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MISSISSIPPI ALABAMA SEA GRANT CONSORTIUM

A SEA GRANT COLLEGE

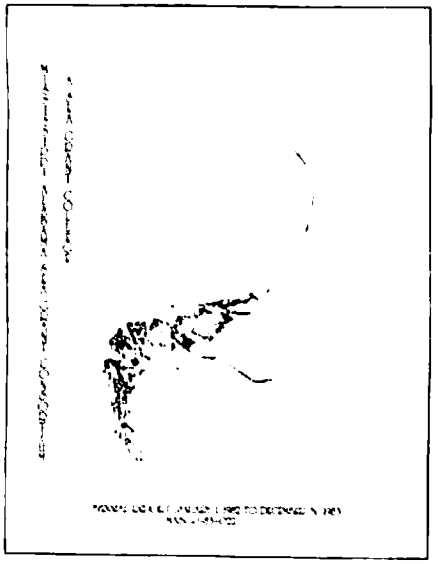
BIENNIAL REPORT JANUARY 1, 1982 TO DECEMBER 31, 1983

MASGP-83-022

Sea Grant

in Mississippi and Alabama

supports research, education and public service projects that help the people of Mississippi, Alabama and the nation to better understand, use and conserve marine and coastal resources.

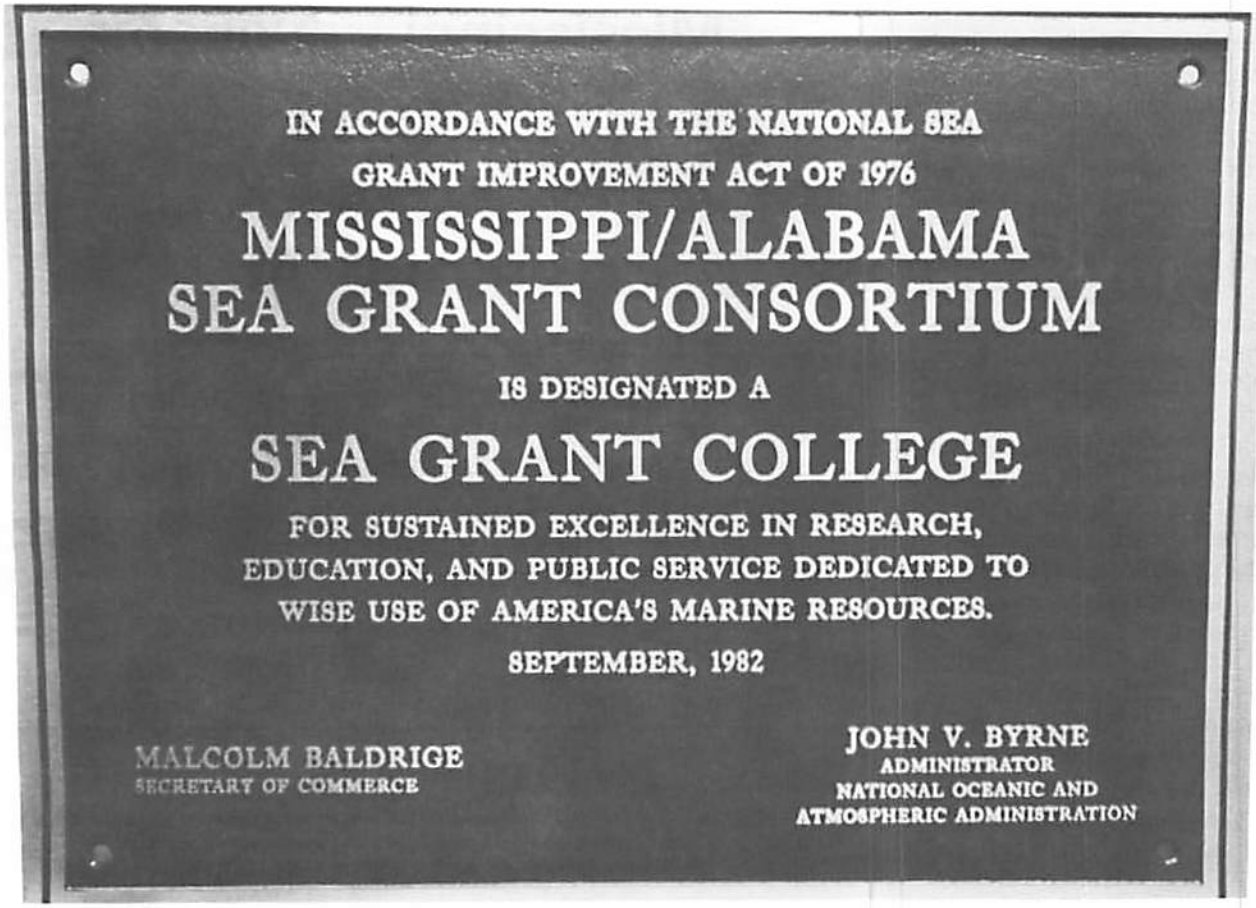


Cover

Gyotaku is the technique of making prints of sea life by direct contact printing or rubbing. The Japanese word "gyotaku" translates as "fish rubbing."

Max Flandorfer, program manager of the Mississippi-Alabama Sea Grant Consortium, made this print of a gulf shrimp. Flandorfer says one of the best things about the technique is that, once finished, you can wash water based ink off your subject and include the fish or shrimp in your dinner menu.

This work is the result of a program sponsored by the National Oceanic and Atmospheric Administration (NOAA) Office of Sea Grant Programs, U. S. Department of Commerce under Grant NA81AA-D-00050, the Mississippi-Alabama Sea Grant Consortium and by the States of Mississippi and Alabama. The U. S. Government is authorized to produce and distribute prints for governmental purposes notwithstanding any copyright notation that may appear hereon.



Director's preface

Sea Grant comes of age in Mississippi, Alabama

One of the most significant accomplishments possible in a Sea Grant program — its designation as a National Sea Grant College — was achieved by the Mississippi-Alabama Sea Grant Consortium on September 23, 1982. The "College" designation, awarded by the Secretary of Commerce, is reserved for those Sea Grant Programs which develop and maintain a program of exceptional quality and scope in marine research, education and advisory services. It is the highest designation attainable, reserved for a select group of mature, well conceived and developed institutional programs.

Many persons' efforts are responsible for this significant honor, including scientists, educators, marine advisory service personnel and administrators. We may all take justifiable pride in this prestigious accomplishment. It has been a major team effort, and I am proud to have been a part of it.

Programmatic emphasis in the last several years has been upon resource evaluation and assessment activities. Those activities will now translate into development efforts for appropriate resources. Current and future efforts will emphasize the development of marine resources within the context of their multiple use, with the knowledge that our coastal resources may be most effectively developed through understanding the cause-and-effect relationships of the natural environment in its response to man's many activities. Thus the goal of Sea Grant to promote sound economic development and appropriate use of marine and coastal resources will be met.

Dr. James I. Jones

As this is written, the "Year of the Ocean" has begun, largely through the efforts of the National Oceanic and Atmospheric Administration (NOAA). This effort is promoted as an opportunity for the government and private sector to enhance awareness of the marine environment's importance to human lives and livelihoods. As a means to celebrate the "Year of the Ocean," the MASGC is providing special recognition for outstanding marine research by students,

fellowships for qualified graduate students involved in marine research, and support for field trips for high school students and teachers in Mississippi and Alabama. Equipping children and adults with an awareness of the direct and indirect influence of the oceans on their lives is a monumental and essential task. I believe that the contribution of the MASGC in supporting and promoting educational experiences in marine sciences relates directly to the goals of the "Year of the Ocean" observance.

The Mississippi-Alabama Sea Grant Consortium program is first and foremost a people-oriented effort. The research, education and advisory service efforts derive from the basic mission to serve and promote the welfare of the coastal community. As the MASGC College Program continues to grow and mature, it will fulfill this mission ever more effectively, increasing its ability to significantly improve the lives and welfare of the citizens of Mississippi and Alabama.

Yours sincerely,

James I. Jones

James I. Jones, Director

Mississippi - Alabama Sea Grant Consortium

1982-83

DIRECTOR: Dr. James I. Jones

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Associate Director for Programs: Cdr. Stanley Hecker
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Program Manager: Mr. Max Flandorfer
Writer/Editor: Mrs. Linda Skupien

ADMINISTRATIVE OFFICES:

Caylor Building, Gulf Coast Research Laboratory, Ocean Springs, Mississippi 39564
(601) 875-9341

SEA GRANT ADVISORY SERVICE OFFICES:

In Mississippi, 4646 West Beach Boulevard, Suite I-E, Bailey Gateway Plaza, Biloxi, Mississippi 39531 (601) 388-4710.
In Alabama, 3940 Government Boulevard, Suite 5, Mobile, Alabama 36609
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The Environment

Tracking pollutants and processes

Chemist Julia Lytle checks test results on a Mississippi Sound sediment sample.

"The Escatawpa River looked like the site of an atomic blast. Skeletons of trees stood gaunt in the water. The grass and pine trees on the sides were dead. A terrible stench rose from the river. There was no life at all."

Dr. Thomas Lytle, Gulf Coast Research Laboratory chemist, recalls his first visit to the Escatawpa River, a heavily industrialized area among the rivers, bays and bayous that make up the Mississippi Sound estuarine system. During the next dozen years, attention focused on the environment throughout the nation. Unregulated discharge of wastes into the Escatawpa abated.

"Green things are beginning to grow again, and there are even a few fish. Some life is evident again at the Escatawpa," he says.

But questions remained: Where did all the pollutants go? Could they still cause problems? Are they affecting the fish and shellfish we like to catch and eat?

Such concerns were echoed up and down the Mississippi and Alabama coasts, and there was little or no scientific data on which to base answers.

With Sea Grant support, Mississippi and Alabama scientists have begun to find answers in the marine sediments: the sands, silts and clays that form the bottom of Mississippi Sound and Mobile Bay. Other Sea Grant researchers are looking at relationships between pollutants and organisms in estuarine systems. Applying modern technology and solid investigative procedures, they have begun to decipher the record of man and nature's involvement in coastal processes.

Gulf Coast Research Laboratory chemists Dr. Julia Lytle and Dr. Thomas Lytle have completed a four-year Sea Grant study that establishes a comprehensive picture of pollution in the Mississippi Sound.

Thorough sampling of sediments laid the foundation for their work. The Lytles took 43 10-foot vibracores in the Sound and filled in the geographic gaps between vibracore locations with 78 "grab" samples of top sediment layers.

"We didn't want this to be a case of a sample here and a sample there," Julia Lytle says. "We wanted it to be a total package: Where pollutants are coming from, where they go, whether they change or not and the effects on the environment."

They found that hydrocarbons, particularly aromatic hydrocarbons, pose the most serious threat to the Mississippi estuarine environment. Sources are myriad: refineries, chemical plants, manufacturing plants, domestic sewage, runoff from parking lots and streets.

Their research showed that pollutants from heavily industrialized areas on rivers and bayous adjacent to the Sound appear to accumulate close to the original source instead of moving into the open Sound.

The fate of pollutants that do enter the open Sound is influenced more by geology than geography. Clays trap more pollutants than do the sandy sediments characteristic of the eastern and central Sound.

Once pollutants move into the open Sound, natural westerly currents carry them into the western region, an area comparatively rich in clay content.

"Sediments within the eastern Sound have a very high sand/low clay content. It is not surprising that the sediments there contain low pollutant residues, even though they are in close proximity to the Escatawpa/Pascagoula River area where the largest industrial complexes on the Mississippi Coast are located," Thomas Lytle says.

"It is important to emphasize that, although there is pollution in the western Sound, it is a dispersed, diluted effect. Most pollution stays up in the rivers, bays and bayous. The worst that is in the open Sound is relatively clean compared to the Biloxi Back Bay/Industrial Seaway region or the Escatawpa/Pascagoula River system."

The scientists have put together some creative packaging to organize their data into useable formats for scientists and lay people involved with marine resources. They have developed depth profiles that show the clay, sand and silt composition of sediments at varying depths and the kinds and amounts of pollutants at those same depths.

With the depth profile, an individual can look for potentially harmful concentrations of toxic materials," Julia Lytle says. "If someone needs to dredge four feet down, he can see what he is going into. It could be clean sand that has washed in on top and covered toxic materials underneath."

The Lytles also recognized that factors other than the concentration of pollutants may determine how damaging polluted sediments can be to the estuarine environment. To account for those factors they developed an "Environmental Stress Index" that identifies and rates potentially harmful "hot spots" of polluted sediments in 34 regions of the Sound.

The results of their research have been used in court cases concerning discharge permits, location of specific dredging projects and the development of scientific sampling programs by other agencies.

The husband-wife team recently completed a study for the U. S. Army Corps of Engineers on dredged material that had been previously dumped at sites in the Gulf of Mexico beyond the Mississippi barrier islands.

Based on their Sea Grant work, the chemists could recognize sources of pollutants which in turn identified when the material was deposited. The Lytles could also tell how the dredged material had been transported by marine processes and how long the pollutants had remained in the sediments.

"The Corps was surprised that we could give them that much specific information about what had occurred at the disposal site."

Their work will continue to provide a sound base for marine resource management decisions and further scientific investigation.

"For the first time, we have a good grip on the status of the Mississippi Sound. We know where the pollutants collect, where the potentially harmful areas are located. It is wonderful to have that information — to have the entire picture."

Isphording found that zinc in Mobile Bay oysters runs as high as 2,200 parts per million, nearly three times the zinc in the Mississippi oysters checked.

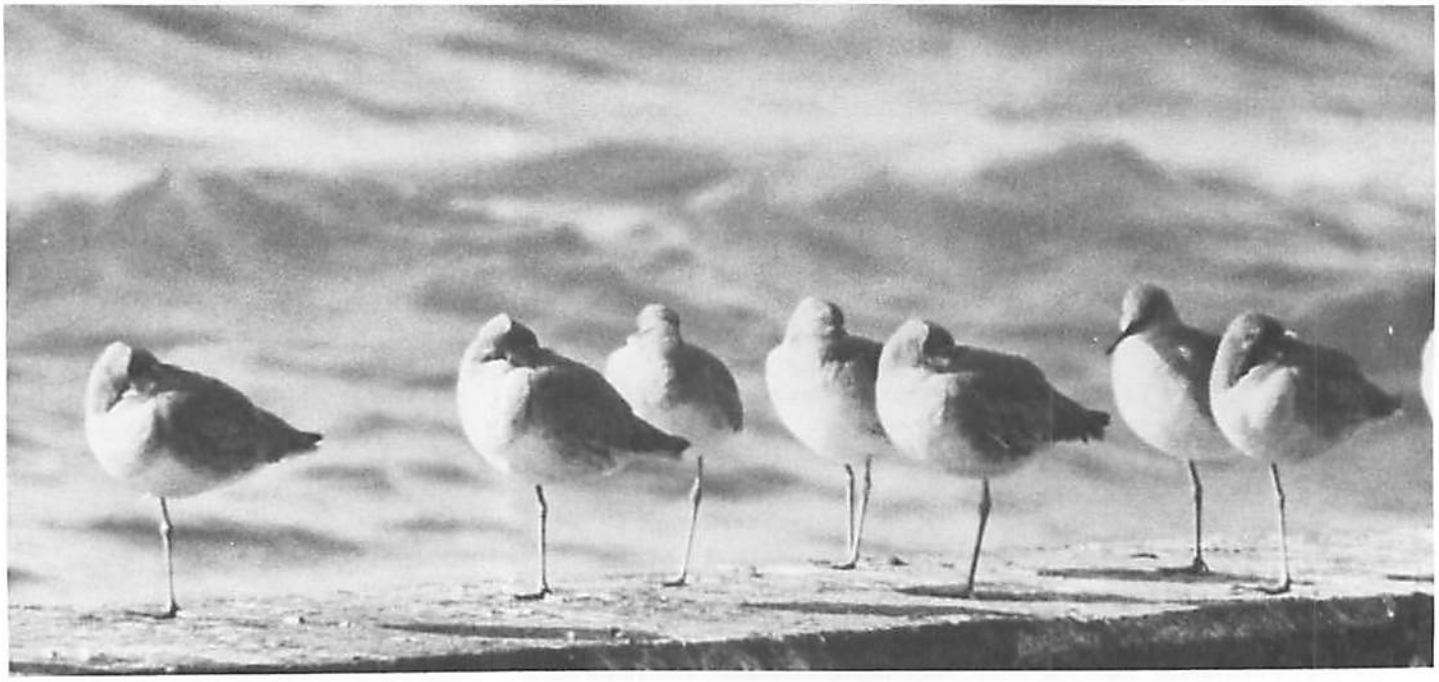
Zinc levels produce 'galvanized' oysters in Mobile Bay

Geologist Dr. Wayne Isphording of the University of South Alabama used a different approach to put together a picture of Mobile Bay pollutants.

In his Sea Grant study on heavy metals in estuarine sediments, Isphording checked what he is tempted to call "galvanized" oysters

He found 1,287 parts per million zinc in oysters taken near the mouth of Mobile Bay in 1982 and almost double that, 2,200 parts per million, in oysters taken near the head of the Bay in 1983. That compares with 821 parts per million zinc in oysters from Bay St. Louis, Mississippi, and 103 parts per million in Texas Gulf Coast oysters.

Isphording points out that as early as 1971 the U.S. Geological Survey suspected that Mobile Bay sediments contained heavy metals in potentially harmful quantities. The U. S. Geological Survey Circular 643



Sea wall sunbathers

published that same year noted that Mobile ranked high in cases of cancer of the gastrointestinal tract.

He doesn't offer opinions on the potential harm such high metal content presents to human beings who eat seafood. That is out of his field, he says.

But he does have a good idea about how the metals accumulate in oyster tissue in the first place. His interest in that transfer process has grown out of his four-year effort to document where heavy metals are concentrated in Mississippi and Alabama estuaries, how much is there and what percentage is trapped — "partitioned" — in ways that allow release back into the water.

He has mapped heavy metal concentrations and their potential for release in Mobile Bay, Wolf Bay and Perdido Bay in Alabama and St. Louis Bay and Mississippi Sound in Mississippi.

Determining the total content of heavy metals in sediments doesn't tell you whether the substance is harmful or not," Isphording says. "What makes a difference is if heavy metals are partitioned in forms that can be easily released back into the water column."

Heavy metals partitioned in structural sites by strong chemical bonds are "safe," he says. They are locked in. Disturbing the sediments won't cause the metals to be resuspended in the water, and lower animals' metabolic processes can't pull the metals out of the structural sites.

But the problem, especially in Mobile Bay, is that the clays in bottom muds gather up metals in other ways that allow release if sediments are stirred up.

There are iron and manganese oxide and hydroxide "scavengers" that pull metal ions out of solution only to release them if some disturbance alters the chemical balance. There are also what Isphording calls the real troublemakers, the organometallic chelated compounds adsorbed on the surface of clay mineral platelets.

A "chela" is a claw and that is just how the compound acts. It grabs the metal ion. The result is a ring structure, "a little bomb." If a disturbance brings the compound to the surface of the sediment and it meets the water, the bond is broken, the metal is released, the "bomb" goes off.

Tom Weaver (right), captain of the research vessel Amity, explains computerized navigational equipment to University of South Alabama students Jon Summer and Brian Dunnihoo.

Analysis of 65 sediment cores from Mobile Bay and 119 cores from Mississippi Sound and Lake Borgne confirmed that Mobile Bay sediments are heavily polluted in comparison with the other areas studied.

To determine how much is available for release back into the water, Isphording used a process that strips metals from particular sites in a series of steps.

He checked Mobile Bay sediments for copper, zinc, iron, chromium, nickel, barium and manganese. All except nickel had more than half their total content in easily releasable forms.

Using oysters supplied by Chris Nelson of Bon Secour Fisheries and Ken Marion and Robert Settine, investigators involved in another Sea Grant project at the University of Alabama in Birmingham, Isphording found that significant levels of those "available" heavy metals were finding their way into the tissues of lower life forms. "How?" was his next question.

Field data showed that metal levels in the waters of Mobile Bay were no higher than and sometimes lower than those of the other estuaries in the study.

"Because oysters are sedentary filter feeders, it seemed likely that metals are in some way being extracted from either the substrate or from fine particulate material that is kept in constant suspension in the water column above the sediments."

Submicroscopic organic and inorganic particles form the hydrosol — a murky, milky zone from one to several feet thick above bottom sediments, and preliminary tests reveal even greater percentages of metals in those particles than in underlying sediments.

Isphording is convinced that the submicroscopic particles hold the key to how metal pollutants are actually transferred to oyster tissue.

He plans to delve into that possibility in future research. In the meantime, his mapping of physical and chemical properties of estuarine waters and sediments has led to his participation in a cooperative Sea Grant-U. S. Army Corps of Engineers project. Isphording and Dr. Don Raney and Dr. John Youngblood, investigators on a Sea Grant project at the University of Alabama, are working on an assessment of Apalachicola Bay, Florida.

Ninety sediment cores and 180 water samples are providing initial data for the project. He will also be mapping changes in the bay bottom in the past 30 years by comparing present characteristics with maps and data dating from the mid-1800's.

"Cross section maps show numerous passes have opened and closed," Isphording says. "The shoreline has changed dramatically. It is quite dynamic."

Creative packaging breaks language barrier

Compiling technical data into some form that can be understood and used by people who are not trained chemists has been a stretching experience for Thomas and Julia Lytle.

Julia Lytle is head of the Gulf Coast Research Laboratory's environmental chemistry section and Thomas Lytle is head of the analytical chemistry section. Their work as scientists had always focused on research, not the public.

"But Sea Grant continuously emphasized that the research should benefit the public. They asked us at every stage of our work to specify how we could help people and their government planners. Before we generated any information, we identified who would use that information.

"Scientists are not trained that way. They are trained to speak the scientific language only."

But the Lytles began experimenting with graphs, charts and tables that would condense raw data into understandable doses. They came up with depth profiles and the "Environmental Stress Index," trying them out on anyone who ventured into the laboratory.

"Every year we receive calls asking for help on science fair projects. Since we have been working on the depth profiles, if a student and his mother come in, we show him a depth profile and see if he can understand it. Then we try it out on his mother."

Biologists from the Corps of Engineers, representatives of Mississippi's Bureau of Marine Resources, other scientists — no one is immune. The result is an easy to use format for environmental data that has individuals, local governments, regulatory agencies, small businesses and industries using research results from the study.

Scientists involved in estuarine studies in other areas of the United States and abroad are also interested in the Mississippi chemists' approach.

"This study was not designed to attack anyone. We just wanted facts. We wanted to know what pollution really exists and to provide information so people could answer questions themselves."

Their success in doing that has been recognized by the Mississippi Wildlife Federation. The federation named the Lytles Air and Water Conservationists of the Year for 1983.

"We appreciate that, and we hope that we are beginning to see a change in attitude about scientific information. It doesn't have to be a language spoken only by scientists in a particular field. Scientists can communicate with lay people — not just other scientists."

Ancient sediments supply clues to modern puzzles

Unlike Isphording and the Lytles, geologists Dr. William R. Reynolds of the University of Mississippi and Dr. Scott Brande of the University of Alabama in Birmingham have investigated natural processes that have been at work for thousands of years in the sediments of Mississippi and Alabama estuaries.

The reason is simple, according to Brande.

"If you go against the natural pattern, you have problems."

Selecting disposal sites where dredged material will stay put is a good example, he says. It is far better to choose an area that has had a high rate of sediment accumulation for thousands of years than an area that has been continually scoured clean through the years. The area with the high rate of accumulation would be the more stable site.

Although both Reynolds and Brande are fitting pieces into the puzzle of past estuarine sedimentation patterns, their procedure for coming up with the right pieces is different.

In the last phase of a four-year study, Reynolds and his graduate and undergraduate assistants have examined 39 sediment cores to outline changes that the past 5,500 years have brought to the Mississippi Sound.

Sediment analyses have determined the full spectrum of grain-sizes for the sands, silts and clays of each sample. Analysis of the combined data show that half of all the cases fit known statistical patterns for depositional environments of marine sediments.

From those patterns the geologist has classified sediments from beach dune ridges, wave zones, front and back shore areas of barrier islands, channels and mud beaches. He has partially reconstructed the lithofacies — the patterns of sediment deposits.

At three to four thousand years ago, for example, a sandy beach in front of what is now Gulfport and St. Louis Bay was being replaced by a lagoonal mud bank. An extensive beach system had developed in front of Biloxi Bay and extended eastward beyond Pascagoula.

Two thousand years later, the sands pouring out of the Biloxi Bay system had accumulated into a massive beach that eventually merged with sands moving eastward toward the Gulf. The result was a barrier system that almost completely enclosed the Sound.

A dozen centuries later natural forces of wind and wave had destroyed the barrier system, leaving the remnant barrier islands that are found today off the Mississippi and Alabama coasts.

The degree of change experienced by different areas varies. Sediment samples taken north of Horn Island, for example, contain beach

ridge sands up to the top levels. That area was never under water until most recent times, Reynolds says.

In contrast, sediments taken from a site northwest of Dauphin Island record frequent change. At the earliest levels examined, the site contains nearshore sand. Later levels show distributory sand and distributory silty sand. Distributory sands are usually associated with the mouths of rivers. But these sands, Reynolds says, were probably deposited in response to an east/west channel that operated much like a river in the central Sound. Still later levels show estuarine silt and nearshore sandy silt.

Brande's search for similar changes recorded in Mobile Bay sediments began with a seismic survey designed to help site vibracoring stations for other Sea Grant studies.

Mississippi Sound, Mobile Bay and selected shallow water areas of the Gulf of Mexico offshore of Alabama's Fort Morgan penninsula were surveyed using seismic reflection profiling techniques that send sound waves through sediments. Once received and recorded, variations in the returning acoustic signal reveal the arrangement and character of sediment layers.

The seismic survey in Mobile Bay recorded ancient buried oyster reefs and river channels, evidence of erosion during an age when Mobile Bay was above sea level, inclined bedding near barrier islands and distinct layers of sediment deposits.

Brande's research has provided the first survey of Mobile Bay that is available to the public and that has wide geographical coverage of the bay's relatively recent geological history.

His work has shown that natural delivery of sediments from the Mobile River system to the bay continues although channelization and associated maintenance dredging appears to have altered patterns of natural sedimentation across large areas of the bay bottom.

His research has also moved several steps closer to explaining an unusual feature, labeled "Horizon A," that shows up on the seismic record. Covering a wide area in the central portion of Mobile Bay, Horizon A masks underlying geologic structures, Brande says. It lies below the sediment-water interface and seems to absorb the seismic signal. Little of the acoustic energy penetrates below or returns to the surface through Horizon A.

Proximity to the main channel and disposal sites for dredged material suggested the likelihood of drifting dredged material as an explanation for the puzzling feature.

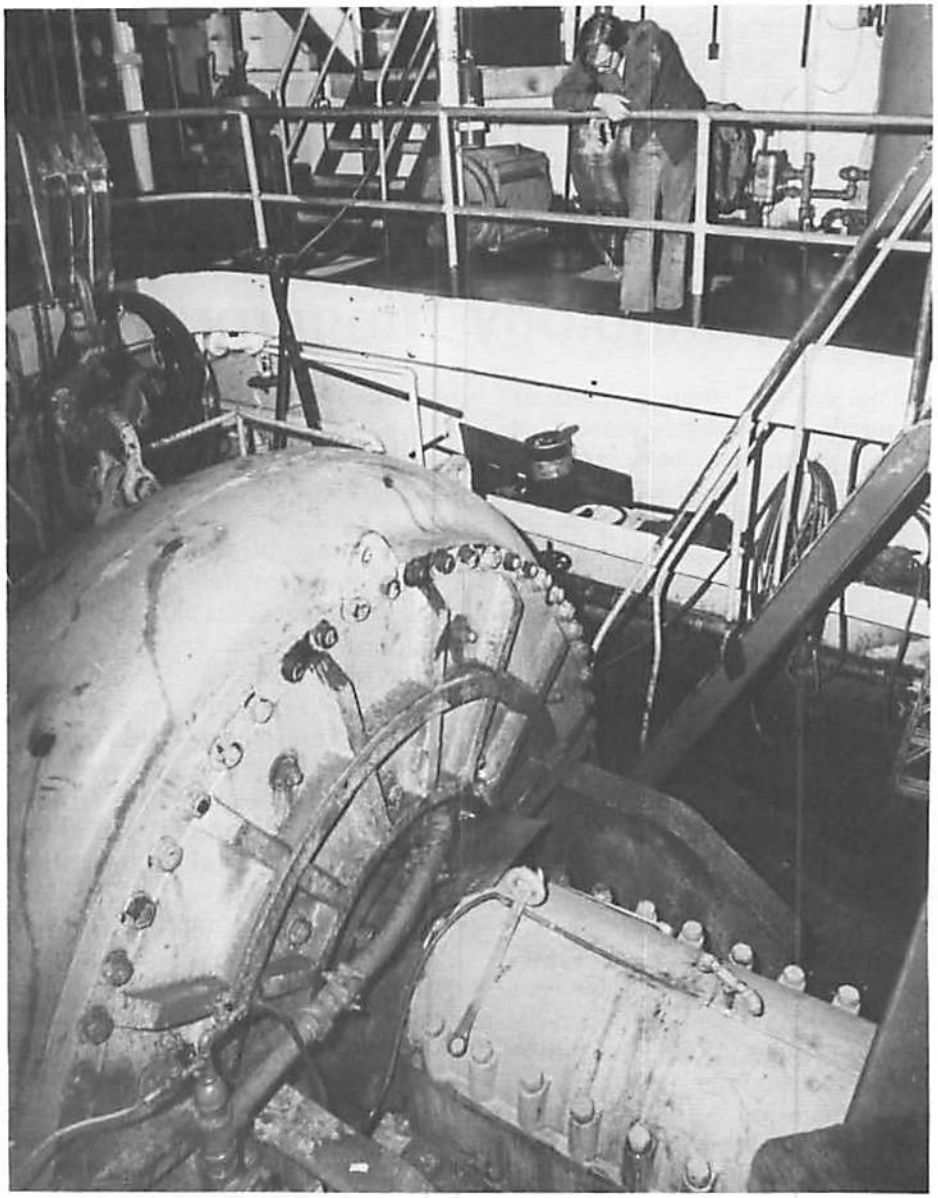
Analysis of 21 sediment cores helped correlate the seismic record with actual sediments, but the cores offered no clear evidence that redeposited dredged material was the answer to Horizon A.

"After examining the cores, I think it is probably due to gas bubbles in the sediment," Brande says. When he and his assistants opened the cores, they noticed a foul-smelling gas would sometimes bubble to the surface.

"Decaying organic matter would produce such gases as methane and hydrogen sulfide, the latter exhibiting a characteristically foul odor."

Other possible sources of the gas, he says, could be upward diffusion of gases from sediments below, trapped atmospheric gases and gas produced by geothermal processes.

Brande points out that the presence of shallow gas weakens



This powerful, high volume pump forces a slurry of mud and water through a temporary pipeline to a disposal area for dredged material. Sea Grant is helping answer questions about dredging and disposal alternatives.

sediments and could require extra safety precautions to secure structures such as oil rigs that might be sited in the area in the future.

"This consideration may be particularly important for Mobile Bay and Mississippi Sound due to the tremendous increase in recent drilling activity which will probably continue in the near future."

Seeking an instrument that would measure gas in the sediment as each core was opened, he found none that fit the need and budget of the project. Through the cooperation of Sea Grant and the UAB physics department, Brande set out to develop an acoustic velocimeter with the help of a physics graduate student and an electronics technician.

Brande wanted the device to provide needed data on gas in the sediments, but he also wanted something portable that he could take on a boat with him and plug into a microcomputer to record data.

Ready too late for use with cores on this project, it has been used successfully in the field by a Canadian scientist studying deep sea sediments of the Arctic Ocean.

"If you can imagine it, you can do it," Brande says of the invention.

That has been a valuable lesson for the students working with him. In fact, the entire project has had an impact in training future marine geologists, he says.

"The UAB geology department has no graduate program, and this project has offered an opportunity for undergraduate geology majors to participate in ongoing research.

"There are not many institutions where undergraduates can get a piece of the action — real research. One of our students that worked on the project is now a graduate student in marine sciences at the Marine Sciences Research Center at Stony Brook, New York.

"Others are still undergraduate students in the program here. They have all gone out on the boat, helped operate the coring equipment, opened the cores in the laboratory and been involved in core analysis. That is an important part of the program."

Although Brande has completed his Sea Grant investigation, the sediment cores still hold a storehouse of information. He continues to tap that storehouse.

He has students looking at micro-fossils from the cores — the foraminifera and ostracodes that will help establish a history of Mobile Bay's salinity. He also wants to learn more about the clean beach sands that showed up under 15 feet of mud in cores taken off the western shore.

He plans eventually to consolidate such data and see how it all fits in with the most drastic change in Mobile Bay's recent geologic past, the emptying and refilling of the bay during the Ice Age.

"It is important," he says. "It is part of the natural pattern."

New technology 'fingerprints' organic pollutants

The day is coming when an "oyster alert" could give notice that organic pollutants have reached dangerous levels in Mobile Bay.

Dr. Robert L. Settine and Dr. Ken R. Marion, scientists at the University of Alabama at Birmingham, are using oysters to monitor organic pollutant levels in Mobile Bay. Marion is a biologist and Settine a chemist and director of the University's Gas Chromatography/Mass Spectrometry Center (GC/MS Center).

Settine and Marion's Sea Grant project has already proved that combining oysters and state-of-the-art analytical techniques is an effective way to monitor organic pollutants.

To reach that conclusion, they had to overcome a major hurdle — finding a method for separating pollutants from lipids, fats that collect the pollutants in oyster tissue. Any technique used had to extract even minute traces of contaminants from oyster tissue and had to be compatable with procedures for analysis by gas chromatography/mass spectrometry.

Gas chromatography is a means of separating organic mixtures into single components. Mass spectrometry fragments components to give a distinctive "fingerprint" of individual molecules. Those molecules can then be identified by comparing their fragmentation patterns with a computer library of known fragmentation patterns.

Settine and his team at the GC/MS Center began experimenting with "clean up" procedures to prepare oyster samples for GC/MS analysis. They worked out a procedure using gel permeation chromatography.

"The chromatography method separates molecules on the basis of size. It separates the bigger lipid molecules from the smaller pollutant molecules," Settine says. "The per cent recovery of contaminants using these methods in our laboratory has been excellent.

"Prior to this project, no one had been monitoring organic pollutants. The state monitors fecal coliform levels and work has been done with heavy metals. Now Sea Grant has helped us to do the fundamental research necessary to come up with a good analytical method for separating pollutants from lipids."

"Settine is on the cutting edge in the field of gas chromatography," Marion says.

There have been earlier investigations of organic pollutants in the Bay, but today's sophisticated techniques and equipment just didn't exist. Armed with the new extraction procedure and the most up-to-date computerized equipment available, Settine and Marion set out to discover what information Mobile Bay oysters could supply on contaminants.

In the first three years of the four year project, the scientists have accumulated valuable baseline data on what kinds and how much organic pollution exists in the Bay right now.

Broad patterns have also started showing up, particularly differences between seasons and sites. The oysters are proving excellent indicators of local pollution conditions, the scientists note.

The wide range of contaminants identified include compounds classified as priority pollutants by the Environmental Protection Agency.

"Right now they are a cause for concern but not anxiety. They just need watching," Settine says.

Settine is keeping a close watch on phenanthrene and other polynuclear hydrocarbons, compounds that can be carcinogenic in high concentrations.

"There are unusual levels of phenanthrene and other types of ring compounds." Settine says. "Concentrations of phenanthrene have varied from 8 parts per billion in 1981 to 300 parts per billion in 1982."

Another puzzle is the level of compounds that result from the breakdown of DDT.

"They were quite high for some sites in 1981, and we don't know why."

Marion's investigation from the biological angle supports Settine's findings on overall organic pollution. Research results published earlier by a number of scientists show that oysters in polluted areas will have reduced levels of fat. The size of the oyster will also be small in comparison to its shell size.

"Organic pollution can cause tissue damage and the oyster's fat stores are used for repair," Marion says. "The oysters we have checked vary seasonally. They are naturally fatter in winter than after they spawn, but in the last two years we haven't been picking up any real tendencies that indicate strong effects of organic pollution. There has been no real drop in lipid levels.

"We don't have a clean bill of health, but we haven't reached the point in Mobile Bay where the animals are being severely affected. That is encouraging anyway."

Marion points out that oysters studied have come from the lower part of the Bay. In the project's final year, investigation will be expanded into the upper Mobile Bay area closer to industrial sources. The investigators will be using a small clam, *Rangia cuneata*, as the biological indicator in brackish waters.

"There is no monitoring program on a regular basis in the Gulf," Settine says. "This project has proven that organic pollutants can be monitored very efficiently by this method.

"Sea Grant has funded the initial research; we hope to find some other agency to fund an ongoing monitoring program."

The time is right. A surge in industrial growth and increased barge traffic is expected once the Tennessee-Tombigbee Waterway opens. Increased activity in Mobile Bay by the oil and gas industry is anticipated. The Theodore Ship Channel area is already experiencing industrial expansion.

"It needs to be done," Settine says. "Somebody needs to keep an eye on the Bay."

Pinpointing sources of fecal pollution

University of Southern Mississippi scientists Dr. R. D. Ellender and Dr. Fred Howell have pooled their skills on a Sea Grant project to fingerprint a bacterium with a bad reputation.

Ellender is a microbiologist. Howell is an entomologist with "an incredible understanding of the relationship between biology and statistics," Ellender says.

The bacterium, *Escherichia coli*, is the standard indicator organism for fecal pollution and is found in the intestinal tract of warm-blooded

Lab technician Evelyn Deich executes one step in a new procedure that makes an "oysterwatch" program feasible for Mobile Bay.

animals. Pili — filament-like appendages on the bacterium's surface, may hold the secret to a biological fingerprint that can quickly and inexpensively identify the animal source of fecal pollution.

Current tests based on *E. coli* provide information on where fecal pollution occurs and the level of pollution. That is not enough, according to Ellender.

"Scientists have been looking at bacteria in water since the 1880's. But as time goes on, people are going to be reusing water more and more. We need to reevaluate some of our standard procedures. We would like to have procedures that are more specific and that will tell us what is going on in the environment."

For *E. coli*, that means being able to determine the animal of origin.

"If tests could show, for example, that *E. coli* in the area of a condemned oyster reef are coming from surface runoff and animals in the area, then guidelines for oysters in that particular area could be lowered. If oysters were found safe for human consumption, the reef could be reopened.

"If you can tell that the *E. coli* is from human wastes, then you know there is a potential problem with human viruses and other pathogenic organisms."

The pili research is a beginning. The investigators are using electrophoresis to detect patterns in the pili proteins of *E. coli* from specific animal sources.

"Electrophoresis separates particles using an electric charge. Some proteins are negative, some positive. When you put them into an electric field, they separate according to the amount of charge on them. You can tell how many different proteins are there, basically what their molecular weight is and how they fall in relation to the protein of other pili."

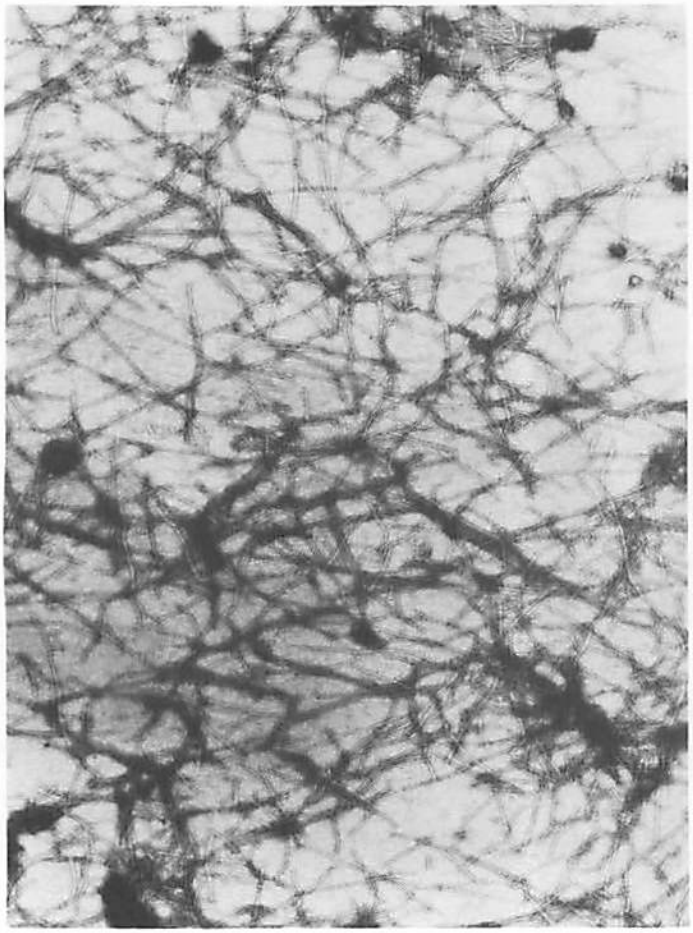
But the research team found out in the first few months that it takes an abundance of *E. coli* to harvest enough pili for testing. Pili are hollow protein tubes about 5 to 10 nanometers in diameter. That is one-billionth of a meter. Ordinary procedures and standard petri dishes were not going to turn out the volume needed.

Ellender solved the problem with a foray into the kitchen section of a local department store. He purchased 40 stainless steel cookie sheets. One isolate reproducing on 10 cookie sheets produces a good handful of *E. coli*.

Once the bacteria are scraped off the growing medium, a session in the blender breaks off the pili, centrifugation separates bacteria and pili, then application of other techniques concentrates, purifies and digests pili proteins.

The time-consuming process limits preparation to two to four bacteria a week, Ellender says. With bacteria from 7 human beings, 2 cows, 4 horses, 2 dogs, 3 cats and 17 other assorted animals and environmental locations, time became a definite factor.

That prompted the research team to try an additional approach. One function of pili is to attach the



Graduate research assistant Cindy Shows (above) prepares to harvest a crop of Escherichia coli bacteria for the pili, filament-like appendages on the bacterium's surface. Pili (left) may hold the key to identifying specific sources of fecal pollutants.

bacteria to surfaces. In hemagglutination experiments, the investigators mixed specific isolates with five different types of blood to see if bacteria from different species animals linked the blood cells in distinctive patterns.

"The first pass through looked promising," Howell says. "But as we increased our sample sizes, we began to see more and more overlap among the patterns. The problem was that bacteria from a human and bacteria from a dog, for example, might show similar patterns at one time and not at another time."

Ellender is now in the process of preparing data from the electrophoresis study for Howell's statistical analysis. Data already point to the need for exploring more complex methods of analysis, Howell says. Ellender concurs.

"This project does raise the question about whether we can go straight from the environment to a simple technique," Ellender says. "It may take something more involved, but it can be done." Identification of fecal pollution sources will be an established technique in the future, he says.

"If we are to control fecal pollution, eventually we are going to have to pinpoint even the house and remedy the situation. We are not giving up on this research. It is too important a problem.

"My concern is being able to say, 'Here is the source of your problem.' If we can say that, it would revolutionize water pollution microbiology."

For the record

Dr. Scott Brande, University of Alabama in Birmingham. "Dredge Spoil Mapping by Seismic Survey and Sediment Analysis in Mobile Bay, Alabama." Cooperating agency: U. S. Geological Survey, Corpus Christi, Texas. Dr. Charles Holmes. R/ER-6

Dr. R. D. Ellender, University of Southern Mississippi. "Characterization of Fecal Coliform Isolates by Electrophoretic Analysis of *pili*." R/ER-12

Dr. Wayne C. Isphording, University of South Alabama. "Sedimentation, Dispersal and Partitioning of Trace Metals in Coastal Alabama-Mississippi Estuarine Sediments." R/ER-4

Dr. Thomas F. Lytle and *Dr. Julia S. Lytle*, Gulf Coast Research Laboratory. "Pollutant Transport in Mississippi Sound." R/ER-2

Dr. Frederick H. Manley, Dr. William R. Reynolds, Dr. Albert C. Staheli and *Dr. Ray L. Frederking*, University of Mississippi. "Modern and Ancient Sedimentary Process and Response Within the Mississippi-Alabama Linear-Barrier-Coastal System." R/ER-1

Dr. Ken R. Marion and Dr. Robert L. Settine, University of Alabama in Birmingham. "Organic Pollutant Levels in Bivalves of Mobile Bay." R/ER-8

Vibracores of Mississippi Sound and Mobile Bay sediments have helped Sea Grant researchers determine the effects of man and nature on estuarine systems.

Computers In Science

Predicting the future with mathematical models

How fast will a dredged ship channel in Mississippi Sound fill in again? Where should a new oyster reef be planted — on the east or west side of the channel?

One way to answer such questions about how a natural system works is to build an actual, scaled down model of the system. But to build and operate a scale model of Mississippi Sound or Mobile Bay out of bricks and mortar — one that could accurately depict salinity movement, sediment transport and other complex phenomena — would cost millions of dollars and a substantial amount of time. It may take years to build the model and many more years to test and analyze the data collected.

In these days of soaring costs, decreasing availability of research dollars and the pressing need for reliable answers on short notice, the scaled down physical model is often too expensive in both dollars and time.

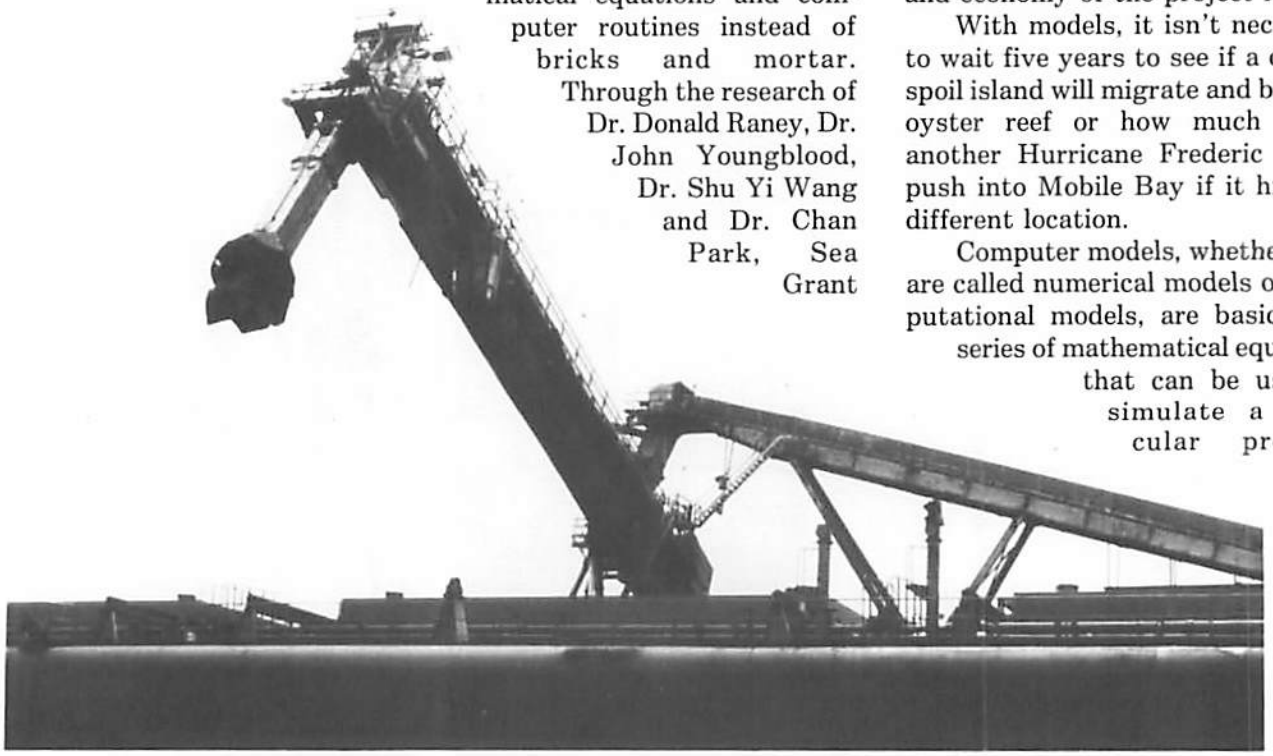
The age of large, fast computers has met that need with a new kind of model, one made of mathematical equations and computer routines instead of bricks and mortar. Through the research of Dr. Donald Raney, Dr. John Youngblood, Dr. Shu Yi Wang and Dr. Chan Park, Sea Grant is building computer models to simulate such things as hydrodynamics, the movement of sediments and the operation of a ship port.

University of Alabama engineers Raney and Youngblood are working on hydrodynamic and water quality models for Mississippi Sound, Mobile Bay and Apalachicola Bay. Wang, a researcher and professor at the University of Mississippi, is building computer models to explain sediment movement in the Sound in response to natural and manmade forces. At Auburn University Park is designing a simulation model of a commercial seaport.

The researchers emphasize that the new computer era makes mathematical models an economical tool for planning and engineering design. People responsible for making decisions on dredging, disposal of dredged material and development can examine short- and long-term effects of proposed projects during the planning stages. Those effects can include both changes in the environment and the stability, safety, and economy of the project itself.

With models, it isn't necessary to wait five years to see if a dredge spoil island will migrate and bury an oyster reef or how much water another Hurricane Frederic would push into Mobile Bay if it hit at a different location.

Computer models, whether they are called numerical models or computational models, are basically a series of mathematical equations that can be used to simulate a particular process.



A ship loader at McDuffie Export Coal Terminals at the Port of Mobile.

Although both Raney and Wang start with the same basic equations, each uses a different mathematical approach for solving the problem.

Raney's finite difference model breaks the study area into small rectangular elements or cells to simulate what is happening at a specific time. Wang uses a finite element model based on irregularly sized elements such as triangles and quadrilaterals.

Although it might sound simple, for a two-dimensional problem, each element requires at least three equations to define the flow at a given point. That means a particular model might require solution of more than 6,000 non-linear simulateous equations. Those who have encountered the difficulties in solving three simultaneous equations in algebra have an idea of the magnitude of the task.

Raney and Youngblood's hydrodynamic models show changes in water elevation, direction and speed in response to specific variations in tide, wind, river flow and land boundary conditions. Water quality models predict how those conditions affect salinity or other water characteristics over one or more tidal cycles.

The investigators have used the hydrodynamic models to explain the exchange of water between Mobile Bay and the Gulf of Mexico, between Mississippi Sound and the Gulf of Mexico, and between Mobile Bay and Mississippi Sound, complex systems involving a limited number of narrow barrier island passes.

A major application of the project has been to help local planners and the U. S. Army Corps of Engineers with alternatives on the disposal of dredged material. Ship channels along the Gulf Coast require frequent dredging to keep them navigable, and Raney and Youngblood are now developing fine detailed hydrodynamic models for Biloxi Bay and ship channel and Gulfport Harbor and ship channel.

The cooperative arrangement with the Corps has also solved another major problem facing those who work with models of natural systems — making sure that the model does, in fact, predict what happens.

That process, called calibration and verification, requires accurate data and is usually one of the most difficult and expensive parts of a modeling project.

"The Corps spent a lot of money getting extensive prototype data in Mississippi Sound," Raney says. "We now have enough data to calibrate and verify the model to a much greater degree than usual. Confidence in its predictive ability should be high."

In other practical applications, the investigators have examined the effect of an existing railroad line on flooding problems in the Bayou Sara area of the Mobile Bay flood plain. Residents were concerned that a railroad line in the area was contributing to local flooding. Developing and applying a model of the area, the investigators found that the railroad's effect on flooding was small.

They have also examined the possible effects that a proposed breakwater for Apalachicola, Florida, would have on the environment. The breakwater, along with relocation of a navigation channel, was requested by the local fishing fleet to provide protection from storm waves. Raney and Youngblood were able to show that environmental changes due to the breakwater would be negligible.

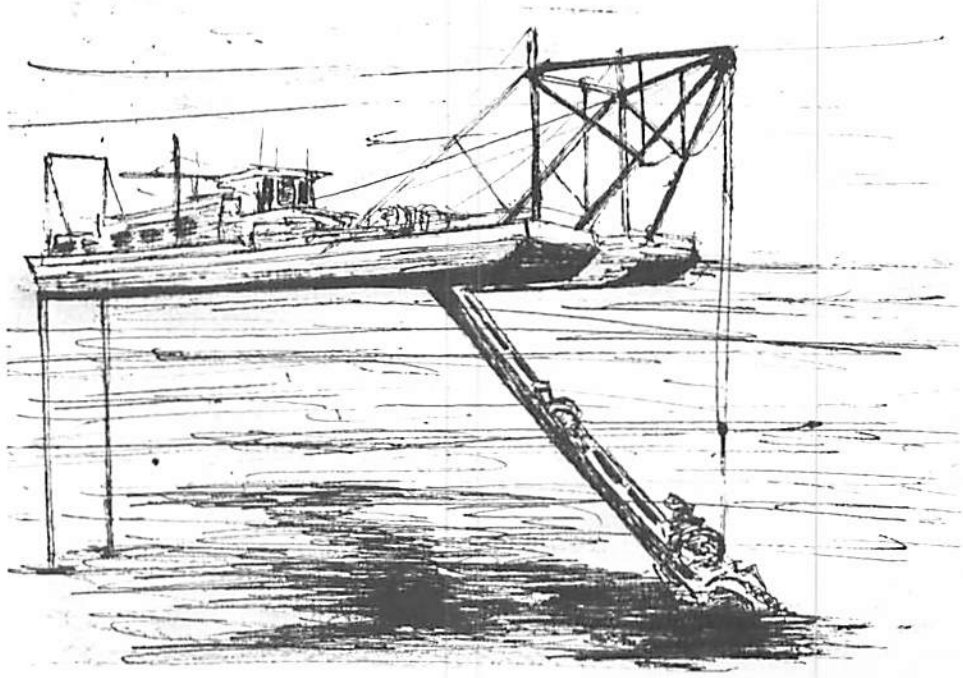
Still in the fundamental stages of his research, Wang has recently completed an overview of the state-of-the-art numerical modeling of sedimentation processes. His effort should help prevent duplication of efforts and provide a base line for international research efforts. He has given presentations of his overview in China, Japan, West Germany and the United States.

Before starting his project with Sea Grant in mid-1982, Wang developed simulation models of sedimentation movement for various processes occurring in the Mississippi River. Building on these computer subroutines, he has successfully applied finite element modeling to several basic cases of sediment movement for Mississippi Sound:

— The back-filling of a dredged trench — The model will help explain just how a dredged channel will fill in again under varying conditions of current, sediment type and channel depth;

— The local scour and deposition of sand-bed materials near a spur-dike system — The model shows how sediments move around a structure such as a pier or groin, that sticks out into the current perpendicular to the shore; and

— Sediment movement in an alluvial channel.



Hydraulic dredge.

Although these models are theoretical so far, they are a necessary step before proceeding to practical applications.

"An important milestone for this work," Wang says, "was the verification of the back-filling of a dredged trench model by physical data provided by the prestigious Delft Hydraulics Laboratory in the Netherlands."

Wang says that Delft's confirmation gives added confidence that the finite element model can be successfully used in simulating sediment transport phenomena in the Mississippi Sound.

Whether in the Sound, Mobile Bay or elsewhere, mathematical modeling is proving to be a valuable tool in understanding the behavior of natural systems that can influence marine life cycles, water quality conditions or sediment movement.

Model simulates commercial port operation

Dr. Chan Park is building a different type of computer model — one designed to simulate the operations and economics of a large commercial port.

In 1976, the inland waterborne commodity receipts for 17 mid-America states equaled 443 million tons. Estimates are that by the year 2000, the tonnage will increase to 900 million tons. The 1979 oceanborne foreign trade was over 900 million tons and predictions are that it will also increase proportionately. The U. S. Army Corps of Engineers estimates that the Tennessee-Tombigbee will be opened for traffic by 1985, substantially increasing the load on Gulf Coast ports.

Large capital investments in ports and port facilities will be required to accommodate these major increases in waterborne commerce. It is essential that a port determines as early as possible the right level of capacity it requires. It is critical to know how much to invest in port capacity, not only to avoid congestion and its large expense, but because port investment involves lengthy planning delays due to government regulations. In addition, large dollar outlays are required and there is a long lag-time before completion of improvements.

Park, in examining past work on port operations and expansion, found that earlier researchers had no commonly accepted method of appraising proposals for investment in port facilities. This educated guesswork led to under-investment, over-investment, or misplaced and mistimed investment.

Early attempts helped fill the void and were useful to a certain extent. It was apparent, however, that most early port models are based on elaborate exercises in queing theory, techniques for scheduling dock space for unloading and loading. These early models were more concerned with minimizing costs rather than maximizing the profits of the port for a private port or the net social benefits for a public port.

The reluctance of many port planners to accept the shortcomings of these models has given rise to a different approach — the simulation model. A simulation model's purpose is to explain the changes in operations due to modifications in the ports' physical facilities and to estimate as accurately as possible the impact on port systems from different alternatives for investment strategies. The main idea is to simulate the whole system in a computer using data actually collected from the operational statistics of a particular port.

"The nature of the problems involved makes solution by traditional analytical techniques difficult," Park says. "But they are rather ideally suited to solution by computer simulation."

"The purpose of this project is to develop a user-oriented, predictive simulation model for port expansion." The model will include the physical impacts associated with port expansion, such as manpower and facility requirements; trade-offs involved in the type of resources selected; and loading/unloading times for each carrier type in terms of available resources. The economic impacts associated with port expansion will include investment required and its timing, operating and maintenance costs, expected revenues and savings due to port improvements.

"Although the model being developed is a general model, the Port of Mobile will be used as a source for verifying the various model assumptions," Park says.

In cooperation with the Alabama Sea Grant Advisory Service, Park is working with Mobile port authorities to assure that the model produced will be a useful, practical tool. He has developed the computer program using SLAM (Fortran Based Simulation Language). The most advanced simulation language available on the market, SLAM combines GASP and Q-GERT computer languages. Actual programming work is virtually complete, and Park has given the model a trial run with hypothetical data.

Next year should see the model tested with real data. The model will then be validated by using data from a port that has already undergone expansion. Future tasks also include economic impact analysis associated with port expansion, the development of model documentation and, perhaps the most important part, training the users on how best to use the model effectively.

Modeling, assessment expands to Apalachicola

Dr. Donald Raney and Dr. John Youngblood of the University of Alabama were looking for support to extend their computer modeling efforts from Mobile Bay and Mississippi Sound into Apalachicola Bay when they discovered that the U. S. Army Corps of Engineers was looking for someone to develop a model of that same area.

The outcome was a cooperative Apalachicola Bay project with Raney and Youngblood doing hydrodynamic and water quality modeling. Dr. Wayne Isphording of the University of South Alabama, an investigator in another Sea Grant project, is handling sediment characterization and bathymetric studies. The Consortium's cooperative sampling program is responsible for the field work — collecting sediment samples, bathymetry, delineating oyster reefs and supplying the prototype current, tide, meteorological and other data necessary for the modeling.

Starting in late 1983, the project so far has collected current meter data from nine locations in the Bay simultaneously over a 30 day period, completed more than 400 line miles of bathymetric survey, collected 90 vibracores distributed over the Bay and collected other measurements and data in support of the mission.

"A project of this magnitude requiring this much data collection was not possible for Sea Grant at this time. It was simply too expensive," says Consortium Program Manager Max Flandorfer. "When the Corps offered to fund a substantial portion of this project, we jumped at the chance."

"There is a real scarcity of hard data available on the Bay," says Raney. "When we were asked to do a modeling study of the possible effects of a proposed breakwater in Apalachicola Bay, we found we had very little to work with."

Further dredging to maintain the ship channel is imminent in the Bay and other projects are being proposed. "An area such as Apalachicola, dependent on the seafood industry and economically vulnerable to the possible disruption of that industry through ill-advised marine development, absolutely needs this type of study to avoid disaster," Raney says.

Another series of 30 day current meter measurements is planned for the spring of 1984. The collection effort will give prototype data for the high freshwater input of spring to supplement data on the low freshwater input period taken in the fall of 1983. Additional vibracores, bathymetry and water chemistry measurements will also be taken at the same time.

The proposed products of this project are computerized hydrodynamic and water quality models of the Bay, a characterization of Bay sediments, maps of past and present sedimentation patterns and the mapping of existing oyster reefs. This information should contribute to the preservation of a valuable economic asset.

Sea Grant sets up coastal information system

Since its beginning, Mississippi Alabama Sea Grant Consortium has funded numerous research and data collection efforts providing a broad range of useful and practical scientific information. Much of this information exists in published reports, but there has been no easily accessible system to which a potential user could refer to find out what information was available and where it could be obtained.

Dr. Eldon Blancher of the University of South Alabama is now in the process of developing a coastal information management system (CIMS) for the Consortium. Blancher explains that CIMS integrates management, bibliographic and basic scientific information into a single system using a microcomputer.

"The system consists of two distinct levels," Blancher says, "The first includes the data base programs, a general information file, a bibliographic file and a condensed data file with scientific and management information.

"The second level consists of a data base in a large mainframe computer which is accessed through the microcomputer system. This distributed data base design makes available a large variety of data in a single system that is relatively inexpensive to implement and operate.

"The system utilizes and is linked closely with the existing Marine Environmental Sciences Consortium scientific management system at Dauphin Island Sea Laboratory, Alabama. Accessible now to the Consortium management staff, the system and its entire data base will ultimately be accessible to all Sea Grant investigators, participating scientists, governmental agencies and any other interested parties," Blancher says.

Blancher was based at the Dauphin Island Sea Laboratory when he started this project in 1982 but moved to the University of South Alabama in early 1983. Data originally stored in the University of South Florida mainframe computer is now transferred into the University of South Alabama Statistical Analysis System (SAS) in Mobile.

In addition to entering Sea Grant and Marine Environmental Sciences Consortium data, Blancher is in the process of entering a substantial bibliographic reference into the system entitled Alabama Coastal Regional Ecological Characterization.

"This reference was compiled by the U. S. Department of the Interior and will be an important addition to our existing data base," he says.

"Data currently in level two consist of previous Sea Grant projects as well as other non-proprietary data from other agencies and organiztions. This data bank is continually updated as new data become available."

Blancher has made presentations on data management systems at the National Oceanographic Data Center (NODC) in Washington and at other national meetings. He is now looking at the possibility of linking the Consortium's system with NODC's Ocean Pollution Data Information Network (OPDIN). The linkage could increase the versatility of CIMS and make Gulf area data more widely available to researchers elsewhere.

"Next year," Blancher says, "should see continued imput of new data into the basic data sets and the completion of the general information, bibliographic and condensed data files."

"Mighty Mo," a Paceco container handling crane at the Port of Mobile, is capable of lifting more than 45 tons in one lift. Sea Grant studies coastal resources in the context of multiple uses ranging from fisheries and recreation to industry and transportation.

For the record

Dr. Eldon Carl Blancer II, University of South Alabama. "Development of a Coastal Information Management System for the Mississippi-Alabama Sea Grant Consortium." R/ER-10

Dr. C. S. Park, Auburn University. "Port Expansion Simulation Model." R/EN-3

Dr. Donald C. Raney and *Dr. John N. Youngblood,* University of Alabama. "Hydrodynamics of Mobile Bay and Mississippi Sound." R/EN-1

Dr. S. Y. Wang, University of Mississippi. "Finite Element Modeling of Sediment Transport in Mississippi Sound." R/EN-2

A look at what we have — for now and the future

Biologist Joanne Laroche prepares sampling gear.

They begin life offshore, beyond the barrier islands that ring the Mississippi Sound. Then, through a process that is still part mystery, the larvae of such species as croaker, menhaden, seatrout and drum move into the Sound to mature in nutrient rich estuarine waters.

Biologists Drs. Sally Richardson and Joanne Laroche of the Gulf Coast Research Laboratory (GCRL) have spent five years finding out just how important the Mississippi Sound is to commercial and sport fish species known to depend on estuarine environments during early life stages.

The project has furnished investigators with a number of surprises that have led to developments of local, regional and national import.

"To begin with, the densities of larval fishes in the Sound are even higher than we expected," Laroche says.

The sheer abundance was staggering. The sampling program netted 600,000 fish larvae in all.

"The project was designed to cover the entire Sound to find out where the larval fishes accumulate in the Sound, when they are there and how they are transported; so there was no part we could cut out," Laroche recalls. "We did cut down on tow times, but there still might be 10,000 or more fish larvae in a single sample."

A second surprise was the magnitude of "problem" groups that defied identification. One of the largest groups was the ground mullet, or southern kingfish, and its relatives the king whiting and the gulf kingfish. Scientists have identified the group as *Menticirrhus* since the early 1900's, but no one has ever been able to distinguish the larvae by species.

Laroche tackled the problem. Using a dissecting scope, she began to notice subtle differences in body shape and pigmentation that divided the *Menticirrhus* larvae into three types.

She worked individual specimens of the same type into a "developmental series" from the youngest stages through progressively older stages. For each group, the older stages finally "linked up" with a specimen that could be positively identified by counting rays and spines in the fins, a kind of fish "fingerprint."

To document the identification process for use by other scientists, Laroche is working on specific body measurements for 40 to 50 specimens of each species. But her discovery has already cleared up identification on more than 1,000 *Menticirrhus* larvae in the Sea Grant study.

White trout larvae presented similar puzzles. With thousands of specimens to identify, Laroche kept coming up with two distinct types.

"One appeared in April through June samples. The other was in July through October samples and was chunkier and more heavily pigmented," Laroche says. "Scientists at Lousiana State University and in Texas and Florida are seeing the same thing. We followed it as far as we could because it is important. If the two types are different subspecies, then all our data have implications for their management and fishing."

The study has also supplied physical data that documents patterns of water movement in the Sound. One such pattern is the exchange of water between the Sound and the Gulf of Mexico during flood tide and ebb tide.

In a study of larval transport through barrier island passes, the biologists had current meters set at surface, mid-depth and bottom locations in Dog Keys Pass. The meters measured current speed and direction every 15 minutes during three 36-hour sampling experiments. Data showed that at all three depths, water flows into the Sound for 5 to 7 hours longer than it flows out of the Sound.

"With that physical data, we have documented one major fact about why larvae are accumulating in the Sound. Something else is

going on, though, to keep them in the Sound and hold them in certain locations.

"We're hoping an oceanographic study on Mississippi Sound by the U. S. Army Corps of Engineers will give us some answers. We have been looking forward to seeing the results from that study, and now it is available," Laroche says. "Correlating data on currents, tides, eddies and other hydrographic characteristics with our data will give us a clearer picture about why larvae accumulate in the Sound in such abundance."

Development of computer programs for that analysis and the transfer of data to computer files is under way, Laroche says. The task of identifying the larvae taken in the extensive ichthyoplankton sampling program is also more than one-half complete.

The analysis should answer long-standing questions about specific aspects of the Sound's role as a fish nursery, she says.

A number of agencies have been in contact with the scientists about the larval fish study, but it has been the red drum data that has really set Laroche's phone to ringing.

"Controversy has been brewing in other states about who gets a share of the red drum resource and are purse seiners catching and draining a sport fishing resource," Laroche says. The scientists and resource managers who called all wanted to know where red drum spawn.

"We were getting 100 red drum larvae per 1,000 cubic meters at the offshore stations. That is greater than croaker and on a par with menhaden. The people who were calling were not catching nearly that many red drum larvae."

Laroche and Dr. John Steen, another GCRL marine biologist, teamed up on a Sea Grant study to find out where red drum spawn. They also wanted to find out how red drum survive the major threats to larvae — starvation and predation.

If they could answer those questions, a new tool would be available for predicting how many red drum in a particular year class could be available for sport and commercial fishermen.

The biologists started looking at the trophic (nutritional) relationships of red drum young: what prey is available, what the red drum choose to eat, what species are competing for the same prey, the condition of larvae as they grow, and environmental conditions.

Laroche and Steen set up an intensive sampling program designed to gather maximum information from a minimum of samples.

"We weren't looking for broadscale coverage in this study," Laroche says. "From the earlier Sea Grant study we knew where red drum larvae were located. We planned to begin sampling there. We wanted to stay with one batch of larvae to see what they were feeding on and how they were growing."

The biologists tested their sampling methods with good results during the fall of 1983. To stay with a group of fish within a water mass they used a window-shade drogue. Made of polyethylene plastic sheeting that the current could catch and move, the drogue trailed a small buoy and transmitter.

Another piece of equipment that supplied accurate and complete data is a modified electronic water quality sampling system hooked into shipboard computer. When the sampling nets are in use, the system reads and records precise time, depth of nets, temperature and salinity every 15 seconds.

To pull all the pieces of the survival puzzle together, the biologists are studying the daily growth rings found on calcareous concretions in the internal ear of fishes. When the tiny "rocks" or otoliths are ground down, they reveal growth rings similar to those in a tree. Scientists can determine age — to the day — of larvae and juvenile fishes caught in sampling.

"By being able to age them we will know how long they have been in the water. We are getting satellite information; and combining that with other information on water movement (speed and direction) that we have collected by using the drogue, we should be able to back up and estimate where the red drum spawn and factors affecting their condition.

"We will have the most refined estimates of where they are spawning. Whatever alternatives are chosen about how to use the resource, that kind of information is significant to management decisions."

Researchers stretch dollars for science

Do-it-yourself ingenuity and cooperation among agencies has state-of-the-art equipment supplying valuable data and stretching taxpayers dollars in the red drum study of Drs. Joanne Laroche and John Steen.

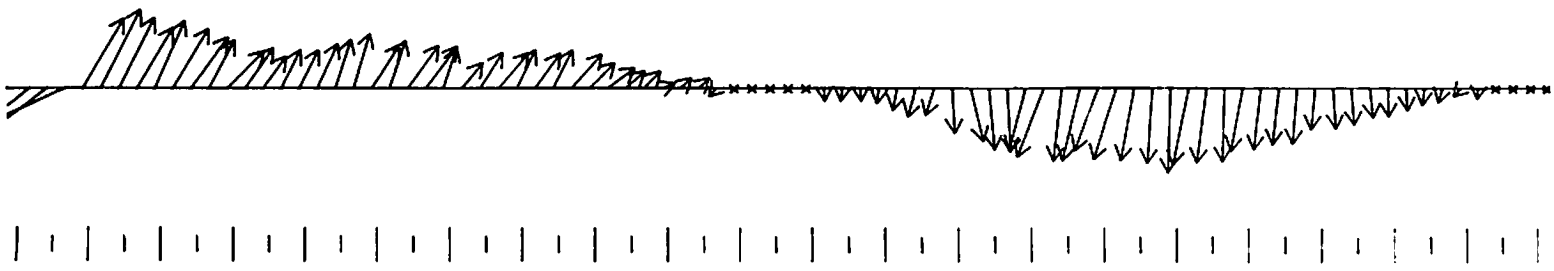
A key element to the success of the biologists' sampling effort is the ability to move with one water mass — and the same batch of larvae — through an entire day and night period.

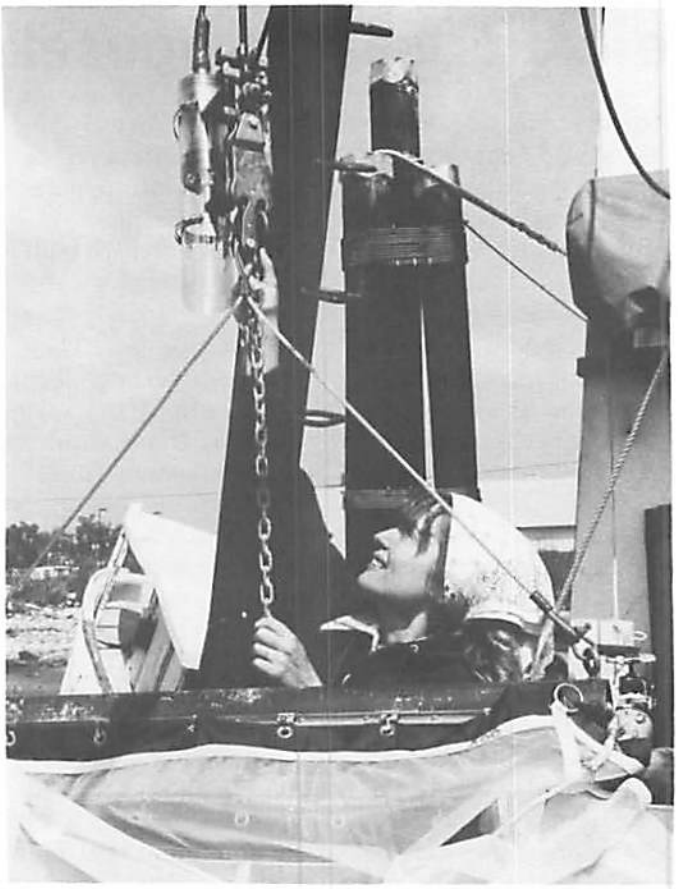
The equipment that makes that possible is a window-shade drogue, put together for less than $5.

"Scientists at the National Space Technology Laboratories told us about the drogue. It is so simple but so effective," Laroche says.

The research team attached a 3 meter by 4 meter sheet of plastic to two pieces of PVC (polyvinylchloride)

A current meter record of the direction and velocity of water flowing through Dog Keys Pass between Mississippi Sound and the Gulf of Mexico during a 36-hour larvae study.





Do-it-yourself projects are not limited to home improvements. Through the cooperation of Sea Grant, other marine agencies and Gulf Coast Research Laboratory personnel, an electronic water quality monitoring system (above) has been hooked up with plankton sampling nets (right) and a shipboard computer.

pipe and weighted the sheet at the bottom, Steen explains. A small buoy and radio transmitter already on hand at Gulf Coast Research Laboratory (GCRL) completed the equipment.

Steen says the drogue is easier to deploy and retrieve than more expensive systems designed for the same purpose. Once the whole thing is in the water, the current catches the drogue, and the research team tracks red drum larvae through intricacies of current and tide.

"Superb," says Steen.

But Larache and Steen are even prouder of another do-it-yourself project — an electronic water quality monitoring system that can be hooked up with ichthyoplankton and zooplankton sampling nets and shipboard computer.

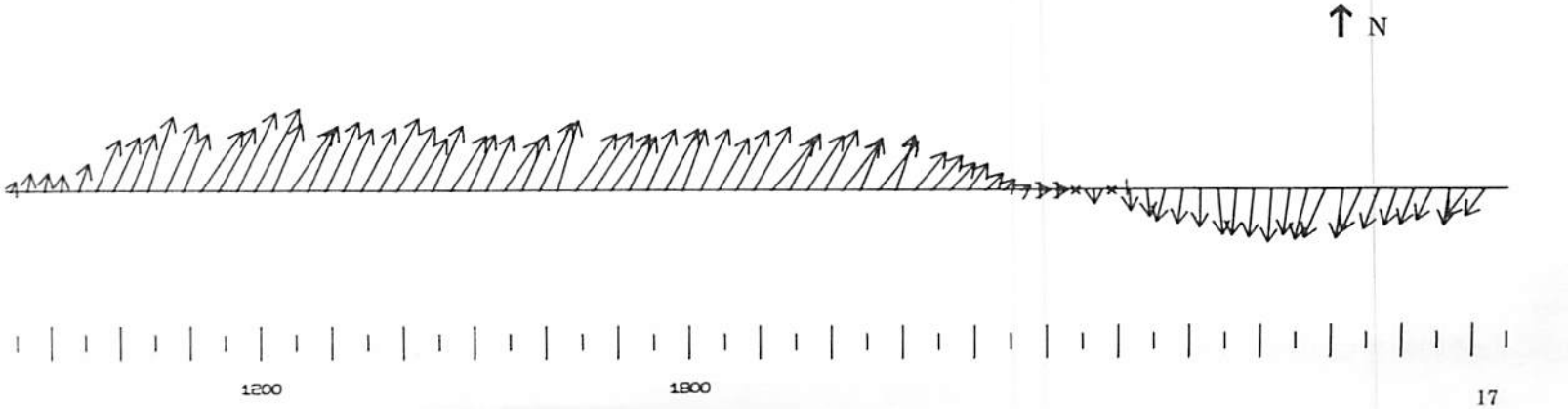
Whenever the sampling nets are in use, the monitoring system is reading salinity, temperature and depth every 15 seconds. The data is recorded on magnetic disks and provides a hard copy printout.

Similar systems in use elsewhere cost $40,000 to $50,000, far beyond the budget of the red drum study. Steen put together the system he and Laroche are using for less than $12,000, thanks to the cooperation and support of Sea Grant, GCRL, National Marine Fisheries Service and the Naval Oceanographic Office (NAVOCEAANO).

"It was really a cooperative effort," Steen says. "NAVOCEANO loaned us the electronic cables we needed to get the signal from the water quality monitor to our shipboard computer. NMFS, through Sea Grant, supplied funds for the sampling nets. Sea Grant supplied funds for equipment, and the lab (GCRL) provided in kind support."

That in kind support was crucial. GCRL personnel Dr. Terry McBee and Walt Brehm helped Steen modify the monitor and develop the computer programs that make the whole system work together.

"They did most of the computer work," Steen says. "I'm proud we were able to do this within our funding. The system just puts us into the twentieth century."



Stone crabs set up housekeeping in Mississippi

The stone crab *Menippe mercenaria* has set up housekeeping in Mississippi Sound in the past few years, and Sea Grant is funding research to find out why.

The answer is important to Mississippi and Alabama blue crab fishermen who may find a source of supplemental income in stone crabs. Seafood fanciers who like the sweet claw meat that makes the crabs famous are also interested in the answer.

Stone crabs first started showing up in large numbers in the crab pots of Mississippi Sound blue crab fishermen in 1979. Their numbers have been increasing ever since. And they have been appearing in Gulf of Mexico waters in Texas and Louisiana as well as Mississippi.

"We're not sure whether we are looking at a long term or a short term change yet. Their appearance may be associated with favorable conditions for two or three years or it may be an actual long term environmental change that has allowed them to establish and remain established," Harriet Perry says.

Perry and Kenneth Stuck, marine biologists at Gulf Coast Research Laboratory (GCRL), have been studying Mississippi Sound stone crabs for more than a year now. They have managed to stay clear of the controversy over whether the northern Gulf stone crabs are a subspecies of *Menippe mercenaria*. Their research has, however, started supplying key environmental data on the northern Gulf populations of *Menippe*.

Most crab fishermen here are concerned about the resource . . .They want the resource to be here in the future. --Harriet Perry

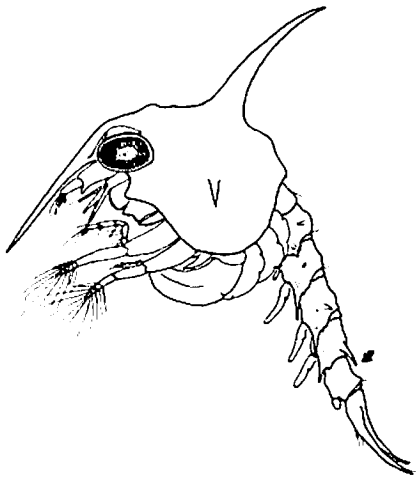
"The northern Gulf species is ecologically distinct from the Florida species. They have different ecological requirements," Perry says. "Being able to define those requirements is the most important thing."

Perry is looking at those requirements for adult stone crabs; Stuck is concentrating on larval and juvenile stages.

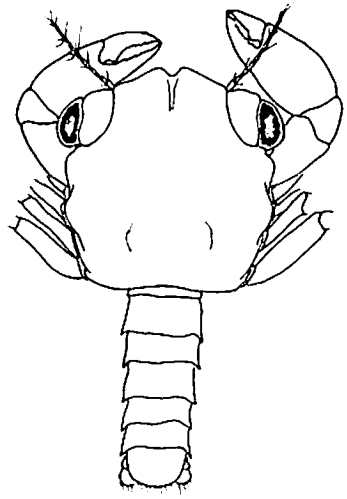
The study of adult crabs has taken Perry into the field to interview and work with commercial fishermen. She has recorded data on numbers, sex and size of stone crabs caught and date and location of capture.

She found that half of the total catch recorded showed up in July and August. Fishermen collected crabs from nine different general areas in the Mississippi Sound, and more than 63 per cent of the catch came from areas near the barrier islands of Petit Bois, Horn and Cat in the eastern, central and western portions of the Sound respectively.

Although Mississippi has no regulations governing harvest of stone crabs, Perry found that 50 per cent of the crushers (major claws) and 12.3 per cent of the pincers (minor claws) were of harvestable size according to Florida standards.



Fresh-from-the-egg stone crab (zoeal stage).



A later stage (megalops).

For 1984 Perry and Stuck have set up a collection program using 120 stone crab pots on loan from the Everglades National Park.

"We are getting different data this year," Perry says. "Our 1983 data was tied to the blue crab fishery. Based on what we have learned, this year we are doing our own sampling where we think the stone crabs are."

Once crabs are caught and their measurements recorded, they are tagged and released. The tagging operation should yield more specific information on the migratory habits of *Menippe* in the Sound, Perry says. The biologists have also planted artificial habitats — bags of oyster shells — throughout the Sound.

"They are working well," Stuck says. "The post larval stages settle out on something hard, and with the artificial habitats we can detect when that occurs. The way the habitats are distributed in the bays and offshore gives us an idea of salinity tolerances."

Scientists familiar with Florida *Menippe* have long considered salinity too low in the Mississippi Sound for survival of juvenile crabs, Stuck says.

"It is too low for Florida stone crabs," he says. "Florida *Menippe* can't survive below 20 parts per thousand salinity. Ours do quite well at 12 parts per thousand."

Stuck points out that severe flooding made 1983 an abnormal year for salinity levels in the Sound but a good year for determining limiting factors for juvenile survival.

"As salinity went down, populations went down. Juvenile and post larval stages could tolerate salinity at 10 parts per thousand. That was the cutoff point. When we had all the flooding and salinity went to 0, there was 100 per cent mortality. It killed all the juveniles. Then as salinity

went up, populations began to rebuild, although not in the same abundance as before."

A salinity range of 15 to 25 parts per thousand seems to be most productive, Stuck says. He is hoping for a "normal" year without excessive flooding in 1984. He also plans to compare field observations with experiments on salinity levels using juveniles reared in the laboratory.

Much of the evidence collected on larval and juvenile stages indicates that the *Menippe* may go through their complete life cycle in the waters of the lower Sound.

"When stone crabs first hatch out, they are in the zoeal stage. They grow and go through five molts in zoeal stage. They look the same, just bigger in each stage — like tadpoles with spines.

"If you get a lot of zoeae in plankton sampling, you know the crabs are spawning in the area. For blue crabs, we get the first and last stages. The middle stages are growing somewhere else. But we get all zoeal stages for stone crabs in our samples. That means the populations are produced in our local waters."

Mississippi management decisions and Mississippi crabbers could have a definite influence on the future of stone crabs in the Sound, he says. Crabbers are interested in that future, and assistance from crab fisherman has been a definite asset in the study.

Softshell crabs spark enthusiasm

Harriet Perry has worked with Mississippi and Alabama commercial blue crab fishermen for 13 years. She says they are an independent lot, exceptionally knowledgeable about the species they harvest.

That is why it was no surprise to Perry when commercial blue crab fishermen turned out in force for a workshop on shedding systems for softshell crabs. What was surprising was that so many other people showed up for the all day sessions.

Electrical engineers, housewives, construction workers, nurses, restaurant owners — close to 200 participants from six states converged on Lacombe, Louisiana, for the 1983 spring workshop.

The softshell crab, object of all that interest, is just what it's name implies. The blue crab — *Callinectes sapidus* — sheds its hard shell; the new, larger shell stays soft as the crab absorbs water and expands. After about one hour, the shell begins to harden unless the crab is taken from the water.

Crabs obligingly fatten themselves up for the whole process, and the result is good eating and a price for fishermen that is sometimes nine times higher than the hardshell price.

That is why softshells spark such enthusiasm. And with the softshell industry in an expanding stage in Louisiana and in the idea stage in Mississippi and Alabama, individuals with even a slight involvement with blue crabs seem likely to launch independent experimentation with systems for holding pre-molt, or "peeler" crabs.

Floating boxes or onshore tanks filled from nearby natural bodies of water are commonly used systems. But people using them often run into problems with fluctuating water quality. Crabs begin to die or halt the shedding process.

The workshop, sponsored cooperatively by the Consortium, the Louisiana Sea Grant College Program and the Louisiana Department of Wildlife and Fisheries, focused on Sea Grant research into systems that keep "peelers" healthy and happy until they shed.

The key exhibit in the workshop was the commercially successful crab shedding operation of Cultus Pearson. Pearson has been operating, and making a profit, with his closed recirculating seawater system for more than three years on the northern shore of Lake Ponchartrain in Lacombe.

Contributing knowledge accumulated in more than two decades of crab fishing, Pearson initially worked with Perry to set up his system with a biological filter. The filter, he says, is the heart of the system.

"The filter is basic aquarium technology applied and adapted for crab shedding systems," Perry says. "The use of the biological filter for crab shedding systems evolved in the early 1970's through trial and error. Several people from GCRL were involved in its development, and over

A crab shedding system that works means income from softshells.

the years we were able to work with interested fishermen to get it all together."

Pearson's system successfully sheds out 90 per cent or better of the crabs he puts into it. Research supported by the Mississippi-Alabama and Louisiana Sea Grant programs has evaluated his operation and tested small scale replicas of the system for the effects of temperature, salinity, pH and numbers of crabs on crab survival.

Perry, Dr. J. G. Lakshmi and biotechnician Christine Trigg of GCRL began work in 1983 on another Sea Grant project to experiment with ammonia levels and their affects on crab shedding success.

Ammonia, the result of the animals' own excretion processes, has a toxic effect on crabs in a shedding system, Lakshmi says.

Based on test results, the investigators recommend that the level of free ammonia not be higher than 1 part per million in the closed shedding systems. Kits available commercially measure total ammonia, and the 1 part per million free ammonia is equivalent to about 20 parts per million total ammonia at pH of 8 or about 200 parts per million at pH of 7.

Lakshmi says analysis of data from experiments on ammonia and nitrite levels is near completion and will supply information on relationships between a range of ammonia concentrations and the success or failure of crabs to complete the molting process.

Even safe concentrations of ammonia can slow that process. With present technology, ammonia levels can be controlled by limiting the number of crabs in the system to one crab per each gallon of water, Lakshmi says.

Future research on softshells will probably be directed at the problem of an established source of peelers, according to Perry.

"In Mississippi and Alabama there is no directed fishery for peeler crabs. We don't have specific gear to harvest peelers or fishermen who are going out specifically for peeler crabs. And most of the gear used to harvest peelers in areas such as Chesapeake Bay is illegal in Mississippi, Alabama and Louisiana."

One research priority, she says, will be the evaluation of the physical and biological impact on the environment of gear designed to harvest peelers.

Mississippi geologists track space-age minerals

Two University of Mississippi geologists are on a Sea Grant safari, tracking space-age minerals beneath the ocean floor.

Drs. James R. Woolsey and William R. Reynolds are leading a Sea Grant project to locate deposits of heavy minerals valuable to high technology industries. They are conducting the search in the 30 to 50-foot depths of the Gulf of Mexico beyond Mississippi and Alabama barrier islands.

Their No. 1 quarry is titanium, and they have found "interesting" accumulations. Refined as a metal, titanium is stronger than aluminum and not as subject to corrosion. But the greatest demand is for use as a paint pigment. Titanium is the mineral that has replaced lead as the "whiter than white" in white paint.

A Dupont plant in Bay St. Louis, Mississippi, and Kerr-McGee Chemical Company plants in Mobile, Alabama, and Hamilton, Mississippi, are involved in the process of turning titanium oxides into compounds usable as pigments, Woolsey says. The plants now import the bulk of their raw material from Australia.

The Sea Grant survey has also turned up large deposits of the aluminum silicate, kyanite, and a sister mineral, sillimanite. Both are high grade refractories that fit into the advanced technology of space-age ceramics.

"A refractory is something that doesn't burn," Woolsey says. "A high grade refractory can be exposed to intense heat, and it won't distort or break down. It can stand extreme temperatures for space vehicles' reentry into the atmosphere or high temperatures in furnaces.

"We found an abundance of the aluminum silicates in sampling. That could be significant if there is any abundance and continuity in actual deposits."

Other marketable minerals that have shown up are bulk-type minerals — blasting sand, foundry sand and shell.

The geologists also found a line of mud volcanoes along what appears to be a small fracture zone northwest of Cat Island and within the Chevron lease tract.

"The mud volcanoes could possibly be caused by escaping gas. Whatever caused them, they are no longer active. The tests we have run show no oil seepages, although the results were inconclusive for natural gas." Woolsey says.

"Our 1983 results mainly pointed out that we needed more samples in all areas of the study. The vibracoring system we were using worked fine in the muds of the Sound but failed to recover the more densely packed sands of offshore sediments."

Target minerals for the study are either found in sand or are the size of sand, and the investigators wanted samples of sand to depths of 7 meters below the ocean bottom. Woolsey is adding his own innovations to get those samples.

Director of the Mississippi Minerals Resources Institute based at the University, he developed and built an air-lift drill and a 1,200 pound vibracorer with funding from the institute.

"The equipment has a dual purpose. We used it in October-November of 1983 for a United Nations funded project in the territorial waters of the Republic of

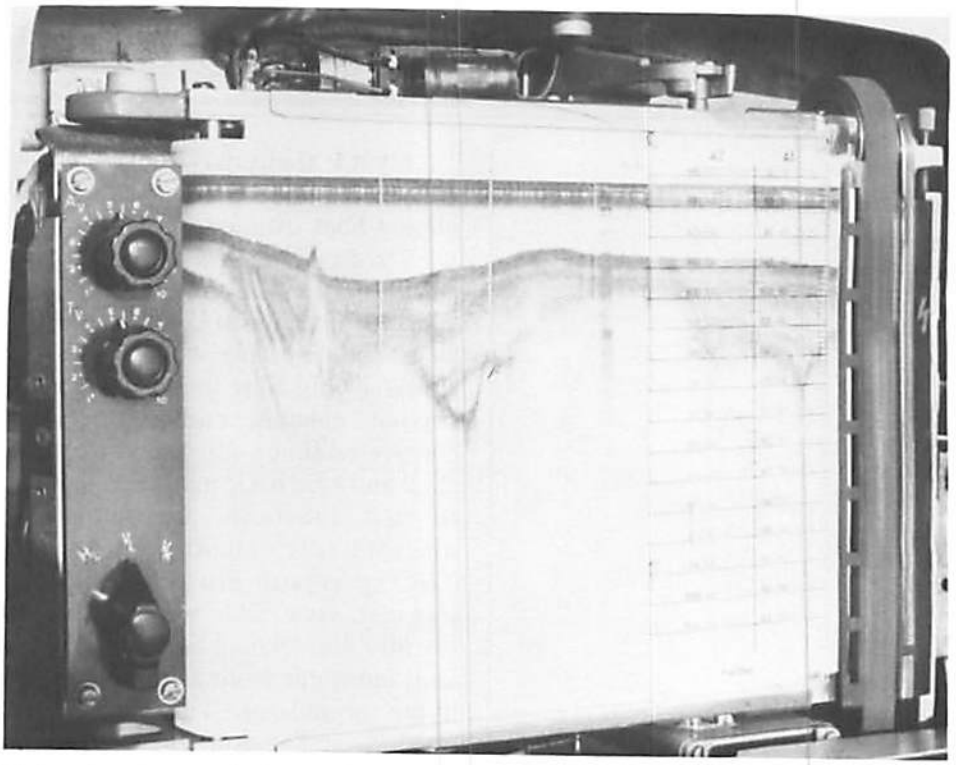
Congo. We also plan to use it for another 44 offshore sampling sites that we have scheduled for the Sea Grant study."

Woolsey and Max Flandorfer, program manager for the Consortium, are planning modifications that will accomplish sampling with minimum sediment disturbance.

"We plan to incorporate features of a piston coring device with the standard vibracorer. I don't know if this has ever been done before, but we are going to try it. The piston feature will help preserve the sedimentary structure of the sample. And we have an even larger pneumatic vibrator to punch those core tubes down into the sand."

The geologists plan to tackle the 1984 sampling in May. Examination of samples taken with the new equipment should clear up questions raised by anomalies noted in 1983 samples. With matching funds provided through the minerals institute, additional faculty and students will help with the analysis, Woolsey said.

But until that analysis is complete, Woolsey is reluctant to start counting dollars that could flow into Mississippi and Alabama pocketbooks. And even if mineral deposits exist at commercially valuable levels, mining them could conflict with other resources.



This seismic record shows the internal structure of sediment layers beneath the waters of Mississippi Sound.

"Mining is a dirty word to some people," Woolsey says. "But technology is advancing so rapidly that what constitutes a conflicting use today could be resolved by new techniques tomorrow.

"The point is that states need to inventory their resources. We need to identify what is in our mineral storehouse, whether the resource can be exploited with present or future technology. Our project is a beginning for that kind of assessment."

For the record

Dr. Joanne L. Laroche and *Dr. Sally L. Richardson,* Gulf Coast Research Laboratory. "Factors Influencing the Movement of Fish Larvae into Mississippi Sound Through a Barrier Island Pass." R/LR-10

Dr. Joanne L. Laroche and *Dr. John P. Steen, Jr.,* Gulf Coast Research Laboratory. "Trophic Dynamics, Growth and Condition of Red Drum Larvae *(Sciaenops ocellatus)* in Mississippi Coastal Waters." R/LR-12

Ms. Harriet M. Perry and *Dr. G. Lakshmi,* Gulf Coast Research Laboratory. "The Effect of Ammonia Accumulation on Blue Crab Shedding Success." R/RD-2

Ms. Harriet M. Perry and *Mr. Kenneth C. Stuck,* Gulf Coast Research Laboratory. "*Menippe mercenaria:* The Potential for Development of a Fishery." R/LR-11

Dr. Sally L. Richardson and *Dr. Joanne L. Laroche,* Gulf Coast Research Laboratory. "The Role of Mississippi Sound in Recruitment to Sport and Commercial Fish Stocks." R/ER-5

Dr. James R. Woolsey, University of Mississippi. "Exploration for Industrial Minerals in Mississippi Sound and Adjacent Offshore Territories of Mississippi and Alabama." R/ER-11

Turning old problems into money-making solutions

Botanist Charles Rhyne examines algae growth.

Oyster shells may contain a new weapon against the barnacles that plague boat owners.

Dr. Steven Sikes of the University of South Alabama and Dr. Hap Wheeler of Clemson University have been collaborating since 1978 on research into how living organisms deposit calcium carbonate. They discovered that a substance in oyster shell and synthetic materials similar to that substance are potent inhibitors of calcium carbonate ($CaCO_3$) crystal growth. Following this discovery, Sikes wanted to see if the inhibitors would be usable to prevent inorganic fouling and fouling by living organisms. The idea was a good one and a natural for Sea Grant.

The inhibitor could prevent the growth of barnacles and other calcifying organisms in marine environments. And in places such as boilers and pipelines, the inhibitor could prevent the inorganic growth of calcium carbonate scale. Coupled with this double barreled approach, Sikes also proposed to study the chemistry involved and to seek to identify other compounds with similar inhibitor properties. Sea Grant started the project in spring 1983.

"We have completed an initial screening of over 50 compounds and have identified several natural and synthetic compounds that inhibit calcium carbonate crystal growth both in living systems such as barnacles and oysters, and in non-living systems such as scale formation in boilers, pipes and heat exchangers," Sikes explains.

Organisms that produce calcium carbonate structures grow on or burrow into structures often in contact with sea water. These organisms damage the structure, shorten its useful life and cause enormous expense for both prevention and maintenance.

"The current solution to the problem is to coat the structure with an antifouling paint. Although this approach has had some success, it has some serious drawbacks," Sikes says. The compounds used are generally highly toxic and can have serious environmental effects. Additionally, antifouling paints have become expensive as the cost of their active ingredients, mainly copper and tin, has soared.

"One purpose of our project is to introduce new compounds that could replace or augment existing active components of antifouling paints. The compounds we are studying are highly potent inhibitors of calcification. If the barnacles, oysters or other fouling organisms can't build their protective shells, then they probably can't survive to be a fouling problem."

Sikes says another goal of the project is to devise industrial antiscaling compounds that are more effective and more environmentally sound than those in use now.

Where inorganic calcium carbonate scale builds up in heat exchangers, boilers and pipes in power plants or ships, the operating efficiency goes down. That means operating costs go up. Consequently, industry is now treating water to prevent or slow down scale formation. Even so, major cleaning operations are necessary, and systems must be shut down for expensive descaling.

Although current commercial antiscaling compounds are not thought to be especially toxic, they may contain more than 80 percent phosphate by weight, and millions of pounds of those compounds are introduced into the environment annually.

"That points to another advantage of the new compounds," Sikes says. "They contain no phosphates. These new compounds also appear to do a much better job of preventing scale formation."

As part of the screening process, oyster shell matrix, polyaspartate, polyglutamate and several other compounds that are especially potent as inhibitors were evaluated to see how changes in temperature and molecular weight affected their potency as inhibitors.

"Temperature appears to be a critically important variable, with only a few degrees difference causing pronounced effects," Sikes says. "Preliminary studies show that a specific molecular weight will be the most potent for a particular compound." Sikes hopes that his work will also help to shed some light on the relationship between inhibitor molecules and the size of nascent, or initiating, crystal molecules.

Another finding from the screening program led to the discovery of a proteinaceous compound from sea urchin tests (shells) that is an effective calcium carbonate crystal inhibitor.

"This is especially interesting for two reasons," says Sikes. "Previously, natural inhibitors like this have come from molluskan shells, and sea urchins are not mollusks. This suggests that matrix material from other calcified structures such as calcareous algae, coral and chalk has a potential for effectiveness. The second reason is that the literature indicated that sea urchin tests lack an organic matrix. This is obviously not the case."

So far, four patent applications have been filed for discoveries resulting from Sikes' Sea Grant research.

"We think other useful discoveries will be forthcoming in the near future," the biologist says. "We have also received expressions of commercial interest, and we would look forward to industrial participation in this research."

New herbicide benefits soybeans and shrimp

It might be hard to imagine the possible connection between the production of shrimp and soybeans. But a University of Southern Mississippi polymer chemist, Dr. Charles McCormick, is using chitin, a product from shrimp shells, to make a novel herbicide for soybeans that could also go a long way toward protecting shrimp and other marine organisms from excess pesticide pollution.

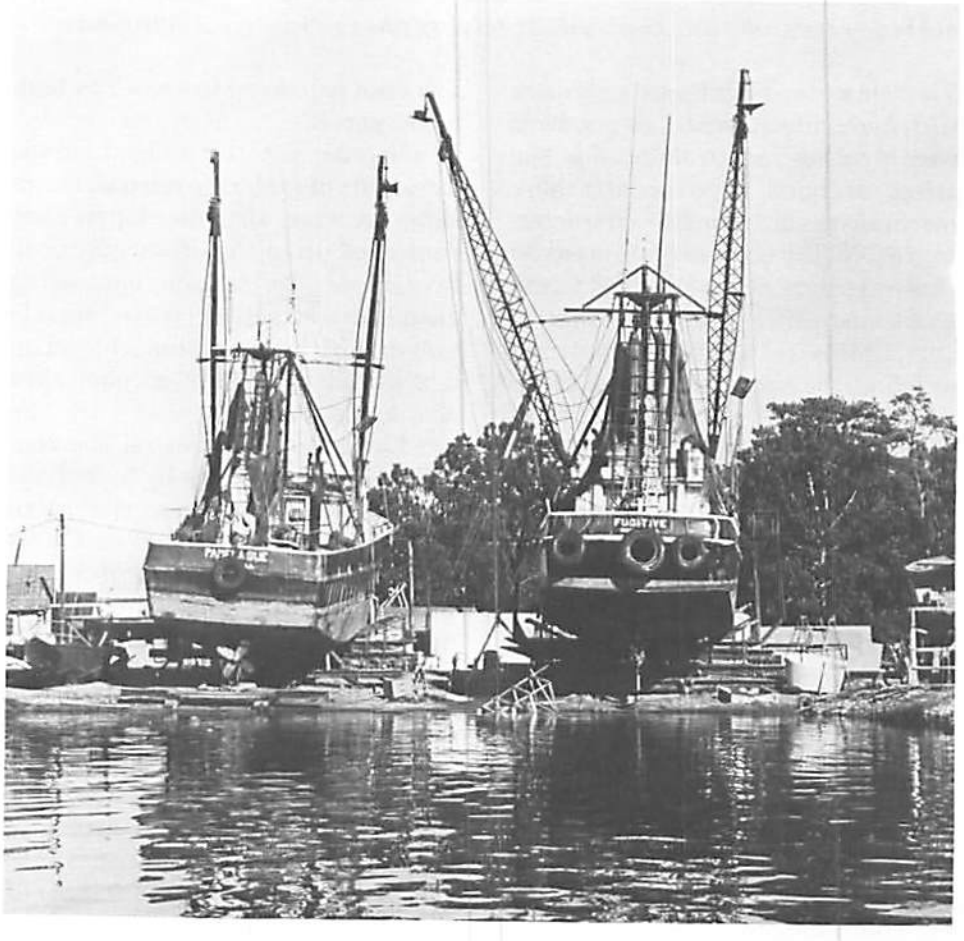
McCormick explains that farmers now often lose 70-80 percent of a herbicide applied to a field. If it rains too much too soon, the herbicide will leach out of the soil. If it doesn't rain soon enough, the herbicide may evaporate. Or it may be destroyed by chemicals or microorganisms in the soil.

The common approach is to apply much more than what is actually required so that the herbicide's effect will last longer. The farmer needs to be sure that field concentrations don't fall below a minimum level of effectiveness. But the overdose method is not only expensive it can even damage the crop it is supposed to protect. The problem is that the herbicide molecule is much smaller and more mobile compared to other molecules.

"What we are doing," explains McCormick, "is joining that small, mobile herbicide molecule to a larger molecule called a polymer to form a new compound that tends to stay put."

The larger molecule of the polymer-herbicide combination retards evaporation; it doesn't dissolve and wash away as easily; and it is less affected by light, chemicals or enzymes in the soil.

When the new compound is applied in the field, water or some other process slowly breaks the chemical bonds between the herbicide and polymer and the herbicide is free to work. The farmer needs to apply much less herbicide fewer times to obtain the same effects. And fishermen don't have to worry about the excess herbicide leaching into their fishing grounds. The term for the process is "controlled release."



Sea Grant is developing new weapons for boat owners waging war against barnacles.

From field to estuary

When herbicides leach out of a soybean field, neither the farmer nor the environment benefit. Sea Grant has supported research on controlled release herbicide systems that keep weed killers where they do the most good for the farmer and the least harm to the environment.

"Numerous synthetic polymers with herbicide attached, or pendent, were synthesized to determine the effect of bond type or attaching mechanism on release characteristics," McCormick says. "Based on those experiments, we decided to use chitin and other polysaccharides."

"Chitin is a natural polymer found in the shells of shrimp, crabs and similar shellfish," says McCormick. "It is a biodegradable, renewable marine resource and is presently a problem waste product for seafood processors."

First choice for the herbicide was metribuzin, a common agricultural herbicide used in soybean farming. One problem with metribuzin, however, is that it won't react with chitin on its own.

"We first had to develop a reactive derivative of the metribuzin, one that would react with and attach to the chitin molecule. We tried several paths, but we settled on the chloroformamide derivative as the most productive. The efficiency of herbicide attachment to the polymers has been increased to values as high as 88 percent."

In order to better understand the dynamics of herbicide release, chitin samples were also developed that contained up to 16 percent physically entrapped herbicide (as opposed to chemically attached). Water soluble polymer-herbicide systems based on dextran and polyvinyl alcohol were also made.

Laboratory studies on the controlled release systems by hydrolysis showed that they release the metribuzin slowly at 25 degrees C. As expected, the highest rate of release was found from the water soluble polymers. Water swellable polymers such as chitin released quite slowly. McCormick found that polymers containing high levels of metribuzin do not release as fast as might be expected. Apparently their water repellent nature prevents access of water to the chemical linkages.

"The present rates of release of metribuzin from systems based on direct chemical bonds between herbicide and polymer are slower than desired for maxium efficiency," McCormick says. "The linkage appears to be too stable. However, the breakdown and release of the polymers by enzymes in the soil is presently under study, and this may bring the release up to desired levels."

"Although the system still needs to be fine tuned, the potential benefits of this research are threefold," says McCormick: "1) Economic — the farmer needs to apply much less pesticide to obtain the required control over a longer period of time. That's a real dollar savings. Shellfish processors would benefit from the increased value of the waste shell material, currently a serious disposal problem. 2) Environmental — the substantially reduced quantities of pesticides required would go a long way in reducing their potential damage to the ecosystem. 3) Technological — increases in the technological base for and the knowledge of the synthesis, characterization and analysis of these controlled release systems are significant advances in the state-of-the-art."

Algae offers sewage clean up, pet food potential

Dr. Charles Rhyne of Jackson State University and graduate student Lois Crump are looking for a way to treat wastewater so that it won't harm the environment. They may also be able to make a product from the treatment process that has a ready market and a high price.

The runoff of poorly treated or raw sewage into the natural system is a problem throughout the country, but it is especially troublesome in coastal estuarine areas. Besides the actual dollar expense for treatment of the wastes, there is the potential damage to productive marine areas.

"The basic goal of our project," says Rhyne "is to develop a system that will use marine algae growing in a sewage-seawater mixture as the basis for the production of a valuable feedstock. At the same time, we are looking at the potential for use of the system in the treatment of sewage water."

"We needed an alga that would clean up sewage water and at the same time serve as a resource for producing a useful product. We worked with several species of algae and decided that *Spirulina major*, a filamentous blue-green algae, was the best candidate for this part of the project," Crump says. Her work on this project formed the basis for her master's degree.

The researchers found that when surrounded by nutrients in a 60-40 percent mix of sewage to seawater, the alga grows rapidly and is rich in protein. A 60-70 percent protein content is common. When the water is cleaned up and the nutrients, especially nitrogen, are depleted, the alga goes into a survival state. Growth shuts down and instead of protein the alga produces carbohydrates for storage.

"By controlling the conditions and nutrients in the sewage-seawater mix we can manipulate the final protein/carbohydrate content of the produced algae," Rhyne says.

The researchers say that their system so far has achieved production of 130 milligrams of dry weight per liter per day. And although this yield needs to be increased for a commercial application, the researchers were able to manipulate the alga cell carbohydrate content from 16.4 percent in a high nitrogen media to 42.2 percent carbohydrate in a low nitrogen media.

"While trying to increase the production of the alga, the effect of the alga on the sewage/seawater nutrient levels was also an important part of the study," says Rhyne. "We wanted to see how far we could reduce nitrogen and phosphorous compounds since these are important potentially harmful components of sewage effluents.

"We found that we were able to reduce nutrient concentrations in the effluent by 97 percent for ammonium, 100 percent for nitrate and 47 percent for phosphate. These are significant reductions and show that an algal system can be an effective component of a sewage treatment plan."

Spirulina algae is already produced commercially on a limited scale in different parts of the world, and there is considerable international demand for the product. Clean-water raised *Spirulina* is used as a human health food supplement now, but at least in the United States, algae raised in a wastewater system would be out of the question because of public health reasons.

An area that does provide a possible profitable market is animal feed. Producers of pet food, particularly fish and bird feeds, livestock and poultry supplements, and aquaculture feeds are now using all the algae the market can supply.

"If we can devise a system to provide a high protein animal feedstock at a reasonable cost and contribute to the reduction of sewage treatment problems, we will really have something," Rhyne emphasizes. "And that's the direction we are going to go next year."

Student research

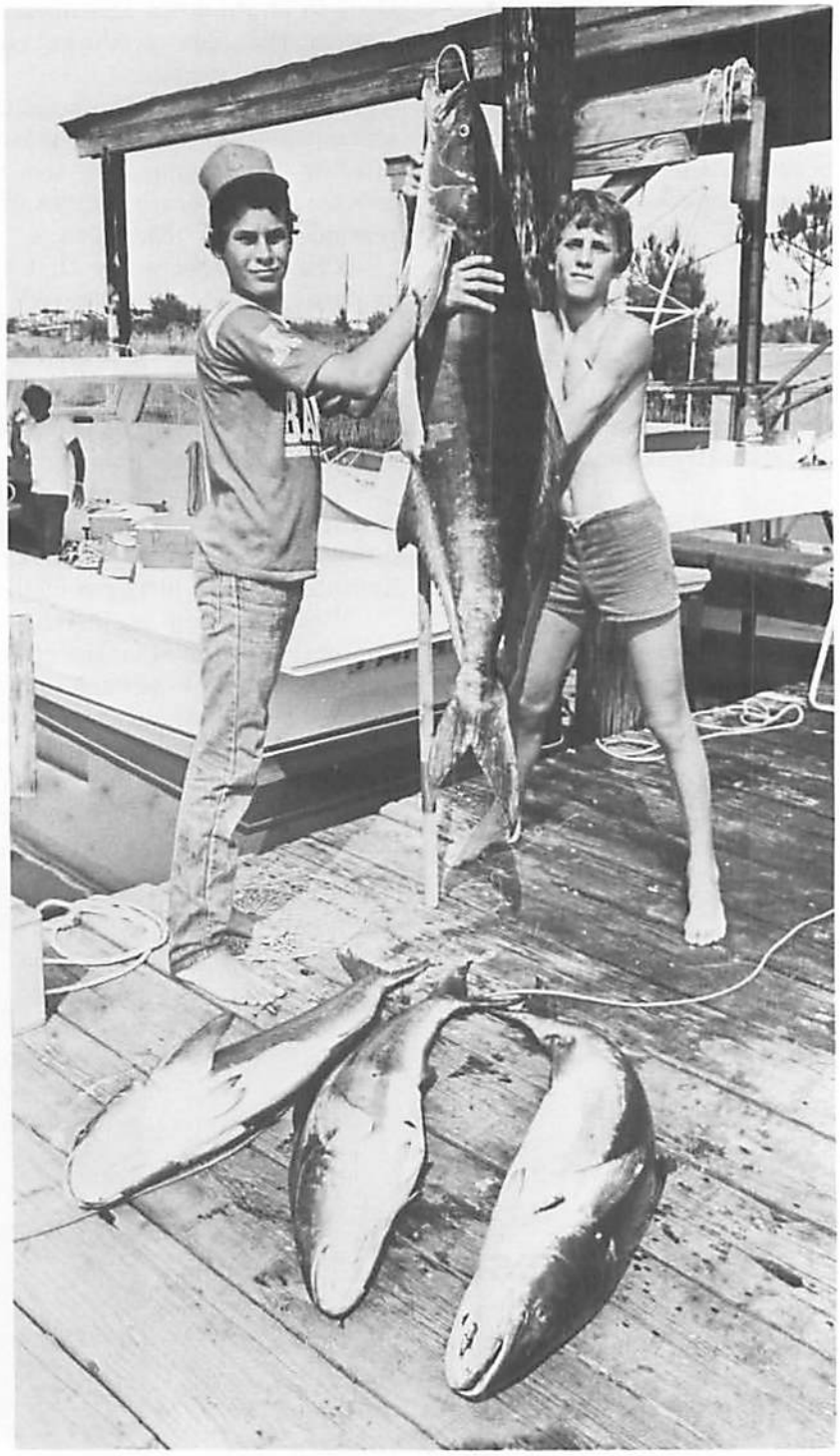
Lois Crump, left, earned an honorable mention in the master's degree category at the 1982 national Sea Grant awards banquet in Washington, DC for her algae research conducted with Dr. Charles Rhyne. Among the earliest gradutes of the Jackson State University marine sciences program developed through Sea Grant support, Crump was the first graduate of that program to receive a national award for research.

For the record

Dr. Charles L. McCormick, III, University of Southern Mississippi. "Utilization of Chitin to Control Pesticide Mobility," R/MT-1

Dr. Charles Rhyne, Jackson State University. "Protein Feedstock Production Using an Algae/ Seawater/Wastewater System." R/MT-8

Dr. C. Steven Sikes, University of South Alabama. "Prevention of $CaCO_3$ Fouling of Marine Surfaces by Potent Synthetic Inhibitors of Crystal Growth. R/MT-6



These young men display their day's catch of lemon fish, another of the resources that are drawing businesses, industries, residents and visitors to Mississippi and Alabama coastal areas.

Education

Introducing people to marine environments

Teachers experience salt marsh environment.

Sea Grant in Mississippi and Alabama encourages a "hands-on, feet-in" approach to learning.

The "Man and the Gulf of Mexico" (MGM) Sea Grant project is using the hands-on approach to help equip children with an awareness of the direct and indirect influence of oceans on their lives. The MGM strategy is to reach young people through their teachers.

In the summer of 1983, the MGM team, led by Dr. Bobby Irby of the University of Southern Mississippi, invited selected Mississippi and Alabama teachers to week long marine science workshops. The workshops were held in cooperation with the Marine Environmental Sciences Consortium (MESC), Dauphin Island Sea Lab on Dauphin Island, an Alabama barrier island south of Mobile Bay.

Sea Grant provided housing and meals on the Sea Lab campus. Teachers who chose to receive three semester hours college credit paid their own tuition.

Once the 46 to 50 teachers gathered for a workshop, the MGM leaders divided them into groups, marched them ankle deep into marsh mud to look at plants and other more mobile living things, loaded them on board boats for personal introductions to bottom dwelling marine creatures and sent them onto beach dunes to forage for water, food and shelter in a simulated shipwreck situation. And that was just Day One of the five-day course.

"They were involved 24 hours a day in the environment," Irby says. "The Gulf of Mexico is on one side and the estuarine environment of Mobile Bay and Mississippi Sound on the other."

The workshops have grown out of MGM efforts to survey marine education needs in schools, develop marine educational materials and equip teachers to use those materials. The methods workshop leaders use coincide with activities suggested in teaching materials that Irby and his team have developed, field tested and revised.

The materials are arranged into four books that teachers can use for selected activities, a unit study, a semester course or a course for the entire school year. The books are *Marine and Estuarine Ecology, Marine Habitats, Diversity of Marine Animals* and *Diversity of Marine Plants,* published and distributed by the University Press of Mississippi, Jackson, Mississippi.

Most Mississippi and Alabama science teachers responding to the project's early surveys said they had little or no formal coursework in marine science and felt inadequately prepared to teach anything in the marine field. Changing that is one of the beauties of the workshops, Irby says.

"Teachers were actually able to see the marine environment and its influences first hand. That was something many had not been able to do in their past studies."

Workshop leader Bess Moffatt of Pascagoula recalls the reaction of a teacher from Auburn, Alabama, who was unfamiliar with the marine environment prior to the workshop.

"He was so enthusiastic that he brought his students back to Dauphin Island," Moffatt says. "The kids worked hard washing cars and selling donuts to make money to come on the field trip."

People in Mississippi and Alabama are becoming more aware of the importance of teaching marine science at all grade levels, Irby says.

"When we first began working with a marine topics project in 1976, Biloxi High School was the only high school in Mississippi that offered a marine science course. Now all 11 school districts in the three coastal counties, as well as many other schools throughout Alabama and Mississippi, teach marine sciences."

A shoebox library

MEMS (Marine Educational Materials System) is a special resource available to teachers at Sea Grant workshops and all through the year as well.

Close to 2,000 marine education documents are stored on microfiche — microfilm sheets about the size of index cards.

"It's a library in a shoebox," says Dr. Bobby Irby, leader of the Sea Grant project "Man and the Gulf of Mexico." "Everything written on marine education is there. About 64 pages fit on one card, so when you talk about a shoebox full, you are talking about a library."

Materials are not restricted to science. Marine-related materials for home economics, art, English, social studies and other subjects are available for all grade levels.

The National Sea Grant Program set the system up to collect and store marine educational materials and to make the materials readily available. The central MEMS operation is located at Virginia Institute of Marine Science, but MEMS centers complete with microfiche readers are located throughout the United States.

In Alabama, MEMS is housed at the Marine Environmental Sciences Consortium library on Dauphin Island. The Mississippi MEMS center is located on the campus of the University of Southern Mississippi in Hattiesburg in the science education resource center, Johnson Science Tower.

Materials can be retrieved by subject, title, author or grade level. Using a reader-printer supplied by Sea Grant, the Alabama MEMS center can also provide photocopies of specific materials.

Sea Grant turns students on to marine science

When an opportunity bumps into Mississippians Dr. Vernon Archer, Della McCaughan and Sharon Walker, it doesn't get loose until it has had a good workout.

Archer is a professor in Jackson State University's biology department in Jackson. McCaughan is chairman of the high school science department in Biloxi, and Walker teaches science at Ocean Springs High School. All are masters at introducing young people to the marine sciences and at brightening futures in the process.

When Sea Grant came calling on Archer shortly after he joined the JSU faculty, he saw potential support for a pilot project to involve students in marine sciences.

"Marine environments and marine studies were outside the experience of most of our students," he says.

Sea Grant approved a proposal with funds earmarked for financial support for selected students, purchase of sorely needed research equipment and travel to the coast from the campus in the state's interior.

Archer parlayed contacts through Sea Grant into valuable academic and work experiences that JSU students couldn't get on campus — special field trips, summer work on government research vessels and work in research laboratories.

Less than three years later, Archer and four other scientists at JSU are deep into marine research supported by close to $1 million in research contracts from such agencies as the Office of Naval Research (ONR) and the Naval Ocean Research and Development Activity (NORDA).

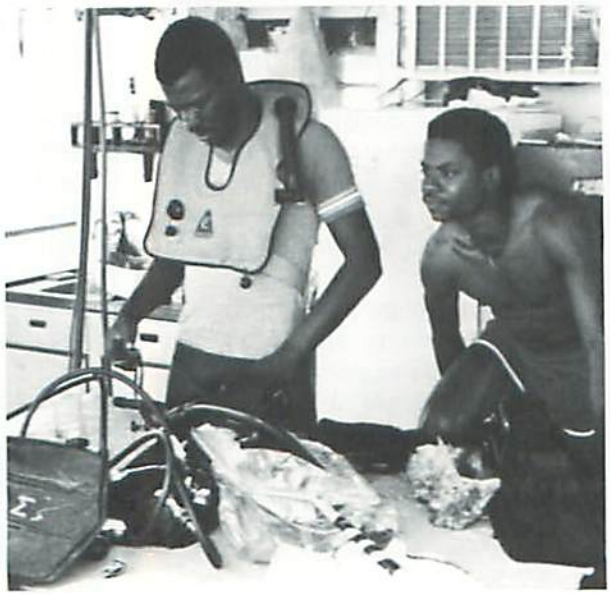
"If we hadn't had that Sea Grant seed money, the Navy wouldn't have committed the amounts they have," Archer says. "And one of the best things is that now we can fund good students for master's thesis research."

The harvest from that Sea Grant seed has already started. One graduate of the marine science program is working in oceanographic research, another in environmental research. Several are working with federal and state pollution control agencies. One is a university instructor. Others are working toward advanced degrees.

Unlike Archer, McCaughan already had good students involved in marine science classes. But she was concerned about the students who weren't in her classes: the blacks, the young people whose parents couldn't pay for lab fees and field trips, the learning disabled and handicapped students.

Those students became the target of a Sea Grant pilot program.

"Some of these students weren't outstanding academically. We try to get a student interested in working on something using his or her talents, perhaps drawing marine animals or working with an aquarium. Later the student finds out he needs facts to keep working. He sees a need for factual information. He reads so that he can keep working. He wants to do it," McCaughan says. "Getting a student



Jackson State University students Alexander Norman (left) of Jackson and Anthony Dawson of Mobile prepare to dive on a coral reef.

To love to learn is simply a teacher teaching."

Her strategy is successful and has evolved into a junior instructor program that has educators from around the country writing, calling and visiting. Her students prepare demonstrations on all sorts of marine-related topics and present them to community and school groups. They work as field guides. They work on publications.

In the midst of all that work, they begin to see themselves differently. Students not sure about making it through high school have finished and gone on to college.

"I'm proud of that kind of change in what students expect from themselves," McCaughan says.

Walker's approach was to use a variety of tactics to keep students reaching toward their highest potential. Her Sea Grant program was aimed at students who had already shown a strong interest in science and the environment and who had a solid foundation in science and mathematics.

"We wanted to give the students a broader knowledge and understanding of our marine environment by using both biological and chemical research." Walker says.

"Each month we had guest speakers come in, each an expert in some aspect of marine or environmental science. Guest lecturers covered underwater photogaphy, chemical oceanography, coral reef ecology, the Bermuda Triangle and ichthyology. There were enough different subjects presented for each student to find some area of interest."

Overnight field trips to the offshore barrier islands and one day canoe trips to local estuaries also broadened their interest.

"These field trips are the spark plug for the course," explains Walker. "They give the students hands-on experiences that really turn them on to an environmental project. You can talk about salinity and fishes in the classroom, but when the students taste the saltwater and pick and identify fishes from a beach seine, that's putting their knowledge to use. When we get back to the classroom and laboratory, the work becomes meaningful to them and they develop a respect for the environment."

The course included 96 hour toxicity tests on the effects of pesticides and heavy metals on both freshwater and brackish water fishes. One student, Ricky Lane, used this part of the course as a springboard for a project for the Mississippi State Science Fair. He won first place in the environmental science category and special awards from the U. S. Navy and U. S. Coast Guard. Lane also won a marine technology society prize at the International Science Fair in Albuquerque, New Mexico.

"If we can stimulate the student's interest in marine science, there may be students who will pursue a career in marine science. And even if they don't make that career choice, the hands-on experiences which Sea Grant has afforded them will enhance their understanding and appreciation of the world in which they live."

Students and Sea Grant

Former students contribute to marine-related fields

During the 1982 program year, Sea Grant contributed to the education and professional training of 54 students at Mississippi and Alabama member institutions.

Training for individuals who will one day be marine scientists and policymakers is a vital, continuing Sea Grant investment that pays. Students who were once involved in Sea Grant projects are now contributing to marine-related fields in government, research and education.

Dr. Courtney T. Hackney is now an associate professor at the University of North Carolina at Wilmington. His research is helping unlock secrets about low salinity marshes and the contribution of marsh soils to highly productive estuaries.

Much of his work at UNC-Wilmington had its beginnings in his involvement with the Sea Grant projects of his former major professor, Armando A. de la Cruz of Mississippi State University. Hackney worked as a graduate student and later as a post doctoral research associate.

De la Cruz was one of a handful of scientists in the United States who began in the 1970's to investigate the role of marsh soils in the estuary.

"Sea Grant was instrumental in starting some of these new lines of investigation," Hackney says. "Dr. de la Cruz would organize the overall project so that there would be time for little offshoot investigations. Those offshoots often lead to breakthroughs."

Hackney passes that kind of scientific training on to his own students. He has had five masters' students, and all are using their training in doctoral programs, business, industry or government positions.

"The value of working with a professor in his research is that students learn to think. They learn to do research first; then they learn how to interpret data. They learn to go from a world where everything is in books to a world where there are no absolute answers. They have to look at the data and interpret it for the best possible answer."

The value of working with a professor in his research is that students learn to think. — Courtney T. Hackney

R. Douglas Nester
U. S. Army Corps of Engineers

Reginal Neal
NAVOCEANO

Casey Jarman
Sea Grant Legal Program

R. Douglas Nester is one of a number of scientists and engineers responsible for sorting out alternatives for dredging and disposal of material dredged from channels and harbors under federal jurisdiction in Mississippi, Alabama and Florida estuaries.

Nester is a biologist with the Mobile District, U. S. Army Corps of Engineers. Sea Grant, he says, gave him the opportunity to learn about marine species and habitats, knowledge essential in his work now.

Nester worked with Dr. Robert L. Shipp of the University of South Alabama on Sea Grant projects that included regular data gathering cruises in the Gulf of Mexico and exploration of an underwater canyon with the research submersible *Diaphus*. That kind of experience has been valuable, Nester says.

"I can look at an area proposed as a dumping site and know something about what is there. I have had on-site experience. If I have a problem on the job, I know who to go to and where to go to get answers."

* * * *

Reginald Neal credits scientist/educator Vernon Archer of Jackson State University with putting him in the right place at the right time for the opportunity to sign on as a physical scientist with the Naval Oceanographic Office (NAVOCEANO).

Archer and Dr. Joy Morrill lead a Sea Grant project that has helped strengthen the marine sciences program at Jackson State.

When Archer and Neal met, Neal had just signed on as an ensign with the NOAA Corps, the agency that operates research vessels for the National Oceanic and Atmospheric Administration. Archer persuaded Neal to enter Jackson State's growing marine sciences program as a graduate student.

The decision to change direction was a good one, Neal says. At NAVOCEANO he works with the Coastal Survey Division, helping keep track of nature's continuous alterations on navigational channels around the world.

In less than two years, he has worked on a four-month cruise in the Pacific and two month-long cruises to Haiti. In between cruises he is becoming more involved in computers and the mathematics of hydrography and geodesy, the branch of applied mathematics that deals with measurement of large portions of the earth's surface.

"This work is never the same," Neal says. "We are doing something different every day. This is a whole new world for me and it is challenging."

* * * *

Sea Grant attorney Casey Jarman already had one career going well when her interest in law surfaced.

Program director for the Louisiana Mental Health Association, she was also active in the Sierra Club. Louisiana was working on a Coastal Zone Management plan at the time, and Jarman found herself in the middle of marine and environmental law, working with legislators and liking it.

"I went to law school with that in mind. I wanted to be involved with marine law, and I was fortunate that the Sea Grant Legal Program provided that opportunity," she says.

As a law student at the University of Mississippi School of Law, Jarman worked on *Waterlog*, the Sea Grant newsletter on legal issues affecting Mississippi and Alabama coastal areas. Interest and support from Sea Grant, she says, helped make her goal of becoming an ocean and coastal law attorney a reality.

And now she is passing along that investment.

Jarman is editor of *Waterlog* and helps law students dig beneath the surface of marine issues to research and write articles.

Catherine L. Mills was one of those students. Mills is working with the National Advisory Committee on Oceans and Atmosphere (NACOA) for one year through a national Sea Grant Fellowship.

During her stint as a student research associate and staff attorney with the Sea Grant Legal Program, Mills worked with Jarman, research-

ing the Mississippi Coastal Program and serving as associate editor of *Waterlog*.

"The benefit of that experience was the substantive knowledge that came along with doing research and interviewing people actively involved in coastal zone management issues."

Meeting those contacts in the marine resource management field and having opportunities to hone research and writing skills were valuable facets of her Sea Grant training, she says.

"I was actively involved with state and federal agencies. I received a good education on how things work and don't work in managing our state's coastal resources."

For the record

Dr. Vernon G. Archer and *Dr. Joy F. Morrill*, Jackson State University. "A Proposal to Maintain Marine Science Studies at Jackson State University." E/O-4

Mr. Gerald Corcoran, Gulf Coast Research Laboratory, and *Mrs. Sharon Walker*, Ocean Springs High School. "Applied Environmental Marine Science: A Secondary School Marine Education Course." E/O-14

Dr. Roger Wayne Hanson, University of Alabama in Birmingham; *Dr. David W. Cook*, Gulf Coast Research Laboratory; *Dr. Robert L. Shipp*, University of South Alabama; and *Dr. Herbert C. Eppert, Jr.*, Naval Ocean Research and Development Activity. "Sea Grant Fellowship Program." E/O-17

Dr. Bobby N. Irby, University of Southern Mississippi. "MGM, A Field-Based Enrichment Program in Marine Science Education for In-service Teachers." E/O-15

Mrs. Della McCaughan, Biloxi High School; *Dr. Bobby N. Irby*, University of Southern Mississippi. "Secondary School Minority, Underprivileged and Handicapped Student Exposure to Marine Education." E/O-1

Dr. Judy Stout, Marine Environmental Sciences Consortium. "Marine Educational Materials System Support." E/O-8

Marine workshops for teachers translate into hands-on experiences for Mississippi and Alabama students. Here, teachers meet residents of Mobile Bay estuary.

Public Service

Sea Grant Advisory Services

Advisory service programs benefit individuals, businesses and communities involved with marine resources.

Getting the word out. That is the job of the Sea Grant Advisory Services — supplying information that makes a difference in the work and play of Mississippi and Alabama residents.

Getting the word out also works in another direction. Advisory service agents are the ones who most often encounter the problems and puzzles troubling marine resource users. If advisory service agents can't find a solution, they pass the word along to scientists and educators involved in Sea Grant work. The goal is to help people and solve problems.

No hospital bills

When 41-year-old shrimper Mickey Nelson walked out of a Mobile, Alabama, infirmary, he didn't have to worry about hospital bills sending his blood pressure skyrocketing again. Insurance through the Alabama Fishermen's Association, Inc., took care of more than $2,000 in hospital bills.

The organization's group insurance program is an important fact of life for Nelson and more than 500 other association members and their families.

The program also represents a job well done to a lot of people: to Nelson, association president, to his wife Faye, to the other leaders and members who worked to see the program established and healthy, and to the Alabama Sea Grant Advisory Service.

Up until Sept. 30, 1981, free medical care was taken for granted by most Alabama commercial fishermen. A free Public Health Service clinic was available in Mobile. In Bayou La Batre, a major fishing center and home of most association members, a contract physician was available to treat fishermen and bill the federal government.

No matter where his fishing took him, a fisherman could still get treatment at a Public Health Service clinic, hospital or contract physician.

Few fishermen had health insurance coverage of any kind when federal budget cuts closed the clinics. The association asked the advisory service to look into the possibility of group insurance with a commercial insurance company.

"The Alabama Sea Grant Advisory Service did the footwork for us. They got us started," Nelson says.

The result is a group insurance plan described as "walk in and walk out."

"I can verify that it is that," Mrs. Nelson says. "Mickey came out of the hospital awhile back, and we just paid the phone bill: $10.50. The insurance picked up the hospital bill, more than $2,000. Our final bill came, balance 0."

"There are other fishermen's associations with insurance plans, but they are mainly the large operations," notes Bill Hosking, coordinator for the Alabama advisory service. "Alabama Fishermen's Association is one of the first to be organized by and for the smaller fishermen and one of the first to offer a group insurance program."

Shrimping workshops

Commercial fishermen are not the only fishermen Sea Grant encounters. Every shrimping season there are individuals who take to coastal waters with outboard motors, small boats and relatively simple gear to catch shrimp for themselves and their neighbors.

Officially they are recreational shrimpers. Unofficially they are the "mosquito fleet" or "weekenders," and workshops designed especially for recreational shrimpers were popular with both Mississippi and Alabama residents in the summer of 1983.

During the sessions, volunteers from science, government, business and industry supplied tips on the where, how and why of shrimping: shrimp biology, choosing, using and maintaining gear, catching shrimp and keeping them fresh, and state regulations and safety.

Meeting visitors

The Sea Grant Advisory Service has teamed up with the Mississippi Department of Economic Development and Harrison County Tourism Commission to find out who is visiting the Mississippi Gulf Coast and why.

"We have been receiving data on actual visitors for more than a year now," says David Veal, program leader of the Mississippi advisory service. "The data was taken by sampling visitors' registration cards at major hotels. We mailed questionnaires on where they were from, what attracted them to the Coast, how much money they spent, the resources they used, number of people in their party, their length of stay and a number of other questions.

"A total of 3,500 questionnaires were mailed out. Response was 25 per cent."

Once analysis is complete, the study should give the growing Gulf Coast tourist industry information that will help in everything from advertising campaigns to arranging tour packages, Veal says.

Processors' deadline

The advisory service's success at matching problems with answers has translated into an estimated $54,000 annual savings for individual seafood processors on the Mississippi Gulf Coast.

Seafood processing plants were faced with an Environmental Protection Agency deadline for tying into regional sewage systems for wastewater treatment. The wastewater comes from the large volumes of water used for washing and moving shrimp from one machine to another. Once processing is complete, shrimp hulls and other solids are screened out, and the wastewater is discharged into Biloxi Bay and Mississippi Sound.

Shrimper Mickey Nelson and wife Faye worked with the advisory service and fellow shrimpers to set up group health insurance for Alabama's commercial fishermen.

"We estimated that tying into a sewage treatment system would cost processors $250 to $300 a day for the 150 to 180 days that a plant is usually in operation," Mississippi advisory service program leader David Veal says.

Veal has been working with processors since 1974 to provide a link between factory operators and the Bureau of Pollution Control, the Mississippi agency charged with enforcing the EPA regulations.

Veal and Allison Perry, Gulf Coast Research Laboratory's coordinator for fisheries assistance, presented data concerning the problem to authorities. They showed that the processors' wastewater had not adversely affected estuarine waters. The result of that cooperative effort has been a mutually satisfactory resolution of the problem, Veal says.

Now he and the Mississippi advisory service team are working with representatives of the oyster industry and the regional wastewater treatment authority on locations chosen for outfall from regional sewage systems. Both fishermen and processors worry that locations chosen might close productive oyster reefs.

Bridge hunt

Sea Grant and the Naval Ocean Research and Development Activity (NORDA) joined forces in 1982-83 to locate misplaced bridge rubble that was giving shrimpers trouble in the Gulf of Mexico.

After Hurricane Frederic destroyed Alabama's Dauphin Island drawbridge and causeway in 1979, authorities approved dumping 219,000 tons of bridge rubble to create an artificial fishing reef about 11 miles south of Dauphin Island.

Portions of roadbed and guardrail never made it to the reef, and the Alabama Sea Grant Advisory Service started receiving calls from shrimpers who were tearing up nets and losing gear, time and shrimp.

Sea Grant set administrative wheels in motion on a cooperative project with NORDA to find bridge debris and other obstructions in the 25-square-mile area between reef and island. Until the hangs could be accurately located, shrimpers would have to avoid waters known for producing good landings of larger shrimp.

Sea Grant provided funds, NORDA provided sophisticated remote sensing equipment. Mobil Oil

supplied dock space for the vessel used in the survey.

Bill Hosking of the Alabama advisory service and Peter Fleischer, NORDA marine geologist, coordinated the survey using NORDA's side scan sonar to produce a record similar to aerial photographs.

"Side scan sonar sends out a fan-shaped sound impulse to each side of the ship and echoes off a whole area rather than one point," Fleischer says. "You get a two-dimensional echo, an image of the ocean bottom."

NORDA identified 700 "targets" that ranged from obvious obstructions to water turbulence. Advisory personnel condensed the information into a list of 84 areas most likely to cause trouble for shrimpers.

Shrimpers were not alone in their interest in the survey. In addition to 1,600 lists of Loran C coordinates distributed through the advisory service's newsletter "Sea Harvest News," more than 800 requests came in about the rubble survey. And about 600 of those were from sport fishermen wanting information to help locate fishing sites, Hosking says.

In the final stages of the project, Fisheries Specialist Rick Wallace and Sea Grant intern Tony Lowery have dived on sites and used multiple fathometer readings to verify locations of rubble.

"A great many of the sites checked did not appear to have obstructions," Wallace says. "The list of Loran C coordinates is greatly reduced from the previous list."

The final tally is 11 areas that are hazardous for shrimp trawlers.

"We identified them as areas rather than by Loran C coordinates because rubble within the areas is so close together," Wallace says. They are definitely locations shrimpers should avoid.

"At one site we found a complete shrimp trawl — the whole net and both boards. There were also good fish populations for sport fishermen— snapper, groupers, amberjacks and triggerfish. For sport fishermen we have identifed 43 sites more specifically within the 11 areas."

Diesel and dollars

When fuel prices soared in 1980, shrimpers in the Gulf of Mexico felt the economic crunch. Ideas on new technology to conserve fuel and ease the pinch began to flow, but little information existed on the kinds of vessels and gear already in use and the time and fuel expended in shrimping operations in the Gulf.

The Sea Grant Consortium and its advisory services in Mississippi and Alabama pooled resources with the Gulf and South Atlantic Fisheries Development Foundation, Inc., and the National Marine Fisheries Service (NMFS) to fill that information gap.

The result is a study that details the amount of time and fuel used in shrimping operations and characterizes the Gulf shrimp fleet, particularly in Mississippi and Alabama, according to size, age and horsepower of vessels.

"The extremely rapid increase in fuel prices made it necessary for the commercial fisherman to do something about reducing operating costs," says Bill Hosking of the Alabama advisory service. "One way he can do that is to know where the bulk of his fuel is used."

"The study indicates that approximately 70 per cent of the fuel is consumed in the actual trawling operation with as little as 15 per cent consumed in travel," reports David Veal of the Mississippi advisory service. "It is evident that a 10 per cent savings in fuel use during the

NORDA geologist Peter Fleischer checks torpedo-like towfish used in sonic survey for misplaced bridge rubble in Alabama waters.

fishing operation is greater than even a 30 per cent savings during any other activity."

That kind of information is important to scientists working on ways to increase fuel efficiency and to individual boat operators who plan to invest in modifications on their own vessels, Veal says.

Data for establishing the time budget for the fleet came through a NMFS observer system already in operation for a study of incidental catch of endangered sea turtles. NMFS expanded observer activity on 20 offshore shrimp vessels in the Gulf and on the East Coast to record data on the time vessels spent traveling to and from port, traveling between fishing grounds, laying to, picking up and putting out gear and pulling one, two or four nets in their fishing operations.

Sea Grant observers collected additional information from computerized fuel monitors that the advisory service installed on three Gulf shrimp vessels. The monitors supplied data on engine rpm, fuel flow per minute and hour, fuel consumed per day and fuel remaining on board each day.

In a related Sea Grant Study, University of Southern Mississippi economists Dr. Edward Nissan and Dr. D. C. Williams devised a method for the fisherman to evaluate whether or not a proposed modification to his boat or equipment would be profitable in the long run.

"It's a complex problem for the boat owner," Nissan and Williams explain. "He has to consider such things as initial cost, depreciation, interest expense if its necessary to borrow money, loss of interest income if he uses his own money, changes in his taxes, whether the modification will let him catch more shrimp or less. If a fisherman guesses wrong he could invest a large sum of money and find that the expensive 'improvement' is actually costing him more per year to operate.

"We developed an equation that takes all the variables into account to predict whether a given investment in boat modification is economically worthwhile." The economists then worked out a set of simplified tables that will help a fisherman determine whether he should invest in an improvement.

Advisory specialists work with Gulf of Mexico shrimpers hit by rising fuel costs.

Such cooperative effort among marine agencies is paying off in dividends — directions for future research and information for individual marine resource users.

Longer-lasting crab pots

The advisory service is taking a closer look at ways to extend the functional life of the crab traps that commercial fishermen use to harvest blue crabs in the upper Gulf of Mexico.

With the help of biologist Harriet Perry of the Gulf Coast Research Laboratory, the advisory service has applied commercially available treatments to 120 crab traps and put them into service in the Mississippi Sound. Thirty traps were galvanized, 30 galvanized and painted with anti-fouling paint, 30 constructed with vinyl coated wire and 30 painted with vinyl. Collection of data is continuing through the summer of 1984.

Dredging forum

When planners with the U. S. Army Corps of Engineers started a study of disposal alternatives for dredged material in the Mississippi Sound and adjacent waters, they called on the Sea Grant Advisory Services to help them find out just what concerned people most.

There are about 350 miles of navigable coastal waterways in Mississippi and Alabama; and figures from the Corps' Mobile District show that even 5 to 10 years ago an average of 13,725,573 cubic yards of material was removed from coastal waters yearly. Considering the fact that a regular dump truck holds about 14 cubic yards, that figure adds up to a nice-sized mountain of mud. And that mud often contains toxic pollutants.

The prospect of stirring up polluted sediments worries individuals who harvest shrimp, oysters, fish and other sea creatures for sport or profit. At the same time, commerce and industry in Mississippi and Alabama depend on dredging to keep channels open and other people working.

Advisory service personnel in both states set up workshops where individuals could voice their concern and views about dredging and disposal alternatives in Mississippi Sound and Mobile Bay.

One of the things that came out of the workshops was that there was not enough information to understand the biological and physical impacts of dredging activities.

"We would hear that dredging and disposal of dredged material ruin the environment, but we didn't have enough information to say 'yes' or 'no,' " says Dr. Susan Ivester Rees, an oceanographer with the Corps.

The advisory service set up committees to help decide what information was needed to supply those yes and no answers. Since then the advisory services in both states have continued to arrange workshops and meetings as work progressed on various elements of the Corps study.

"The best time for the public to have input into public projects is before decisions are made," says Bill Hosking, coordinator of the Alabama advisory service. "That is what the advisory service tries to do, to provide a forum for the public to express concerns prior to instead of after the fact."

One Corps planner describes that kind of public involvement another way.

"The different groups can see what the alternatives are and how they came to be considered. Neither group will get exactly what they want, but they will know why."

That kind of understanding is important for striking a balance between the question of disposal sites, the potential for environmental damage, the cost of maintaining waterways and the effects of dredging on the economy.

Complexity of marine law challenges legal program

The coastal environment is an inticate, interacting web of relationships between living things, natural processes and people whose work or play modifies that environment. Laws and regulations that deal with coastal ecosystems are equally complex.

The Sea Grant Legal Program's goal is to try to unravel that complexity. The program helps those responsible for the management of the system to make their decisions based on a firm understanding of the alternatives and probable effects of a management choice.

Working with the program located at the University of Mississippi are Director Eugene Bricklemyer, co-investigators William Hooper and Casey Jarman and law students interested in marine and environmental law.

One example of their success in solving legal problems is the program's involvement from the very beginning in development of a coastal management plan in Mississippi. A coastal management plan provides for rational development and preservation of a state's natural resources. It also makes the state eligible for federal money.

During development of the plan, the Mississippi Coastal Program, controversy simmered over regulation of the different coastal development commissions and port and harbor authorities.

"After meeting with many of the managers concerned we felt that to help resolve the conflict we needed two things: an objective analysis of the statutes and regulations that led to the conflict and recommendations to assist the legislature and other coastal resource managers in clarifying areas of conflicting policy and jurisdiction," Jarman explains.

"We researched the problem and developed a publication entitled *Mississippi Marine Resource Management and Coastal Industrial Development: An Analysis of Conflicting Mandates.* We feel that our efforts have helped those involved to put their differences to rest and get on with the business of managing our coastal resources."

After the management plan was put into operation, Jarman and Catherine Mills, a law student assistant, did a follow up study. In *The Mississippi Coastal Program: A Review,* they traced the development of the program, analyzed the disputes that arose, surveyed the successes and suggested action for making the plan more effective.

Another important part of the program is *Waterlog*, the Sea Grant quarterly newsletter of legal issues affecting Mississippi and Alabama coastal areas. As editor, Jarman helps law students dig beneath the surface of marine issues into the federal and state statutes and regulations and the judicial interpretation of them all.

"*Waterlog* trains students," Jarman points out. "It give them an opportunity to write, it requires critical thinking, and it expands their knowledge on a broad variety of issues. The newsletter is also a valuable educational tool for anyone in the marine resources field and for the general public."

The legal program also deals with specific problems. The Mississippi Board of Health and the Gulf Coast Research Laboratory, for example, asked for help in clarifying seafood quality standards.

"Present seafood quality standards are often inconsistent, poorly enforced and always confusing," Jarman says. "We reviewed the applicable federal and state statutes, rules and regulations, examined the administrative structures for overseeing seafood quality management and made recommendations for a strengthened, cooperative regulatory program."

"We're working as part of the volunteer committee to help preserve sea turtles and promote the trawl efficiency device (TED), an innovation in trawling that helps reduce the mortality of sea turtles caught in trawls and increases the shrimpers' catch as well."

At the request of the Alabama Sea Grant Advisory Service, the program reviewed the remedies available to shrimpers who damaged their nets on the improperly placed debris from

the demolition of the Dauphin Island Bridge. The shrimpers might have a chance of collecting in an action against the contractor that dumped the debris in the unauthorized location, Jarman says.

At the request of Mississippi Sea Grant Advisory Service, Sea Grant attorneys also helped settle questions on allocation and charges for temporary and permanent berths in the small craft harbor of the city of Pass Christian.

On the national level, Jarman and Mills played a major role in organizing the legal component of the Sea Grant Association into an effective nationwide network call "Sea Net." The Mississippi-Alabama legal program also organized the law segment for the 1983 National Sea Grant Week in San Antonio, Texas.

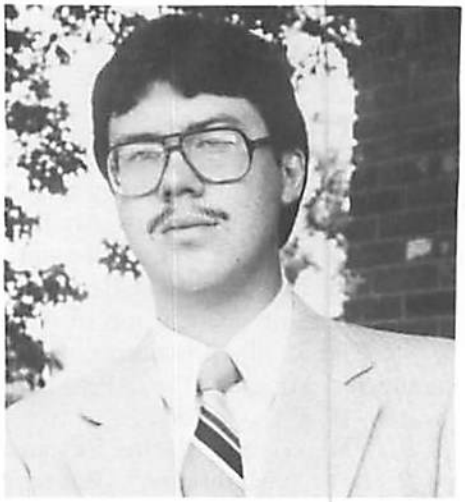
Bricklemyer says future work includes the legal component on a proposal to turn abandoned oil rigs in the Gulf of Mexico into artificial reefs and a management study of the Estuarine Sanctuary Program.

"We will also be looking at the ramifications of the territorial sea from three to twelve miles and at the marine transportation of hazardous waste, a problem that is becoming a major issue in the Gulf of Mexico."

Law student wins national recognition

The Sea Grant Legal Program provides future attorneys with experience in marine law. Part of that experience is research and writing — skills that paid off for student research associate Stanton J. Fountain, Jr.

Fountain received honorable mention for two abstracts he submitted to the Sea Grant Association 1982 national student marine research competition. The abstracts



Stanton J. Fountain, Jr.

are *Littoral Rights: Rights of Property Owners Along Mississippi's Tidal Water* and *Public Rights for Coastal Lands: Three Common Law Theories Affecting Deer Island's Future.*

Fountain is now an associate of the law firm of Bobby G. O'Barr in Biloxi, Mississippi.

For the record

Dr. Eugene C. Bricklemyer, Jr. (1983), *Dr. William Hooper, Jr., Dr. Casey Jarman, Dr. Michael Gibbs* (1982), University of Mississippi. "Sea Grant Legal Program." R/SL-4

Dr. William Hosking, Sea Grant Advisory Service, and *Dr. Peter Fleischer,* Naval Ocean Development and Research Activity. "Side Scan Sonar Survey of Bridge Rubble Dumps, Mobile Bay Entrance, Alabama." A/O-11

Dr. Warren R. McCord and *Dr. William Hosking,* Alabama Cooperative Extension Service. "Sea Grant Advisory Service — Alabama Component." A/O-9

Dr. Edward Nissan and *Dr. D. C. Williams, Jr.,* University of Southern Mississippi. "Economic Analysis of Shrimp Operation, Mississippi-Alabama Coastal Counties." R/SL-5

Dr. C. David Veal, Mississippi Cooperative Extension Service. "Sea Grant Advisory Service — Mississippi Component." A/O-9

Decisions on dredging and disposal of dredged material affect the future of Mississippi and Alabama's marine and coastal environments.

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General Interest

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Budget

	1982 Program Final Costs (January 1982-June 1983) NOAA/ Sea Grant	1982 Program Final Costs (January 1982-June 1983) Grantee Match	1983 Program Proposed Budget (January 1983-September 1984) NOAA/ Sea Grant	1983 Program Proposed Budget (January 1983-September 1984) Grantee Match
Research				
Marine Resources Development				
Aquaculture	11,744	6,012	39,291	37,862
Living Resources	114,012	38,849	59,062	45,086
Mineral Resources	110,468	88,679	54,958	30,688
Marine Biomedicinals & Extracts	-0-	-0-	11,800	5,815
Socio-Economic and Legal Studies				
Ocean Law	44,275	83,101	47,639	49,144
Socio-Political Studies	1,100	589	-0-	-0-
Marine Technology Research & Development				
Resources Recovery & Utilization	52,546	24,804	17,276	32,449
Tranportation Systems	-0-	-0-	19,471	9,750
Marine Environmental Research				
. . .Coastal Management Decisions	-0-	-0-	46,266	23,507
Ecosystems Research	-0-	-0-	34,038	17,019
Pollution Studies	-0-	-0-	17,403	8,719
Environmental Models	17,997	9,306	553,989	60,063
Applied Oceanography	73,152	36,386	-0-	-0-
Total Research	425,294	287,726	901,193	320,102
Education				
College Level	15,000	6,166	15,083	7,542
Other Education	69,288	40,779	50,543	13,871
Total Education	84,288	46,945	65,626	21,413
Advisory Services	171,875	62,999	217,515	96,642
Program Management				
Program Adminstration	213,977	54,467	236,953	118,477
TOTALS	$895,434	452,137	1,421,287	556,634

Program Summary

			1982	1983
Marine Resources Development				
R/RD-2	Evaluation of a Closed Recirculating Seawater System for Production of Soft-Shelled Crabs	Perry	N	C
Living Resources				
R/LR-10	Factors Influencing the Movement of Fish Larvae into Mississippi Sound Through a Barrier Island Pass	Laroche Richardson	–	N/C
R/LR-11	*Menippe mercenaria*: The Potential for Development of a Fishery	Perry/Stuck	–	N/C
R/LR-12	Trophic Dynamics, Growth and Condition of Red Drum Larvae *(Sciaenops ocellatus)* in Mississippi Coastal Waters	Laroche Steen	–	N/C
Socio-Economic & Legal Studies				
R/SL-4	Sea Grant Legal Program	Hopper/ Bricklemyer/Jarman	C	C
R/SL-5	Economic Analysis of Shrimp Operation, Mississippi-Alabama Coastal Counties	Nissan/ Williams	N/E	–
Marine Technology Research and Development				
R/MT-1	Utilization of Chitin to Control Pesticide Mobility	McCormick	E	–
R/MT-4	Marine Algae in the Production of Fuel/Chemical Feedstocks and in Wastewater Recovery	Rhyne	C	E
R/MT-6	Prevention of $CaCO_3$ Fouling of Marine Surfaces by Potent Synthetic Inhibitors of Crystal Growth	Sikes	–	N/C
R/MT-7	Evaluation of Blue Crab Pot Life as Affected by Externally Applied Coatings	Veal/Perry	–	N/E
R/MT-8	Protein Feedstock Production Using an Algae/Seawater/Wastewater System	Rhyne	–	N/C
Marine Engineering Research				
R/EN-1	Hydrodynamics of Mobile Bay and Mississippi Sound	Raney	–	N/C
R/EN-2	Finite Element Modeling of Sediment Transport in the Mississippi Sound	Wang	–	N/C
R/EN-3	Port Expansion Simulation Model	Park	–	N/C
Marine Environmental Research				
R/ER-1	Modern and Ancient Sedimentary Process and Response Within the Mississippi-Alabama Linear-Barrier-Coastal System	Manley	E	–
R/ER-2	Pollutant Transport in Mississippi Sound	T. Lytle/J. Lytle	E	–
R/ER-3	Hydrodynamics of Mobile Bay and Mississippi Sound	Raney	E	–
R/ER-4	Sedimentation, Dispersal and Partitioning of Trace Metals in Coastal Alabama Estuarine Sediments	Isphording	C	C
R/ER-5	The Role of Mississippi Sound in Recruitment to Sport and Commercial Fish Stocks	Richardson	E	–
R/ER-6	Dredge Spoil Mapping by Seismic Survey and Sediment Analysis in Mobile Bay, Alabama	Brande	E	–
R/ER-8	Organic Pollutant Levels in Bivalves of Mobile Bay	Marion/Settine	C	C
R/ER-9	Finite Element Modeling of Sediment Transport in the Mississippi Sound	Wang	–	N/C
R/ER-10	Development of a Coastal Information Management System for the Mississippi-Alabama Sea Grant Consortium	Blancher	C	C/R
R/ER-11	Exploration for Industrial Minerals in Mississippi Sound and Adjacent Offshore Territories of Mississippi and Alabama	Woolsey	–	N/C
R/ER-12	Characterization of Fecal Coliform Isolates by Electrophoretic Analysis of *pili*	Ellender	–	N/E
R/ER-13	Hydrodynamic and Water Quality Modeling and Bathymetry and Sediment Characterization of Apalachicola Bay and Adjacent Waters	Raney	–	N/C
Marine Education and Training				
E/O-1	Elementary, Secondary Minority, Underprivileged, Handicapped and Community Exposure to Marine Education	McCaughan	E	–
E/O-2	Man and the Gulf of Mexico	Irby	E	–
E/O-4	An Experimental Program to Intensify Marine Science at Jackson State University	Archer/Morrill	C	C
E/O-8	MEMS Program Support	Stout	E	–
E/O-13	MASGC – Marine Summer Fellowship Program	Hanson	E	–
E/O-14	Applied Environmental Marine Science: A Secondary School Education Course	Cocoran/Walker	N	C
E/O-15	MCM, A Field-Based Enrichment Program in Marine Science Education for Inservice Teachers	Irby	–	N/C
E/O-16	A Sea Grant Fellowship Program	Committee	–	N/C
Advisory and Public Services				
A/O-7	An Evaluation for Energy Consumption, Problems and Potential Solutions in the Mississippi and Alabama Shrimp Fleet	Veal	E	–
A/O-9	Sea Grant Advisory Services Programs	Veal/McCord	C	C
A/O-11	Side Scan Sonar Survey of Bridge Rubble Dumps, Mobile Bay Entrance, Alabama	Hosking/Fleisher	N	C
A/O-13	Development of International Cooperation on Sedimentation Research	Wang	N	C
Program Administration, Planning & Development				
M/PA-1	Program Management: Administration and Planning	Jones	C	C

LEGEND

E – Project completed or terminated
C – Project continued
R – Project redirected
N – Project initiated

Credits

Photos

Max Flandorfer: 8 (right), 9, 21, 28; *Linda Skupien:* 1, 3, 7, 10, 14, 15, 17, 19, 22, 27, 31-35; *Jerry Moulder,* Mississippi Press: 2, 26, 37 (bottom); *Bill Elmore,* The Sun-Herald: 5; *Mississippi Cooperative Extension Service:* 24; *Staff*: 23.

Drawings

Beryl Story, 11; Kenneth C. Stuck, 18.

Written and edited by

Max Flandorfer

Linda Skupien