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VIRGINIA SEA GRANT PROGRAM



1981-82 BIENNIAL REPORT

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University.

VIRGINIA SEA GRANT PROGRAM
VIRGINIA GRADUATE MARINE SCIENCE CONSORTIUM

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Dear Friends,

This annual report represents the first summary of Virginia Sea Grant activities since the inception of the Virginia Graduate Marine Science Consortium. The State Council of Higher Education recommended the creation of the Consortium in 1979 in order to better coordinate the various complementary marine research, education and advisory efforts within the Commonwealth. Consequently in 1981, the Presidents of the College of William and Mary, Old Dominion University, the University of Virginia and Virginia Polytechnic Institute and State University created the Virginia Sea Grant Program.

These first two years have been exciting for Virginia Sea Grant, the Consortium and its member institutions. They have been characterized by administrative change, growth and maturation.

The Sea Grant Program in Virginia is dedicated to the wise use and conservation of the Commonwealth's natural marine resources. Virginia is indeed fortunate to share the beauty and wealth of the Chesapeake Bay and the Atlantic Ocean. However, with the riches of the marine and estuarine environments come responsibility. One measure of Sea Grant's response to this obligation is its diversified research activity which is addressing marine and coastal resource issues for the benefit of all who would use our coastal areas. I am proud to report that during 1981 and 1982 the Virginia Sea Grant Program supported research or advisory services projects at eight institutions of higher learning. These included the four member institutions of the Consortium as well as George Mason University, Hampton Institute, Norfolk State University and Virginia State University.

The following report which covers the 1981 and 1982 funding years briefly summarizes the research, education and advisory efforts conducted by talented and dedicated people. While many benefits have been identified in the report, many more will materialize as the program results are further disseminated in the coming years.

Yet, as we look back over the accomplishments of the past two years, we also look ahead to the challenges awaiting us tomorrow.

Sincerely,

William L. Rickards

William L. Rickards,
Director

MEMBER INSTITUTIONS
UNIVERSITY OF VIRGINIA
OLD DOMINION UNIVERSITY
VIMS OF THE COLLEGE OF WILLIAM & MARY
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Marine Resources Development - Aquaculture

Where Virginia's inshore fisheries are concerned, the hard clam is second only to the oyster as the Bay's most commercially valuable bivalve. Three current Sea Grant research projects are investigating the production of superior genetic lines of hard clams for use in clam seed hatcheries and the economizing of hatchery production. Three other projects involve the development of disease-resistant oyster broodstock, nutrition for oyster larvae and the reduction of oyster hatchery costs.

HARD CLAM CULTURE

GENETICS AND BREEDING STRUCTURE OF CLAMS, MERCENARIA SPP. (R/A-5)

Drs. J. R. Wall and S. L. Adamkewicz of George Mason University (GMU), recently completed work on a three-year project designed to furnish basic information required for the development of breeding programs for producing superior breeds and hybrids of hard clams. Information of this type was unavailable, and constituted a limiting factor in efficient clam aquaculture development.

Working closely with Michael Castagna at the VIMS Eastern Shore Laboratory, Wachapreague, who had in progress a long-term project to produce superior seed clams, the investigators accomplished their primary purpose. In the process, they allayed the concerns of practical breeders in selecting broodstock by showing that natural populations of hard clams tested did not show geographic differentiation for allozyme genes or inbreeding. The knowledge gained as a result of this project has guided a breeding program to select only genetically superior parents, thus shortening the number of generations needed to produce an improved strain.

GENETICS OF GROWTH AND REPRODUCTION IN THE HARD CLAM MERCENARIA MERCENARIA (R/A-13)

In an associated project, Dr. S. L. Adamkewicz (GMU) sought to develop improved strains, using information gathered from the previously described project. In the process, she developed a practical method of live-testing for superior parent clam stock. Clams can now be tested for genotype, selected on that basis to produce special offspring, and be kept for years of useful breeding. The testing procedure has been used successfully, and yields an unexpectedly high survival rate.

An unanticipated benefit of this work has been the development of a new procedure to induce spawning in clams, greatly simplifying the process at the convenience of the experimenter.

ASSESSMENT OF SUPPLEMENTAL FEEDS FOR COST REDUCTION IN GROWING HARD CLAM, MERCENARIA MERCENARIA, SEED (R/A-11)

A major constraint to commercial culture of hard clams is the inability of hatcheries to economically produce adequate quantities of larger size seed clams (8 mm shell length) for field planting. In a one-year Sea Grant project addressing this problem, Dr. John N. Kraeuter and Michael Castagna of the VIMS Eastern Shore Laboratory, Wachapreague, tested and evaluated a number of diets formulated from inexpensive, easily obtainable agricultural and fishery products.

These diets, the most successful of which were various combinations of crab scrap meal, soybean meal, calcium casein and rice meal, provide nutrients which are essential for growth, have long shelf lives and are inherently non-toxic. The investigators feel the diets will benefit a hatchery operation



VIMS graduate student David S. Gussman, with the cooperation of Anheuser-Busch Breweries, is investigating the use of brewery by-products for growing juvenile oysters.

economically, replacing the costly and often inadequate practice of pumping large volumes of seawater supplemented with cultured algae.

OYSTER MARICULTURE

MARICULTURE OF SHELLFISH - DISEASE RESISTANCE (R/A-3)

Drs. Frank O. Perkins and Morris H. Roberts are concluding work on developing oyster broodstock which is resistant to Perkinsus marinus, commonly known as Dermo. Dermo is the less devastating of the two oyster diseases which have curtailed oyster production in Chesapeake Bay since the late 1950's. Oyster broodstock resistant to Minchinia nelsoni (MSX) was developed during the late 1960's and early 1970's.

While not as deadly to oysters as MSX, Dermo is more widespread, with significant occurrence not only on the U.S. Atlantic coast but in the Gulf of Mexico as well. Using methods similar to those which produced MSX-resistant oyster broodstock, Perkins and Roberts have produced 10 families of potentially Dermo-resistant oysters and have developed a procedure for controlling dosing of oysters with P. marinus zoospores for later resistance testing. Disease-resistant oyster broodstock will be made available to hatcheries for the production of Dermo-resistant seed.

ARTIFICIAL FOOD FOR OYSTER LARVAE (R/A-10)

Since January 1981, Drs. Kenneth L. Webb and assistants Dr. Fu-Lin E. Chu and Daniel A. Hepworth of VIMS have worked to formulate an artificial diet capsule acceptable to and digestible by oyster larvae.

Because oysters of several species lend themselves to propa-



As an alternative to costly live algae diets, Drs. Fu-Lin Chu (l) and Kenneth L. Webb of VIMS are working to formulate a less expensive artificial diet capsule digestible by oyster larvae.

gation in hatcheries, researchers in the U.S. and abroad are continually striving to minimize the costly and labor intensive aspects of a hatchery operation. One of these is propagating and maintaining a supply of live algae upon which oyster larvae feed, a procedure whose cost is increasing. As an alternative to algal food, the artificial encapsulated diet, if feasible, will represent a breakthrough in oyster culture. Thus far, Webb and his associates have tested five different encapsulated diets for optimal larval growth and survival.

A doctoral dissertation on the nutritional requirements of the American oyster resulted from this project.

UTILIZATION OF BREWERY WASTES FOR OYSTER MARICULTURE (R/A-9)

In another project aimed at reducing oyster hatchery costs, VIMS graduate student David S. Gussman, with the cooperation of Anheuser-Busch Breweries in

Williamsburg, Virginia, is investigating the use of brewery by-products for growing juvenile oysters. Gussman has found that feeding oysters protozoans which grow on the brewer's condensed solubles (bcs), a by-product of beer production, holds promise as a protozoan nutrient. Protozoans provide an alternative to costly algal food for the bivalves. One species of protozoan in particular, the heterotrophic microflagellate Paraphysomonas vestita, was found to give the best growth in a group bed (bcs). The protozoans can be cultured in the dark, while conventional microalgae used in hatcheries must be cultured under banks of lights. The results are a significant cost reduction and easier storage.

Results of the project will be published in the form of Gussman's doctoral dissertation.

Marine Resources Development - Fisheries and Oceanography

Due to rising costs of popular Bay fishery products, scientists are currently investigating the fishery potential for several underutilized but palatable species such as shark and butterfly. Other Sea Grant projects involve parasites in summer flounder, commercial use of striped bass and the economics of the Bay's fisheries. Also under investigation are the population dynamics of the world renowned Chesapeake Bay blue crab fishery.

UNDERUTILIZED SPECIES

AN EVALUATION OF THE FISHERY POTENTIAL FOR SHARKS IN VIRGINIA (R/CF-3)

VIMS scientists Dr. John A. Musick and associate investigator James A. Colvocoresses recently completed one project evaluating the fishery potential for sharks in Virginia waters, and concluded that the spiny dogfish, Squalus acanthias, is present in commercially harvestable numbers in range of Virginia ports in winter. This project resulted from a rising interest in the development of a commercial shark fishery (particularly for dogfish during winter) on the part of area commercial fishermen, plus a steadily increasing recreational fishery for other species of sharks primarily taken during summer. The investigations conducted by Musick and Colvocoresses, enhanced by cooperation with local commercial fishermen and recreational shark fishing groups, have provided baseline data on dogfish and other shark species which will help managers set realistic harvest regulations as they become necessary.

AN EVALUATION OF THE FISHERY POTENTIAL OF UNDERUTILIZED MARKETABLE SPECIES IN VIRGINIA: ANGLERFISH (R/CF-10)

In a similar project focusing on another underutilized species, the anglerfish or monkfish Lophius americanus, Musick and Colvocoresses saw evidence of rising landings and a solid export market potential, but little concrete population and biology data to assist managers. Project goals, slated for completion in late 1983, are to assess the fishery potential for anglerfish in the northeast Atlantic, consider initial stock and potential yield, and describe the life history of the species.

ASSESSMENT OF THE BIOLOGY AND COMMERCIAL UTILIZATION OF THE ATLANTIC BUTTERFISH, PEPRILUS TRIACANTHUS, FROM VIRGINIA WATERS (R/CF-4)

A third Sea Grant project being conducted at VIMS concerns another commercial fish species, the Atlantic butterfly. In view of the fact that little was known concerning the biology, movements or mortality of the species, the project will assess the biology and commercial utilization of Peprilus triacanthus.

As a result of the study, VIMS graduate student Kenneth J. Sulak and associate investigator Dr. John A. Musick have been able to document the age-growth curve of the fish in Virginia waters, leading to a good measure of how long it takes the butterfly to attain commercial size, and in which age classes the bulk of the population is concentrated. (In 1981, 139,562 pounds of butterfly worth \$44,358 were landed in Virginia ports. The national harvest that year was worth \$2.6 million.)



VIMS scientist Dr. Eugene M. Burreson is conducting research to determine the effect of a certain parasite on juvenile summer flounder, an important commercial and recreational species.

The investigators also have documented the length-weight curve for the species, and have synthesized data on the seasonal timing of movements of size classes into and out of Chesapeake Bay. The project has supported Sulak's doctoral dissertation work.

EEL POT MESH SELECTION AND CATCH EFFICIENCY (R/CF-9)

Virginia eel fishermen and processors and the Virginia Marine Resources Commission have expressed concern in recent years that the increasing use of smaller-than-normal wire mesh eel pots might be detrimental to Virginia's eel resource. Reports of a decreasing average size of harvested eels and declining catches in the fall silver eel fishery indicated that the resource might be overfished.

VIMS marine scientists Marion Y. Hedgepeth, and later Robert K. Dias, undertook a study in 1981 to quantify the mesh selection characteristics and relative efficiency of eel pots.

Upon completion, study results were presented to the Potomac River Fishery Commission, which then developed minimum mesh-size restrictions for the Potomac River eel fishery. A master's thesis on the subject of eel biology and life history resulted from this work.

CHESAPEAKE BAY FISHERIES

EPIZOOTIOLOGY OF THE GILL FLAGELLATE CRYPTOBIA SP. IN THE CHESAPEAKE BAY (R/PM-2)

A gill flagellate of the genus Cryptobia, long known to cause large-scale mortalities in carp culture ponds in eastern Europe, was recently discovered in several marine species taken from Chesapeake Bay. This parasite has implications for future aquaculture of

marine fishes, and its occurrence in Virginia was deemed important enough to warrant a thorough study and documentation of the host range and environmental factors associated with the parasite.

VIMS scientists Dr. Eugene M. Bureson and Dave Zwerner determined that the gill parasite Cryptobia occurs year round in all salinities sampled (5-30 parts per thousand) and that it infests all the dominant fish in Chesapeake Bay. The experimental work was concluded at the end of 1981 when Bureson saw a need to switch his investigation to a more immediate threat: a blood parasite depleting stocks of juvenile summer flounder.

EFFECTS OF MORTALITY CAUSED BY THE HEMOFLAGELLATE, TRYPANOPLASMA BULLOCKI, ON YEAR CLASS STRENGTH OF SUMMER FLOUNDER, PARALICHTHUS DENTATUS (R/MP-1)

VIMS scientist Dr. Eugene M. Bureson, aware through previously funded Sea Grant research that the hemoflagellate Trypanoplasma bullocki could kill juvenile summer flounder, felt it was important to determine the magnitude of the mortality of this important commercial and recreational species.

Bureson, aided in his efforts by graduate student Joseph P. Sypek, has not found T. bullocki in any adult flounder examined. Yearling fish which survive the infestation cast the flagellate out when their immune response is triggered by warming water temperatures. The fish either die from the infestation or survive the encounter, and are not likely to be infected again. The parasite is vectored to juvenile summer flounder by a marine leech, Callinobdella vivida. Bureson stresses that flounder which have survived the parasite do not constitute a health hazard to

humans. This project is supporting work toward a doctoral dissertation on temperature influence on flounder immune response.

A REGIONAL SOCIAL ECONOMIC ANALYSIS OF COMMERCIAL USERS OF STRIPED BASS, MORONE SAXATILIS, IN VIRGINIA AND MARYLAND (R/SE-1)

The declining catches of striped bass north and east of Delaware, researchers feel, likely are related to the catches and size of the year class in the spawning grounds of Maryland, Virginia and North Carolina. A three-state workshop addressing this fisheries problem concluded that regional research of a socio-economic nature was necessary to complement the biological work being done. In Virginia, this Sea Grant sponsored work is being carried out by William & Mary sociologist Dr. Victor A. Liguori, and economist Dr. Samuel H. Baker.

Liguori is attempting to describe the individuals and populations of Virginia watermen who participate in the commercial striped bass gill net fishery, and the nature and extent of that fishery. Baker is developing two types of baseline data: returns and costs of representative fishery operators; and potential and actual economic impact of the striped bass fishery in Virginia. Similar work is being conducted by other investigators in Maryland and North Carolina.

ALTERNATIVE FUTURE DIRECTIONS FOR VIRGINIA'S CHESAPEAKE BAY FISHERY: AN ECONOMIC ASSESSMENT (R/SE-3)

The decline in the fishery harvest of the Chesapeake Bay and in income in the fishery has been a topic of public concern since the 1970's. Since 1977, there have

been two major legislative studies in Virginia which have examined the fate of these fisheries. However, according to Dr. Leonard A. Shabman, agricultural economist at VPI & SU and principal investigator on this Sea Grant project, it was clear that carefully designed economic models for evaluating public policies affecting the fishery were needed.

Shabman and associate investigator Dr. Oral Capps, Jr., are now developing such economic models, which will be used for the analysis of policy options for the Virginia inshore fishery. The analysis of the oyster industry, for example, has already set the stage for development of pilot programs in market development and ground productivity by the Virginia Marine Resources Commission and the Virginia Marine Products Commission.

This project is supporting work toward a doctoral dissertation on the economic, biological and institutional forces affecting Virginia's oyster harvest, a master's thesis on returns to effort management in the Virginia blue crab fishery, and a master's thesis on a systems model of demand for Virginia oysters.

BLUE CRAB LARVAE

DISTRIBUTION AND MIGRATION OF BLUE CRAB LARVAE IN THE LOWER CHESAPEAKE BAY AND ADJACENT COASTAL WATERS (R/CF-2)

Drs. Anthony J. Provenzano and John R. McConaugha of ODU designed a research project to trace the movement and distribution of blue crab larvae at the mouth of Chesapeake Bay, where most of the egg-producing female blue crabs overwinter. The scientists set out to determine the extent to which crabs spawned at the mouth of the Bay



Scientists at ODU are aiding management of the important blue crab fishery by investigating the distribution, recruitment and migration of blue crab larvae in the Chesapeake Bay and the Mid-Atlantic bight.

become part of the commercial crab fishery of the Bay itself.

Using sampling stations at the mouth of the Bay and further out on the Continental Shelf, and sampling at different water depths, Provenzano and McConaugha determined that blue crab larvae are released into the water column in a synchronized hatch at night on an ebb tide. Also, they discovered that the vast majority of the larvae are concentrated in the neuston layer, the first 10 cm of surface water. This suggested that the net movement of the larvae was seaward, and that further development occurred in shelf waters, an hypothesis later confirmed. Also, it was determined that prevailing wind patterns during the peak reproductive period set up surface currents which likely would keep the larvae near the mouth of the Bay. Attempts currently are under way to verify this latter hypothesis with field measurements.

DISTRIBUTION AND RECRUITMENT OF BLUE CRAB LARVAE IN THE MID-ATLANTIC BIGHT (R/CF-11)

A later blue crab project sponsored by Sea Grant, this time investigated by Drs. McConaugha, Provenzano and Dr. David F. Johnson of ODU is aimed at broadening the extent of knowledge gained in the first project.

The overall objective of this second proposal is to develop a population dynamic model of blue crab larval recruitment which will aid in the prediction of crab populations several years in advance. This project is part of a tri-state blue crab investigation being conducted by scientists at the Universities of Delaware and Maryland, and at ODU. Completion of the project should aid rational management of the important blue crab fishery.

This project has supported four graduate students doing work on doctoral dissertations and three completing master's theses.

Marine Environmental Research

The determination of realistic "buffer zones" near marinas, where shellfish harvesting is prohibited for public health reasons, and the factors affecting fecal coliform levels in given shellfish beds near marinas are points which have concerned regulatory agencies, marina operators and commercial fishermen for decades in the Chesapeake Bay and elsewhere. In Sea Grant projects at VIMS and ODU, scientists are aiming to produce an inexpensive but accurate method of setting marina buffer zones.

In other Sea Grant marine environmental research, scientists are attempting to determine dissolved oxygen content in estuaries, identify different sediments' history of movement, assess the impact of dredging on water quality, determine the mineral content of seafood, and improve understanding of weather in estuarine Virginia.

MARINA POLLUTANTS

HYDRAULIC MODEL VERIFICATION OF MARINA POLLUTANT FIELDS (R/CM-3)

Drs. Carvel Blair and George Hecker of ODU, and graduate students Michael J. Jugan and Larry White, hoped that the Corps of Engineers' Chesapeake Bay hydraulic model in Stevensville, Maryland, would allow researchers to predict the spread of pollutants at marina sites in Tidewater. Jugan's thesis subject centered on the model work. Unfortunately, Blair discovered that in comparisons with actual dye releases in the field, the model was inaccurate for predicting pollutant spread in shallow areas, where most marinas are located. In a followup phase of his investigation, Blair and co-workers at ODU are using a tidal flume they have designed to determine the minimal usable model depth for similitude of mixing.

EVALUATION OF REPRESENTATIVE MARINAS AS SOURCES OF FECAL COLIFORMS AND THE CONCEPT OF FECAL COLIFORM "BUFFER ZONE:" A COMBINED FIELD AND NUMERICAL MODELING STUDY (R/CM-5)

In a study conducted at VIMS, Drs. Howard Kator's and Martha Rhodes' work in bacteriological studies of fecal coliforms in the vicinity of estuarine marinas was meshed with Dr. Paul Hyer's expertise in developing a computerized mathematical model to determine tidal flushing. Hyer and his associate, Dr. Albert Y. Kuo, are conducting dye studies in the creeks, then developing mathematical models from the results.

Using the model for a representative marina, it was demonstrated that the application of buffer zone standards as presently used is inappropriate. In fact, the model demonstrated that an existing buffer zone could be decreased in size and still provide for an acceptable fecal coliform level in adjacent shellfish beds. Applied to other marina situations, the mathematical model concept could open some previously restricted shellfishing areas.

ESTUARINE PROCESSES AND PRODUCTS

OXYGEN DEMAND AND ESTUARINE WATER QUALITY (R/BP-1)

Field studies by VIMS marine scientists have revealed low dissolved oxygen concentrations in areas which had heavy loadings of organic detritus on the bottom, a finding corroborated by other observers in the past. Low dissolved oxygen in the waters of shallow estuaries creates a persistent problem for both fishes and invertebrates during summer, even in unpolluted locations. This is



In Sea Grant projects at ODU and VIMS, scientists are aiming to produce an inexpensive but accurate method of determining marina buffer zones.

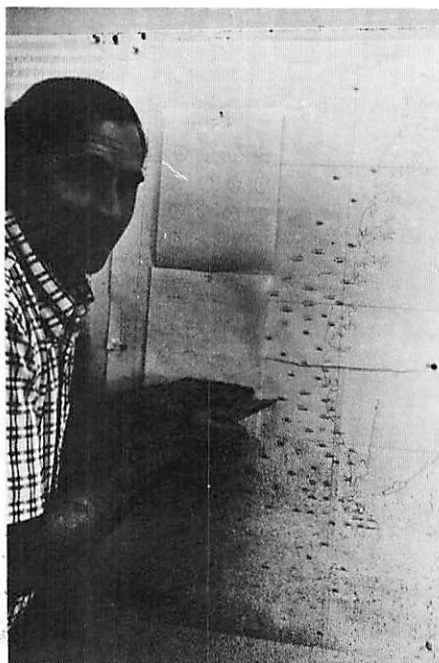
largely the result of the biochemical oxygen demand (BOD) from naturally occurring organic material, both dissolved and in particle form, originating from marsh plants, seagrasses, macroalgae, terrestrial plants and aquatic animals.

Dr. William E. Odum, University of Virginia (UVA), is principal investigator of this Sea Grant project to carry out a laboratory study establishing oxygen demand estimates for a number of estuarine dissolved organic materials. These BOD estimates will be incorporated into a water quality model to predict the effects of various dissolved organic matter on estuarine oxygen levels. Such information will be useful to land use planners, engineers and resource managers.

THE ENVIRONMENTAL GEOLOGY AND GEOCHEMISTRY OF WETLANDS IN SMALL INLETS (R/CM-6)

Planning, policy and management decisions concerning inlet and wetland development are based on a static set of data with respect to sedimentation rates and pollution uptake. However, because inlet systems normally progress through sequential evolutionary stages, policy and management plans have to be made in light of dynamic rather than static estimates.

Drs. George F. Oertel and George T. F. Wong of ODU hope to develop a method that will provide an index for determining the navigable life and environmental quality of critical use areas. These include waterfront communities, recreational marinas, and coves and marinas for sport fishing. The researchers are using cesium-137 and lead-210 as tools for measuring the rates of sedimentation in wetlands and basin floor sediments.



By identifying a sediment's source and history of movement, VIMS scientist Dr. John Boon is providing data to make decisions regarding dredging, waste disposal and containment of harmful contaminants in Bay sediments.

Graduate work supported by this project includes doctoral dissertations on radio geochemistry of coastal waters and sediment movement of the Metomkin Island complex, and master's work on the distribution of cesium-137, copper and zinc in the James River sedimentary deposits.

SOURCE IDENTIFICATION AND TRACING OF SAND SHOAL DEPOSITS IN LOWER CHESAPEAKE BAY USING FOURIER GRAIN SHAPE ANALYSIS (R/GO-1)

Scientists at VIMS have found that a process known as Fourier Grain Shape Analysis can identify a sediment's source and history of movement. Through a project being conducted by Drs. John Boon and David A. Evans it may be possible to distinguish between sands entering the Chesapeake Bay from the continental shelf and those that have come from rivers or an eroding shoreline. Their analysis would

provide data to make decisions regarding dredging, waste disposal and containment of harmful contaminants introduced into Bay sediments. Recent studies have shown that quartz particle morphology can be utilized to discriminate between sand deposits of different origins and dissimilar process histories of transport and abrasion.

A master's thesis on sand transport phenomena in the Rappahannock River estuary and a doctoral dissertation on particle abrasion and Fourier grain shape power distribution are being supported by this project.

SYNERGISTIC EFFECTS IN METAL ION/ORGANIC INTERACTIONS WITH SEDIMENTS (R/PS-1)

The impact of dredging upon estuarine water quality, especially since dredge material is removed predominantly from industrial sites, is a real concern to those managing dredge locations and schedules. Slightly less than half a billion tons of dredge material is displaced annually. This activity poses the threat of releasing heavy metals and other pollutants into the water, but the rate at which this occurs under varying environmental conditions is little understood.

This project, being conducted by Drs. John G. Dillard and Lucian W. Zelazny at VPI & SU, consists of tests documenting the attraction and release of lead and cadmium ions from representative sediment samples in the presence of different organic compounds and rates of salinity. Results from this research, while not transferable to all heavy metals in the marine environment, will at least give an indication providing baseline data for further specific work.

The project has supported master's thesis work on the exchange of lead and cadmium on selected test surfaces, and doctoral dissertation work on the characteristics of selected exchange surfaces.

CONTENT OF MINERAL ELEMENTS AND BIOAVAILABILITY OF CALCIUM, IRON AND ZINC FROM SEAFOOD (R/FD-1)

Information concerning the availability of actual nutrients from all foods, including fish, is essential to nutritional scientists and health professionals in the planning of diets for populations and individuals with specific health problems.

This Sea Grant project, under VPI & SU nutrition scientists Drs. S. J. Ritchey and L. Jannette Taper, was designed to provide proximate and mineral content of several species of finfish and shellfish, and to determine the bioavailability of calcium, iron and zinc in raw and cooked seafood. Species studied included herring, bluefish, croaker, sea trout, striped bass, fluke, oyster, clam, scallop and blue crab.

Graduate work toward master's degrees being supported by this project are in the following areas: proximate analysis and mineral determination of selected seafoods; relative bioavailability of zinc and manganese to rats from selected seafoods; and nutrient composition of selected Virginia seafoods.

METEOROLOGY

DEVELOPMENT OF HIGH-RESOLUTION WEATHER FORECASTS FOR CHESAPEAKE BAY AND ESTUARINE VIRGINIA (R/CM-7)

The abrupt change in elevation between Virginia's Blue Ridge and Piedmont ranges is one of the most



Dr. Patrick J. Michaels (r) of UVA, pictured with graduate student Chris Meyer, is conducting research designed to improve our understanding of the local climatologies of the Chesapeake Bay and Tidewater area.

climatically significant in the U.S. In many cases, erroneously favorable weather forecasts are given for Chesapeake Bay and estuarine Virginia, since severe weather can and does redevelop east of Washington, D.C. and Richmond.

Dr. Patrick J. Michaels, State Climatologist at UVA, and Dr. Roger A. Pielke are investigators on a current Sea Grant project designed to improve our understanding of the local climatologies of Chesapeake Bay and the Tidewater area. The scientists are attempting to develop county-based weather forecasts using information gained in local climate studies and remote sensing from satellite and radar.

The investigators feel benefits from this project, if successful, will aid weather sensitive industries and recreationists and will decrease rates of personal injury and mortality resulting from weather events. Five graduate

students in the UVA Department of Environmental Sciences are being supported by this project.

Marine Resources Utilization

As the world's population continues to expand, seafood is becoming increasingly important as a source of protein. Five Sea Grant projects are currently investigating species formerly overlooked or discarded in commercial catch, and investigating methods for utilizing the scrap or waste from the processing of traditional species. Various aspects of seafood processing dealing with cooking of battered seafood portions in fast food restaurants, air quality near seafood processing plants and modulation of seafood processing plants are also under investigation by Sea Grant researchers. Another project effort is researching alternatives to the costly technique of lowering gear to obtain information on manganese nodule deposits.

SEAFOOD SCRAP UTILIZATION

SEAFOOD WASTES IN PELLETTED FISH RATIONS AS FISH MEAL SUBSTITUTES (R/UW-1)

The accumulated wastes from crab-picking houses and fish-processing plants started presenting a disposal problem to processors in the mid-1970's in Virginia and elsewhere. At the same time, aquaculturists were experiencing an unstable protein supply in their feeds. Several concerned seafood processors in Virginia brought the problem to the attention of scientists at VPI & SU.

Drs. Larry A. Nielsen, George J. Flick and Roy L. Kirkpatrick of VPI & SU are seeking to determine the quality of seafood wastes as a fishfood ingredient, and also to determine the supply of such wastes available in Virginia. It was anticipated that a good product might be formed from the wastes,

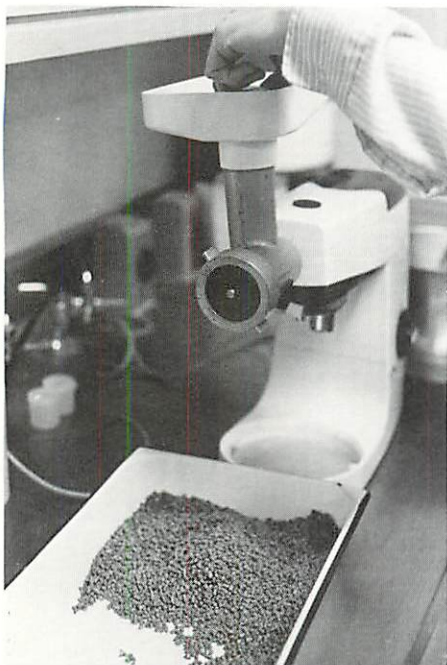
which amounted to 22,000 tons annually in the Commonwealth. If an acceptable fish food did in fact result, a profitable avenue of waste disposal benefitting both processors and aquaculturists would result.

Unfortunately, this did not occur. There were two reasons: the primary waste material (crab scrap) did not perform as well in feeding tests on channel catfish as did traditional feed sources; and changes in the feed processing procedure reduced the protein content to a commercially unacceptable level. Further details concerning this project are contained in a VPI & SU Sea Grant Extension bulletin entitled "Seafood Processing Wastes as Fish Meal Substitutes in Catfish Feeds."

A doctoral dissertation on the nutritional physiology of channel catfish also resulted from work supported by this project.

INVESTIGATIONS OF THE INFLUENCES AND PROPERTIES OF FISH SOLUBLES FOR CROP FERTILIZATION (R/UW-2)

A major fishmeal producer in Reedville, Virginia, Zapata Haynie Corporation, requested the assistance of scientists at VPI & SU in 1978 to help solve a waste disposal problem emanating from their production of menhaden meal. The National Pollution Discharge Elimination System had proscribed overboard discharge of the waste, and most municipal sewage plants would not take it because of cost and prohibitions listed in the Solid Waste Management Act. An alternative approach, chosen by Drs. Louis Aung and George J. Flick of VPI & SU, was to convert fish wastes into fish solubles to be used as agricultural crop fertilizer.



Scientists at VPI & SU have found that seafood wastes in pelleted form are a good source of protein in fish food.

Support for the project came initially from Zapata Haynie Corporation, and subsequently from the National Office of Sea Grant. The primary aim of this project was to demonstrate the value and practicality of using fish solubles as nutrients for commercial crops. It was demonstrated in laboratory and greenhouse studies by the investigators that a wide range of food and non-food crops did indeed respond favorably to fish solubles fertilization.

The Investigators concluded that while fish solubles do not possess a balanced nutrient composition (calcium was low) for crop plants, they still contained all the elements necessary for growing any crop plant.

FISH SOLUBLE NUTRIENTS FOR AGRICULTURE CROP FERTILIZATION UNDER DIFFERENT FIELD GROWING ENVIRONMENTS (R/UW-5)

A similar Sea Grant project, and one conceived as an extension of the VPI & SU work with the Zapata Haynie Corporation on fish solubles, was also funded by Sea Grant. Dr. Louis Aung, again assisted by Dr. George J. Flick, determined that information derived from laboratory and greenhouse studies might not necessarily correlate with crop responses to fish soluble nutrients under field growing conditions. The Investigators felt that validation of the results achieved in the laboratory and greenhouse would determine where the fish soluble nutrients could best be applied in commercial crop fertilization, thereby facilitating its marketability for major crops usage.

Work is now underway to determine the suitability of using the fish soluble nutrients on corn and soybeans under field growing conditions. Preliminary results indi-



Dr. Louis H. Aung (r) and research associate Janis B. Hubbard are using corn plants to demonstrate and determine the value of seafood by-products for agricultural crop fertilization and production.

cate an alteration in the grain chemical composition of treated plants, but no excessive evidence of heavy metals.

UTILIZATION OF SEAFOOD WASTE AS RUMINANT FEED (R/UW-4)

In another project aimed at finding a use for seafood wastes, Drs. Joseph Fontenot and George J. Flick of VPI & SU, and graduate student Winston Samuels, developed a program to study the practicality of ensiling the wastes with certain crop residues. The resulting silage was tested for palatability, and it was found that silages made from both crab scrap and finfish scrap were readily consumed by sheep.

Digestibility of the silages was fair, according to Fontenot, who adds that good ensiling was achieved with mixtures of crop residues and finfish processing wastes. In order to produce satisfactory silage from crab processing wastes and crop residues, it was necessary

to add substantial amounts of acetic acid.

The crab wastes and finfish wastes used in this project were supplied at no cost by Graham and Rollins Company (crab scrap) and Fass Brothers, Inc., (finfish scrap) of Hampton, Virginia, because of their interest in product development. A doctoral dissertation on the fermentation characteristics and nutritional value of the silages was supported by this work.

PHYSICO-CHEMICAL ASPECTS OF THE UPTAKE OF HEAVY METALS BY CHITIN AND CHITOSAN (R/UW-3)

A major portion of the approximately 400 million pounds of seafood waste produced annually in the U.S. comes from crab and shrimp processing. Virginia, with its proximity to Chesapeake Bay, accounts for a substantial amount of this total.

Much of the waste material left from crab processing is chitin, found in a crab shell. A

derivative of chitin, chitosan, has long been known as an effective material for combining with heavy metals. A current Sea Grant project by Dr. James P. Wightman at VPI & SU concerns an in-depth study of the interaction of a chitinous material (crab scrap) with various heavy metals, particularly those found in chemical waste effluents.

Wightman is conducting tests to determine the feasibility of using chitin, chitosan and raw crab wastes to remove arsenic, cadmium, copper, chromium, lead, mercury, nickel, silver and zinc from industrial waste water. The success of the project, it was anticipated, would benefit both crab processors (looking for waste disposal sources) and industrialists (operating under heavy metal discharge constraints).

Attempts have been made to obtain research results in a number of areas, primarily two industries in Blacksburg, Virginia. At these sites, the use of chitin to remove heavy metals from actual industrial effluent was demonstrated. Research results have been shared with two major industries outside of Virginia, and queries about this research have come from a total of six major U.S. companies, four U.S. government agencies, five foreign industries and government agencies, and ten universities in the U.S. and abroad.

A doctoral dissertation, "The Interaction of Heavy Metals with Chitinous Materials," is being supported by the project.

SEAFOOD PROCESSING

STANDARDIZATION OF BATTERED SEAFOOD PORTIONS FOR USE IN FAST FOOD RESTAURANTS (R/SP-2)

A representative of Gino's, Inc., a restaurant chain, contacted the scientific staff at VPI & SU in

1981 for assistance in solving a cooking problem associated with the battered portions of fish filet served in their restaurants. The director of research and development at Gino's, Inc., estimated that losses from serving undercooked and overcooked seafood portions approached 40 percent of total sales in some retail food stores.

Drs. Robert L. Ory and George J. Flick developed product specifications which resulted in uniform cooking times for battered fish portions, and also developed procedures for the preparation, holding and serving of the portions in fast food restaurants.

Research from this project, when applied, reduced losses to almost zero within two years. Cooperation on this work, scheduled for completion at the end of 1983, is continuing among the representatives of the U.S. Department of Agriculture, VPI & SU, Modern Maid Foods and Chick-fil-A, Inc. An education program for training fast food managers and employees in the preparation and serving of battered fish portions is now being developed.

This project has supported a masters' thesis on the subject of standardizing battered seafood portions for fast food restaurants.

AIR QUALITY ASSESSMENT OF SEAFOOD PLANTS AS IMPACTED BY SOLID WASTE (R/SP-1)

Seafood processors periodically have problems with high microbial counts on their products, especially during summer. The shell waste piles of crab and oyster processing plants, overlooked as sources of contamination previously, are characterized by flies and foul odors. This project, endorsed by the seafood industry and the Virginia State

Health Department, is examining the effect, if any, of shell waste piles on associated seafood products.

Dr. Donn R. Ward, VPI & SU researcher who is the principal investigator in this work, is determining the number and types of bacteria associated with air near shell piles, and is correlating bacterial numbers to factors which may affect air-borne bacterial numbers. These include ambient temperature, relative humidity, time of year and wind velocity.

If the air quality is adversely affected to a significant degree by the shell and scrap piles near the plants, Ward will make recommendations to mitigate the contaminating effects the air might have on product quality and wholesomeness.

APPROPRIATE TECHNOLOGY FOR SEAFOOD PROCESSING AND HANDLING (R/FD-5)

The highly labor intensive technology evident at Virginia seafood processing facilities differs little from that of several decades ago. Such is the opinion of Dr. Jose M. A. Tanchoco at VPI & SU who is conducting a Sea Grant study to provide production analysis and design modules for improving seafood processing.

The most significant result to date from this project is the development of a prototype workstation and processing line. The recommended design for the workstation is based upon the principles of standardization and modularization. Modular components of a workstation have been designed which can be easily assembled with a minimum of material, thus holding costs down. Hand motion economy, component interchangeability, modular dimensioning and material conveyance based on motorized and

gravity flows are characteristic of the workstations. Using workstation principles, it is hoped that currently used equipment can be upgraded to an economical level.

INSECT AND RODENT PESTS OF SEAFOOD PLANTS (A/AS-2)

The presence of insect and rodent pests around seafood processing plants, plus the presence of control chemicals for these pests, constitutes an unsanitary condition which can lead to plant closure. An increasing number of concerned seafood plant operators in Virginia have approached Sea Grant advisory agents at VPI & SU in the past several years for help in solving their pest problems.

Entomologist Dr. William H. Robinson saw a need to design a training program on the management of pests associated with the seafood plants, in view of the fact that plant-to-plant pest remedies across Tidewater Virginia varied so widely. Robinson and Sea Grant agreed to a four-step plan: a survey of current pest control programs in seafood processing plants; a comprehensive in-house training program for pest control personnel; a training program for management; and a schedule of regional and national workshops for management.

To date, formal training sessions have been conducted and several comprehensive manuals on pest control are nearing completion.

OCEAN MINING

ACOUSTIC SOUNDING FOR MANGANESE NODULES (R/OE-1)

This Sea Grant project is an attempt to design an acoustic system of nodule sampling which can be incorporated into a survey ship



Dr. Allen H. Magnuson of VPI & SU is studying the feasibility of using acoustic waves as prospecting tools for mining manganese nodules.

operating at or near normal cruising speed. Drs. Allen H. Magnuson and Karl Sundkvist of VPI & SU propose that, since acoustic sounding is commonly used to obtain information concerning the nature of the ocean floor, the presence and absence of manganese nodules can be inferred by proper analysis and interpretation of bottom-reflected pulse data.

The overall objective of this project, initially, was to establish the feasibility of the acoustic sampling concept. A project change was effected in mid-1981 when it became known that a Japanese metal mining company had put a nodule sounding analysis system on the market in early 1981. Contact with the company representatives resulted in a cooperative field test cruise where the Japanese Multi-Frequency Sounding System (MFES) was demonstrated.

The investigators report that other than facilitating the ocean testing phase, the MFES system has

had a minimal effect on their effort, which is based on analysis, computer predictions and laboratory work. They feel their more sophisticated approach is better suited to refinements and improvements of the first generation MFES system.

This project is supporting graduate work for two master's theses and one doctoral dissertation in manganese nodule-related acoustical sensing.

Marine Advisory Services and Education

The Sea Grant Marine Advisory Services (MAS) program is administered cooperatively through the Virginia Institute of Marine Science of the College of William & Mary (VIMS) and the Cooperative Extension Service at Virginia Polytechnic Institute and State University (VPI & SU). Activities of the Sea Grant MAS are diverse, involving research projects, advisory efforts and educational programs in such fields as seafood processing, seafood consumer education, export marketing and marine recreation.

MAS personnel reach their audiences in a variety of ways. By developing, testing and presenting business management materials and resource economic information, MAS programs serve industry managers and professionals concerned with the commercial fishing industry. Technological materials and educational programs are developed for managers and workers employed in the harvesting, processing, distribution and preparation of marine food products. Other MAS program efforts are designed to convey technical information in an understandable format to marine resource users and educators, and identify marine resource problems so that appropriate response can be taken.

Throughout their programs, MAS personnel maintain dialogue among users and managers of marine resources in order to promote understanding and cooperation.

MARINE FOOD RESOURCES

In the area of seafood processing the efforts of Virginia Sea Grant MAS are focused through VPI & SU. Activities during the past two years have encompassed a broad spectrum of seafood processing related problems ranging from the development of new products to the

problems of waste recovery and disposal. These programs have involved a wide range of industry and agency partners on local and national levels. Cooperating and participating partners include the Mid-Atlantic Fisheries Development Foundation, The National Marine Fisheries Service, Reynolds Metal Co., National Fisheries Institute, U.S. Dept. of Agriculture, National Blue Crab Industries Assoc., The Food and Drug Administration and many local seafood processing companies.

Hot water is used in many applications in seafood processing and demands significant amounts of energy. Researchers at VPI & SU are introducing heat recovery systems for hot water heating in seafood processing plants, with the goal of a 25 percent reduction of hot water energy expenditures.

Two waste products are currently produced in surf clam processing plants: adductor muscles which remain attached to the clam shells after processing, and large amounts of shell. Potential markets exist for both products.

The intent of VPI & SU researchers is to determine whether meat exists in sufficient concentration per volume of shell to make additional investment profitable, and to determine optimal particle size of shell as an alternative liming agent. Another objective is to have processors adopt effective waste recapture technologies in order to reduce lime cost to farmers.

Because most crabmeat products should be refrigerated and consumed within two weeks, a 20 to 50 percent extension on shelf-life can mean considerable savings for the industry and consumers. Research-



Research sponsored by Virginia Sea Grant resulted in production of a step-by-step manual for growing the hard clam. Subsequent annual short courses have drawn participants from 16 states, one territory and three foreign countries and established over 20 commercial hard clam seed hatcheries.

ers at VPI & SU are investigating the effectiveness and application of chemical food preservatives in suppressing the growth of coliform bacteria in crabmeat products.

Another VPI & SU project is assessing equipment capable of on-site quality determination of finfish. It is anticipated that a fast, repeatable, inexpensive means of determining the quality of finfish can be developed so processors could offer price incentives for a well-handled, quality product. The project is supported by the Mid-Atlantic Fisheries Development Foundation.

During the 1981 grant year, VPI & SU advisory personnel evaluated the use of potassium sorbate as a means of extending the shelf life of fresh oysters. Results demonstrated that the bacterial growth on oysters can be retarded and thus the marketable shelf-life of the product extended. The research was done on a grant sponsored by Monsanto Industrial Chemical Co.

During the sorbate application study, a promising technique to determine the quality of fresh oysters was discovered. Using a turbidity index of the oyster liquor, it may be possible to determine the quality of the oysters. It is hoped that by developing this rapid and repeatable means of determining oyster quality, processors and buyers will be able to test for quality using a known objective index.

Clam hearts, the muscles which open and close the shell, are currently included with the portion of surf clam salvage that is chopped and sold for clam chowder bases. At VPI & SU, work with industry is being done to determine if clam hearts, which are rather large



VPI & SU Home Economist Laurie M. Dean (r) familiarizes the public with the value of Virginia seafoods by appearing on the Metro show, hosted by Nancy Davis (l) and produced by WSET-TV in Lynchburg.

muscles, might yield a marketable product.

Research to enhance the marketability of another underused resource was prompted when the oyster industry indicated that work should be done to develop a product using small oysters that could be marketed in fast food restaurants. VPI & SU researchers are investigating uses for small oysters, with indications that successful utilization of small oysters could have a value over \$100,000 per year to the industry.

In other efforts, educational programs, workshops and manuals are currently promoting steam shucking of oysters. Steam treatment can improve shucking efficiency and make oyster shucking less demanding and energy-intensive, without unfavorable effects in the final product. VPI & SU researchers are also developing an analytical procedure to predict oyster meat temperature based on oyster travel time in the steam tunnel.

Another VPI & SU project is designed to develop and present energy management conferences and workshops to seafood processors, brokers and distributors in several East Coast states. Emphasis will primarily focus on reducing electrical demand, which currently represents 33 percent of the total electric charge. Since energy usage varies from one plant to another, an energy monitor will be used to evaluate a different seafood processing facility each month. VPI & SU researchers estimate that an energy management program would achieve a 10 percent reduction in electrical energy costs, saving from \$500 to \$36,000 per year depending on plant size.

In conjunction with two local crab packers and Reynolds Metal Co. in Richmond, Virginia, a project to study the feasibility of pasteurizing and sterilizing crabmeat using the retort pouch has been underway at VPI & SU. Major advan-

tages of the retort pouch include efficient heat penetration, reduced storage space for containers, and ease of opening.

With efficient heat penetration, a less severe thermal process of the pouched product, it is possible to preserve the desirable characteristics of crabmeat. At the same time, energy reduction during processing contributes to energy conservation and cost reduction. The use of flexible packaging for thermal processing was demonstrated at the Reynolds Metal Co. facility.

Through the Wetlands Department at VIMS, the MAS has assisted several seafood processors in understanding and interpreting permit requirements for plant discharge and plant modifications on the shoreline. Many such requests require permits from several agencies, and the permitting process can be complex and time consuming. In a very complex permitting requirement, a seafood processor requested assistance from VIMS MAS and estimated that their help saved him six months of work.

SEAFOOD HARVESTING

Sea Grant commercial fisheries activities are focused through the VIMS MAS fisheries and economic specialists, who provide a focal point for information transfer between the commercial fishing industry, the seafood industry and the scientific community. Activities within the section encompass a broad cross-section of disciplines ranging from marine economics to gear and technology transfer.

The soft-shell blue crab industry, although a major component of the Bay's fisheries, has

had little investigation into its structure. The VIMS MAS commercial fisheries specialist is compiling a much needed documentation of basic information on members of the soft crab industry, identifying their production techniques and problems, and assessing the economic impact of the soft-shell crab business. A very successful area of soft-shell work has been assistance to developing crab shedding operations and, in particular, consultation services to individuals desiring to enter the industry or interested in updating their current systems. A diagnostic on-site water quality service, which evaluates temperature, salinity and dissolved oxygen within shedding systems, has become very popular.

In March 1981, it was found that swans were inflicting heavy damage on oyster beds in Virginia's Northern Neck. While searching for benthic organisms, the swans would



Current Sea Grant projects are investigating the use of potassium sorbate as a means of extending the shelf life of oysters, steam shucking of oysters, and the marketability of small oysters in fast food restaurants.

"blow" holes in the bottom, causing silting over of oyster beds and damaging oysters planted in less than four feet of water. At the request of oyster planters in the Northern Neck, VIMS MAS assessed the swan damage, estimating total losses approaching \$70,000 for planted oysters. The Virginia Commission on Game and Inland Fisheries has taken the lead in this problem and will work with other agencies and affected individuals on possible actions to reduce future oyster losses due to swan damage.

Rock crabs, which historically have been discarded from catches of blue crabs in the winter dredge fishery in Virginia, represent a potentially important resource in the Bay. Past experience has shown that rock crabs may be held in tanks for soft-shell production, such as blue crabs are. A VIMS MAS project is assisting in the potential emergence of the soft rock crab fishery. To date, a shedding facility for one individual has been designed. The entire process, and subsequent production is being monitored and chronicled.

A large portion of Virginia's oyster fishery relies on privately planted and harvested oysters. A VIMS MAS service is helping oyster growers monitor water temperature and salinity over their oyster grounds. Assistance has also been given to the Potomac River Fisheries Commission in their planting program.

The first annual Virginia Fisherman's Forum was held in 1982, co-sponsored by VIMS MAS and the Virginia Marine Products Commission, with support of watermen's

associations. Industry and academic representatives participated in the day-long series of presentations relating to seafood marketing and economics.

In the absence of an offshore fisheries gear specialist, VIMS MAS enlisted the aid of an experienced offshore shipper to provide services to that segment of the fishing industry. Onboard training sessions were provided to the captains and crews of commercial fishing vessels wishing to convert to finfish on such subjects as proper net rigging, net minding and fishing methods.

In the area of marine economics, a second banker's seminar in 1981 emphasized the fisheries industry in terms of vessel cost and returns, profitability and risk assessment. The day-long seminar was co-sponsored by VIMS MAS, Virginia Banker's Association and Virginia Marine Products Commission. Other economic activities concentrated on an analysis of major fishery products of the Bay, hard clam economic analysis and management assistance for commercial fishermen.

The export of U.S. fish and seafood products has become a major program focus on the part of the NMFS and regional fisheries development foundations. VIMS MAS has actively supported these efforts by developing a program to assist Virginia seafood producers in exploring the potential of export markets. These efforts are in coordination with the Virginia Marine Products Commission, Virginia Department of Agriculture and Consumer Affairs, NMFS, USAID and regional fisheries development foundations.

Activities in 1981 were highlighted with participation in the

USDA Cain, Egypt, Food Show. VIMS MAS coordinated the shipment of frozen seafood samples and represented regional interests at the show and during visits with Egyptian government officials and USAID representatives.

SEAFOOD EDUCATION AND MARKETING

This major program effort, focused through VPI & SU MAS involves interactions with news media, home economics teachers, students, extension agents, seafood retailers, restaurateurs and the general public. Outreach activities include programs for extension agents and educators, youth programs, seafood training for retailers, and television and in-store seafood demonstrations for consumers.

A weekly column discussing some aspect of seafood continues to be prepared at VPI & SU and distributed to daily newspapers. Also, in

cooperation with the Mid-Atlantic Fisheries Development Foundation Institute of Food Technologists, a national information system was established to obtain information for food editors.

Home economics teachers were encouraged to implement seafood product units within their foods curricula during a three-week course, Marine Food Products, which enabled all teachers within the Tidewater school systems to participate. During 1981 and 1982, the Mid-Atlantic Fisheries Development Foundation awarded VPI & SU MAS \$20,000 to teach the course to seafood marketing professionals. Teacher training activities included seminars on seafood nutrition; how to purchase, prepare and serve seafood; use of seafood in institutional food service; and development of educational materials relating to seafood use.

A cooperative seafood consumer education program was cosponsored



Marine Trades and Recreation Specialist Jon Lucy (l) of VIMS MAS helped organize the first American Conference on Sail-Assisted Power Technology. Pictured with Lucy is Capt. Jesse Briggs of the sail-assisted tugboat "Norfolk Rebel."

by the VPI & SU MAS, Virginia Marine Products Commission, Virginia Seafood Council, Virginia Department of Agriculture and Consumer Services, and the Mid-Atlantic Fisheries Development Foundation to promote seafood consumption. During the past two years, programs have been developed in response to the "Catch America" program sponsored by the National Fishery Institute and the National Marine Fisheries Service. Programs included a weekly tip-line to inform consumers on topics such as seafood availability and economical purchases, exhibits, workshops, and educational programs for home economics teachers and extension agents.

Work with seafood retailers included a fresh seafood marketing program developed by VPI & SU, the Pennsylvania Food Merchants Association and the National Association of Grocers of the United States, and a seafood industry workshop for food retailers.

MARINE TRADES AND RECREATION

The VIMS MAS marine trades and marine recreation specialist addresses issues and problems concerning a broad cross-section of groups including sport fishermen, boaters, divers, marine trade businesses and boat operators. Close communication is maintained with these coastal audiences and an effective combination of workshops, seminars, conferences, and media responds to their many needs.

The diverse marine trades in Virginia, like elsewhere, have gone through hard economic times in the past few years. These issues were addressed in a financial management seminar in conjunction with the annual meeting of the Virginia



A major focus of the Marine Education Program is providing marine education activities designed to improve young people's understanding of the marine environment and its resources.

Association of Marine Industries. In addition, a joint meeting of the Virginia Peninsula Marine Trades Association and Tidewater Marine Trade Association, hosted by VIMS MAS, addressed the topic of product liability law.

The first American conference on sail-assisted power technology, cosponsored by VIMS MAS, the National Marine Fisheries Service and Florida Sea Grant, drew people from Norway, Britain, Canada and the United States.

In response to demand by Virginia sport divers, VIMS MAS organized and hosted the second annual Sport Diving Workshop in Virginia Beach.

In the area of urban waterfront development, the first Chesapeake Work Boat Race was organized for Norfolk's Harborfest.

Also, a 27-minute video program about dangerous marine animals was produced through The College of William & Mary's television services and aired on commercial and PBS stations.

MARINE EDUCATION

The nationally recognized VIMS Marine Education Program provides programs and assistance designed to improve public understanding of the marine environment and its resources. A major focus of the program is professional development for educators through workshops, courses and field trips.

In 1981 and 1982, the VIMS MAS education staff conducted two-day marine life courses for the Virginia Resource Use Education Council's Environmental Education program, and sponsored two one-credit marine courses at the 1982

Mid-Atlantic Marine Education Association Conference. Another course, "Coastal Problems and Resource Management," was used in five Virginia schools. Other activities included student and teacher research vessel cruises.

The development of inexpensive activity-oriented materials to be used by teachers included a science education film produced with the Virginia Department of Education, the slide program "CREST - A Marine Education Program for Gifted Students," and the "Marine Science Methods for the Classroom" (MSM's) written series. The "Oceanography for Landlubbers" program series, offered through the College of William and Mary, continued to address the need for continuing education in the area of marine studies.

The Marine Education Materials System (MEMS) is a central part of the VIMS MAS education effort. MEMS provides a growing collection of curricula, field guides, and laboratory manuals distributed through a computerized nationwide network.

The VIMS MAS marine education staff also serves as a resource for all types of marine education activities for young people including gifted groups, regular classroom students, 4-H and Girl Scouts.

COMMUNICATIONS AND PUBLICATIONS

The overall objective of Sea Grant communications and publications efforts at VIMS and VPI & SU is to implement an educational multi-media program directed at particular audiences and their respective needs.

Continuing publication at VPI & SU were the "Foods from the Sea" column, which is distributed to 21 newspapers in five states, the

"Virginia Marine Times" tabloid, which is mailed to over 3,000 subscribers, and the "Food Service and Technology Notes" series of brochures.

New VPI & SU publications included "Seafood Products Teacher Resource Guide" which was used as a textbook for a seafood products course, and Chemistry and Biochemistry of Marine Food Products, a sourcebook collection of speech manuscripts.

Regular requests continued for the popular VPI & SU publications Analysis of Exploited Fish Populations, Endangered and Threatened Plants and Animals of Virginia, Sanitation Notebook for the Seafood Industry, and Microbiological Techniques Manual for the Food Industry.

Continuing quarterly publications through VIMS MAS were the "Marine Resource Bulletin," which is mailed to over 7,000 subscribers, the "Commercial Fishing Newsletter," which is directed to the fishing industry and mailed to over 2,000 subscribers, and the monthly "Tide Graphs," which are free to the public. Special topic monographs continued to be distributed through the "Marine Resource Advisory" and "Fishery Flash" series.

Other VIMS MAS media communications included twice-monthly five-minute segments on the local television morning show "Tidewater Today."

Frequent requests continued for VIMS MAS The Chesapeake: A Boating Guide to Weather, Manual for Growing the Hard Clam, Shoreline Erosion in Virginia, and the popular fish species brochure series.

OTHER PROJECTS

A PILOT PROGRAM IN MARINE ENVIRONMENTAL JOURNALISM (E/J-2)

Linda H. Scanlan, journalism professor at Norfolk State University, has implemented the first academic program aimed at improving writing and reporting in the area of marine environmental journalism. Courses are designed to train undergraduate and graduate students to write and report on marine issues, provide mid-career training in marine environmental writing for working journalists, and increase public knowledge and awareness of environmental and scientific issues.

To date, the program has developed a two-course, six-hour sequence including Reporting the Marine Environment and Issues in Marine Environmental Reporting for graduate and undergraduate communications/journalism students. Internships have been developed to place students in temporary summer jobs where their skills in marine writing can be used. Program efforts have also obtained private funding for workshops in Marine Environmental Reporting for professional journalists.

SEA GRANT INTERNSHIPS (E/I-4), E/I-5)

As part of a continuing exercise to involve talented graduate students in governmental processes, the National Office of Sea Grant instituted an Intern program in 1979. N. B. Theberge, head of the VIMS Ocean and Coastal Law Department, continued to direct the program in 1981/82.

Since the start of the pro-

gram, five interns have been chosen from colleges and universities in Virginia. Michael De Luca, a marine resource management student at VIMS, worked with the National Advisory Committee on Oceans and Atmosphere (NACOA) in 1981, with primary responsibility in the area of marine minerals and ocean mining. Glenn R. Delaney, another VIMS graduate student in marine resource management, worked in 1982 for the House Subcommittee on Fisheries and Wildlife, chaired by Louisiana Congressman John Breaux.

VIRGINIA MARINE 4-H PROGRAM (E/FH-1)

Since January 1981, 4-H'ers in Virginia have been receiving the benefits of a statewide marine lecture and field activities program. Directed by extension 4-H specialist Richard F. Booker of VPI & SU, with assistance from extension specialists Barry W. Fox, Mitchell Peterson, Jr. and Rudolph Powell, this Sea Grant project has enrolled over 5,000 4-H'ers in its first year.

The Virginia 4-H Marine Program, as it is termed, involves 4-H in-school club activities, volunteer leader and agent training and summer field activities. A nine-unit education module for school clubs is in publication.

A UNION LIST OF SERIALS IN MARINE SCIENCE LIBRARIES (A/IS-2)

A basic form of networking among libraries is the interlibrary loan system, a cooperative arrangement by which libraries borrow books and acquire photo-copies. Librarians determine locations for these loans and purchases by referring to union catalogs, which document the collections of a limited number of libraries, primarily mammoth research institutions.

In many cases, though, these same titles are held by smaller, non-reporting libraries. The more obscure titles, particularly those with narrow subject matter or interest, are difficult to locate.

A project design to spread out the information network so librarians know the holdings of libraries nationwide is being investigated by M. Janice Meadows, Susan O. Barrick, and Diane Walker of the VIMS library.

Objectives of the project are to collect up-to-date periodicals and journals holding lists from North American Marine libraries, to integrate these lists into a union list by programming material into a computer, and to produce microfiche copies of the union lists for distribution to all libraries that desire access to marine-related serials.

INSECT AND RODENT PESTS OF SEAFOOD PROCESSING PLANTS: A TRAINING RESOURCE MANUAL AND EDUCATIONAL PROGRAM (A/AS-2)

Modern seafood processing establishments must comply with the high standards of sanitation and pest control expected by the public and strictly enforced by regulatory agencies. In-house pest control personnel need basic and continued training to ensure that pest control in food processing operations is reliable, effective and designed with minimum use of pesticides and maximum use of sanitation.

Dr. William H. Robinson of VPI & SU is designing a training program on the management of pests associated with seafood processing plants. The project involves training for management and pest control personnel, and the dissemination of program materials on a national basis.

THREE-VOLUME CASEBOOK ON OCEANS LAW AND POLICY

A three-volume casebook on oceans law and policy is being prepared by John Norton Moore, director of the Center for Oceans Law and Policy at UVA. Moore plans to develop a two-volume reader and one-volume casebook which will reflect the interface between U.S. domestic and international oceans law and policy.

At present, students in law schools and graduate programs in marine affairs must spend substantial research time and funds searching out, photocopying and updating materials which are on reserve only. It is anticipated that the reader and casebook will reduce research time by 50 to 75 percent, making available for the first time materials integrating U.S. domestic and international oceans law and policy. The publications resulting from this project, available for the start of the 1981-82 school year, will also encourage the promotion of oceans law and policy courses in law schools and marine affairs graduate programs.

Program Administration and Development

The goals of the Virginia Graduate Marine Science Consortium director are to coordinate Sea Grant research, education and advisory services within Virginia, and bring together the resources of consortium institutions to address issues confronting users of Virginia's marine and coastal resources. Considerable effort is put forth in initiating new research projects that address various emerging problems or opportunities. Funds have been provided for several new projects including the design of a physical model of blue crab larvae distribution and the determination of pink shrimp food sources.

Many emerging problems cannot be predicted early enough to permit the evolution of proposal preparation and review as it usually occurs. Thus, capability is also provided for Sea Grant Marine Advisory Services to respond quickly to newly emerging problems by short-term research or advisory actions. For example, rapid response funds were provided for the purchase of equipment to be used in conducting workshops for crab pasteurization machinery operators. This was in direct response to industry needs for resolving product quality issues and providing certified operation personnel.

Activity Budget, 1981

	<u>NOAA GRANT FUNDS</u>	<u>UNIVERSITY MATCHING FUNDS</u>
Marine Resources Development		
Aquaculture	\$ 118,333	\$ 71,971
Living Resources, other than		
Aquaculture	149,048	127,674
Mineral Resources	44,000	25,600
Socio-Economic and Legal Studies		
Marine Economics	46,470	29,874
Marine Technology Research and Development		
Resource Recovery and Utilization	113,600	80,500
Marine Environmental Research		
Research and Studies in Direct Support		
of Coastal Management Studies	54,094	31,809
Pollution Studies	118,100	8,185
Environmental Models	15,320	17,405
Applied Oceanography	21,222	15,073
Marine Education and Training		
College Level	52,938	30,497
Other	62,506	24,386
Advisory Services		
Other Advisory Services	506,873	316,548
Program Management and Development		
Program Administration	<u>135,596</u>	<u>97,353</u>
TOTAL	\$1,438,100	\$ 876,875

Activity Budget, 1982

	<u>NOAA</u> <u>GRANT FUNDS</u>	<u>UNIVERSITY</u> <u>MATCHING FUNDS</u>
Marine Resources Development		
Aquaculture	\$ 119,337	\$ 80,218
Living Resources, other		
than Aquaculture	91,989	49,338
Mineral Resources	47,369	24,003
Socio-Economic and Legal Studies		
Marine Economics	40,000	27,796
Marine Technology Research and Development		
Resource Recovery and Utilization	84,659	55,107
Marine Environmental Research		
Research and Studies in Direct Support		
of Coastal Management Studies	117,559	75,080
Pollution Studies	34,045	27,968
Marine Education and Training		
Other Education	86,221	26,608
Advisory Services		
Extension Programs	499,834	284,478
Other Advisory Services	37,088	23,220
Program Management and Development		
Program Administration	103,558	60,000
Program Development	<u>56,441</u>	<u>0</u>
TOTAL	\$1,318,100	\$ 733,816

Project Summary 1981-82

PROJECT		1981	1982
PROGRAM ADMINISTRATION			
M/P-1	Program Management (VPI&SU)	F	
M/PA-1	Program Administration (VIMS)	F	
M/AD-1	Program Administration (VGMSC)	I	
M/AD-2	Proj. Devel. and Prob. Response		C
E/l-4	Sea Grant Internship	I-F	
E/l-5	Sea Grant Internship		I-F
MARINE RESOURCES DEVELOPMENT - AQUACULTURE			
R/A-3	Shellfish Disease Resistance	F	
R/A-5	Genetics of Hard Clams	F	
R/A-9	Brewery Wastes in Oyster Culture	I	F
R/A-10	Artificial Foods of Oyster Larvae	I	C
R/A-11	Supplemental Feeds for Clams		I-F
R/A-13	Genetics of Hard Clam Growth		I
MARINE RESOURCES DEVELOPMENT - FISHERIES AND OCEANOGRAPHY			
R/BO-1	Phytoplankton Assemblages	I	F
R/CF-2	Blue Crab Larval Distribution	F	
R/CF-3	Potenital Shark Fishery	C	F
R/CF-4	Biology and Use of Butterfish	F	
R/CF-9	Eel Pot Mesh Selection	I-F	
R/CF-10	Anglerfish Population Biology		I
R/CF-11	Blue Crab Larval Distrib. II		I
R/CF-12	Blue Crab Physical Model		D
R/SE-1	Socio-economics of Striped Bass	I-F	
R/SE-3	Chesapeake Bay Fishery Economics	I	C
R/PM-2	Gill Flagellate <u>Cryptobia</u>	I-F	
R/MP-1	Flounder Hemoflagellate		I

F = FINAL YEAR
 I = INITIAL YEAR
 D = INITIATED, PROJECT DEVELOPMENT
 C = CONTINUING EFFORT
 R = RE-DIRECTED

Project Summary 1981-82

PROJECT	1981	1982
MARINE ENVIRONMENTAL RESEARCH		
R/CM-3	Hydraulic Model of Marinas	C F
R/CM-4	Math. Model of Marina Discharge	(combined with R/CM-5)
R/CM-5	Fecal Coliforms From Marinas	C-R F
R/CM-6	Wetland Geology and Geochemistry	C F
R/GO-1	Tracing Sand Deposits	C F
R/BP-1	Estuarine Water Quality	F
R/PS-1	Metal/Organic Interactions	I-F
R/PS-2	Metallothionein in Fishes	D-F
R/CM-7	High Resolution Weather Forecasts	I
R/CM-9	Seagrass Food Webs	D
MARINE RESOURCES UTILIZATION		
R/FD-1	Elements in Seafoods	F
R/FD-5	Processing and Handling Designs	F
R/UW-1	Seafood Wastes in Fish Rations	F
R/UW-2	Fish Solubles as Fertilizer	F
R/UW-3	Heavy Metal Uptake by Chitin	I F
R/UW-4	Seafood Waste as Ruminant Feed	I C
R/UW-5	Fish Solubles as Fertilizer II	I
R/SP-1	Air Quality in Seafood Plants	I-F
R/SP-2	Standardized Seafood Portions	I
R/OE-1	Acoustic Sounding for Nodules	C C
MARINE ADVISORY SERVICES AND EDUCATION		
A/AS-1	Marine Advisory Service (VPI&SU)	(combined with A/EP-1)
A/EP-1	Marine Advisory Service (VIMS)	(combined with A/AS-1)
A/EP-1	Marine Advisory Service (VGMS)	R C
E/J-1	Environmental Journalism	F
E/FH-1	Four-H Marine Program	I C
A/IS-2	Union List of Serials	I F
none	Marine Affairs Casebook	I-F
A/AS-2	Seafood Plant Pests	I C

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Program Management

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