Virginia Sea Grant Biennial Report
1983-84

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Contents

The Virginia Sea Grant College Program is part of the National Sea Grant College Program, a state-federal partnership designed to promote wise use and development of the nation's coasts and oceans through research, education, and advisory services. Virginia Sea Grant is administered through the Virginia Graduate Marine Science Consortium with member institutions at The College of William and Mary, Old Dominion University, University of Virginia, and Virginia Polytechnic Institute and State University.

Introduction

Greetings —

This biennial report describes activities within the Virginia Sea Grant Program during the years 1983 and 1984. In both years, the Program continued its combined research, education, and advisory services mission to address issues related to the utilization and management of marine and coastal resources. Many of the activities involving Sea Grant personnel are designed to assist Virginia's citizens or agencies as they face decisions concerning their particular interests in the Commonwealth's coastal lands and waters. Other Sea Grant projects have regional or national impact, either through the application of research results or as technology transfer occurs through the advisory services.

The Virginia Sea Grant Program was formed in 1981 through the joining together of Sea Grant efforts at the Virginia Institute of Marine Sciences with those at Virginia Polytechnic Institute and State University. The initial two years as a single program with research projects located in several of Virginia's universities demonstrated that an effective administrative structure had been created for the Program and that the management procedures being employed were working as intended.

During 1983, program management and institutional interactions matured and stabilized at a desired level, and in 1984 the Virginia Sea Grant Program achieved designation as the twentieth Sea Grant College in the nation. This designation by Secretary of Commerce Malcomb Baldridge was recognized through ceremonies conducted at the University of Virginia, Old Dominion University, the College of William and Mary, and Virginia Tech—the four institutions which comprise the Virginia Graduate Marine Science Consortium which oversees administration of Sea Grant activities in Virginia.

Sea Grant College status, the highest possible level of achievement for a Sea Grant program, recognized the Virginia Program's ability to effectively manage and conduct the research, education, and advisory services required. It also carries with it the obligation to continue such activities at a high level of competency.

The report which is before you is evidence of the continued dedication and effectiveness of the Virginia Sea Grant College Program in carrying out that obligation. The diverse and talented faculties of the universities within Virginia are being brought together to address the multitude of scientific and policy issues facing those who would use or manage our marine and coastal resources.

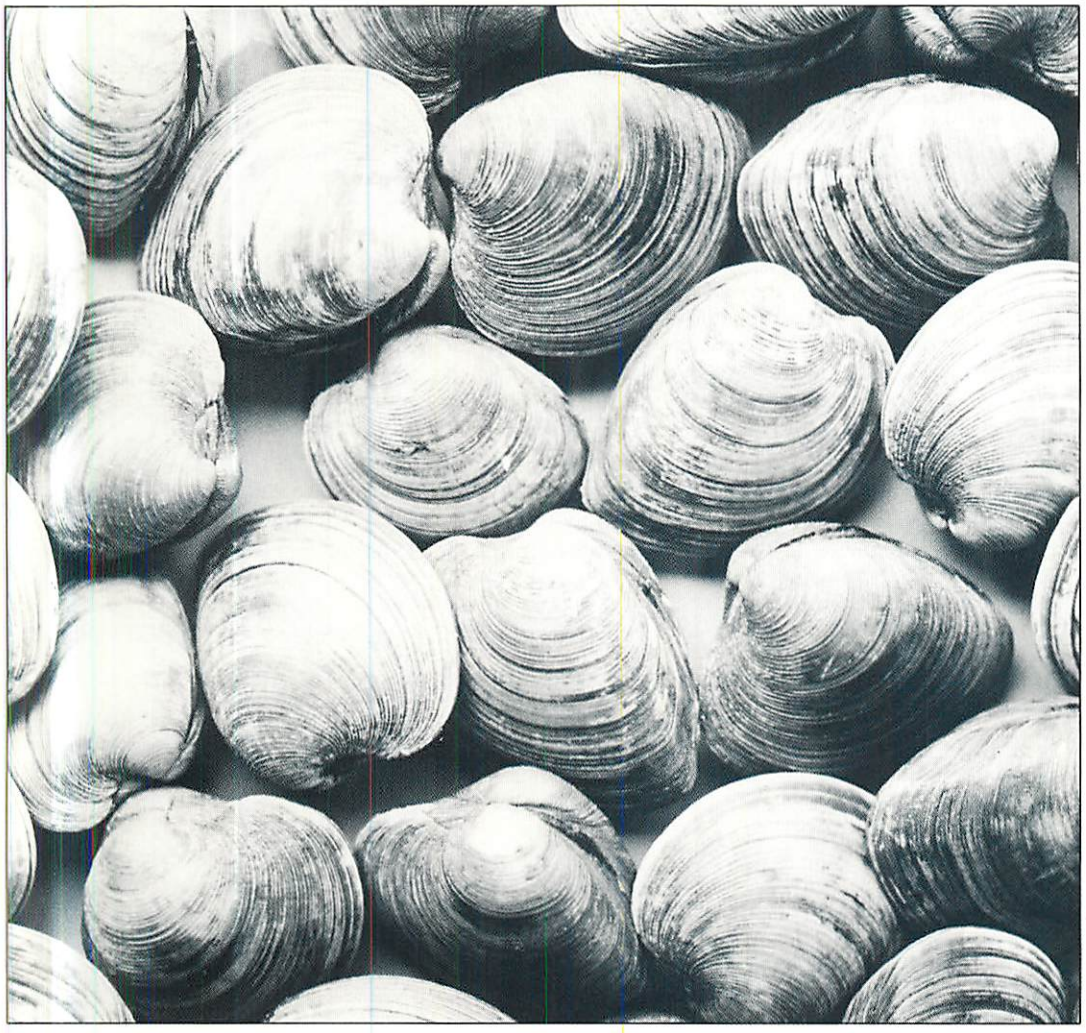
Sea Grant in Virginia has been, and will continue to be, a combined university/government/industry partnership working to produce information and scientific results which have positive impacts on the economic benefits to be derived from our marine and coastal areas.

The descriptions of Sea Grant efforts contained in this report will demonstrate the Program's effectiveness. I hope that you will find this information of interest and use to you.

William L. Rickards

William L. Rickards
Director

Aquaculture



The goals of this program area are: to conduct researc which will aid both existing and emerging aquaculture ven tures in becoming economically stable; and to demonstrat state-of-the-art technology to assist development of the industr

Aquaculture projects initiated in the 1983-84 biennium include:

***Genetics of Geographical Effects on Growth Rates in the Hard Clam,* Mercenaria mercenaria**—*Dr. S. Laura Adamkewicz of George Mason University.* (R/A-14 *initiated in* 1984)

***Investigation of Acquired Immunity: Adaptive Response in the American Oyster,* Crassostrea virginica**—*Dr. Fu-Lin Chu and Dr. Beverly A. Weeks of the Virginia Institute of Marine Science.* (R/A-15 *initiated in* 1983)

Oyster Food in a Capsule

Artificial Food for Oyster Larvae—*Dr. Kenneth L. Webb, Dr. Fu-Lin Chu, and Daniel A. Hepworth of the Virginia Institute of Marine Science* (R/A-10 *completed in* 1983)

The provision of live algal food for the culture of oyster larvae has been a major difficulty for commercial oyster seed hatcheries. Certain types of algae are necessary as food for growing oyster larvae, but the procedure for cultivating live algae is costly and labor-intensive, and production is often unpredictable. Partly because of the high cost of culturing live algae, the prices of oyster seed and larvae are increasing.

Scientists at the Virginia Institute of Marine Science (VIMS) have found that oyster larvae will eat an artificial diet of food in tiny capsules. In a three-year research project, Dr. Ken Webb and associate investigators Dr. Fu-Lin Chu and Daniel Hepworth successfully encapsulated nutrients in microcapsules and raised oyster larvae to the "eyed" larval stage.

The researchers tested encapsulated diets composed of mixtures of fatty acids, amino acids, and carbohydrates; soybean extract, cod liver oil, and glucose; and the three types of algae that larval oysters are normally fed in culture operations.

Experiments showed that oyster larvae that were fed the artificial microencapsulated food grew nearly as rapidly as larvae that were fed costly live algae. A combination of live algae and microcapsules proved to be equally as effective as a regular live algal diet.

Use of the microencapsulated diet procedures resulting from this project provides one of the technological breakthroughs needed to bring oyster hatcheries into economic feasibility. Once the optimal proportion of live algae and microcapsules in the larval diet is determined, the approach of using mixtures of the two may be a viable alternative to reduce culture costs in oyster hatcheries.

Genetics of Growth and Reproduction in the Hard Clam, *Mercenaria mercenaria*—*Dr. S. Laura Adamkewicz of George Mason University.* (R/A-13 *completed in* 1983)

In the past, much scientific effort has concentrated on developing improved survival and growth rates for shellfish in aquaculture systems. Now that many different species are successfully under cultivation, there is a need to increase production through hybridization and selection of genetically improved stocks.

Through her research, Dr. Laura Adamkewicz of George Mason University has been successful in developing a breeding program for producing superior strains of hard clams for mariculture. In this project, Adamkewicz found that specific allozyme genotypes, rather than the general level of heterozygosity, are associated with rapid growth. This knowledge makes it possible to select genetically superior parents for breeding programs, thus shortening the number of generations needed to produce an improved strain.

Another important project result was development of a nonfatal technique for determining the allozyme genotypes of hard clams. In the new method, clams are narcotized and then a snip biopsy is taken from the mantle edge. This sampling technique showed a much higher survival rate than earlier methods involving quick-freezing or drilling holes in the shell.

Hard clams identified as having superior genotypes were spawned in 1982 to produce the first cohort of a new, high-growth strain. This new stock, monitored at the Virginia Institute of Marine Science hatchery in Wachapreague, was combined with the best genotypes from the next year's selected group of clams. In this manner, each year's superior stock will continue to produce superior offspring to be added to the new selected strain.

Technology developed in this project is now being used successfully in several breeding programs which are attempting to produce superior strains of hard clams for mariculture. Adamkewicz is continuing her work in advancing the field of hard clam mariculture in another Sea Grant-funded project.

Fisheries and Oceanography

The goals of this program area are: to assist the development of new fishery options for the industry; to analyze the population dynamics of exploited marine resources and the influence of environmental and anthropogenic factors on fishery yields; and to develop fisheries and oceanographic information which will assist management agencies and industry in making wise regulatory and investment decisions.

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Fisheries and oceanography projects initiated in the 1983-84 biennium include:

***Assessing an Oyster Production Index for Management of Oyster-Growing Waters*—**
Dr. Bruce J. Neilson, Dexter S. Haven, and Gary F. Anderson of the Virginia Institute of Marine Science (R/CF-15 *initiated in* 1984)

***Investigation of the Process of Self-Purification in Relayed Shellfish*—**
Dr. Howard I. Kator, Martha W. Rhodes, and Dexter S. Haven of the Virginia Institute of Marine Science. (R/CF-16 *initiated in* 1984)

***Evaluating Public Policy Options for Increasing Production of Market Oysters*—**
Dr. Leonard A. Shabman, Dr. Oral Capps, Jr., and Dr. Charles W. Coale of Virginia Polytechnic Institute and State University. (R/SE-4 *initiated in* 1984)

***Life Cycle Studies of the Oyster Pathogens* Minchinia costalis (SSO) *and* Minchinia nelsoni (MSX) Using Florescent Antibody Techniques**—
Dr. Eugene M. Burreson of the Virginia Institute of Marine Science. (R/MP-2 *initiated in* 1984)

***Effects of Environmental Pollutants on the Cellular Immune Response of Fish*—**
Dr. Beverly A. Weeks and J. Ernest Warriner of the Virginia Institute of Marine Science. (R/MP-3 *initiated in* 1984)

Predicting Blue Crab Larvae in the Bay

Distribution and Recruitment of Blue Crab Larvae in the Mid-Atlantic Bight—*Dr. John R. McConaugha of Old Dominion University* (R/CF-11 *completed in* 1984)

Distribution and Recruitment of Blue Crab Larvae: A Physical Model—*Dr. Donald R. Johnson and Dr. John R. McConaugha of Old Dominion University* (R/CF-12 *to be completed in* 1985)

Chronic fluctuations in the blue crab fishery in the Chesapeake Bay have long caused economic hardships for the industry. Is it possible to accurately predict the abundance of blue crabs in the Bay in order to adequately plan harvest strategies? Sea Grant researchers have come up with some encouraging findings.

For the past three years, Dr. John McConaugha and Dr. Donald Johnson of Old Dominion University have been studying the recruitment of blue crab larvae in the Chesapeake Bay. Their research is part of a tri-state cooperative effort funded by Sea Grant Programs in Virginia, Maryland, and Delaware.

Johnson and McConaugha are determining the relationships between seasonal and annual variations of physical oceanic parameters as they relate to blue crab larvae dispersal and recruitment in the Bay. The researchers have found that environmental factors, especially wind direction and strength, play a major role in successful recruitment of blue crab larvae into the Bay.

Field tests identified a synchronized hatching rhythm for blue crabs in the lower Bay, a rhythm associated with a nighttime ebb tide. Since larvae are rapidly concentrated in the surface waters, it was suspected that they were transported offshore immediately.

The hunch proved correct when offshore sampling tests revealed that crab larvae are swept out to the continental shelf. Once on the shelf, wind-driven currents keep the larvae in the vicinity of the Bay's mouth. It is now thought that salt water currents on the bottom move the crab larvae back into the Bay. Researchers are currently investigating this theory by determining the position of larvae in the water column. Better understanding of the mechanisms of larval recruitment into the Bay will lead to better predictions of year-class strength for the Bay's blue crab population.

A model of water currents and wind patterns has been developed which will trace the trajectories of the larvae during their residence on the continental shelf. By using the model, researchers hope to be able to determine how offshore weather patterns may affect the Bay's blue crab population several months down the road — knowledge that will be a valuable asset to commercial crabbers and marine resource managers.

Ultimately, McConaugha and Johnson's model will be used by the Virginia Marine Resources Commission in their blue crab management plan.

Evaluation of Selected Primary Harvest Management Programs for the Blue Crab—*Dr. Phillip R. Mundy of Old Dominion University and Paul J. Anninos of the Virginia Marine Resources Commission* (R/CF-14 *completed in* 1984)

There is considerable concern that gaps in our knowledge of population dynamics may ultimately result in underregulation or overregulation of blue crabs in the Chesapeake Bay. In this study, Dr. Phillip Mundy of Old Dominion University and Paul Anninos of the Virginia Marine Resources Commission analyzed existing data regarding blue crab catch in order to produce a set of guidelines describing a blue crab harvest control program.

By describing blue crab catch as a function of time in months, the researchers constructed performance curves for use in estimating total annual yield. These cumulative catch statistics are being used to forecast total catch for different parts of the Bay.

The study, in addition to providing guidelines for a crab harvest strategy, defined and reviewed information requirements necessary to adequately manage this resource.

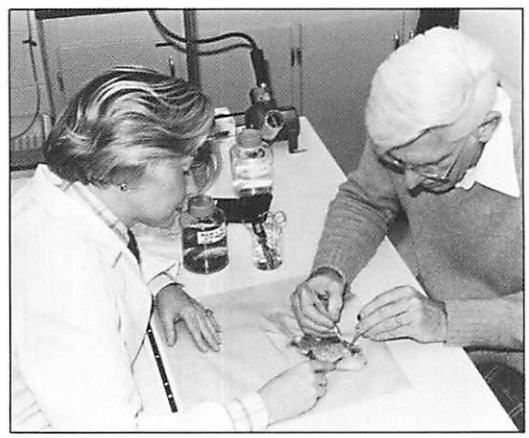
An Evaluation of the Fishery Potential of Underutilized Marketable Species in Virginia: Anglerfish—*Dr. John A. Musick and Dr. James A. Colvocoresses of the Virginia Institute of Marine Science.* (R/CF-10 *completed in* 1983)

Commercial fishing interests and resource managers require a great deal of data in assessing the present and potential levels of exploitation of fishery stocks. Information on many species, though, is inadequate for even a crude assessment of ultimate potential yield.

In this project, Dr. John Musick and Dr. James Colvocoresses of the Virginia Institute of Marine Science collected much needed information on the marketable but underutilized anglerfish, commonly known as the monkfish.

The researchers analyzed existing data and compiled missing life history information from over 600 specimens collected during research and commercial cruises. From this information, estimations of monkfish stock and potential yields were compiled for the first time.

Monkfish, which traditionally have been discarded during commercial fishing operations, are now being looked at as a fishery product for domestic consumer markets. Results of this study will contribute to rational development of the growing monkfish fishery before it is over-exploited.



Identification of Striped Bass (*Morone saxatilis*) Stock Units within Chesapeake Bay Using Natural Tags—*John E. Olney and Dr. George C. Grant of the Virginia Institute of Marine Science.* (R/CF-13 *completed in* 1983)

In this study, scientists at the Virginia Institute of Marine Science (VIMS) and at the Chesapeake Biological Laboratory (CBL) in Maryland used new techniques to identify the existence of multiple stocks of striped bass within the Chesapeake Bay system. Because populations of striped bass spawned in different areas exhibit different mortality and growth characteristics, the ability to identify individuals in each stock is important to successful management of the fishery.

Researchers used osteological (skeletal) characters, otolith (internal ear) elemental signatures, and meristic (counts of rays, vertebrae, gill rakers) criteria found in larval and juvenile striped bass to identify different stock units within the Bay. These natural tags were found to be useful in identifying spawning location and the degree of homing in striped bass populations.

The natural population tag data generated by VIMS and CBL researchers will contribute to a more comprehensive understanding of the nature and composition of striped bass stocks in the Bay. In the future, researchers hope that management of fishery stocks on a subregion basis will be feasible.

Alternative Future Directions for Virginia's Chesapeake Bay Fishery: An Economic Assessment—*Dr. Leonard A. Shabman and Dr. Oral Capps, Jr. of Virginia Polytechnic Institute and State University.* (R/SE-3 *completed in* 1983)

Management of fisheries is a difficult task because while the biological productivity of the fishery must be protected, the economic objectives of watermen, processors, and consumers also must be served. In order to address these needs, Dr. Leonard Shabman and Dr. Oral Capps, Jr. of Virginia Tech analyzed the economic structure of Virginia's blue crab, oyster, and food finfish industries in a multi-faceted study.

By evaluating consumer demand, processor demand, and harvest supply for blue crabs, oysters, and selected food finfish over a three-year period, the researchers developed an integrated input-output econometric model relating the commercial seafood industry to the state's economy.

Econometric analysis of historical data was used to interpret watermen's harvest responses to changing prices, costs, and environmental changes. Additional mathematical programming was used to evaluate the effect of factors not included in historical data, such as new harvesting technologies and recent fishery management programs. The researchers also analyzed household

consumption and expenditure behavior for individual species of food finfish and shellfish according to sociodemographic variables, and integrated several models to interpret how different circumstances might affect fishery management policies.

Results of this project were used by Virginia legislators in formulating a General Assembly resolution calling upon the Virginia Marine Resources Commission (VMRC) to design action programs to enhance Virginia's oyster fishery. Shabman and Capps also provided input to the Joint Legislative Audit and Review Committee (JLARC) in its study of the economic potential of Virginia's seafood industry. Project results are now being used by the VMRC for data evaluation and analysis services for certain fishery statistics.

Effects of Mortality Caused by the Hemoflagellate, *Trypanoplasma bullocki*, on Year-Class Strength of Summer Flounder, *Paralichthys dentatus*— *Dr. Eugene M. Burreson of the Virginia Institute of Marine Science.* (R/MP-1 *completed in* 1983)

The blood parasite, *T. bullocki*, is known to cause mortality of yearling summer flounder in the Chesapeake Bay and other East Coast estuaries. The extent to which this parasite can affect overall flounder stocks, ranked first in Virginia's finfish trawler landings, is a subject of concern both to fishermen and fishery managers.

It is suspected that yearling fish that survive *T. bullocki* infestation cast out the parasite when their immune system response is triggered by warming water temperatures. In this project, Dr. Eugene Burreson of the Virginia Institute of Marine Science collected data that will help determine the role of temperature in mortality of infected flounder.

Extensive field sampling revealed that winter mortality of juvenile summer flounder is indeed temperature-dependent, with highest mortalities during cold winters and lower mortalities during warmer winters. Data on infected flounder mortality during overwintering will allow prediction of the overall effect of *T. bullocki* infections on summer flounder stocks in the Bay.

Project data is being used by the Mid-Atlantic Fisheries Management Council and the Virginia Marine Resources Commission in formulating management plans for the Bay's economically important summer flounder fishery.

Marine Environmental Research

The goals of this program area are: to elucidate the relationships between physical and chemical variables describing the marine environment and productivity of estuarine and coastal ecosystems; to understand chemical and biochemical processes in the estuarine and nearshore environment as they are affected by the introduction of foreign substances, especially pathogenic materials and toxic chemicals; to determine the impact of man's activities on estuarine and nearshore environments, and to develop appropriate measures for ameliorating undesirable effects; and to develop our ability to forecast future environmental conditions and to predict consequences of planned future activities that may have significant effects on the marine environment.

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Marine environmental research projects initiated in the 1983-84 biennium include:

The Use of Multiple Stable Isotopes to Delineate Coastal and Estuarine Sea Grass Based Food Webs — *Dr. Joseph C. Zieman and Dr. Aaron L. Mills of the University of Virginia.* (R/CM-9 *initiated in* 1983)

Nursery Value of Coastal Marshes Determined by Multivariate Comparison of Habitat Factors — *Dr. William E. Odum of the University of Virginia.* (R/CM-11 *initiated in* 1984)

Currents and Sediment Transport in a Groin Field — *Dr. John C. Ludwick of Old Dominion University.* (R/CP-1 *initiated in* 1984)

More Accurate Thunderstorm Predictions

High Resolution Weather Forecasts for Chesapeake Bay and Estuarine Virginia — *Dr. Patrick J. Michaels and Dr. Steven Colucci of the University of Virginia* (R/CM-7 *completed in* 1983)

As the use of Virginia's waterways grows, so will the need for more detailed weather forecasts. In this research project, Dr. Patrick Michaels and Dr. Steven Colucci of the University of Virginia were successful in increasing the understanding of the eastern Virginia climate system, thus improving forecasting accuracy.

According to Michaels, who is also Virginia's State Climatologist, standard National Weather Service (NWS) forecasts often are not fine-tuned enough to predict weather phenomena with an aerial extent of less than 10,000 square miles. Weather events that occur in this spatial realm, termed 'mesoscale' disturbances, include severe squalls, cyclones, strong wind shear zones, and areas of heavy snow.

In the event of a mesoscale weather event, the NWS may issue a severe weather watch for the entire eastern half of Virginia, when in reality the severe weather is confined to a small area. The high resolution forecast methods being developed by Michaels and Colucci will allow for longer lead times for areas which will experience a mesoscale disturbance, while not alarming those areas which will not be affected.

The researchers used state-of-the-art statistical techniques to correlate the observed probability of storm occurrence with the subtle changes in mid-atmospheric heights that are the result of the Jet Stream, a major meteorological feature determining weather patterns nationwide. The results of these correlations were then used to modify the equations currently used in the NWS's thunderstorm probability model.

The new approach has tested positively, and NWS researchers are interested in applying the new technique to many areas of the United States in order to provide better forecasts of disruptive mesoscale events.

Marine Resources Utilization

The goals of this program area are: to develop knowledge and skills necessary for providing seafoods with maximum availability, nutritional value, safety, and economy; to develop technology which will enable food service managers to maximize wholesomeness, efficiency, and product uniformity; to develop good management practices for unit processing operations, marketing, safety, and technical decisions by the seafood industry; and to facilitate the optimum utilization of both living and non-living marine resources for industrial, medical, or food purposes.

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Marine resources utilization projects initiated in the 1983-84 biennium include:

***Development of Food Products from Menhaden, Brevoortia tyrannus*—**
Dr. George J. Flick of Virginia Polytechnic Institute and State University; and Dr. Harold Dupuy and Dr. Robert L. Ory of the USDA Southern Regional Research Center in New Orleans. (R/SP-3 *initiated in* 1983)

***Shelf-Life Predictions for Finfish Based on Initial Product Composition and Microbiological Quality*—**
Dr. Donn R. Ward of Virginia Polytechnic Institute and State University. (R/SP-4 *initiated in* 1984)

***Development of a Microcomputer Process Controller for the Pasteurized Blue Crab Meat Industry*—**
Dr. George J. Flick and Joseph W. Boling of Virginia Polytechnic Institute and State University, and J. William Keller and F. Meade Bailey of Keltech, Inc. (R/SP-5 *initiated in* 1984)

New Uses for Seafood Wastes

Utilization of Seafood Waste as Ruminant Feed—*Dr. Joseph P. Fontenot and Dr. George J. Flick of Virginia Polytechnic Institute and State University.* (R/UW-4 *completed in* 1983)

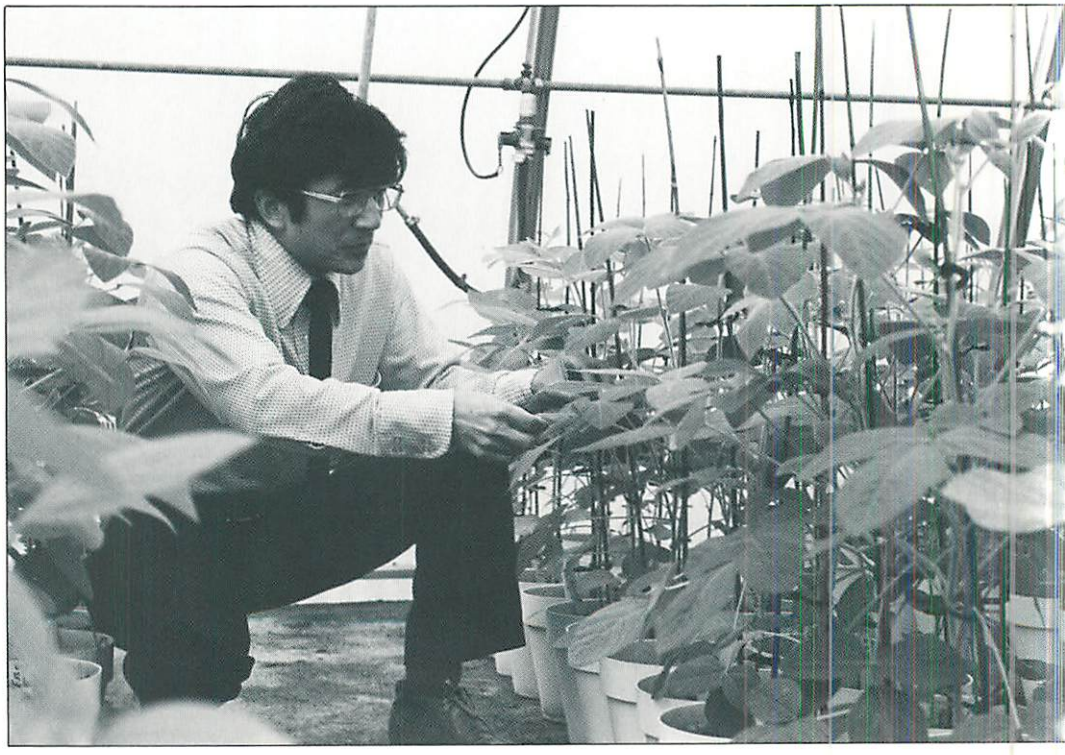
Fish-Soluble Nutrients for Agricultural Crop Fertilization Under Different Field-Growing Experiments—*Dr. Louis H. Aung and Dr. George J. Flick of Virginia Polytechnic Institute and State University.* (R/UW-5 *completed in* 1983)

In the Mid-Atlantic region, the disposal of crab- and fish-processing wastes has become an increasingly serious problem over the past decade. On an annual basis nationwide, there is an estimated 14 million metric tons of waste or scrap derived from fish used for human consumption and scrap from crab processing accounts for another 135,000 metric tons.

Sea Grant is lending a hand to alleviate this pressing problem. In two recently completed projects, researchers found successful uses for seafood wastes as food for livestock and as fertilizer for crops.

Dr. Joseph Fontenot and his associates at Virginia Tech successfully combined seafood wastes with crop residues to form a stable silage product which holds promise for lowering the cost of feeding beef cattle and other livestock.

Experimental silage mixtures contained varying amounts of seafood scrap, ground wheat straw, and dry molasses. These were ensiled (sealed in airtight containers until the fermentation process stabilized) and the resulting mixtures were evaluated for stability, odor, nutritional value, and palatability to livestock.



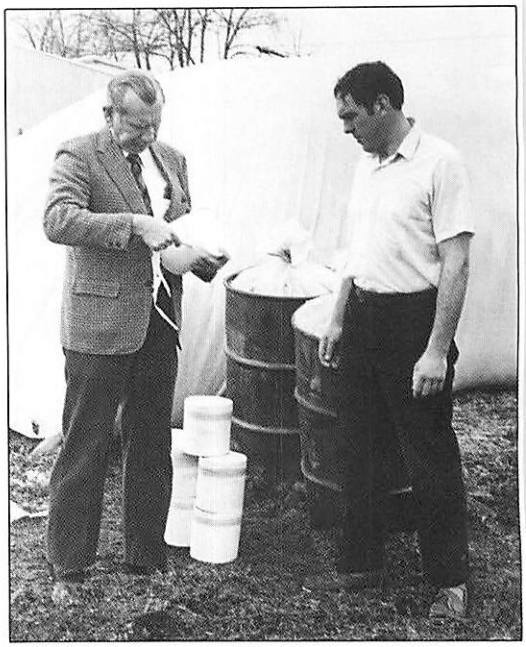
Hereford and Angus cows fed the silage made from finfish wastes showed good weight gain compared to animals fed a traditional feed. Silages made from both finfish and crab scrap were readily consumed by sheep.

According to Fontenot, a stockman using silage made from finfish scrap could expect a 10 to 20 percent cost savings for feeding beef cattle, and this cheaper ration could then be reflected by a price drop for beef and beef products in retail stores.

Dr. Louis Aung of Virginia Tech has had similar success with finfish wastes by using menhaden processing wastes, termed Fish Soluble Nutrients (FSN), to fertilize various plants.

FSN proved to be effective as a fertilizer, sometimes with added calcium supplements depending on soil composition, for production of seedlings, bedding plants, and ornamentals. FSN-enriched plants showed good root development, excellent foliage growth, and delay in aging. Long-term results of field-grown crops showed positive results for corn and sorghum crops, but did not significantly increase the yields of soybeans or rice.

Aung's research has demonstrated that excellent benefits can be achieved for selected crops. Increasing crop production will be a matter of more experimentation. Long-term benefits of the judicious use of FSN as nutrients for crop production could benefit the seafood industry through the sale of fish solubles as fertilizers and through minimizing the need for storage and disposal of seafood wastes.



Standardization of Battered Seafood Portions for Use in Fast Food Restaurants—*Dr. Robert L. Ory of the USDA Southern Regional Research Center in New Orleans, and Dr. George J. Flick of Virginia Polytechnic Institute and State University.* (R/SP-2 *completed in* 1983)

When the managers of a fast food restaurant chain found that losses from serving under- and over-cooked battered seafood portions approached 40 percent, they contacted Sea Grant for assistance. The resulting project evaluated current deep-fried seafood preparation techniques and recommended specific standards for improvement.

During on-site observations in several fast food stores, Dr. Robert Ory and Dr. George Flick of Virginia Tech determined that variables affecting fried seafood portion quality included the number of battered fish portions in the deep fat fryer, temperature of the cooking oil, and equipment performance. These criteria varied widely, due to lack of standardized industry production guidelines.

By determining the effect of cooking temperature on fat absorption in fish portions, the researchers developed specifications that resulted in uniform cooking time. Working with industry managers, Ory and Flick then formulated specific guidelines for an education program for use by fast food restaurants in training employees in the preparation of battered fish portions. Research resulted in reducing losses to almost zero.

Acoustic Sounding for Manganese Nodules—*Dr. Allen H. Magnuson and Dr. Karl E. Sundkvist of Virginia Polytechnic Institute and State University.* (R/OE-1 *completed in* 1983)

The enormous economic potential of manganese nodule deposits has stimulated interest in the deep-sea mining industry. Existing methods of locating deep-sea mining sites require lowering instruments by cable several miles to the ocean floor, making prospecting slow and expensive.

Dr. Allen Magnuson and Dr. Karl Sundkvist of Virginia Tech designed this project to develop a technique for prospecting for manganese nodules by using remote acoustical sounding from a survey vessel in order to distinguish the presence and amount of nodules on an area of ocean floor.

After obtaining statistical information on size distribution and spacing of manganese nodule deposits on the ocean floor, the researchers developed mathematical models of the nodule acoustic response and computer programs for predicting response.

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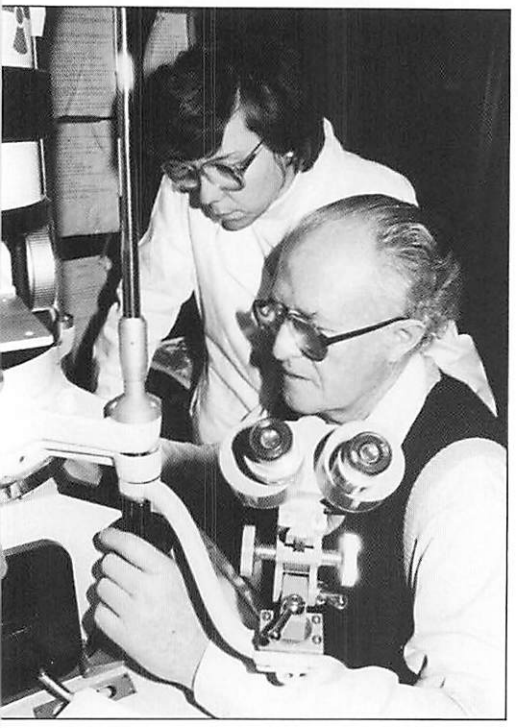


Laboratory experiments in a man-made towing basin, and open ocean sounding experiments both indicated that the technique is feasible and can increase the speed of surveillance while decreasing prospecting costs. Mining firms from the United States and Japan participated in the open-ocean survey.

Antineoplastic Substances from Ovaries of Marine Invertebrates—*Dr. Leonard I. Rebhun and Dr. Carolyn C. Walker of the University of Virginia.* (R/MB-1 *completed* 1984)

A major problem in the treatment of cancer with drugs is the development of resistance to the drugs. Thus, as wide a spectrum as possible of substances that prevent the spread of malignant cells (antineoplastic substances) is needed for the treatment of this disease. In this project, Dr. Leonard Rebhun and Dr. Carolyn Walker of the University of Virginia investigated such anti-tumor substances present in the ovaries of starfish and surf clams.

In laboratory experiments, the researchers extracted antineoplastic substances from the marine invertebrate ovaries, then observed their inhibitory effects on synchronized, dividing eggs under a microscope. Preliminary evidence indicates that the ovotoxins have anti-tumor activity, and can be useful in inhibiting the growth and spread of malignant cells.

Results could help lead to the understanding and control of cancer, and will be of great interest to a wide variety of cell, molecular, and developmental biologists. Because of the interest generated by this project, details for follow-up research are now being formulated.

Marine Advisory Services

The goals of this program area are: to establish and maintain dialogue with marine resource users, and to educate the general public on marine-related matters; to analyze and transfer technical information in an understandable format to marine resource users and to identify the problems of the users of the marine environment so an appropriate response can be undertaken; to promote understanding and cooperation among users and managers of resources by serving as a clearinghouse of information; and to develop scientific and technological materials and educational programs for people employed in the marine food products industry.

Assistance for Many Marine-Related Industries

MAS initiated a "Gear Assistance Program" in which onboard workshops are conducted for vessel captains and crews regarding design and repair of trawl nets and deck gear, and vessel conversion from scalloping to finfishing. One boat captain credited MAS assistance with saving his fleet a total of $44,000.

MAS marine advisory agents implemented a program that provided volunteers with free training in seafood promotion techniques. The volunteers then gave demonstrations at seafood festivals and in-store seafood promotions that attracted thousands of dollars in new seafood sales.

The MAS commercial fisheries gear specialist designed a "split winch-combination net reel" which allows vessels to operate a multi-purpose otter trawl. The new gear configuration makes it possible for fishing vessels to switch easily from one fishing method to another, and increased the productivity of the prototype test vessel by a factor of 12. A videotape demonstrating use of the split winch-combination net reel is now in production.

Seafood technology specialists developed a gas chromatograph technique capable of determining fish quality. The accurate, time-saving method was adopted by a national retail food chain to enhance their quality control program for seafood.

Over 1,000,000 people per year participate in Virginia's growing sportfishing trade. In 1983, the MAS marine recreation and trades specialist organized the first annual Virginia Sport Fishermen's Forum. The forums, attracting more people each year, provide the opportunity for fishery management leaders, anglers, charter boat captains, fishery biologists, and outdoor writers to address major recreational fishery issues.

Serving Virginia's Marine Community

Virginia Sea Grant's Marine Advisory Services (MAS) is the necessary link between researcher and user, between advisory agent and fisherman, between educator and student. MAS maintains this link by identifying the marine community's needs for assistance, working to insure that an appropriate response is undertaken, then making sure that information and results are transferred to the appropriate audiences.

MAS specialists and agents in commercial fisheries, marine resource economics, marine trades and recreation, marine home economics, seafood technology, marine education, and communications maintain contact with Virginia's marine community through workshops, conferences, one-on-one contact, and media. Whether organizing a state-wide conference on marina management, helping a seafood processing plant streamline its operation, or showing a fisherman how to build a better net, MAS provides valuable services for Virginia's marine community, including the public, management agencies, and industry.

Following are some selected examples of MAS accomplishments during the 1983-84 biennium.

The Growing Business of Soft Shell Blue Crabs

When a Virginia soft shell crab shedder experienced excessive mortalities in his shedding operation, he came to commercial fisheries specialist Mike Oesterling for help. With Oesterling's guidance, the shedder coverted his onshore flow-through facility to a closed system in which the water was filtered, conditioned, and recirculated. Crab survival in the closed system jumped from 35 to 65 percent, and the shedder gained over $7000 in his 1983 soft shell crab production.

This success story is typical of MAS work with Virginia's soft crab producers. The specialist has supervised the design and construction of numerous shedding facilities, from small family operations with as few as two tanks to the nation's largest closed system with 81 tanks.

In the past two years, several MAS soft shell crab workshops succeeded in attracting hundreds of individuals interested in entering the business or improving existing operations. In order to address the industry's needs on a continuous basis, diagnostic services started by MAS provide on-site visits to monitor shedding facility water temperature, salinity, and dissolved oxygen, as well as consultation on mortality problems.

The Manual for Handling and Shedding Blue Crabs *Callinectes sapidus*, published in 1984, has been in great demand by members of the crab shedding industry. The comprehensive manual, written by Oesterling, covers everything from peeler harvest to facility design.

Work with rock crab shedding is also proving to be highly successful. The blue crab shedding season only lasts from April to November, leaving almost six months when shedding facilities are idle. Because rock crabs shed in the winter, they can be used to keep shedding facilities operating year-round.

Fresh Fish Reach Wider Markets

Seafood is a very perishable food commodity, and if it is to be marketed in top quality condition, it must be handled carefully at each step from boat to supermarket shelf. A recently completed MAS project focused on how to produce fish with a minimum shelf-life of 12 days after processing—long enough to ship fresh seafood products to Midwest markets. The project, actually a series of studies, focused on three aspects of fish handling—aboard the fishing vessel, at the processing plant, and during transport to the marketplace.

Under the leadership of seafood technology specialist Dr. George J. Flick, MAS personnel developed guidelines for on-board icing and handling of fish, sanitation procedures in processing facilities, high-pressure washing of fish, and temperature control during transportation. Acceptable

fresh finfish shelflives of 15 to 17 days were regularly achieved with the alternate processing practices developed by MAS, and retail firms involved in the study are reporting significant increases in product demand.

Working in conjunction with Virginia Sea Grant were the Mid-Atlantic Fisheries Development Foundation; The Kroger Company; Amory Seafood Co., Inc.; Empire Fish Company; National Fisheries Institute; Koch-Multivac; and Plicon Corporation.

Better Quality Control for Crab Pasteurization

Because most crab meat pasteurization firms are small and unable to hire a quality control director, evaluation of crab meat pasteurization systems is an important service provided by MAS. Plant evaluations emphasize can seam inspection, process monitoring, and recommendations for equipment use and modification.

During recent monitoring, marine advisory agents Ken Riggins and Tom Rippen discovered major can seam defects in containers of pasteurized blue crab at several plants. Subsequent development of an improved container saved one processor $20,000 worth of pasteurized crab meat.

At the request of the Shellfish Institute of North America, the agents are working closely with state and industry representatives to develop an education program and training manual documenting the effects of variations in processing and cooling times, temperature, and container size. Part of this training program will involve production of a video tape which demonstrates the principles and techniques of properly pasteurizing crab meat.

State and industry cooperators in this MAS effort include the Virginia Marine Products Commission, Mid-Atlantic Fisheries Development Foundation, Virginia Seafood Council, National Fisheries Institute, and Steeltin Can Corporation.

Scouts Study Science by the Sea

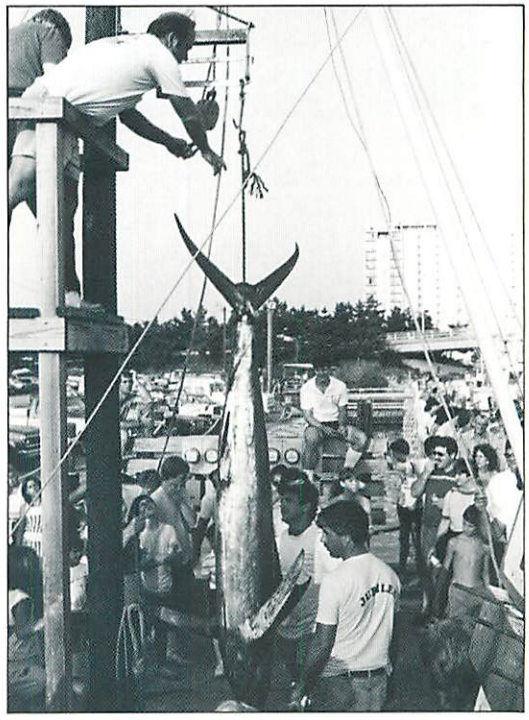
In 1982, Virginia's Commonwealth Girl Scout Council asked MAS marine education specialists Lee Lawrence, Sue Gammisch, and Mary Sparrow to assist in planning a two-week camp focusing on the resources of the Chesapeake Bay. The resulting camp for Girl Scouts from Virginia, "Water is FUN-damental," was so successful that it has been offered every year since, and has expanded to accept Girl Scouts from across the nation.

Camp participants are chosen on a competitive basis according to interest in and aptitude for marine studies. Thirty-six scouts, aged 13 to 17, from 25 states attended the 1984 camp. The scouts participated in activities such as trawling, building crabpots, and hanging gill nets; heard lectures on subjects such as water safety and coastal management; and visited seafood processing plants and marshes. The scouts also met with officials in the Environmental Protection Agency in Washington, D.C. and visited the National Aquarium in Baltimore, Maryland.

In 1984, the national Girl Scouts USA organization designated "Water is FUN-damental" as one of 19 prestigious Girl Scout Wider Opportunity Camps in the nation, and the only marine-related one. The camp will be continued in 1985.

Insect and Rodent Pests of Seafood Processing Plants: A Training Resource Manual and Educational Program—*Dr. William H. Robinson of Virginia Polytechnic Institute and State University.* (A/AS-2 *completed in* 1983)

The application of pesticides in and around food processing plants requires a thorough knowledge of the chemicals used, and of the regulations regarding their proper application and disposal. In this project, Dr. William Robinson of Virginia Tech designed a training program for in-house pest control personnel.



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The successful program, consisting of training manuals and color slides, has been presented in regional and national training conferences and has benefited seafood processing plant owners throughout Virginia.

Virginia Marine 4-H Program—*Richard F. Booker, Barry W. Fox and Rudolph Powell of Virginia State University.* (E/FH-1 *completed in* 1984)

Over the last four years, the Virginia Cooperative Extension Service, in conjunction with Virginia Sea Grant, has developed a 4-H Marine Program in order to promote understanding and appreciation of marine resources. The program is coordinated by Barry Fox, marine education specialist with the Virginia Cooperative Extension Service.

Fox and his colleagues Richard Booker and Rudolph Powell saw a need to develop programs in the area of Virginia's marine environment and history that are similar to established 4-H educational programs in the fields of agriculture and economics. During this project, over 2250 4-H'ers, 110 volunteer leaders and 42 Extension personnel in 37 Virginia counties have participated in a variety of programs such as marine education workshops, state fair marine exhibits, and marine day camps.

A four-unit 4-H Marine Education Module currently is being developed. The manuals, which include lessons on marine ecology, marine life, marine pollution, and other topics, will be used in future 4-H marine education programs.

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Program Development Projects

Some problems and opportunities cannot be predicted or anticipated far enough in advance to permit proposal preparation and review as it usually occurs. Program development funds provide the capacity to initiate new projects on short notice, supplement existing projects, and develop innovative ideas. In this way, short-term applied research and marine advisory services efforts can address issues of immediate concern rapidly.

Following is a list of mini-grants awarded during the 1983-84 biennium. Six of these new project efforts resulted in full-funded proposals.

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Marine Advisory Services Mini-Grants

1983—

Crab pot fouling studies and demonstrations—J. Kenneth Riggins and Thomas E. Rippen of Virginia Polytechnic Institute and State University, and Michael J. Oesterling of the Virginia Institute of Marine Science (MAS/MG-83-1)

Development of a hydrofoil scallop dredge—Philip W. Cahill of the Virginia Institute of Marine Science (MAS/MG-83-2)

1984 —

Comparison of methods for the enumeration of E. *coli* from oysters: collaborative studies—Dr. Donn R. Ward of Virginia Polytechnic Institute and State University (MAS/MG-84-1)

Regional workshop on the histopathology of fishes—Dr. William J. Hargis of the Virginia Institute of Marine Science (MAS/MG-84-2)

4-H marine camp partial scholarships for disadvantaged youth—Richard Blanton and Barry W. Fox of Virginia State University (MAS/MG-84-3)

Virginia Sea Grant state government interns—Dr. William L. Rickards and Dr. David E. Smith of the Virginia Graduate Marine Science Consortium (MAS/MG-84-4)

Development of video tapes for the seafood industry: cooperative effort with the National Fisheries Institute—Dr. George J. Flick of Virginia Polytechnic Institute and State University (MAS/MG-84-5)

Investigation of frying oils used in fast food restaurants: cooperative effort with Chik-Fil-A—Dr. George J. Flick of Virginia Polytechnic Institute and State University (MAS/MG-84-6)

Alexandria water front festival conference workbook—Dr. William D. DuPaul of the Virginia Institute of Marine Science (MAS/MG-84-6)

Research Mini-Grants

1983—

Investigation of the terminal molt hypothesis on the blue crab—Dr. John R. McConaugha of Old Dominion University (R/MG-83-1)

Industrial applications for the utilization of chitosan for the removal of heavy metal wastes—Dr. Joseph P. Wightman of Virginia Polytechnic Institute and State University (R/MG-83-2)

Electrophoretic stock identification of summer flounder (*Paralichthys dentatus*)—Dr. John A. Musick of the Virginia Institute of Marine Science (R/MG-83-3)

1984—

Verification of high-resolution thunderstorm forecasts for Virginia and Chespeake Bay—Dr. Patrick J. Michaels of the University of Virginia (R/MG-84-1)

The use of selected fish species to biologically control predation by crabs in the field culture of juvenile hard clams—Michael Castagna and Mary C. Gibbons of the Virginia Institute of Marine Science (R/MG-84-2)

In *situ* studies of ocean quahog growth in natural populations—Michael Castagna and Richard Lutz of the Virginia Institute of Marine Science (R/MG-84-3)

The chemical induction of spawning in the hard clam, *Mercenaria mercenaria*, by serotonin—Michael Castagna and Mary C. Gibbons of the Virginia Institute of Marine Science (R/MG-84-4)

Research Project Development

1983—

Investigation of acquired immunity: adaptive response in the American oyster—Dr. Fu-Lin E. Chu of the Virginia Institute of Marine Science (R/PD-83-1)

Evaluation of crab by-products as a substrate for methane production—Dr. Howard I. Kator of the Virginia Institute of Marine Science (R/PD-83-2)

Development of a practical model for management of shellfish growing waters—Dr. Bruce J. Neilson of the Virginia Institute of Marine Science (R/PD-83-3)

Rationale for studying physical processes at the Chesapeake Bay entrance—Dr. George Oertel of Old Dominion University (R/PD-83-4)

A study of the organizational, management and technical approaches used in submerged land management of the U. S.—Dr. Maurice P. Lynch of the Virginia Institute of Marine Science (R/PD-83-5)

Virginia Sea Grant state government internships—Dr. William L. Rickards and Dr. David E. Smith of the Virginia Graduate Marine Science Consortium (R/PD-83-6)

Erosion and deposition of cohesive sediment in tidal flows—Dr. John A. Hamrick of the University of Virginia (R/PD-83-7)

1984 —

Determination of salt water intrusion into surface and Yorktown aquifers of coastal Virginia—Dr. Grant Goodell of the University of Virginia (R/PD-84-1)

Development of techniques to study acquired immunity to *Perkinsus marinus* in the oyster—Dr. Fu-Lin E. Chu of the Virginia Institute of Marine Science (R/PD-84-2)

Cryopreservation of gametes and larvae of commercially important bivalve mollusks—Michael Castagna and Dr. Lehman L. Ellis of the Virginia Institute of Marine Science (R/PD-84-3)

(Completion of) A study of the organizational, management and technical approaches used in submerged land management in the U. S.—Dr. Maurice P. Lynch of the Virginia Institute of Marine Science (R/PD-84-5a)


CAROLYN
Dixie Queen

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Aquaculture

Manual for Handling and Shedding Blue Crabs *Callinectes sapidus*
M. Oesterling. SRAMSOE No. 271. 76 pp. $6.00

Intensive Culture of Striped Bass: Review, Recommendations and Feasibility
R. Grulich and M. Oesterling. Marine Resource Report No. 84-9. 53 pp. Free.

Reprints

Adamkewicz, L. S., S. R. Taub, and J. R. Wall. 1984.
Genetics of the clam *Mercenaria mercenaria*: II—Size and genotype. Malacologia, 25(2):525-533.

Castagna, M. 1984.
Methods of growing *Mercenaria mercenaria* from postlarval- to preferred-size seed for field planting. Aquaculture, 39:355-359.

Chu, F. L. and K. L. Webb. 1984.
Polyunsaturated fatty acids and neutral lipids in developing larvae of the oyster, *Crassostrea virginica*. Lipids, 19(11):815-820.

Oesterling, M. J. and W. D. DuPaul. 1983.
Closed system shedding of blue crabs: The Virginia experience. pp. 147-156 **In** R. Nickelson (ed.), Proceedings of the Eighth Annual Tropical and Subtropical Fisheries Conference of the Americas, Texas A&M University Sea Grant Publication TAMU-SG-83-112.

Fisheries and Oceanography

Squid Nets of the Mid-Atlantic
P. Cahill and W. Mansfield. Marine Resource Advisory No. 27. 16 pp. $1.00.

Split Winch-Combination Net Reel Allows Greater Variety of Fishing
P. Cahill. Marine Resource Advisory No. 26. 12 pp. 50 cents.

Seed Oysters Stressed by Low Spring Salinities in Virginia
D. Haven and J. Andrews. Marine Resource Advisory No. 25. 1 pp. Free.

Tangier Sound Waterman's Association vs. Douglas: Chesapeake Bay Blue Crab Residency Restrictions Held Unconstitutional
A. Rieser and N. Ziegler. Marine Resource Advisory No. 24. 6 pp. Free.

Feasibility of Crab Meal Processing in the Chesapeake Bay Region, Part II: An Integrated Economic Analysis for Hampton Roads and Newport News, Virginia
R. Grulich and W. DuPaul. SRAMSOE No. 273. 41 pp. First copy free to Virginia citizens, all others $2.00.

Price Flexibility Analysis of Virginia Hard Clams
A. Kvaternik, W. DuPaul, and T. Murray. SRAMSOE No. 266. 66 pp. $2.50.

A Comparison of Expected Returns to Independent and Joint Venture Squid Vessels on the East Coast of the U.S.
R. Grulich. Marine Resource Report No. 83-8. 15 pp. Free.

The Virginia Oyster Industry: Its Present Status and Remedial Measures Needed to Increase Statewide Production
D. Haven. Marine Resource Report No. 82-1. 9 pp. Free.

Reprints

Burreson, E. M. and D. E. Zwerner. 1984.
Juvenile summer flounder, *Paralichthys dentatus*, mortalities in the western Atlantic Ocean caused by the hemoflagellate *Trypanoplasma bullocki*: Evidence from field and experimental studies. Helgolander Meersunters, 37:343-352.

Johnson, D. R., B. S. Hester, and J. R. McConaugha. 1984.
Studies of wind mechanism influencing the recruitment of blue crabs in the Middle Atlantic Bight. Continental Shelf Research, 3(4):425-437.

McConaugha, J. R., D. F. Johnson, A. J. Provenzano, and R. C. Maris. 1983.
Seasonal distribution of larvae of *Callinectes sapidus* (Crustacea: Decapoda) in the waters adjacent to Chesapeake Bay. Journal of Crustacean Biology, 3(4):582-591.

Provenzano, A. J., J. R. McConaugha, K. B. Phillips, D. F. Johnson, and J. Clark. 1983.
Vertical distribution of first stage larvae of the blue crab, *Callinectes sapidus*, at the mouth of Chesapeake Bay. Estuarine, Coastal and Shelf Science, 16:489-499.

Marine Education

Chesapeake Bay Education Week Packet—1983
M. Sparrow, F. Lawrence, and Virginia Council on the Environment. Educational Series No. 34. 12 pp. Free.

Developing Crab Creek: Fifteen Points of View on Economy and Ecology in an Estuary
F. Lawrence. Educational Series No. 27. 32 pp. $2.00.

Marine Environmental Research

Reprints

Michaels, P. J. and S. J. Colucci. 1984.
Modification of MOS-derived thunderstorm probabilities over complex terrain with continental-scale upper air data. pp 160-164 **In** Preprint Volume: 10th Conference on Weather Forecasting and Analysis, June 25-29, 1984, Clearwater Beach, Florida.

Michaels, P. J. and R. B. Gerzoff. 1984.
Statistical relations between summer thunderstorm patterns and continental midtropospheric heights. Monthly Weather Review, 112(4):778-789.

Orth, R. J., K. L. Heck, Jr., and M. P. Weinstein, eds. 1984.
Estuaries: Faunal Relationships in Seagrass and Marsh Ecosystems. Special issue of Journal of the Estuarine Research Foundation, 7(4A).

Weeks, B. A. and J. E. Warriner. 1984.
Effects of Toxic Chemicals of Macrophage Phagocytosis in Two Estuarine Fishes. Marine Environmental Research, 14:327-335.

Zieman, J. C., S. A. Macko, and A. L. Mills. 1984.
Role of Seagrasses and Mangroves in Estuarine Food Webs: Temporal and Spatial Changes in Stable Isotope Composition and Amino Acid Content During Decomposition. Bulletin of Marine Science, 35(3):380-392.

Marine Resource Utilization

Reprints

Anthony, J. E., P. N. Hadgis, R. S. Milam, G. A. Herzfield, L. J. Taper, and S. J. Ritchey. 1983.
Yields, proximate composition and mineral content of finfish and shellfish. Journal of Food Science, 48(1):313-314, 316.

Aung, L. H. and P. D. Relf. 1983.
Effect of fish solubles on food crops. The Virginia Gardener, 2(1):3.

Aung, L. H., J. B. Hubbard, and G. J. Flick. 1983.
Mineral composition of vegetable crops fertilized with fish-soluble nutrients. Journal of Agriculture and Food Chemistry, 31(6):1259-1262.

Magnuson, A. H. 1983.
Manganese nodule abundance and size from bottom: Reflectivity measurements. Marine Mining, 4(2-3):265-296.

Magnuson, A. H., K. E. Sundkvist, M. Yushieh, D. Riggins, and R. Sen. 1982.
Remote acoustic sensing of manganese nodule deposits. pp. 431-443 **In** Proceedings of the 14th Annual Offshore Technology Conference, Houston, Texas, May 3-6, 1982. OTC contribution no. 4260.

Suder, B. J. and J. P. Wightman. 1983.
Interaction of heavy metals with chitin and chitosan: II—Cadmium and zinc. pp. 235-244 **In** R. H. Otwell, C. H. Rochester, and A. L. Smith (eds.), Adsorption From Solution, Academic Press, London.

Sundkvist, K. E. 1983.
Size distribution of manganese nodules. Marine Mining, 4(2-3):305-316.

Sundkvist, K. E. 1983.
Spacing statistics of manganese nodules on the ocean floor. Marine Mining, 4(2-3):255-264.

Sundkvist, K. E. 1983.
Wave-speed measurements in manganese nodules. Marine Mining, 4(2-3)297-303.

Sundkvist, K. E., A. H. Magnuson, F. T. Manheim, and D. Porta. 1982.
Geophysical studies of ferromanganese deposits on the Blake Plateau. pp. 1-5, internal paper, VPI&SU.

Marine Trades and Recreation

Initial Performance Analysis of the Sail-Assisted Tug/Fishing Vessel *Norfolk Rebel*: Fuel Savings and Economic Return
J. Briggs, R. Lukens, and J. Lucy. VIMS Contribution No. 1125. 36 pp. $1.50.

Waterfront Festivals: Catalysts for Maritime Heritage and Waterfront Redevelopment
J. Lucy. VIMS Contribution No. 1017. 8 pp. 25 cents.

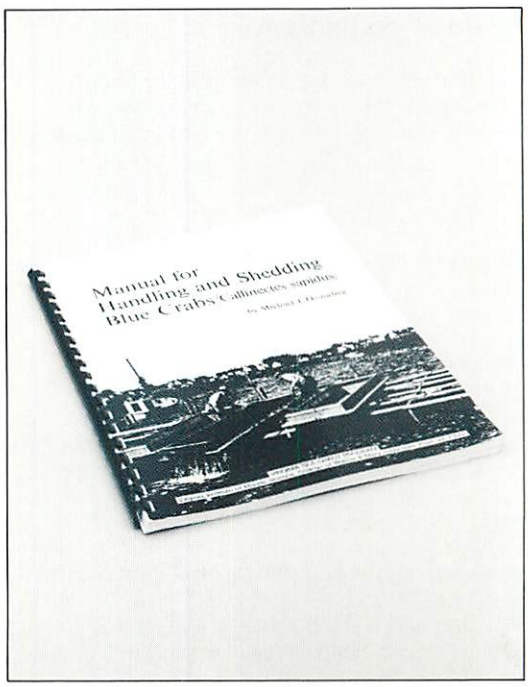
Waterfront Festivals: Potential for Developing Events on Public Lands and Availability of Technical Services
J. Lucy. VIMS Contribution No. 966. 10 pp. 25 cents.

Virginia's Coastal Marine Industry: A Descriptive Analysis
J. Lucy. VIMS Contribution No. 957. 8 pp. 25 cents.

Transcript of the Forum on Greater Hampton Roads as a Center for National and International Seafood Marketing
R. Grulich, ed. Marine Resource Report No. 84-8. 74 pp. Free.

ROKA '83—Exhibition for Delicatessen and Drinks, Utrecht, Holland: Report of Contacts
W. DuPaul and C. Thomas. Marine Resource Report No. 83-12. 10 pp. Free.

The Value of Virginia's Saltwater Recreational Fishery
J. Lucy. Marine Resource Report No. 83-7. 4 pp. Free.



Development of Virginia's Artificial Fishing Reefs: A Historical Outline (1959-1977)
J. Lucy. Marine Resource Report No. 83-6. 4 pp. Free.

Summary of the Economic Impact of the Eighth Annual Virginia Beach Anglers Club Small Boat Marlin Tournament
J. Lucy. Marine Resource Report No. 83-3. 3 pp. Free.

22nd Urbanna Oyster Festival: Analysis of Patrons and Expenditures
J. Lucy and T. Vance. SRAMSOE No. 257. 14 pp. $1.00.

Reprints

Briggs, J. A., R. J. Lukens, and J. A. Lucy. 1983.
Initial performance analysis of the sail-assisted tug/fishing vessel *Norfolk Rebel*: Fuel savings and economic return. pp. 1-33 **In** J. Shortall and B. Lowry (eds.), International Conference on Sail-Assisted Commercial Fishing Vessels: Proceedings (Vol. 2), Florida Sea Grant College Program Report Number 58.

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Seafood Technology

Demonstration of a Quality Maintenance Program for Fresh Fish Products: A Report submitted to the Mid-Atlantic Fishery Development Foundation, Inc. by Kroger Technical Center and Virginia Sea Grant at Virginia Tech VPI-SG-84-04R. 252 pp. $12.00.

Seafood Processing Pest Management: Materials and Methods
W. Robinson. VPI-SG-83-02. 32 pp. $3.00.

Chemistry and Biochemistry of Marine Food Products
R. Martin, G. Flick, C. Hebard, and D. Ward, eds. VPI-SG-82-13. 474 pp. $45.00, U. S.; $49.50 other countries. (Available from AVI Publishing Co., Inc., 250 Post Rd. E., P. O. Box 831 Westport, CT 06881)

Engineering and Economics of Oyster Steam Shucking Process
F. Huang and C. Hebard, eds. VPI-SG-82-07. 129 pp. $20.00 with notebook binder; $12.00 without binder.

Using Cans in Home Food Preservation
K. Long. VPI-SG-81-06. 22 pp. $2.50.

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Marine Education Specialist

Mary E. Sparrow
Marine Education Specialist

Budget Summaries

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1983 Activity Budget

	NOAA Grant Funds	Matching Funds
Marine Resources Development		
Aquaculture	$ 63,666	$ 49,138
Living Resources	139,304	82,870
Mineral Resources	13,000	6,497
Marine Biomedicinals	39,995	12,234
Marine Law/Socio-economics	43,660	25,358
Marine Technology Research And Development		
Resources Recovery/Utilization	89,972	78,999
Marine Environmental Research		
Direct Support of CZM Decisions	79,056	43,736
Marine Education and Training		
Other Education	82,000	15,269
Advisory Services		
Extension Programs	469,235	263,695
Other Advisory Services	13,513	11,869
Program Management And Development		
Program Administration	114,535	60,000
Program Development	108,064	0
TOTALS	$1,256,000	$ 649,665

1984 Activity Budget

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	NOAA Grant Funds	Matching Funds
Marine Resources Development		
Aquaculture	$ 15,838	$ 24,117
Living Resources	192,783	106,812
Marine Biomedicinals	41,382	29,925
Marine Law/Socio-economics	25,050	14,766
Marine Technology Research and Development		
Ocean Engineering	21,804	10,904
Resources Recovery/Utilization	68,558	44,866
Marine Environmental Research		
Direct Support of CZM Decisions	76,248	45,444
Pollution Studies	16,968	8,774
Marine Education and Training		
Other Education	93,200	0
Advisory Services		
Extension Programs	555,771	307,499
Program Management and Development		
Program Administration	90,805	60,000
Program Development	94,793	0
TOTALS	$1,293,200	$ 653,107

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Photographs/Photo Credits

Contents

Storm clouds gather over Brown's Bay in Severn, Virginia.
— *Kym Young*

Dr. William L. Rickards, Director of the Virginia Graduate Marine Science Consortium and the Virginia Sea Grant College Program.
— *Kym Young*

Aquaculture

Technology developed by Virginia Sea Grant researchers at George Mason University is being used successfully in breeding programs which are attempting to produce superior strains of hard clams for mariculture.
— *Kym Young*

Dr. Fu-Lin Chu of the Virginia Institute of Marine Science immunizes an individual oyster by hand. Chu is conducting research to develop a mass-immunization technique for oysters.
— *Kym Young*

Fisheries and Oceanography

Virginia Sea Grant researchers at Old Dominion University have found that blue crab larvae are hatched in the lower part of the Chesapeake Bay and swept out the continental shelf by wind and water currents. Just how and why these larvae reinvade the Bay is the subject of a tri-state cooperative effort funded by Sea Grant Programs in Virginia, Maryland, and Delaware.
— *Virginia Sea Grant photo*

Dr. John McConaugha of Old Dominion University examines the growth of crab larvae kept in compartmentalized trays. McConaugha's research has shown that blue crab larvae are swept out to the continental shelf after being hatched in the Bay.
— *Kym Young*

Dr. Eugene M. Burreson (l.) and graduate student Linda Frizzell of the Virginia Institute of Marine Science set up plastic vials for examination of oyster serum. Burreson hopes to discover information that will lead to solving the mystery of the life cycles of oyster diseases MSX and SSO.
— *Kym Young*

Dr. Beverly A. Weeks (l.) and Ernest J. Warriner of the Virginia Institute of Marine Science remove the liver of a hog choker in order to test for toxicant levels. The researchers are working to develop a technique to determine the extent to which finfish have been stressed by environmental pollutants.
— *Kym Young*

Marine Environmental Research

As the number of boaters using Virginia's waterways increases, so does the need for more detailed weather forecasts for "mesoscale" disturbances such as severe squalls. Techniques developed by Virginia Sea Grant researchers at the University of Virginia are being used by the National Weather Service to improve forecasting accuracy for disruptive weather events in many parts of the country.
— *Virginia Sea Grant photo*

Dr. John C. Ludwick of Old Dominion University is conducting research to gain detailed knowledge of sediment transport in groin fields used to stabilize ocean beaches.
— *Kym Young*

Marine Resources Utilization

Virginia Sea Grant researchers at Virginia Tech have found that processing wastes from menhaden such as these are an effective fertilizer for the growth of ornamentals and crop plants.
— *Dick Cook*

Dr. Louis Aung of Virginia Tech inspects a group of schefflera plants, just one of the many species that thrive on fertilizer made from menhaden processing wastes.
— *Dick Cook*

Dr. Joseph Fotenot (l.) of Virginia Tech and livestock unit manager Hugh Chester-Jones inspect silage made from finfish scrap. The small cartons, 55-gallon drum, and sausage silo (background) represent the three storage testing levels employed.
— *Dick Cook*

Using an electron microscope, Dr. Lionel L. Rebhun (r.) and Dr. Carolyn Walker of the University of Virginia determine the effects of ovotoxin on the internal structure of cells. The discovery of an ovotoxin that inhibits the growth of malignant cells will help lead to understanding and controlling cancer.
— *Kym Young*

Marine Advisory Services

When Virginia Sea Grant MAS designed and installed the innovative "Split Winch/Combination Net Reel" aboard the York Split, the new gear increased the boat's productivity twelve-fold.
— *Dick Cook*

Marine Extension Agent Ken Riggins fills experimental see-through containers for pasteurized crabmeat. Virginia Sea Grant MAS is helping many seafood plants monitor quality control of the crab pasteurization process.
— *Virginia Sea Grant photo*

Over 1,000,000 people per year participate in Virginia's growing sportfishing trade. To provide a forum for this economically important group, Virginia Sea Grant MAS organized the first annual Virginia Sportfisherme" Forum in 1983.
— *Jon Luc*

The national Girl Scout "Water is Fundamental" camp sponsored by Virginia Sea Grant MAS, brings outstanding scouts from across the country together to learn about the resources of the Chesapeake Bay region.
— *Lee Lawren*

Program Development Projects

Virginia's marshes provide food and shelter for many commercially important shellfish and finfish species. Virginia Sea Grant researchers are examining the value of these shallow water habitats for blue crabs and shrimp.
— *Virginia Sea Grant phot*

Publications

Graceful Chesapeake Bay deadrise fishing boats are a familiar site in Virginia's waters.
— *Kym Youn*

The Manual for Handling and Shedding Blue Crabs, *Callinectes sapidus*, published in 1984, has been widely distributed to members of the soft-shell crab shedding industry.
— *Virginia Sea Grant phot*

These "Seafood Processing Pest Management" manuals were designed as part of a training program for in-house pest control personnel.
— *Virginia Sea Grant phot*

Budget Summaries

From the fishing vessel to the marketplace, Virginia Sea Grant conducts many projects to enhance the quality of Virginia's marine food resources.
— *Virginia Sea Grant phot*