,000 pounds)	$.42/pound	15 hours	Most	Smallest

Cost considerations are generally very important. In this case, however, quality determines salability, and time affects quality. Alternatives with shorter delivery times are clearly the most advantageous. Also, shorter times permit the use of less ice, which reduces the cost of transportation. The cost of a charter becomes a fixed cost to be absorbed by whatever amount will be shipped. Thus Alternatives 2 and 3 can only be used for large shipments. This is not true of Alternative 1 where the shipper pays only for the actual amount of the freight. The cost of a charter airliner is negotiable and is likely to be lower for a regular 1-year contract.

In the event of bad weather or other acts of God, the chartering airline will cancel the flight upon notification and no cost will accrue to the shipper.

As to the hazards of air shipment, the rates include insurance against most perils. Rerouting is always a possibility, but according to an Italian importer who has been using the service for a number of years, no damaging complications have been encountered in spite of adverse weather and strikes.

There is no doubt that the demand for fresh mullet in Italy is real and large. Domestic production is not adequate to satisfy this demand, and fresh mullet is imported into Italy from a number of countries.

Italian importers are always looking for quality fish at competitive prices as well as dependable supply sources. The supply of fresh mullet from Mississippi and Alabama is very limited. Should present interests and production capacities of fishermen and producers continue, it is unlikely that a supply of mullet for export will become available.

The Mississippi and Alabama producer and seller of fresh mullet, by proper selection of Italian importers, those offering top prices, has an opportunity to make substantial profits by selling fresh mullet.

LEGAL PROBLEMS OF THE GULF COAST REGION 15(1)

James W. Zirkle

University of Mississippi

The Sea Grant Legal Program has continued to utilize the research facilities available at the University of Mississippi Law Center to provide legal assistance and research into problems of the coastal region.

Energy exploration in the Gulf of Mexico is expanding rapidly as the increasing consumption of oil and natural gas continues to deplete existing domestic sources. Thousands of acres on the bottom of the Gulf of Mexico have been leased by oil companies for exploration. Many of these tracts are in Mississippi waters, but until recently the state had no plan for cleaning up oil pollution or for compensating property owners for damages they might incur. The Sea Grant Legal Program undertook a project to analyze the plans of other states and to develop a plan for the State of Mississippi. This plan prohibits the spilling of oil into state waters and specifies that no terminal facility shall operate without a license. The significant feature of this plan is that individuals or agencies responsible for oil pollution can be held liable for damages, and in some instances they are subject to a penalty in addition to the cost of clean-up operations. Funds derived from penalties and taxes imposed on persons operating a terminal facility will be used for abatement of pollution and payment of reasonable third party damage claims.

At the request of the Mississippi Marine Conservation Commission, the Sea Grant Legal Program analyzed and codified all regulations dealing with the Mississippi seafood industry and developed a new system for classifying regulations.

Laws affecting the Mississippi coastal zone were updated with the inclusion of those passed during the 1975 session of the Mississippi Legislature. The results of this research are contained in several publications which are in preparation.

The Mississippi Marine Resources Council, the agency responsible for coastal zone management planning, has required extensive analyses of local and state laws to determine the organizational structure and authorities necessary to implement the Mississippi Coastal Program, and the best method for land and water use controls.

The Advisory Service has made use of legal information to publish several brochures on credit for fishermen, loan guidelines, and small business operation. Other legal research has centered on the practice of leasing fishing boats to other parties who provide the crews and engage in commercial fishing. The Federal tax implications of this situation were researched and the information was furnished to the commercial fishing industry through the Advisory Service.

Shrimp trawler captains often hire people under the age of 18 to work during the summer. The legality of this practice has been open to question, so the Mississippi and Federal Fair Labor Laws were researched to determine the minimum age and in what types of jobs juveniles could legally be employed on a trawler. The analysis revealed that young people over 16 could be employed in non-hazardous activities. However, a person must be at least 18 to participate in hazardous activities, as defined by the Federal Fair Labor Laws. A parental exclusion allows children below the age of 16 to work for their parents in non-hazardous activities only.

For many years persons involved in agriculture have had a number of tax advantages not available to fishermen. In an effort to obtain more equitable taxation, Internal Revenue Service laws and regulations applicable to farmers and fishermen were compared. Discrepancies in treatment under the law were noted and brought to the attention of senators and representatives to make them aware of the inequitable situation. This information is now being used to encourage the passage of tax reform legislation.

Legal research provided by the Sea Grant Law Center is an ongoing project.

MARINE TECHNOLOGY RESEARCH AND DEVELOPMENT

UTILIZATION OF SHRIMP AND FOODFISH FLEET DISCARDS 30(1)

J. William Cliburn — University of Southern Mississippi

The objectives of this project were to estimate the volume of groundfish discarded by commercial shrimp and foodfish fleets in the north central Gulf of Mexico, and to determine the seasonal species composition, sizes, and weight of the discards.

Increased activities of the shrimp and finfish fleets have caused their working areas to overlap. Trawling in areas of high finfish density often results in the capture of large quantities of trash fish, which increases labor costs in sorting out the shrimp. The fish are discarded with almost complete mortality, and accumulations of dead material on the bottom renders the catch of the finfish fleet unfit for pet food or human consumption. Hazards to human health also exist when accumulations of dead fish wash up on beaches and private property. Prior to this study there were no statistics to determine the magnitude of trash fish discards in Mississippi waters.

Ten sampling trips were made, and the contents of 108 trawls were examined. Breton, Chandeleur, and Mississippi Sounds were sampled east of the Mississippi River Delta. The open Gulf of Mexico also was sampled out to the 22 fathom contour east and south of these estuarine areas. Thirty trawl drags were made in the Gulf between Barataria Bay and Tiger Point, Louisiana, at depths of from three to 37 fathoms. See Table 1.

Data obtained from each trawl sample included location, depth, time and duration of the trawl, and a description of the contents. The gear was also described as to size, door sizes, the use of tickler chains, rollers, floats, and the cod mesh dimensions.

Table 2 provides information on the contents of each trawl including an accurate count of the total shrimp catch, in addition to weight estimates for the total haul. These data reflect the percentages of the total catch of shrimp and finfish, along with calculations of the shrimp-finfish discard ratio.

A 50-pound subsample of discards was taken from each trawl to determine the finfish species composition, number, weight and size range of each species, except on two occasions when only 25 pounds could be removed and sampled because of adverse conditions. The five most abundant species of finfish captured are listed in Table 3 by number, weight, and percentage of the finfish catch for each of the ten cruises.

One hundred and seven species of finfish representing 50 families have been collected from the trawl subsamples. The families Sciaenidae, Triglidae, Bothidae, and Clupeidae are numerically dominant, totaling 79.9 per cent of the finfish discards. The Atlantic croaker, *Micropogon undulatus*, was the most commonly collected species of finfish, followed by the bighead sea robin, *Prionotus tribulus*, bay whiff, *Citharichthys spilopterus*, blackfin sea robin, *Prionotus rubio*, and sand sea trout, *Cynoscion arenarius*. Table 4 catalogues the species that contribute more than one per cent to the total number of finfish specimens sampled.

The greatest portion of the finfish weight loss was from the Sciaenidae, Ariidae, Triglidae and Trichiurdae families, which accounted for 80.7 per cent of the discards. The predominant species were croaker, sand sea trout, the Atlantic cutlassfish, *Trichiurus lepturus*, and the hardhead catfish, *Arius felis*. See Table 5.

The results of this research clearly document the magnitude of finfish lost during trawling operations. These data will form the basis upon which new technology and techniques can be developed to decrease the capture rate of finfish in shrimp and foodfish trawls, or to determine ways to utilize this valuable protein. This information will be disseminated by the Advisory Service to Sea Grant researchers, fishing gear manufacturers, seafood processors, trawl fishermen, and shrimpers.

TABLE 1

Dates and Localities of Trawls

Sample No.	Date	Vessel	No. of Trawls	Locality
1	April 26-27, 1975	*Miss Donna*	5	East Mississippi Sound
2	May 17-18, 1975	*Miss Donna*	4	East Mississippi Sound
3	July 15-18, 1975	*Golden Dolphin*	9	South Mississippi Sound (South Cat and Ship Islands)
4	July 16-21, 1975	*Jimmy Dian*	24	South Mississippi Sound (Chandeleur and Breton Sounds)
5	August 18-22, 1975	*Golden Dolphin*	10	South Mississippi Sound (Ship and North Chandeleur Islands)
6	August 26-30, 1975	*Jimmy Dian*	15	South Petit Bois and East Chandeleur Islands
7	September 3-6, 1975	*Golden Dolphin*	6	South Horn and Petit Bois Islands, East Chandeleur Island
8	September 20, 1975	*Pride of Saint Tammany*	2	East Mississippi Sound
9	September 25, 1975 October 2, 1975	*Jimmy Dian*	30	South Barataria Bay and Tiger Point, Louisiana
10	October 4, 1975	*Pride of Saint Tammany*	3	East Mississippi Sound

TABLE 2

Total Weight, Percentages, and Fish to Shrimp Ratios for Ten Sampling Periods

Sample No.	No. of Trawls	Total Weight Catch-lbs.	% Shrimp	% Finfish	% Misc.	Finfish/Shrimp Discard Ratio
1	5	1,710	6.7	61.2	32.0	9.1/1
2	4	1,650	6.5	79.6	14.0	12.3/1
3	9	4,940	33.3	57.2	9.8	1.7/1
4	24	47,235	9.4	77.2	13.4	8.2/1
5	10	6,280	25.9	56.9	17.2	2.2/1
6	15	20,300	14.4	66.3	19.3	4.6/1
7	6	5,320	6.2	82.0	11.8	13.2/1
8	2	2,900	11.0	63.6	25.3	5.8/1
9	30	50,375	8.4	84.8	6.2	10.1/1
10	3	875	21.7	64.2	14.0	3.0/1
TOTALS	108	141,585	11.2	76.4	11.8	6.8/1

TABLE 3

Total Weight, Percentages, Species Breakdowns, and Numbers, Weights and Percentages of the Five Species Contributing the Greatest Weight to Trawl Discards

Sample No.	Date	No. of Trawls	Total Wt. Finfish (lbs.)	% Finfish in Catch	Species	Total No./50 lb. Subsample	Total Wt./50 lb. Subsample	% of Total Wt. of Finfish
1	April 26-27, 1975	5	910.0	61.2	*Micropogon undulatus*	1,306	27.0	10.8
					Cynoscion Aronarius	137	4.7	1.8
					Trichiurus lepturus	521	5.9	2.3
					Arius felis	12	0.8	0.5
					Leiostomus xanthurus	810	61.4	24.4
2	May 17-18, 1975	4	1,280.0	79.6	*Micropogon undulatus*	1,108	38.5	19.3
					Cynoscion arenarius	139	12.7	6.3
					Trichiurus lepturus	499	20.3	10.4
					Arius felis	63	31.2	18.8
					Leiostomus xanthurus	258	21.3	10.9
3	July 15-19, 1975	9	2,560	57.2	*Micropogon undulatus*	1,825	105.8	23.5
					Cynoscion arenarius	342	79.0	17.6
					Trichiurus lepturus	43	5.9	1.5
					Arius felis	433	72.5	18.0
					Leiostomus xanthurus	137	14.1	3.5
4	July 16-21, 1975	24	37,505	77.2	*Micropogon undulatus*	4,991	511.4	42.6
					Cynoscion arenarius	884	131.1	10.9
					Trichiurus lepturus	305	47.9	4.8
					Arius felis	130	25.5	2.5
					Leiostomus xanthurus	414	51.4	4.3
5	August 18-22, 1975	10	3,573	56.9	*Micropogon undulatus*	1,888	145.4	43.3
					Cynoscion arenarius	119	21.2	6.3
					Trichiurus lepturus	2	0.2	trace
					Arius felis	216	47.0	14.0
					Leiostomus xanthurus	167	17.9	5.3
6	August 26-30, 1975	15	13,468	66.3	*Micropogon undulatus*	981	212.3	36.8
					Cynoscion arenarius	125	34.6	6.0
					Trichiurus lepturus	213	30.3	6.2
					Arius felis	0	0.0	0.0
					Leiostomus xanthurus	54	9.9	1.7
7	September 3-4, 1975	6	3,464.0	82.0	*Micropogon undulatus*	448	112.7	47.9
					Cynoscion arenarius	4	1.1	0.4
					Trichiurus lepturus	52	11.5	4.9
					Arius felis	6	0.0	0.0
					Leiostomus xanthurus	2	0.6	0.2
8	September 9-20, 1975	2	2,900	63.6	*Micropogon undulatus*	127	29.1	41.4
					Cynoscion arenarius	286	13.0	18.5
					Trichiurus lepturus	105	19.6	27.9
					Arius felis	2	0.1	0.1
					Leiostomus xanthurus	6	0.9	1.3
9	September 9-25, 1975	30	50,375	84.8	*Micropogon undulatus*	7,353	712.8	52.4
					Cynoscion arenarius	594	114.4	8.4
					Trichiurus lepturus	290	80.9	5.9
					Arius felis	198	47.1	3.5
					Leiostomus xanthurus	135	25.3	1.9
10	October 4, 1975	3	562	64.2	*Micropogon undulatus*	167	25.7	22.0
					Cynoscion arenarius	238	24.1	20.6
					Trichiurus lepturus	84	26.8	23.0
					Arius felis	7	1.2	1.0
					Leiostomus xanthurus	18	3.5	3.0

TABLE 4

Ranking of the Most Numerous Finfishes in Trawl Discards

Species	Total No. Sampled	% Finfish Discards
Micropogon undulatus (Atlantic croaker)	20,194	35.58
Prionotus tribulus (bighead sea robin)	7,059	12.43
Citharichthys spilopterus (bay whiff)	3,890	6.85
Prionotus rubio (blackfin sea robin)	2,997	5.28
Cynoscion arenarius (sand sea trout)	2,861	5.04
Leiostomus xanthurus (spot)	2,240	3.94
Trichiurus lepturus (Atlantic cutlassfish)	2,114	3.72
Chloroscombrus chrysurus (bumper)	1,736	3.05
Stenotomus caprinus (longspine porgy)	1,308	2.30
Anchoa hepsetus (striped anchovy)	1,253	2.20
Anchoa mitchilli (bay anchovy)	1,199	2.11
Harengula pensacolae (scaled sardine)	1,051	1.85
Arius felis (hardhead catfish)	979	1.72
Peprilus burti (Gulf butterfish)	806	1.42
Stellifer lanceolatus (star drum)	689	1.21
Synodus foetens (inshore lizardfish)	594	1.04

TABLE 5

Weight Ranking of the Most Important Finfishes in Trawl Discards

Species	Total Wt. Sampled	% Finfish Discards
Micropogon undulatus (Atlantic croaker)	1,903.0	43.02
Cynoscion arenarius (sand sea trout)	436.4	9.86
Trichiurus lepturus (Atlantic cutlassfish)	249.7	5.64
Arius felis (hardhead catfish)	224.1	5.06
Leiostomus xanthurus (spot)	214.0	4.83
Prionotus tribulus (bighead sea robin)	125.8	2.84
Menticirrhus americanus (southern kingfish)	123.9	2.80
Prionotus rubio (blackfin sea robin)	123.5	2.79
Chloroscombrus chrysurus (bumper)	95.6	2.16
Citharichthys spilopterus (bay whiff)	90.0	1.03

RAPID AND ACCURATE CHEMICAL TECHNIQUES TO IDENTIFY SPECIES OF BOTH COMMERCIAL AND UNDERUTILIZED SPECIES OF FISH 35(1)

Paul M. Toom — **University of Southern Mississippi**
Gary J. Blomquist — **University of Southern Mississippi**

The identification of fish samples by chemical means continues to be a difficult procedure. Although electrophoretic techniques based on both polyacetate and polyacrylamide supports have been reported, the routine identification of closely related species of fish based on these techniques is difficult.

A relatively new technique--isoelectric focusing--appears to possess many of the qualities needed for such routine speciation. The objective of this research was to modify polyacrylamide gel isoelectric focusing to such an extent that it could be used as a routine technique for the identification of fish species. Parameters which were tested included length of time of separation, voltages which could be applied to the gel, porosity and composition of gel matrix, techniques for the polymerization of the gel, and optimum ampholine concentrations.

In order to determine the best stain to be employed in the identification of the various fish samples, three methods for developing stains for protein were evaluated along with stains for lipoprotein and glycoprotein. Neither glycoprotein nor lipoprotein stains yielded positive results. The three protein stains (amido black, bromphenol blue, and coomassie brilliant blue R250) resulted in nearly identical staining patterns as revealed by both visual observation and densitometry. However, amido black require 10-12 hours for staining, followed by at least 24 hours for removal of unwanted background stain. Bromphenol blue gave comparable results to the amido black within a few hours time. However, the stained protein bands faded quickly and were almost completely invisible within 72 hours. Coomassie brilliant blue required only 30 minutes for staining and 2 to 3 hours for removal of background stain. The protein zones so stained were found to be stable for weeks and even longer if refrigerated. Thus, coomassie brilliant blue R250 was chosen as the stain for all subsequent studies.

Buffers of varying pH and ionic strength were evaluated to determine the best media for the extraction of muscle protein from fish. The most protein was extracted at a pH of 7.0. This same pH was found to result in the most protein bands following separation by isoelectric focusing. When the molarity of the extraction buffer was increased from 0.01 to 0.6M, the number of observable bands also increased. However, as the molarity was increased above 0.6M, not only did the number of bands observed decrease, but the sharpness of remaining bands was also lost. Densitometer scans and total protein concentrations supported the visual finding that 0.6M NaCl is the optimum ionic strength for extracting muscle protein.

Differences between the anterior and posterior, as well as dorsal and ventral fish muscle, were determined. At the same time, the reproducibility of the system was checked by taking samples from numerous specimens, both juvenile and adult, male and female. Both visual results and densitometer scans indicated that there were no applicable differences in protein profiles in regard to point of sample extraction, sex, or intraindividual variability of the fish.

The isoelectric focusing profiles of a number of fish are shown in Figure 1. As can be seen, the protein profile for each species is unique. These differences were further illustrated by quantitation and visual comparison of densitometer scans.

When similar profiles were determined using either cellulose acetate electrophoresis or polyacrylamide electrophoresis, results of a less definitive nature were obtained. When fish proteins were separated on cellulose acetate, 2 to 5 protein zones were typically found. Resolution on this support was so limited that differentiation of the various fish species by this method was extremely difficult. While resolution was improved considerably with polyacrylamide as the support media, differences in protein mobilities were again so slight that differentiation of some related species was again difficult. On the other hand,isoelectric focusing resulted in patterns which were clearly different for each species of fish studied. These differences were even greater when the relative amounts of each protein were quantitated from the profile by means of a densitometer.

The results of this study reveal that isoelectric focusing has a definite potential for the identification of fish species. The increased resolution of this technique, when compared to other techniques presently in use, means that closely related species of fish can be readily differentiated. In addition, since separation is based on isoelectric points of proteins in the sample rather than on differences in relative mobilities of the different proteins, identical results will be obtained each time an analysis is run. As a result, the costly process of securing known standards to compare to each unknown fish sample can be eliminated once the protein profiles of a wide variety of fish species has been determined and placed in a data bank.

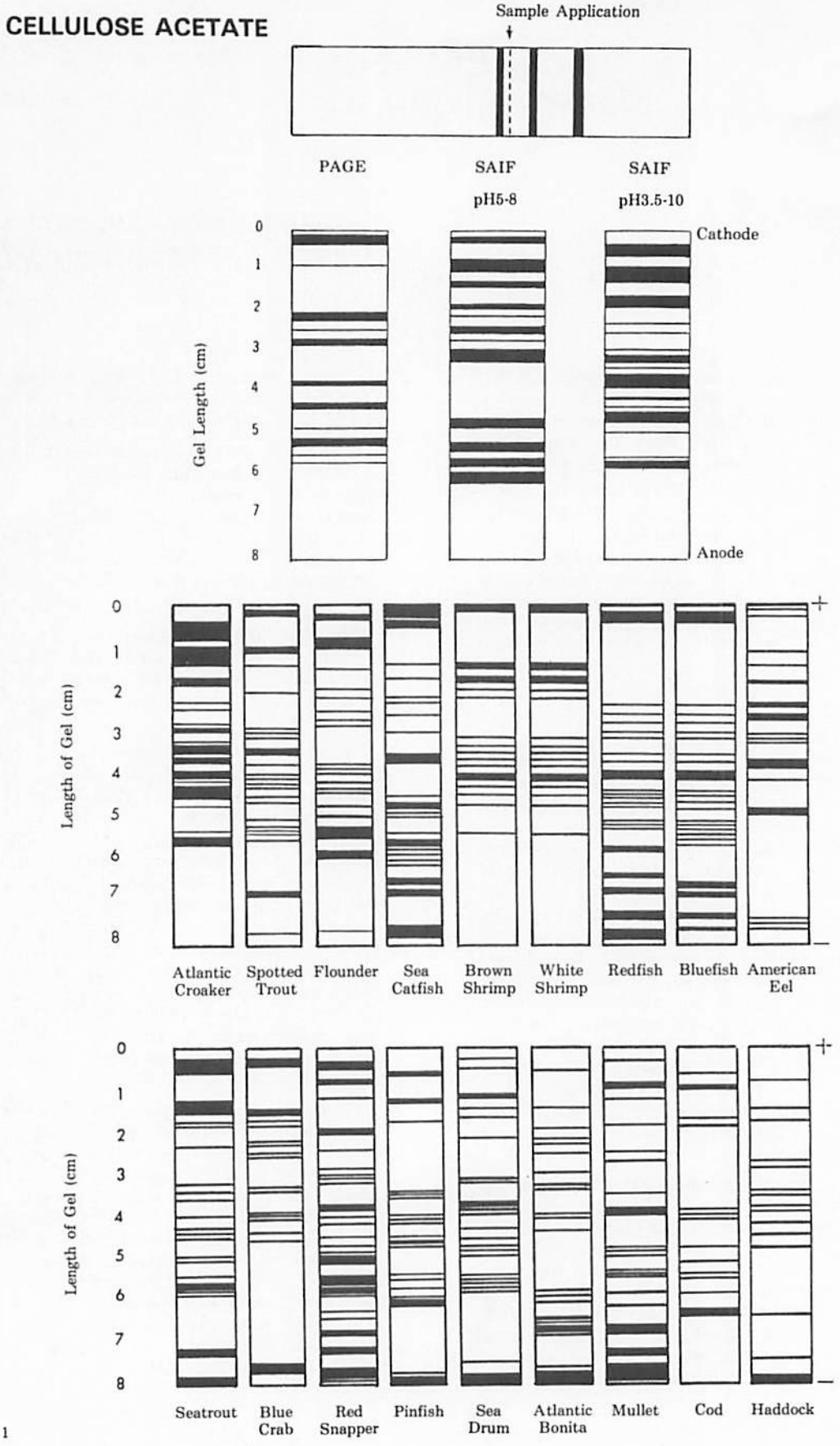

CELLULOSE ACETATE
Sample Application
PAGE
SAIF
pH5-8
SAIF
pH3.5-10
Cathode
Anode
Gel Length (cm)
0
1
2
3
4
5
6
7
8
Length of Gel (cm)
+
−
Atlantic Croaker
Spotted Trout
Flounder
Sea Catfish
Brown Shrimp
White Shrimp
Redfish
Bluefish
American Eel
Seatrout
Blue Crab
Red Snapper
Pinfish
Sea Drum
Atlantic Bonita
Mullet
Cod
Haddock

FIGURE 1

MARINE ENVIRONMENTAL RESEARCH

ASSESSMENT OF ALABAMA COASTAL MARSHES FOR COASTAL ZONE MANAGEMENT PLANNING 39(1)

Judy P. Stout — **University of South Alabama**

An aerial survey of Alabama's coastline was used to select 30 study sites for this project. These sites were selected to provide the broadest coverage of geographic areas, vegetation types, and environmental settings. Four sites were omitted after field observations revealed that erosion and man-made alterations were too extensive to expect unbiased data. A total of 26 stations were used to obtain data for the study.

All stations were marked with stakes at the waters edge and 30 meters in from the outer edge of vegetation. Engineers flagging was used to relocate markers.

Samples were taken in March, June, and late September 1975 to cover the growing season. Several parameters were examined at each station for each sampling date.

A 30-meter line transect was laid between marker stakes, and coverage along the line for each species present was recorded. Vegetation profiles for each station were compiled from cumulative seasonal data throughout the growth period. It was apparent that stations could be grouped into marsh types by their typical species composition and distribution.

Profiles and transect data from this project were provided to the Alabama Coastal Area Board on a consulting basis to support efforts to map habitats within the coastal zone. The resulting Dauphin Island Sea Lab Special Report and Atlas (Vittor and Stout, 1975), published for the Alabama Development Office, provides total acreage in Alabama for marsh types described by the concurrent Sea Grant project as follows:

Salt marsh	2,330 acres
Brackish-mixed marsh	13,512 acres
Fresh-mixed marsh	11,231 acres

Brackish and Intermediate marshes were photographically indistinguishable and were combined.

Mapping by marsh species is approximately 85 per cent complete for Mobile County, utilizing ground truth data from transects. Baldwin County remains to be mapped. It has been possible to obtain photography and to develop map overlays at a scale of 1 inch = 1,000 feet for most of Mobile County. Baldwin County will be mapped at a smaller scale due to restrictions imposed by available photographs. This mapping will be complete by fall of 1976.

Transects were discontinued in 1976 because data were adequate for mapping photointerpretation.

Clip samples 0.1 m^2 each were taken at three locations along the transect at each station. Sampling has been completed for the collection periods in 1975 and late May and June 1976, for a total of four collections. Determinations being made include:

Species composition and abundance
Species growth patterns
Species standing crop (dry weight biomass)
Tidal inundation - depth and salinity of surface waters

Final collections will be made in September 1976. Following the processing and compilation of the data, determinations will be made for coastal Alabama marshes including:

Annual Net Primary Productivity for each marsh type
Annual Net Primary Productivity for each dominant species
Total acreage of each marsh type
Total acreage for each dominant species
Potential Productivity of total Alabama marshlands

Productivity will be verified by data from a concurrent two-year study being conducted for the Alabama Coastal Area Board by Vittor and Stout of the Dauphin Island Sea Lab. This study will examine the productivity of three different types of marsh.

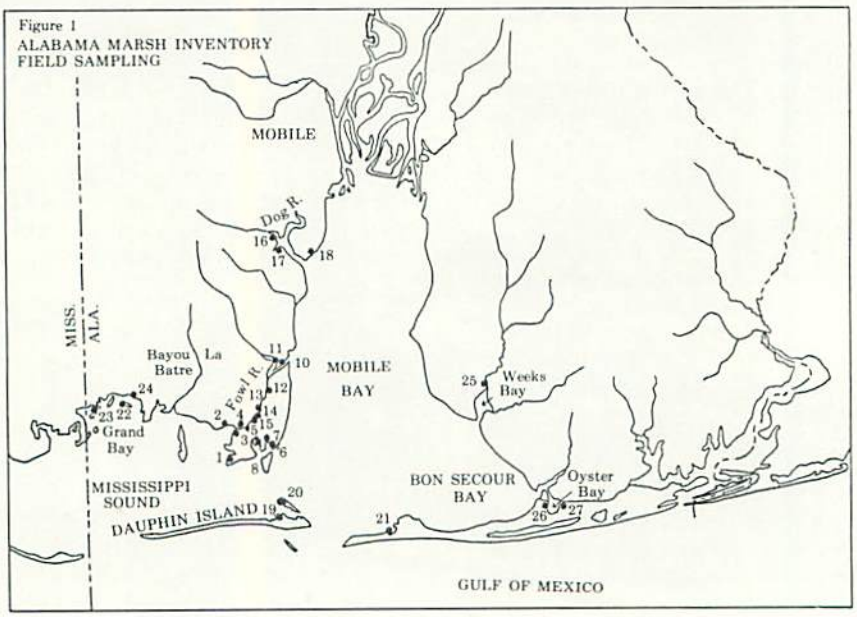


Figure 1
ALABAMA MARSH INVENTORY
FIELD SAMPLING

MISSISSIPPI COASTAL ZONE CAPABILITY ANALYSIS 39(2)

Velon H. Minshew

University of Mississippi

The Mississippi coastal zone, unlike many other coastal areas in the nation, is relatively undeveloped and has not yet experienced severe environmental problems. This area has only begun to encounter serious conflicting demands on its coastal resources. This situation presents a unique opportunity to continue the growth of the region with a minimum of environmental degradation. To accomplish this goal it was necessary to conduct an inventory of the Mississippi coastal environment to determine the nature and distribution of land, mineral, water and energy resources, modern environments, and biological assemblages. Unless this information is known and is made available in an understandable format to business and civic leaders, the scientific community has not lived up to a major obligation to society.

The purpose of this project is to provide coastal decision makers with information upon which meaningful decisions can be made regarding the future development of the Mississippi coastal zone.

It is essential that the management of the Mississippi coastal area should be based upon the unique criteria applicable to Mississippi, not necessarily those which have been developed in other areas with varying environmental and resources characteristics. Management should be flexible, based upon the natural systems before human impact irreversibly changes the character of the coastal zone. Only by understanding the natural coastal system can proper and compatible use of the region be determined.

The Mississippi Coastal Zone Environmental Geologic Map was prepared as an inventory to illustrate natural resource units. The basic units, whether man-made, physical, biologic, or dynamic process-related, form a basis for studying various geologic and geomorphic units as interacting components of a coastal zone system.

The preparation of the Environmental Geologic Map involved the interrelationship of four broad environmental unit types. The first of these was the physical types, concerned primarily with the present physical properties as formed in a dynamic environment. With time the dynamic parameters lessen in importance and the physical properties such as soil type, thickness of strata, topographic relief, and underlying substrata begin to effect a more dominant role. Examples of physical units are the Pliestocene Strandline Systems (Figures 1 & 2). The next type is biologic and implies a predominence of organic activity in determining the mappable character of the units. Salt marsh can be used as a typical biologic unit with its intense and vital organic activity. The last of the natural units is the dynamic-process type which depends upon some form of energy motion to distinguish among the resultant products. Coastal Beaches are dynamic units dependent upon several active geologic processes to determine their areal extent, permanence, and the compositional material associated with their creation. The final type is artificial, with man having the dominant role in the creation of the various units. Man-made spoil disposal areas offer visible evidence of such units.

Forty-three mappable units will be included (Table 1) ranging in age from the Miocene to the modern fluvial and marine systems that constitute the active Mississippi coast.

The methods used to delineate the environmental resource units evolved through the combination of both recent and previously developed mapping techniques with newly collected data. The primary interpretative tool was NASA color infrared and black and white infrared high altitude photography. The black and white infrared photography was enlarged to a scale of 1:24,000 on plastic transparencies for use on large light tables and served as a primary work base. Detailed interpretations and comparisons were made utilizing a smaller light table equipped with the color infrared overflights. Topographic maps (7.5 and 15 minute quadrangle) and vintage black and white conventional photography was instrumental in interpreting the natural systems prior to human modification. In conjunction with the photomapping, Soil Conservation Service soils maps were studied and later developed into soil associations that established patterns related to mappable geologic units. Figures 1 and 2 are generalized environmental geologic maps showing some of the basic geologic units.

At this stage of development drilling data was compiled, correlated, and analyzed as to the subsurface distribution of the various mapped units. After this data had been organized into cross-sections, a drilling program was initiated to produce data that had previously been unavailable. This information filled gaps and aided later field interpretations. In all, hundreds of wells, test holes, and auger borings were utilized from public, governmental, and industrial sources. Figure 3 is a lithologic cross-section of the northern portion of Figure 1. The thickness as well as the lateral distribution of the components is shown.

Associated with each individual sampling method were numerous field trips through the study area in which geologic data were collected from road cuts, sand and gravel pits, and by shallow hand augering. These field trips resulted in physical verification of each interpreted resource unit.

As new technologies and data became available, their use and applicability were tested. At present the use of ERTS imagery is being analyzed in an effort to more completely understand the structural tectonics of the Mississippi coast.

A number of Specific Information Derivative Maps are being prepared. While the Environmental Geologic Map will be the primary data base, additional information from numerous local, state, and Federal agencies will be incorporated. The following is a list of specific Information Derivative Maps in preparation:

Mineral and Energy Resources
Physical and Engineering Properties
Environments and Biologic Assemblages
Active Processes
Ground and Surface Water Resources
Current Land Use
Natural Hazards
Soils
Topography and Bathymetry
Climatology and Meteorology

Maps depicting physical properties and soils are ultimately dependant upon the configuration of the Geologic

Environmental Map, whereas the Current Land Use and Climatology and Meteorology Maps are more dependent upon the compilation of numerical data from the various collecting agencies. It is important that this dispersed data be compiled into a form that is related to one base, thus associating information within an interrelationship concerned with optimum development and utilization of the coastal zone.

Following the preparation of the series of derivative maps, an analysis of the natural carrying capacity of the Mississippi coastal zone will commence. A resource capability unit has been defined as an environmental entity delineated according to its fundamental natural properties and to the nature and degree of use it can withstand without losing acceptable environmental quality. Factors which can determine natural capability or carrying capacity are many and diverse. By considering all factors--physical, chemical, and biological, active or passive--that current and potential land and water use have upon an area, the natural carrying capacity of that area may be assessed. The influence of each factor and use must be weighed on an area-by-area basis, with constant reassessment to assure completeness and consistency.

There have been a series of scientific advances and economic benefits from this project, some of which have been somewhat unexpected.

A combination of the drilling data and environmental maps will yield data that can be utilized by planners to:

1. Determine the distribution of areas of poor foundation characteristics.
2. Locate future sanitary landfills compatible with environmental restraints.
3. Locate areas for future industrial and urban development.
4. Delineate physical coastal zone boundaries which will form the basis for a regional coastal zone management and development plan.

The drilling data has enabled the geological interpretation of various subsurface units. The relationships of these subsurface units will yield locations of commercial sand and gravel deposits within close proximity of the existing network of highways, roads, and railroads. At the present time gravel is being transported more than 80 miles, greatly increasing its cost.

Aquifers identified through geologic correlations have increased the potential amount of potable groundwater available for domestic and industrial users (Figure 4). As the locations of these aquifers become better known, their recharge areas can be protected from unwise development or alteration, thereby insuring an adequate water supply for the coastal area.

TABLE 1. MAPPABLE UNITS

TERTIARY UPLAND SYSTEMS

Undifferentiated fluvial-deltaic-estuarine systems, predominantly clays and silts with some sands
Undifferentiated fluvial-deltiac systems, predominantly sands

PLEISTOCENE-HOLOCENE SYSTEMS

FLUVIAL-DELTIAC SYSTEMS

Alluvial plain channel sands, heavily to sparsely tree covered
Alluvial plain menaderbelt sands and silts
Alluvial plain silts, clays and sands
Abandoned meander loops, mud or water filled
Abandoned fluvial course, swamp filled
Abandoned fluvial course, stream occupied

STRANDPLAIN SYSTEMS

Strandline elongate sand and clay ridge systems
Strandline swale system, swamp filled
Strandplane-estuarine sands, silts and clays
Relic tidal channels-inlets

MODERN SYSTEMS

FLUVIAL-DELTIAC SYSTEMS

Small headward eroding systems
Alluvial valley, tree covered
Natural levee deposits
Abandoned meander loops, tree, mud or water filled

MARSH-SWAMP SYSTEM

Salt marsh
Brackish marsh
Tree dominated swamp
Fresh water swamp-marsh

BEACH RIDGE-BARRIER-ISLAND SYSTEMS

Mainland beach, sand and shell
Island, sand and shell
Beach-ridge dunes
Swales, mud and water filled
Ephemeral ponds

SUBAQUEOUS SYSTEMS

Dead oyster reefs
Live oyster reefs
Oyster reef flank sand and shell
Oyster reef flank mud and shell
Bay and sound estuarine sands
Bay and sound estuarine muds
Upper shore face sands
Upper shore face muds
Lower shore face sands
Lower shore face muds
Open marine shelf sands
Open marine shelf muds
Flood tidal delta
Ebb tidal delta
Abandoned tidal channel

MAN MADE

Spoil (subaqueous)
Spoil (subserial)

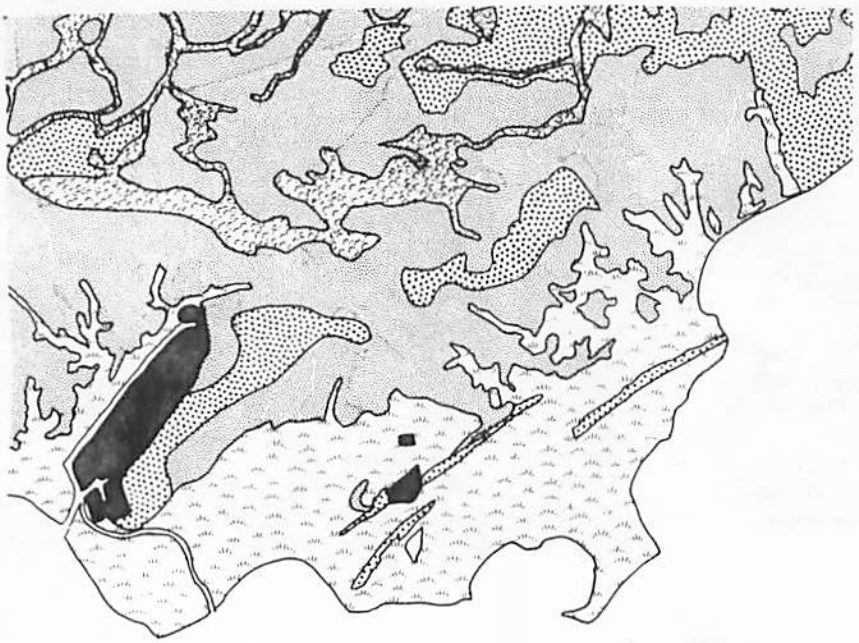


Figure 1

Generalized Environmental Geologic Map
Southern Hancock Co.

Scale 1:100,000

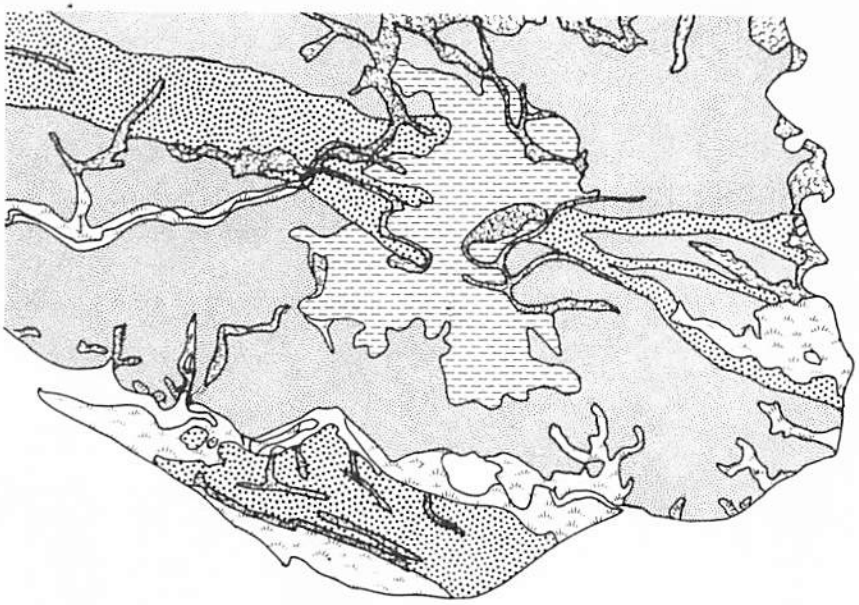


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Figure 2

Generalized Environmental Geologic Map
Southwestern Jackson Co.

Scale 1:100,000

MODERN SYSTEMS

- Fluvial course, swamp filled
- Salt Marsh

PLEISTOCENE-HOLOCENE SYSTEMS

- Strandline sand and clay ridges
- Strandplain-estuarine sands, silts and clays
- Relict tidal channel

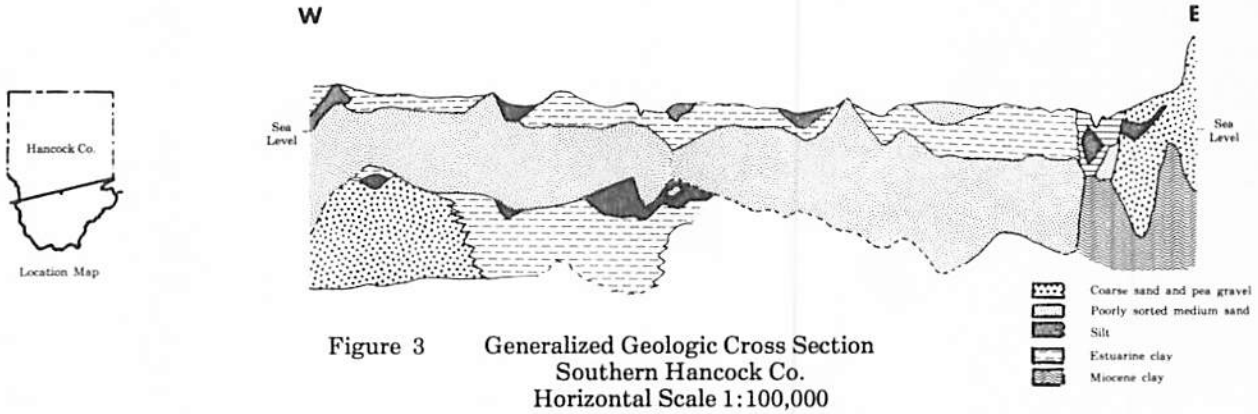


Figure 3 Generalized Geologic Cross Section
Southern Hancock Co.
Horizontal Scale 1:100,000
Vertical Scale 1:500

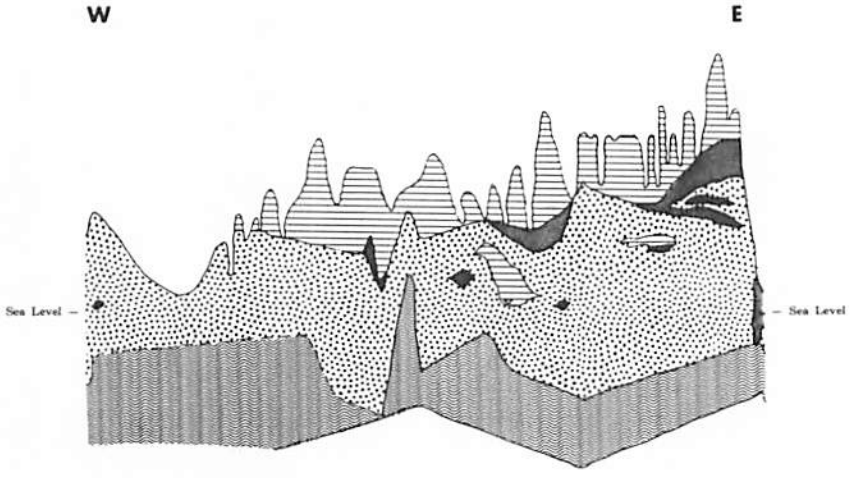


Figure 4

Generalized Geologic Cross Section
Southwestern Harrison Co.
Horizontal Scale 1:100,000
Vertical Scale 1:500

FATE OF SOME HEAVY METALS IN MOBILE BAY AND MISSISSIPPI SOUND 44(2)

Courtney J. Smith

Tuskegee Institute

Mobile bay has been the subject of a number of base line environmental studies. These first efforts were prompted by economic injury resulting from periodic closures of shellfish beds in Mobile Bay, and emphasis was necessarily directed at sources of industrial and domestic wastes and their effects. It became apparent that no data were available on the effects of dredging operations in the bay, and a Technical Committee was formed to investigate the possible consequences. The situation was aggravated by a mercury scare involving fish in Mobile Bay, and concern for the presence of heavy metals developed rapidly.

The Alabama State Department of Conservation and Natural Resources sampled sediment cores and the water column at ten stations in Mobile Bay. Analyses for selected elements, including heavy metals, were performed at Auburn University, and the results were forwarded to the Technical Committee on Mobile Bay Dredging by the Department of Conservation and Natural Resources.

The Technical Committee resampled nine of the ten Bay stations and twenty-four additional core stations in Mobile Bay and adjacent waters. Sediment analysis was accomplished by the Environmental Protection Agency, and chromium, mercury, zinc, lead, and copper were detected.

The lack of reliable data required the collection of new sediment values to establish analytical continuity. In no instance has there been an attempt to relate heavy metal values to the parameters of salinity, temperature, suspended (absorbing) particles, and current velocity as it affects the suspended load. All play obvious roles in the solubility and transport characteristics of heavy metals.

Other projects have proposed to quantitate the hydrographic parameters of the system, but neither have attempted to deal directly with material of management concern.

This project is an integral part of a complex cooperative effort directed toward Mobile Bay and the adjacent Continental Shelf. In addition to the obvious relationship with the Sea Grant hydrographic effort, the principal investigator is pursuing the experimental work on physical interactions between estuarine waters and toxic materials, including heavy metals.

The data are also being correlated with a NASA contract on turbidity ground truth data. It is assumed that sediment load associations are a major transporting mechanism, but verification of this assumption and quantification of the *in situ* amounts are objectives of this project.

The results are also being coordinated with the Alabama Estuaries and Continental Shelf Oceanographic Survey program which is directly concerned with interactions of the continental mass and the Inner Continental Shelf.

The western shore of Mobile Bay and the eastern end of Mississippi Sound are coming under intensive industrial pressure from petroleum, transportation, and mineral extraction interests. Unless the dynamic transport mechanisms of these partially confined bodies of water are closely monitored, the responsible management agencies will be unable to respond to the needs of the coastal community.

This project should provide the first quantitative data to test the predictive capability of the mathematical model with regard to a material of genuine management interest. The Alabama Coastal Area Board is beginning to emerge as a significant force in the region and is in a position to publicize and utilize the results of this investigation.

The primary concern of this research project is to determine the effect of heavy metals entering the Bay. This becomes of prime importance when the many uses of the Bay are considered. Sport and commercial fishermen annually harvest tons of fish from its waters, waterborne commerce fills its channels, and great numbers of pleasure craft dot its blue-green surface.

The toxic element budget of the Bay may occur with a population rise or increased industrialization. The transport mechanisms for metals such as cadmium, lead, zinc, and copper were identified for analysis to assess these possibilities.

Water samples from both sides of the mouth of the Bay were taken at odd intervals over a twelve-month period. Surface and bottom samples were taken over a complete tidal cycle to establish the water column profile. After a preliminary treatment, the samples were transported to Tuskegee where an atomic absorption spectrometric analysis was performed.

Data on the concentration of the heavy metals are being analyzed in relation to pH, salinity, current direction, current velocity, surface and bottom temperatures. Allowances also are being made for the influence of weather. A second method of investigation, a nodic stripping analysis, has been incorporated to expand the capabilities and validity of this research.

Dr. Wesley E. Nelson, formerly at Tuskegee Institute and presently with Auburn University, was instrumental in the formulation and early development aspects of this project.

Although terminated under Sea Grant support, this project is continuing through assistance of the Institute.

BACTERIA AND BACTERIAL VIRUSES AS INDICATORS OF POTENTIAL PUBLIC HEALTH HAZARDS IN ESTUARINE WATERS
45(1)

Thomas W. Feary
Burke L. Brown

University of Alabama in Birmingham
University of South Alabama

This project was designed to evaluate methods for establishing water quality standards and to obtain profiles of bacterial indicators of pollution from specific estuarine sites.

Three estuarine sampling stations were selected on the basis of a sanitary survey. Station 1 was located on a river at a point approximately 2 miles above Mobile Bay (considered polluted). Station 2 was located on the western shore of Mobile Bay at a point approximately midway between the head and mouth of the Bay (moderately polluted). Station 3 was located in the mouth of the Bay on the western shore (considered not polluted). Thirty surface water samples were collected and analyzed by APHA 5-tube multitube Most Probable Number (MPN) methods. Simultaneously, approximately 5 liters were vacuum filtered through a millipore filter following an MF-MPN procedure. Isolation and characterization by IMViC tests of antibiotic drug-resistant bacteria were carried out on each sample. The results of this study are presented in Tables 1 through 6.

This investigation has demonstrated that the MF-MPN method is an effective procedure for isolating and enumerating fecal coliforms and antibiotic resistant bacteria from estuarine waters. An analysis of the data presented in Table 1 indicates, in general, that the highest fecal coliforms and drug-resistant bacterial MPN's were obtained from Station 1, with Stations 2 and 3 showing a progressively decreasing MPN pattern. Significantly, the MF-MPN method consistently allowed isolation of the test organisms from unpolluted areas where routine monitoring demonstrated that the concentrations of these bacteria were near or below detectable levels by standard, conventional MPN techniques.

The relatively high incidence of fecal coliforms and drug-resistant bacteria found may be correlated to sewage overflows during the heavy rains that occurred during the sampling period.

Characterization of the drug-resistant isolates (Table 2) revealed that 68 per cent of the tetracycline resistant isolates and 28 per cent of the chloramphenicol resistant isolates were *Escherichia coli.* Nine per cent of both the tetracycline and chloramphenicol resistant isolates were in the *Klebsiella-Enterobacter* group while the majority (63 per cent) of the chloramphenicol resistant bacteria exhibited the intermediate IMViC patterns. Since the antibiotic media used was inoculated from EC tubes positive by the standard APHA fecal coliform method, it is logical to assume that most, if not all, of the isolates were of fecal origin.

It has been reported that R factors can be transferred by bacterial conjugation to essentially all members of the Enterobacteriaceae. What may be of more consequence is the possibility of chloramphenicol resistant bacteria transferring resistance to pathogenic organisms. R factors usually mediate resistance to as many as eight drugs simultaneously, which may result in a wider spectrum of resistance. The results of this investigation show that the majority (86 per cent) of bacteria selected by chloramphenicol were resistant to three or more antibiotics. Only 39 per cent of the bacteria selected by tetracycline were resistant to three or more drugs. Although none of the strains were tested for their ability to transfer resistance to sensitive recipients, the multiple resistance exhibited by these strains is characteristic of strains harboring R factors.

Due to widespread use of antibiotic therapy with humans and animals, there has been a substantial increase in the incidence of drug resistant strains in the past few years. Therefore, it is not surprising to find drug resistance among the fecal coliforms. Suggestions have been made that drug resistant coliforms might serve as a useful epidemiological marker for the identification of human or domestic animal sources of pollution in contaminated waters. Furthermore, the presence of drug resistance in enteropathogenic coliforms may increase their virulence. Because of these considerations, it would be of particular value to determine the densities of drug-resistant bacteria in waters used for recreational and shellfish harvesting purposes. Since coliform densities are frequently utilized to determine the quality of various waters, the MF-MPN method could provide a useful supplemental procedure for evaluating water quality, particularly in waters exhibiting standard fecal coliform MPN values near indeterminately low levels of less than 1.8 organisms per 100 ml.

Another key to microbiological assessment of water quality is knowledge relative to pathogen presence. This phase of research was directed toward developing a more effective methodology for pathogen detection in estuarine waters and relating these findings to the densities of other microbial indicators of enteric pathogens.

Water samples from Stations 1, 2, and 3 in Mobile Bay were analyzed for total and fecal coliform and *Salmonella* densities. Eighty *Salmonella* isolations were made and confirmed serologically in this laboratory. Because the full complement of antisera necessary for complete serotyping of *Salmonella* species was not available, fourteen cultures were sent to the Center for Disease Control (CDC) in Atlanta, Georgia, for confirmation. Table 5 lists the *Salmonella* serotypes confirmed by CDC. Table 6 correlates

the total and fecal coliform densities with these *Salmonella* serotypes only, along with the sampling stations from which they were isolated. There does not seem to be a correlation between total and fecal coliform densities and *Salmonella* isolations. Although *Salmonella* are more frequently isolated from areas exhibiting a high coliform count, the significant finding was that *Salmonella havana* and *S. gaminara* were both isolated from Station 3 at a time when the fecal coliform count was less than 1.8 per 100 ml by standard coliform parameters (Tables 5 and 6). This water would be considered unpolluted by current standards of microbial assessment. The results of this phase emphasize the importance of information relative to pathogen presence for water quality assessments.

One of the goals of this research project was to examine and evaluate the feasibility of using different and possibly more accurate methods or organisms as indicators of pollution in estuarine waters. The presence of coliform (*E. coli*) bacteriophage has been established in great numbers in wastewater. One possible advantage of using a coliphage system to monitor water quality is the time element involved. Two to three days are usually required for the completion of standard tests on indicator bacteria, whereas coliphage densities can be detected in six to eight hours under ideal conditions. One technique, which is analogous to colony counting in bacteria, makes possible precise counting of plaque bacteriophages. It has been reported that the relationship between plaques formed in plates and the phage number used for inoculation is linear. However, a disadvantage of the plaque-count technique is that low numbers of bacteriophages in samples cannot be detected. Another technique, utilizing the Most Probable Number (MPN) method has had some success in estimating low numbers of bacteriophages. Very little data have been collected, however, in evaluating this method in an estuarine environment.

Preliminary work was done on selecting an appropriate modification of the MPN method when sampling water from Mobile Bay. Raw sewage was also monitored to serve as a basis for comparison because positive results (phage detection) could be obtained readily. A modification of R. P. Kenard's enrichment-MPN procedure was eventually selected as offering the greatest percentage of positive isolations. The *E. coli* B strain was used as the host bacterium in the enrichment procedure because it serves as the bacterial host to a fairly wide range of coliphages. Standard MPN coliform bacteria counts were also performed on each sample tested.

Analyses of the data support some general conclusions. It has been determined that the estimation of low numbers of *E. coli* bacteriophages in estuarine waters is possible by the use of the enrichment-MPN method. However, preliminary results do not show a high degree of correlation between fecal coliforms and the coliphages present in the samples. Obviously, this aspect of the work needs further evaluation.

TABLE 1 Comparison of MPN of Fecal Coliform and Antibiotic Resistant Bacteria from three sites in Mobile Bay

		Standard (APHA) Method			(MF)-MPN Method		
Sampling Interval	Station	Fecal Coliform MPN/100 ml	Antibiotic Resistant Bacteria MPN/100 ml		Fecal Coliform MF-MPN/100 ml	Antibiotic Resistant Bacteria MF-MPN/100 ml Homogenate	
			Te[a]	C[b]	Homogenate	Te[a]	C[b]
1	1	1,100	22	34	160,000	220	68
	2	70	1.8	1.8	700	22	1.8
	3	4.5	2	1.8	49	2	1.8
2	1	3,300	79	17	330,000	11,000	270
	2	7.8	1.8	1.8	220	23	22
	3	1.8	1.8	1.8	26	4.5	2
3	1	13,000	700	49	170,000	49,000	1,800
	2	700	220	11	4,900	1,400	210
	3	13	7.8	4.5	700	230	21
4	1	700	170	21	7,900	340	340
	2	49	1.8	6.8	330	95	12
	3	11	1.8	4.5	170	7.8	1.8
5	1	700	130	13	23,000	4,900	1,100
	2	490	17	2	1,300	330	17
	3	46	7.8	2	790	330	27
6	1	330	230	17	13,000	3,300	270
	2	4.5	2	1.8	460	110	6.1
	3	4.5	1.8	1.8	170	49	2
7	1	220	23	6.8	4,600	460	220
	2	490	79	47	17,000	400	3,300
	3	13	7.8	13	170	49	23
8	1	490	170	3.7	17,000	1,800	20
	2	2	1.8	1.8	49	4.5	6.8
	3	1.8	1.8	1.8	13	1.8	1.8
9	1	490	40	1.8	17,000	2,300	110
	2	6.8	2	1.8	230	17	2
	3	1.8	1.8	1.8	33	23	4.5
10	1	330	230	20	13,000	4,900	330
	2	4.5	1.8	1.8	230	33	7.8
	3	4.5	1.8	1.8	170	23	1.8

[a]Te; tetracycline
[b]C; chloramphenicol

TABLE 2

Summary of Incidence of Coliform IMVIC Patterns Related to Resistance to Tetracycline or Chloramphenicol

IMVIC Pattern of Isolate	Te[a] - Resistant isolates		C[b] - Resistant isolates	
	Number showing pattern	% of total	Number showing pattern	% of total
Total tested	216	—	112	—
Escherichia coli I & II	147	68	31	28
Klebsiella - Enterobacter	20	9	10	9
"Intermediate"	49	23	71	63

[a]Te; tetracycline
[b]C; chloramphenicol

TABLE 3

Summary of incidence of Antibiotic Resistance Patterns of Isolates

	Antibiotic used for Selection[a]			
	Tetracycline		Chloramphenicol	
Strain	Antibiotic Pattern	No	Antibiotic Pattern	No
E. coli	Te	35	Te, Am, C	8
	Te, Ds	21	Te, Ds, Am, C, Cb	7
	Te, Ds, Am	9	Te, Am, Cf, C	2
	Te, Ds, Am, Cf	6	Te, Ds, Am, C	2
	Te, Ds, Am, Cf	5	other patterns	7
	Te, Ds, Am, C	5		
	Te, Am, C	4		
	other patterns	7		
Total		92		26
Klebsiella-Enterobacter	Te	1	Te, Ds, Am, Cf, C	3
	Te, Am	3	Te, Am, C	2
	Te, Ds, Am, Cf	1	Te, Ds, Am, C	1
			Te, C	1
Total		5		7
Intermediates	Te	2	Am, Cf, C	8
	Te, Ds	7	Te, C	4
	Te, Am, Cf	4	Te, Ds, Am, Cf, C, K	3
	other patterns	13	other patterns	16
Total		26		31

[a]Abbreviations: Am, ampicillin; C, chloramphenicol; Cf, cephalothin; Cb, carbenicillin; Ds, dihydrostreptomycin; K, kanamycin; Te, tetracycline

TABLE 4

Summary of the Number of Coliform Isolates Exhibiting Single and Multiple Antibiotic Resistant Patterns

No. of Antibiotics to which each strain was resistant	*E. coli*	*Klebsiella-Enterobacter*	Intermediate	Total	%
selection by Tetracycline					
1	35	1	2	38	31
2	21	3	11	35	28
3	17	0	8	25	20
4	17	1	5	23	19
5	11	0	0	1	1
6	0	0	0	0	0
7	1	0	0	1	1
selection by Chloramphenicol					
1	0	0	2	2	3
2	1	1	5	7	11
3	12	2	13	27	42
4	4	1	3	8	12
5	9	3	4	16	25
6	0	0	3	3	5
7	0	0	1	1	2

TABLE 5

List of Salmonella Serotypes Isolated From Estuarine Waters

Serotype	No. of Isolations Made of Each	Station
S. newport	6	1,2 (5 isolations)
S. muenchen	3	1,1,2
S. mississippi	1	1
S. havana	2	1,3
S. gaminara	1	3
S. rubislaw	1	2

TABLE 6

Quantitation of Coliforms and Salmonella in Estuarine Waters

Sampling Intervals	Station	Coliform MPN/100 ml		Coliform MF-MPN/100 ml Homogenate		Salmonella MF-MPN/100 ml Homogenate
		Total	Fecal	Total	Fecal	
1	1	3,300	230	31,000	7,900	2.0
2	1	4,900	3,300	790,000	330,000	2.0
3	1	7,900	700	79,000	7,900	2.0
4	2	1,300	490	4,600	1,300	2.0
5	2	490	220	13,000	3,300	7.4
6	1	4,900	1,300	130,000	79,000	4.5
	3	13	1.8	230	17	4.5

TREATMENT OF SHRIMP PROCESSING WASTE WATER BY ELECTROLYSIS 45(3)

Richard D. Benton — Mississippi State University
Glenn D. Bryant — Mississippi State University

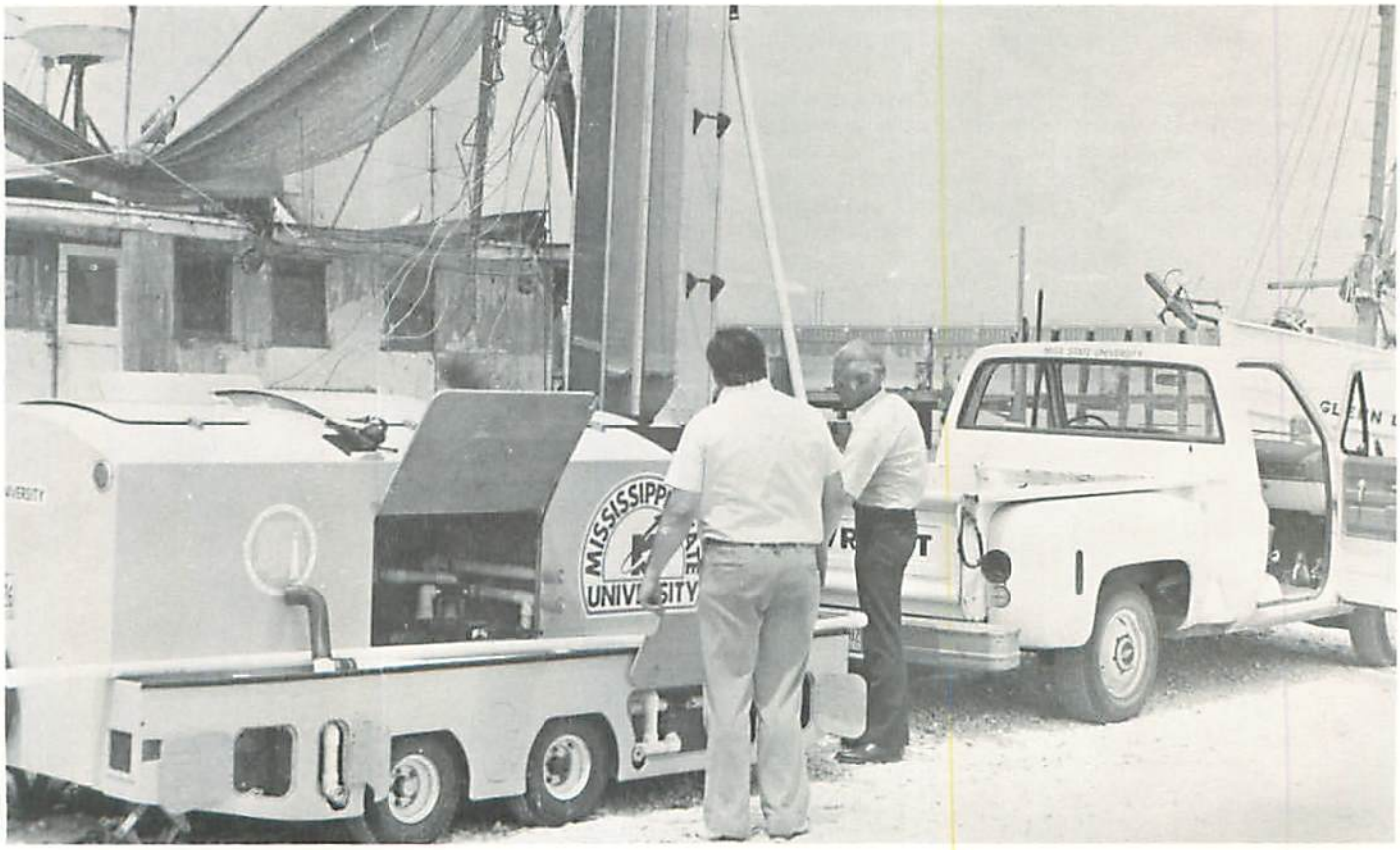
Laboratory investigations into the feasibility of using electrolysis to treat shrimp processing waste water were begun in the summer of 1974, and the results have been encouraging. Significant decreases in chemical oxygen demand, biochemical oxygen demand, protein, ammonia, and phosphate were shown to occur.

Initial tests used direct current and platinum electrodes. Later, it was found that excellent results could be obtained using alternating current and aluminum electrodes. This process can be more accurately called electro-flocculation than electrolysis. Electrical stimulation of the aluminum electrodes in the waste water produces free hydrated aluminum hydroxide which carries down organic matter. The stimulation also produces a large quantity of micro bubbles which aid in the flocculation process. Results depend somewhat on pH but compare favorably with what is defined by the Environmental Protection Agency as best available technology. Owing to the small quantities of waste water used, insufficient data were produced to investigate the energy economics of the process or to determine proper electrode geometry. A decision was made to construct an apparatus to investigate these questions.

Construction began during the summer of 1975. This test unit, which was constructed on a golf cart trailer frame, has two storage tanks with a combined capacity of about 500 gallons. The tanks are insulated by a one-half inch thickness of plywood, a three inch thickness of styrofoam, and a layer of fiberglass. A portable refrigeration unit will be installed to chill the material to about 35 degrees F. for storage and transport. Two pumps are provided to fill the tanks and circulate the liquid. The plumbing system allows single panel control of a large number of fluctuations.

The unit is equipped with three combination AC/DC power supplies which can provide up to 50 amperes each to any number of electrodes in the electrolysis chambers. These chambers consist of three plexiglon towers, each 7.5 inches square and 99 inches tall. A floc catch basin is provided at the top of the towers to separate the floc from the waste water.

Initially it was expected that the test unit would be completed in late 1975 and would be available for the 1976 shrimp season. However, unanticipated construction delays caused a considerable slip in the schedule. The unit is in the final stages of completion and should be available for a test program during the 1977 shrimp season. This is an ongoing project.



UTILIZING SEAFOOD WASTES TO FORM MARKETABLE COMMODITIES 45(4)

Gary C. Wildman — University of Southern Mississippi
Paul D. Frayer — University of Southern Mississippi
B. George Bufkin — University of Southern Mississippi

More than 300 million pounds of seafood waste is generated each year in the United States. Some 60 million pounds of this waste is chitin, which may be separated from the protein and calcium carbonate by a process developed at the University of Washington under Sea Grant funding.

Chitin can be employed in a productive and profitable manner if the technology of utilization can be developed. One example involves the commercial product Kylan, a cationic resin-based chitosan, to reduce the shrinkage of wool. Chitosan is produced by the deacetylation of chitin.

This research project involves utilizing chitin, available derivatives of chitin, and some additional derivatives to produce materials for the construction industry such as hardboards, paint, and coatings binders.

Seafood industrial wastes containing chitin represent a readily available alternate source of an underutilized raw material. The objective of this research effort is to demonstrate the feasibility of employing chitin in marketable commodities.

The physical route to using chitin as a filler or reinforcing agent in thermoplastic polymers has been studied carefully, and the results generally show that chitin can be employed in such a material if the processing temperature is less than 350° F. Above this temperature, the chitin degrades dramatically. However, the size, structure, and amount of chitin fibers, as well as the polymer type, showed no significant change in physical properties as a function of any parameter except for the amount of chitin employed, and to a lesser extent the polymer type. As the amount of chitin was increased, the composite became stronger up to a point and then began loosing strength and became brittle. Increases in strength of up to 100 per cent were experienced with some polymers, while lesser increases were experienced with others.

The idea that the type of polymer could effect the ability of chitin to serve as a reinforcing agent was supported by work conducted by Dr. Paul Frayer at Case Western Reserve University. Thus, it was decided to obtain a polymer of hydrogen bonding capability similar to the protein found in a shrimp hull to determine if the ability of chitin to reinforce a polymer could be optimized. Nylon 6 was obtained and chitin was employed as a reinforcing agent at various concentrations. Due to the high processing temperature (400° F.), it was found that the chitin degraded badly during processing and that it did not appear to reinforce the nylon as well as it did an acrylic polymer. Thus, this line of investigation has been discontinued in favor of utilizing chitin as a filler and curing agent in an epoxy thermosetting polymer. The epoxy can cure at room temperature and since it is a liquid, the chitin or chitosan may serve both as a viscosity modifier and a curing agent.

The degradation of chitin has now been accomplished in a reasonably uniform and controlled fashion. The degraded material subsequently reacted with several biocides to generate products which will have useful properties as poisons in antifouling coatings. Poisons employed to date have included a series of chlorinated acids (chloro, dichloro and trichloro-acetic acids, B-chloropropionic acid, 2, 4-dichlorophenoxyacetic acid and 2, 4, 5-trichlorophenoxyacetic acid). These materials are presently being placed on panels for actual marine exposure tests. The controlled degradation of chitin and chitosan also is being employed to generate agents for epoxy resins.

This project does not terminate at the end of the current funding cycle but will continue through December 1976.

DELINEATION OF THE TIDAL CURRENT REGIME OF MISSISSIPPI SOUND 50(1)

Charles K. Eleuterius — **Gulf Coast Research Laboratory**

Mississippi Sound is a relatively shallow, elongated water body with its major axis oriented east-west. The estuarine waters of the Sound are the result of mixing oceanic and fresh waters. The waters from the Gulf of Mexico enter the Sound through the island passes, while the fresh water is introduced via river discharges and direct runoff.

Several of the barrier islands that define the boundary between the Mississippi Sound and the Gulf of Mexico are part of the Gulf Islands National Seashore. The Mississippi mainland is rapidly developing into a metropolitan band along the coast. Historically known for its seafood industry, the Mississippi coast, in recent years, has experienced growth in the areas of tourism, light and heavy industry, and maritime commerce. The influx of people and industry has resulted in multiple and often conflicting uses being placed on the productive Mississippi Sound estuarine area.

The Sound, with a wet surface area of approximately 680 square miles at mean low water, is the recipient of the effluent from the various activities throughout the drainage basin. Channels are constructed and maintained at authorized depths, and the disposal of dredge spoil constitutes a tremendous problem. Restaurants, jetties, piers, harbors, and boat-launching ramps are constructed along the shoreline with little attention given to the possible effects on the hydrography, or vice versa, and the ecological system as a whole.

Knowledge of the current regime, water exchange characteristics, and the physical structure of the water column is essential to the conduct of wise management of the coastal zone and the marine environment. This knowledge must also include the seasonal and aperiodic short term changes. The problem of pollution is directly related to the temporal and spatial distribution of the contaminants introduced into the estuary. The fundamental mechanism for the dispersal of the contaminants is the natural circulation of the estuarine system.

Since January 1973, 81 hydrographic cruises have been conducted occupying a total of 120 stations in Mississippi Sound. Measurements of water temperature, salinity, pH and dissolved oxygen were made near the surface and through the water column at 5-foot intervals. Water samples were collected at the surface and near the bottom of designated stations. Determinations were made of nitrite, nitrate, orthophosphate and total phosphate. Other observations as to sea state, wind, and water transparency were also noted.

These data have been utilized in determining the flow patterns within the Sound. A number of circulatory features of particular importance to authorities involved in coastal zone management have been identified. Composite charts of the horizontal distribution of salinity at specified depths have been constructed. These composites facilitate the understanding of both the surface and subsurface flow.

The temporal and spatial distribution of the nutrients (nitrite, nitrate, orthophosphate, total phosphate) have been described. While considerable variability existed throughout the Sound, a definite seasonal pattern emerged. The nitrate and phosphate levels were abnormally high in the vicinity of the major industrial park located at Bayou Casotte in Jackson County. The nutrient levels of the near-bottom waters of the two ship channels traversing Mississippi Sound were consistently high with no relationship to season.

Considerable information on many different aspects of the hydrography has been gathered. Much of the data has been processed and awaits final analysis and interpretation. Computer programs previously written by the principal investigator have been supplemented by more recent program contributions. To minimize the delay in getting the information on these various segments into the public realm, the results of the study will be forthcoming as a series of illustrated technical reports and contributions to appropriate scientific journals.

DYNAMIC CHARACTERIZATION OF THE WATERS OF THE MOBILE BAY PASSES 50(2)

William W. Schroeder — **University of Alabama**

Sixteen 26-hour surveys were completed at Main Pass, Mobile Bay. Seven of these surveys were anchor stations utilizing the research vessel *G. A. Rounsefell,* five were at East Main Pass on the Fort Morgan side, and the other two were at West Main Pass of the Fort Gaines side. Data collected during the anchor stations were hourly vertical profiles of temperature, conductivity (salinity), dissolved oxygen, and current direction and speed. The other nine Main Pass surveys were completed by using an 18 foot twin outboard motorboat which occupied three stations across the pass--East Main Pass, the main shipping channel, and West Main Pass--on a six hour cycle. Data collected during these surveys consisted of vertical profiles of temperature, conductivity (salinity), and dissolved oxygen.

An instrumented buoy, which was part of the NASA Landsat DCP program, operated successfully for four and one-half months at West Main Pass. Data collected by this buoy consisted of hourly measurements of surface temperature and conductivity (salinity).

Thirty-two hydrographic surveys were completed from the Dauphin Island Bridge at Pass aux Herons. These surveys consisted of three stations which were occupied either at high or low water. A vertical profile of temperature, conductivity (salinity), and dissolved oxygen was taken at each station.

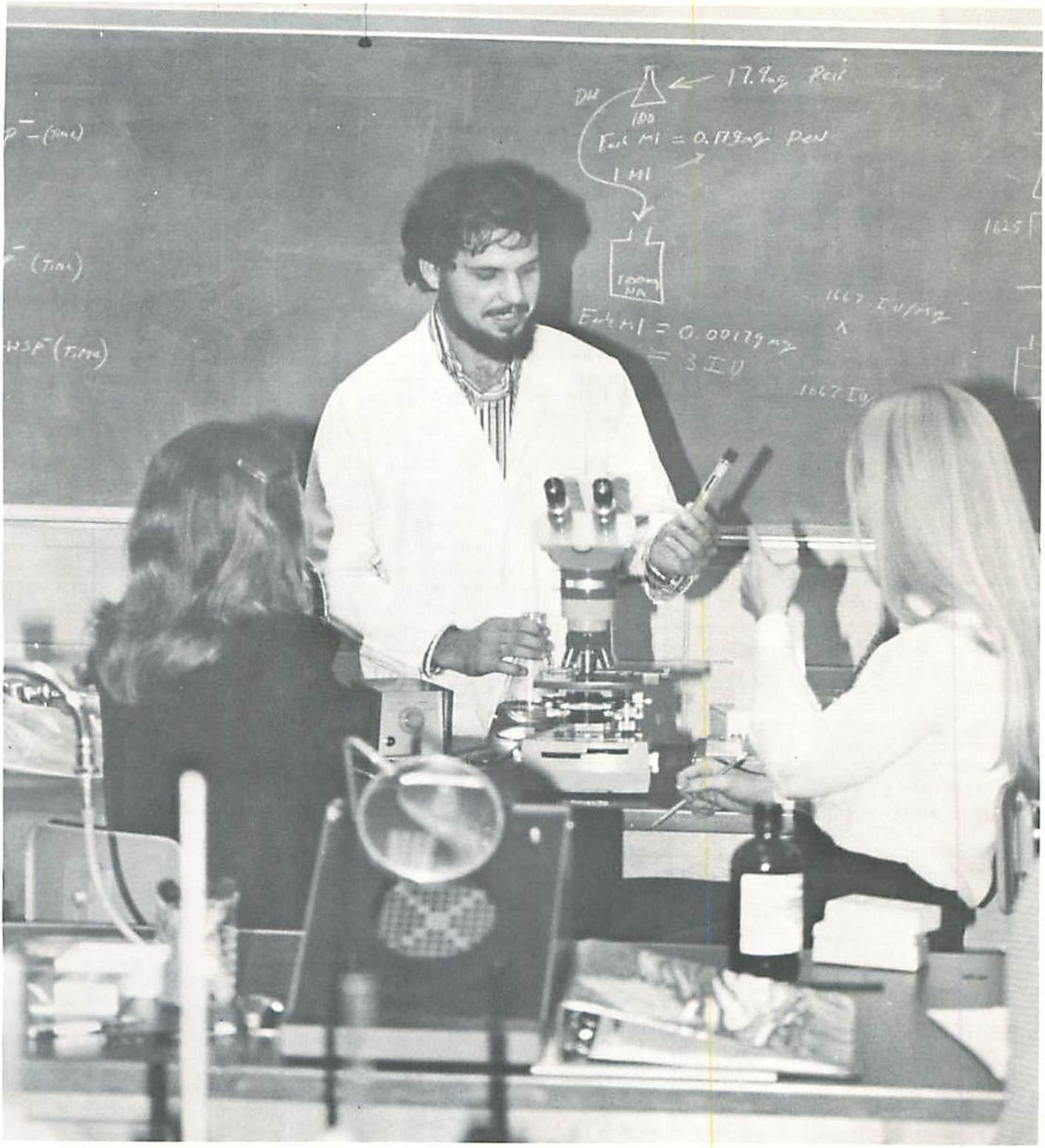
Two 26-hour surveys were completed at Grants Pass, within Pass aux Herons, where hourly vertical profiles of temperature, conductivity (salinity), dissolved oxygen, and current direction and speed were made.

Numerous visits were made to potential users of the planned Physical Environmental Atlas. The purpose of these visits was to outline the contents and to seek input on the formats to be used to display the data. Some of these potential users include the Alabama State Conservation Laboratory; U.S. Army Corps of Engineers, Mobile Office; Alabama Water Improvement Office; State of Alabama Public Health Office; and Mobile County Commissioners.

More than half of the graphic products for the Atlas have been produced. Half of these have been inked and are ready for the printer.

EDUCATION

MARINE EDUCATION AND TRAINING



DEVELOPMENT OF AN OCEANOGRAPHIC INSTRUMENTATION COURSE 62(1)

Richard D. Benton — **Mississippi State University**

Engineering Technology is part of a continum extending from the craftsman to the engineer. Located nearest the engineer, it requires the application of scientific and engineering principles in support of engineering activities. The support is given whether or not the engineering technologist or engineering technician is working under the immediate supervision of an engineer. The term Engineering Technician is applied to the graduates of the associate degree programs. Graduates of baccalaureate programs are termed Engineering Technologists.

An engineering technology program is a planned sequence of college level courses designed to prepare students to work in the field of engineering technology. The term college level indicates the rigor and degree of achievement required.

Engineering problems require solutions of varying degrees of complexity and are constrained by both technical and non-technical considerations. As the technical leader, the engineer determines the policy basic to technical solution and exercises his responsibility to society in the non-technical dimensions. The technician and the technologist work in many functional and responsive ways to execute the applications indicated.

The College of Engineering of Mississippi State University offers a number of programs leading to the Bachelor of Engineering Technology Degree. These programs include Marine Engineering Technology (with emphasis on the shipbuilding industry) and Electronic Engineering Technology (with emphasis on electronics, computers, and instrumentation). Graduates of these programs are highly skilled technologists with an understanding of engineering fundamentals and a practical, problem solving approach.

The Marine Engineering Technology program was initiated with a grant from the Office of Sea Grant Programs in 1967. This program is having a major impact in providing the necessary shipbuilding technologists for the United States shipbuilding industry. Faculty members in both Electronic and Marine Engineering Technology jointly participated in the design and construction of the towed submersible RUFAS II. The project was completed under a grant from the Mississippi-Alabama Sea Grant Consortium. This involvement in marine affairs by the Engineering Technology faculty led to the idea of adding sufficient material to the Electronic Engineering Technology curriculum to give the graduates of that program an appreciation of the opportunities and challenges of working as Electronic Engineering Technologists in the field of Oceanographic Instrumentation.

The Electrical Engineering Technology curriculum is designed to provide an educational program which meets the Engineering Council for Professional Development definitions for an engineering technology program.

The Instrumentation System Technology course was originally included in the Electrical Engineering Technology curriculum to provide the student with an understanding of basic electronic measuring instruments and to provide instruction in the selection of instrumentation systems. This course was purposely placed in the final semester to insure that students were adequately prepared with a strong background in electric and electronic theory and at least three semesters experience in the use of electronic laboratory measuring instruments and signal sources.

The course has been taught for a number of years with industrial process instrumentation to satisfy the instrumentation systems requirement. The major change was the substitution of oceanographic instruments and systems for the industrial process instrumentation portion of the course.

Since the students will have had little or no background in oceanographic systems, it was decided to require them to prepare two term papers. The first paper is due at the 15th class meeting. This short paper provides an overview of oceanographic instrumentation, complete with references which examine the major oceanographic parameters. The paper should include the normal range of values for each of the stated parameters.

The second paper assigned at the same time as the first, is due at the 35th class meeting. This paper is much longer than the first and will generally be limited to one topic, for example salinity, temperature, depth, or some other parameter. Every effort is made to assign a different topic to each student.

During the semester each student is required to make a 15 to 20 minute oral presentation on his second term paper. This provides him practice in the presentation of technical papers and gives the other students an alternate view of the subject.

This course has been taught three times to approximately 35 students. It is now established as a required course in the Electronic Engineering Technology curriculum at Mississippi State University. The influence of this course will be felt as graduates seek employment in marine and ocean related industry.

A textbook has been written for this course and is in the process of being published.

ADVISORY SERVICES

MISSISSIPPI ADVISORY SERVICE PROGRAM: MARINE EXTENSION PROGRAM 71(1)

Leon O. Paulette — Mississippi Cooperative Extension Service
C. David Veal — Mississippi Cooperative Extension Service
John Dale "Zach" Lea — Mississippi Cooperative Extension Service

The mission of the Mississippi Sea Grant Advisory Service is to provide a mechanism for the transfer of useful information to and from those people and organizations who are interested in marine affairs. Since the Advisory Service program is aimed at changing practices, its educational efforts must go beyond straight-line informational flow of research results. It must emphasize public service education in a way that reflects a basic concern for people and the developmental goals of society. Such an approach requires a system that permits the interpretation of new knowledge and retrieval of established facts and information. It requires the application of knowledge to establish new experiences, practices, attitudes, and skills. It helps people organize for worthwhile purposes and assists individuals in developing their leadership potential. Thus the mission of the Sea Grant Advisory Service and the Mississippi Cooperative Extension Service goes beyond educating people who wish to expand their intellectual scope. Education for action is the goal.

The flow of information pertaining to clearly identified problems and problem areas originating from within the marine user audience is as important as the dissemination of completed research results. Problems and research needs are the basis upon which a well-rounded and efficient Sea Grant Program is built.

Public education activities have shown a steady increase. Seventeen publications have been produced and are available to the general public. Approximately 200,000 copies of these publications were distributed during the year. In addition, 29 radio and television programs were used by the staff to disseminate marine information.

The addition of a marine economist has increased the effectiveness of the Mississippi Advisory Service significantly. The three man staff contacted more than 3,400 individuals and dealt with subjects ranging from tourist promotion to fishing vessel financing and new product development.

The Advisory Service encouraged public participation in the development of a National Fisheries Plan. More than 250 fishermen, seafood processors, bankers, lawyers, and interested citizens attended four meetings to discuss important issues to be considered in the development of the plan. Workshops, seminars, and training sessions were held on such topics as income taxes, recordkeeping, social security, witholding taxes, oil discharge from vessels, sport fishing techniques, construction of artificial reefs, waste disposal, sanitation practices, and other related activities.

The first three parts of a seven part series of video tapes on understanding weather were produced and used widely in coastal school systems. With the aid of area 4-H agents, the series was shown to more than 10,000 school children.

A close liaison has been maintained with Sea Grant researchers who have been working directly with coastal resources. Efforts were made to supply researchers with the necessary assistance and raw materials needed to complete the designated project work. As a result, substantial progress has been made in the area of disposal of both liquid and solid waste from seafood plants. A joint project between the Advisory Service and researchers at the University of Southern Mississippi practically insures the introduction of controlled amounts of fresh water into Mississippi Sound to enhance seafood productivity.

A survey of the charter boat industry was initiated in an effort to determine the magnitude of the industry, its economic potential and viability, and its overall importance to the Gulf Coast. In addition, with the aid of the Charter Boat Captains Association, a booth was sponsored in the "Travel Mississippi '75" show extolling the virtues of salt water fishing on Mississippi's Gulf Coast. More than 35,000 persons visited this booth in a three-day period.

A joint project with the Mississippi Cooperative Extension Service area horticulturist resulted in the construction of several beach oases. These attractive clusters of palms and thatch shelters have been widely acclaimed as a giant step in coastal beautification. These oases have been widely used by both tourists and local residents.

No program can be effective without critical self evaluation. The effectiveness of the various Advisory Service functions are monitored and evaluated continually, along with the benefits provided to target audiences. As a result of this additional surveillance and planning, several new audiences with unique problems have been identified, and a master plan has been developed to supply their educational needs.

ALABAMA ADVISORY SERVICE PROGRAM 71(2)

A. Ray Cavender — Alabama Cooperative Extension Service
William E. Powell — Alabama Cooperative Extension Service

During the fall of 1974 the Small Business Administration included shrimp boat owners in its Emergency Energy Shortage Loan program. Alabama's shrimp boat owners were facing a financial crisis due primarily to the short supply of shrimp and the high cost of fuel. In an effort to assist the fishermen, Sea Grant Advisory personnel arranged a meeting so the SBA staff could explain the program. A series of workshops were then conducted in Bayou La Batre where Advisory personnel and SBA staff assisted numerous fishermen with their individual problems. This program was continued through 1975 and resulted in 23 loans totaling $442,000 being made to boat owners in the area. Assistance was also received from Economists on the staff of the Cooperative Extension Service at Auburn University.

Bayou La Batre and the adjacent area has much to offer in the way of scenic beauty and unique surroundings. Advisory Service personnel worked closely with several civic organizations in an effort to make local citizens aware of the tremendous tourism potential and to promote the first annual Alabama Seafood Festival. This three-day event included tours of the seafood industry, historical exhibits, an arts-and-crafts show, seafood dinners, a "Miss Seafood" pageant, and a street dance. The Festival was a great success with the entire community working together to give the more than 5,000 visitors a real insight to Alabama's seafood capitol. The Festival will be an annual event in the future.

Alabama is in the second year of a three-year period of developing a Coastal Zone Management plan. The Advisory Service worked closely with the Coastal Area Board, Alabama Development Office, and Mississippi-Alabama Sea Grant Consortium in planning programs for Coastal Zone Management. Advisory personnel assisted by providing the names of coastal leaders, making arrangements for programs, and giving publicity to conferences through TV and the other news media.

A part-time Marine Science Aide was employed to help reach the fishermen and better serve the community. His responsibilities included collecting and compiling data for various surveys and studies.

For some time the scientific community has been interested in the bulldozer lobster, *Scyllarides nodifer*, that shrimpers catch from time to time; however, base line information is needed on populations and locations before a study could be proposed. Fishermen were interviewed at dockside and a report was compiled listing some 13 specific locations where considerable numbers of bulldozers had been caught. This data was given to the Dauphin Island Sea Lab staff and hopefully they can assist in determining the feasibility of establishing a commercial industry in the area.

A lack of understanding of seafood products by the consumer has been a serious problem for the seafood industry. National Marine Fisheries Service home economists and marketing staff members have worked closely with the Advisory Service staff to provide information about preparing, storing, and serving seafood. Numerous TV programs have been conducted on seafood and its use.

In addition, a program was prepared for the annual convention of the Alabama Restaurant Association. The topics discussed included safety tips, quality control programs, and the use of seafood in restaurants--especially underutilized species. Approximately 150 persons attended. As a followup, a survey was mailed to nearly all the restaurants in the state asking about problems in purchasing, handling, and serving seafood. This information was compiled and made available to the seafood processors.

There are many retail seafood outlets in the two-county area. In order to identify their problems--and also to better assist the consumer--a list of seafood dealers was compiled, including information on items handled and tips on selection and storage.

Highly perishable seafood items often require extensive handling, and good sanitation is extremely important. Several crab processors and fishermen were assisted with sanitation problems. Advisory Service specialists gave demonstrations in the plants and outlined accepted guidelines to follow. Plans have been made to hold a series of sanitation workshops for the various food processors in the area.

Over the past year there has been considerable interest in merchandising underutilized species. Advisory personnel worked closely with two different persons who were interested in processing mullet and croaker for shipment to markets in the North. These persons were provided with statistical information and tours of the area. To date, one of these gentlemen has submitted a proposal for a fish processing plant to several agencies for funding.

Advisory personnel also worked with a group--including a poultry processor--interested in utilizing trash fish and fish discards for making a fishmeal. Fourteen tons of fish were processed in two successful runs, and the group is considering building a plant in the area.

Efforts were made throughout the year to work closely with the various agencies involved with the coastal community. An example of this cooperation is the work accomplished with the Marine Resources Division of the Alabama Department of Conservation and Natural Resources. Several TV programs were made with Marine Resources Division staff members explaining their activities and acquainting people with their work. Meetings have been held from time to time to discuss problems with the seafood industry and to share available information.

Advisory personnel met with the Alabama Sea Grant Management Committee twice to give an assessment of the problems confronting the people of coastal Alabama and to offer suggestions on programs to improve the quality of life.

MISSISSIPPI MARINE EXTENSION PROGRAM: SPECIALISTS SUPPORT, UNIVERSITY OF SOUTHERN MISSISSIPPI 73(1)

D. C. Williams, Jr. — University of Southern Mississippi
David J. Etzold — University of Southern Mississippi
Charles P. Cartee — University of Southern Mississippi
Nell Murray — University of Southern Mississippi

Meetings have continued with key personnel in Mississippi, Louisiana, and Alabama to seek ways and means of introducing controlled fresh water flows into the marine estuaries to enhance seafood productivity. Plans have been made to discuss the project with U.S. Army Corps of Engineers and appropriate Congressional representatives. A supporting document has been written and a presentation has been made to Lt. General Gribble, Chief of the U.S. Army Corps of Engineers, and the Gulf States Congressional Delegation Representatives in Washington, D.C. A progress report has been presented to the Gulf States Marine Fisheries Commission Technical Coordination Committee and the American Shrimp Canners Association. All interested personnel have been informed of the progress to date through the use of various modes of communication. The current status of the project is that it has been submitted to the Committee on Public Works and is being reviewed by the U.S. Army Corps of Engineers prior to being returned to that Committee for further action.

Preliminary short-term investigations have been made into economic and market analyses of seafood and related products in the crab, pet food, fish, oyster, and charter boat industries. An Oyster Transplant Study has been conducted for the Mississippi Marine Conservation Commission to be presented to the State Legislature for possible funding.

Support specialists met with Sea Grant Advisory Personnel to discuss the priorities assigned to the various tasks. It was determined that a Charter Boat Study should be initiated as soon as possible. Data sheets were developed to be put on board charter boats, plus questionnaires and letters for mailing to charter boat customers. This program was initiated in April of 1976 and is continuing.

One of the real problems facing the seafood industry is the lack of crab pickers. Skilled pickers are presently a dying breed, for few young recruits appear to be willing to fill the thinning ranks. The specialists support staff is actively engaged in a program to seek out and train personnel needed for the crab industry.

The Advisory Service has been assisted in special projects and seminars and has been supported with expertise in the fields of management and economics. Most notably assistance has been provided in the areas of motion economy and improvements, planning techniques and management by objectives, questionnaires and sampling procedures, and fishery statistics.

The Tourism and Recreation Committee has continued in its efforts to involve local people in the identification of specific problems within the tourism and recreation industry. Specific tasks have been designed to help define courses of action and to get action on specific problems. The Committee's efforts have centered around the sand beach, the impact of Interstate Highway 10, and various agencies and activities associated with developing the tourist industry along the coast. In an effort to minimize the adverse effects of Interstate 10 on the coast tourist industry, legislation designating Highway 90 as a scenic route was drafted for consideration in the 1975 legislative session. The designation of the scenic route was accomplished through House Bill No. 497, prepared at the request of the Tourism and Recreation Committee and signed by the Governor in March 1975. The Mississippi State Highway Department approved the scenic route designation to be placed on the "Official Road Map" of Mississippi.

The Committee met with other groups along the coast and with various public officials including the Highway Commissioner, Director of the State Highway Department, and the Federal Highway Administrator. These efforts resulted in the approval of signs at major intersections along Interstate 10 that would inform the motorists of the beach or tourist area.

The Committee has maintained contact with other tourism and recreation groups such as the South Mississippi Tourist Promotion Council and has assisted them in their efforts. Tourist groups were assisted by conducting a survey of the golfing activity along the coast during the winter and early spring months to determine the numbers and origins of golfers. These data were used to quantify the potential for a direct Southern Airways flight from Chicago to the Gulf Coast during the golf season.

Public officials were encouraged to provide recreational facilities and comfort stations along the beach. The control of blowing sand from the sand beach onto Highway 90 was of concern to the Committee, and contacts were made to gain a means of alleviating the problem. The U.S. Army Corps of Engineers proposed to study the sand problems and test some alternative solutions.

The Committee was able to bring together various segments of the tourist industry, public officials, planning organizations, and agencies to exchange ideas and seek methods for improving the overall tourist and recreation industries.

This is an ongoing project.

PUBLICATIONS

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Lawler, A. R., Howse, H. D., and Cook, D. W. 1975. "Lymphocystis infections in the silver perch, *Bairdiella chysura.*" *Journal of the Mississippi Academy of Science.* 19:183.
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Norris, D. E., and Overstreet, R. M. 1975. "*Thynnascaris reliquens* Sp.N. and *T. habena* (Linton, 1900) Nematoda: Ascaridoidea) from fishes in the northern Gulf of Mexico and eastern U.S. Seaboard." *Journal of Parasitology.* Vol. 61, No. 2, April, 1975. pp. 330-36.
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MASGP-76-020

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ADVISORY SERVICES

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MASGP-76-021

"Borrow Money Wisely: Your Rights Under the Truth in Lending Act." Brochure.
MASGP-76-007

"First Aid for Fishermen." Brochure. Reprinted by permission of Peter Pownall, Editor, *Australian Fisheries.*
MASGP-75-020

"More Income: What's it Worth in Social Security Benefits?" Brochure.
MASGP-76-004-1

"Investment Tax Credit: What is it?" Brochure.
MASGP-76-004-2

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NEWSLETTERS

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ANNUAL REPORTS

Seward, J. E. ed. *Mississippi-Alabama Sea Grant Consortium 1974 Annual Report.*
MASGP-76-001

ACTIVITY BUDGET SUMMARY

	NOAA Grant Funds	Matching Funds
MARINE RESOURCES DEVELOPMENT		
Living Resources, other than Aquaculture	$109,516	$ 66,631
SOCIO-ECONOMIC & LEGAL STUDIES		
Marine Economics Ocean Law	28,695	6,347
MARINE TECHNOLOGY RESEARCH & DEVELOPMENT		
Resources Recovery & Utilization		
MARINE ENVIRONMENTAL RESEARCH		
Research and Studies in Direct Support of Coastal Management Decisions Pollution Studies Applied Oceanography		
MARINE EDUCATION & TRAINING		
College Level		
ADVISORY SERVICES		
Extension Programs Other Advisory Services		
PROGRAM MANAGEMENT & DEVELOPMENT		
Program Administration & Development		
TOTAL		

This summary is only approximate. The official financial report wi ms in accordance with federal grant requirements.

PROGRAM SUMMARY

	71	72	73	74	75	76	Duration
PROGRAM MANAGEMENT AND DIRECTION							
79(1) Program Management and Development (Mattox)	N	O	O	O	O	O	June 71
MARINE RESOURCES DEVELOPMENT							
07(1) Development of Gulf Coast Artificial Reefs (Crozier, Brown, L. R., Daniel, Dean, Jones, McIlwain, Shipp)				N	O	C	Jan. 74 - Dec. 76
08(1) Parasites of Marine Animals in the Northern Gulf of Mexico (Overstreet)			N	O	O	O	Jan. 73
08(2) Ciguatera Fish Poison (Doorenbos)			N	O	O	O	Jan. 73
SOCIO-ECONOMIC & LEGAL STUDIES							
14(2) An Economic Assessment of Boat Waste Treatment Processes (Cheatham)					N	T	Jan. 75 - June 76
14(3) Potential International Markets for Mullet (Giglioni)					N	C	Jan. 75 - June 76
15(1) Legal Problems of the Gulf Coast Region (Zirkle)	N	O	O	O	O	O	June 71
MARINE TECHNOLOGY RESEARCH & DEVELOPMENT							
30(1) Utilization of Shrimp and Foodfish Fleet Discards (Cliburn)				N	T		July 74 - Dec. 75
35(1) Rapid and Accurate Chemical Techniques to Identify Species of Both Commercial and Underutilized Species of Fish. (Toom and Blomquist)					N	C	Jan. 75
MARINE ENVIRONMENTAL RESEARCH							
39(1) Assessment of Alabama Coastal Marshes for Coastal Zone Management Planning (Stout)					N	O	Jan. 75
39(2) Mississippi Coastal Zone Capability Analysis (Minshew)					N	O	Jan. 75 - Dec. 76
44(2) Fate of Some Heavy Metals in Mobile Bay (Smith)					N	T	Jan. 74 - June 76
45(1) Bacteria and Bacterial Viruses as Indicators of Potential Public Health Hazards in Estuarine Waters (Feary, Brown, B. L.)				N	O	T	Jan. 74 - June 76
45(3) Treatment of Shrimp Processing Waste Water by Electrolysis (Benton and Bryant)				N	O	O	Jan. 74
45(4) Utilizing Seafood Wastes to Form Marketable Commodities (Wildman, Frayer, Bufkin)					N	C	Jan. 75 - Dec. 76
50(1) Delineation of the Tidal Current Regime of Mississippi Sound (Eleuterius)			N	O	O	C	Jan. 73 - June 76
50(2) Dynamic Characterization of the Waters of the Mobile Bay Passes (Schroeder)					N	O	Jan. 75
MARINE EDUCATION AND TRAINING							
62(1) Development of an Oceanographic Instrumentation Course (Benton)				N	O	C	Jan. 74 - June 76
ADVISORY SERVICES							
71(1) Mississippi Advisory Service Program: Marine Extension Program (Paulette, Veal, Lea)	N	O	O	O	O	O	Nov. 74
71(2) Alabama Advisory Service Program (Cavender and Powell)			N	O	O	O	Jan. 73
73(1) Mississippi Marine Extension Program: Specialists Support, University of Southern Mississippi (Williams, et al.)					N	O	Jan. 75

N = New O = Ongoing C = Completed T = Terminated