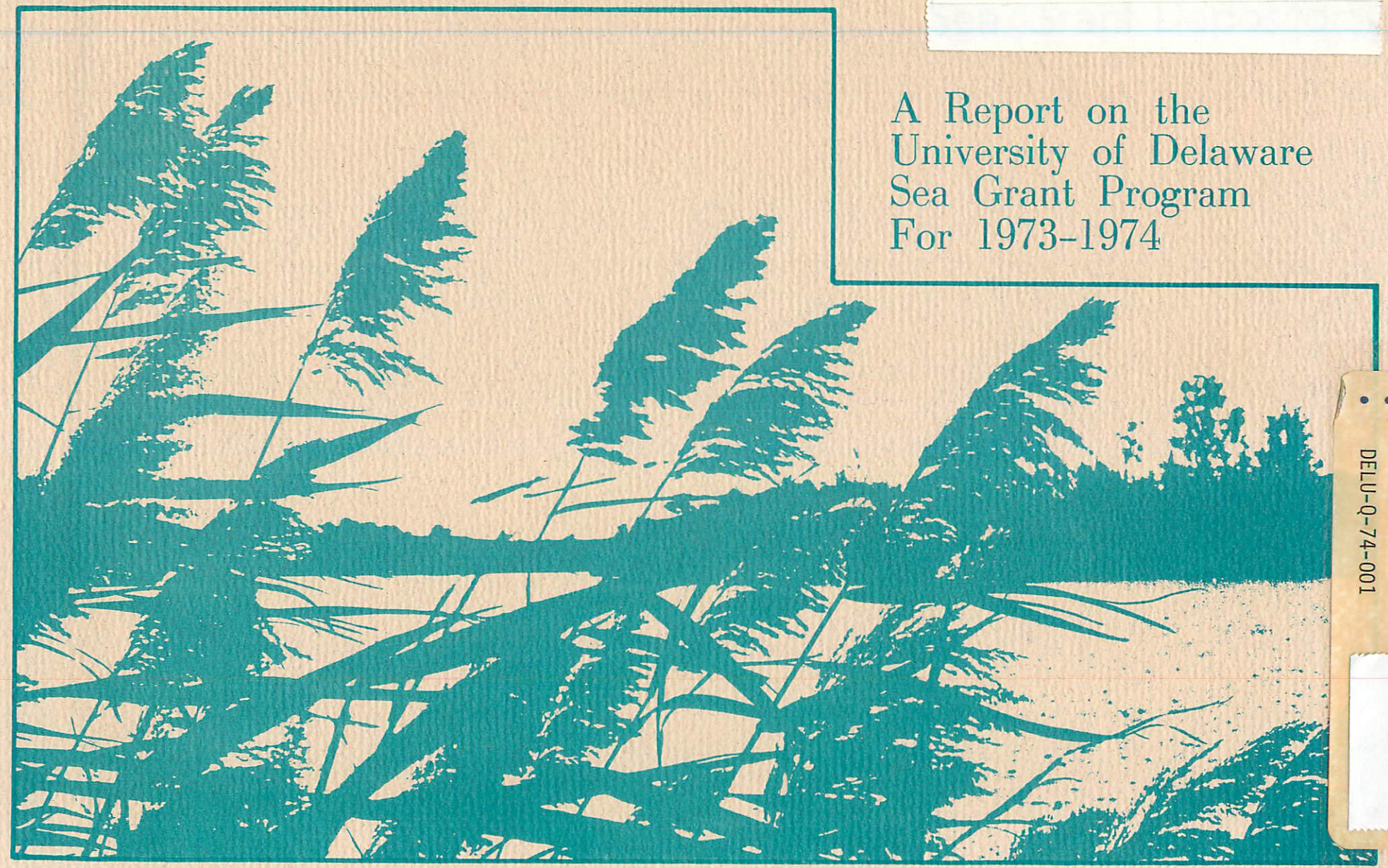
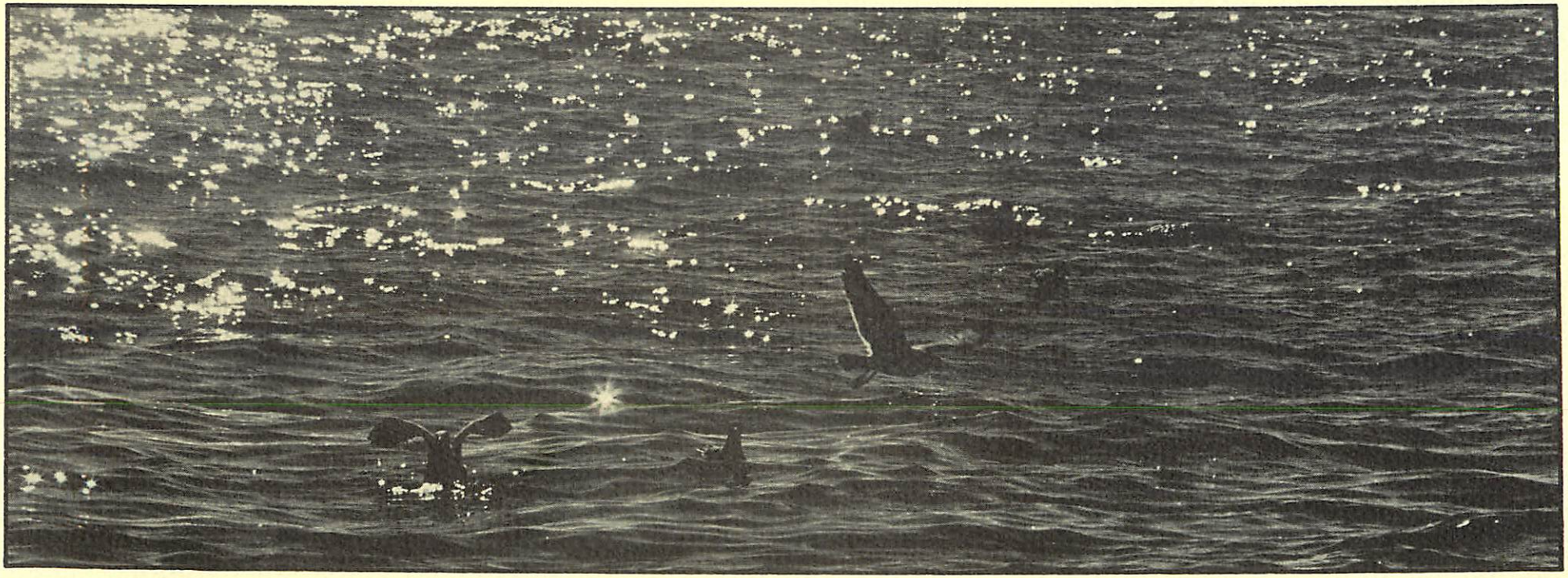
Delaware Sea Grant Program



A Report on the
University of Delaware
Sea Grant Program
For 1973-1974

Sea Grant in Delaware 1973-74



The Sea Grant Concept

In 25 coastal states across the nation, the Sea Grant Program is putting the oceans and coastal zone to work. Teams of scientists and engineers, lawyers and sociologists, educators and entrepreneurs, have set out to determine how man can both use and protect the earth's richest resource.

The program was created in 1966 with the signing of the National Sea Grant College and Program Act. The law calls for rational development of the nation's coastal, marine and Great Lake resources --- development that balances maximum social and economic use with good management and conservation.

Along with research and education, the Sea Grant concept includes the idea of advisory services as the program's "outreach" arm. Through the advisory services channel, research results may be directly applied by the people who use marine resources for business or for pleasure.

Delaware's ties to the sea --- both past and present --- are strong. Sea Grant brings together the university, industry and government to meet coastal and marine challenges in much the same manner that Delaware's land grant program has worked to develop agriculture in the state. Coastal and ocean resource management is as important to us now as land management was in 1862 when the Morrill Act established the Land Grant Program.

The National Sea Grant Program is administered through the Office of Sea Grant in the National Oceanic and Atmospheric Administration, U.S. Department of Commerce. (Until 1970 and the President's Reorganization Plan, however, Sea Grant was assigned to the National Science Foundation.)

Director's Message

This report covers the period September 1, 1973 through August 31, 1974, the third year of Sea Grant institutional status in Delaware and the sixth successive year of Sea Grant program participation. The past year was one of the most difficult in the short history of Delaware's Sea Grant program, yet at the same time it was one of the most rewarding and important years.

It was difficult because the Delaware budget was reduced in line with other reductions in federal spending. It was both a rewarding and important year because the Delaware Sea Grant program emerged at the year's end far stronger and more productive than before, increasing its level of federal support by a greater percentage than any other Institution or College in the nation. The reasons for this success were:

- A concerted effort by the Sea Grant Advisory Council to identify the most important marine resource problems facing the state and the region. These were used as the focus for a restructured research plan.
- The participation of an increased number of senior and talented research faculty and staff.
- The nearly unanimous support of the Delaware State Legislature by providing a matching appropriation of $250,000 for the 1974-75 program year.
- The continued increase in accomplishment and national stature of the closed system mariculture research group.

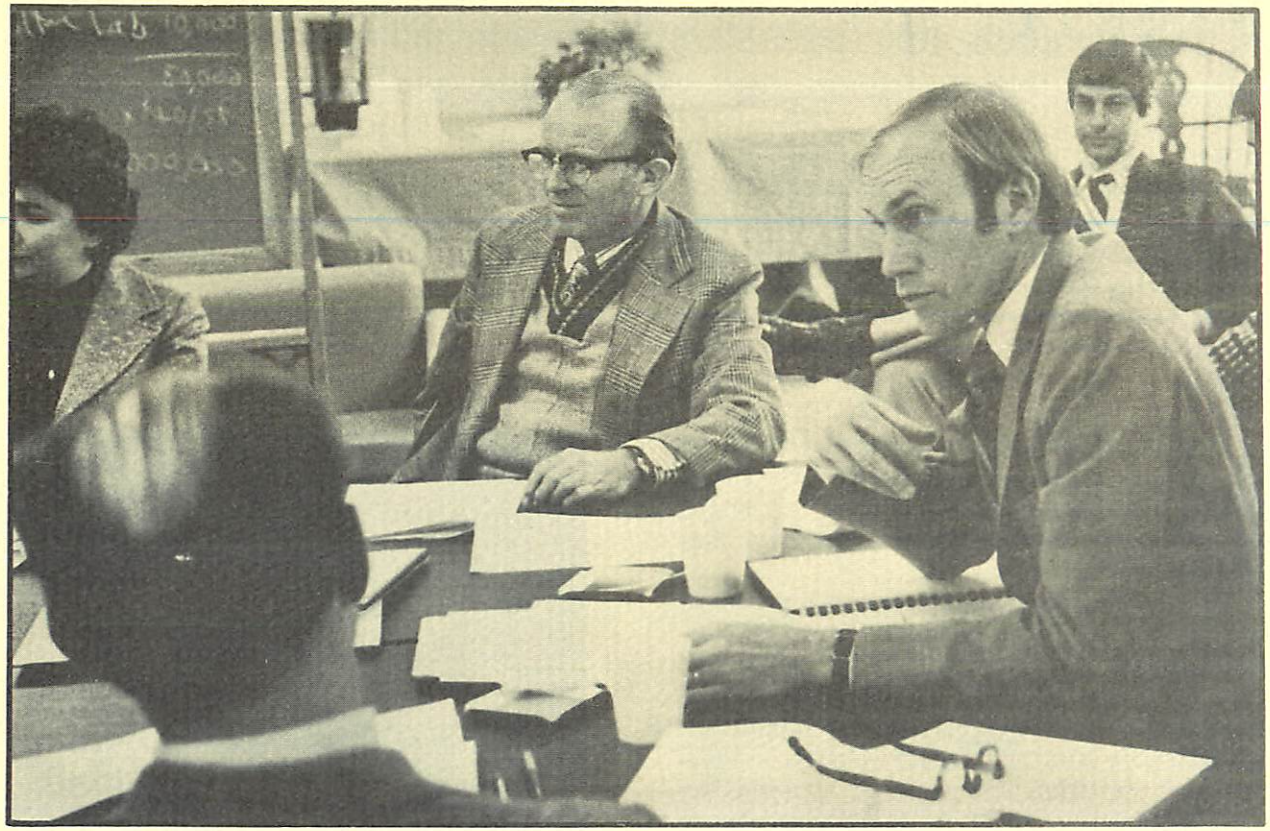
As the year advanced two important and parallel forces helped to shape and direct the program. The first was the positive and rational guidance of the Sea Grant Advisory Council. Everyone associated with the Delaware program sensed the urgency of solving the problems that they identified. The second was the emergence of the federally guided coastal zone management program administered through the state government and closely coordinated with the Sea Grant program. Both of these forces gave definite direction and clear purpose to the program. Efforts were directed to areas where positive accomplishment could be expected.
These included:

- —Accelerated work on closed system mariculture to achieve commercial viability at the earliest possible date.
- —Intensified efforts to define salt marsh productivity for management purposes, and new efforts to identify for domestication, salt-tolerant seed-bearing food plants.
- —Establishment of the Center for the Study of Marine Policy and the further development of the marine affairs discipline in the College of Marine Studies.
- —Completion and distribution of K-12 marine environment educational materials both in the school systems of Delaware and in nine other states.
- —Leadership in planning for an upper mid-Atlantic Marine Advisory Service network.

A total of 34 faculty and professionals, and 12 graduate students were active in this year's Sea Grant program.

In summary, the 1973-74 year was a test of program strength and University commitment in a time of adversity. In both, Delaware grew in stature.

W. S. Gaither
Director



RESEARCH

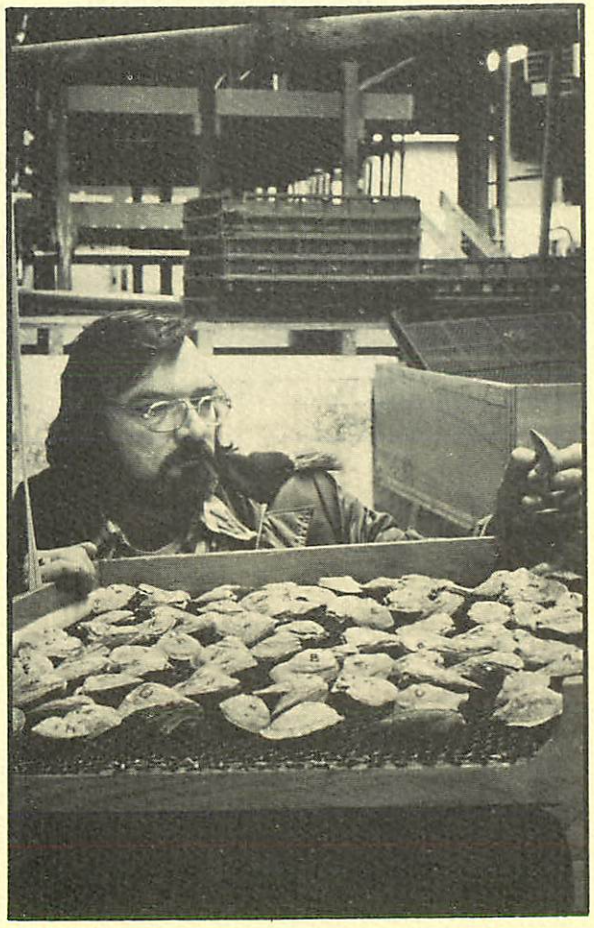
Delaware's coastal zone encompasses a great percentage of the state. There are nearly 160 miles of bay and ocean shoreline and 396,000 acres of contiguous wetlands and bay waters. The constant interactions of land and tidewaters which influence much of the state have been determining factors in Delaware's history, economy, and way of life.

To plan for the wise use and management of our coastal zone, we must understand these natural processes at work and how they interact with the socio-economic processes imposed by man.

Delaware's approach to its research program focuses on functional groups – projects clustered around a central theme. The five groups that made up the 1973-74 program reflect coastal zone problems particularly significant to Delaware and the region. Group leaders provided direction for each set of projects. Four groups continued from last year: *Food From the Sea, Systems Engineering for Development Options, Socio-Economic Aspects of Coastal Zone and Marine Resource Development,* and *Exploratory Resource Development.* One group, *Coastal Zone Management,* was reinstated with new projects.

New research efforts were initiated in three areas during mid-year:

- In June, 1974, a group of scientists assembled at the University of Delaware to consider the potential of finding new plants that would grow in highly saline water and could be developed as food for humans and domesticated animals. The conferees reached a unanimous conclusion – that biological technology was sufficiently advanced to produce feasible solutions, and that research should begin. Delaware Sea Grant is now involved in further investigation into halophytes (plants that grow in salty soil).



- An investigation was conducted on the use of silver and zinc to trace dispersal of sewage sludge through coastal waters. Researchers found that solids from Philadelphia sewage sludge dumped off Delaware Bay have been carried tens of miles away from the dump site on a southwesterly path that heads toward the Delmarva Peninsula.

- Previous Sea Grant investigations of the trace metal geochemistry of Delaware Bay sediments have disclosed that the metal concentration is higher in sediments from low-salinity waters of the Bay than in the "salty" water close to the ocean. But the trace metals may "remobilize" – dissolve out of their original sediments and move with the water. No one has yet been able to prove that this happens or (if it does) where and under what conditions.

  New initiative funds were requested in an attempt to demonstrate the phenomenon, and to determine where the remobilization occurs. River bottom sediments were placed in dialysis tubes and suspended from buoys in various positions in the bay. Periodic resampling of these sediments and determination of their trace metals concentrations should yield a demonstration of remobilization and may allow the calculation of rates at which it occurs.

Food From the Sea

The plants and animals of the sea are probably among the most important food resources of the world right now. Even though they have been harvested for food for thousands of years, the need to feed the rapidly expanding world population has never been more acute. Investigators must find ways of rearing and harvesting large quantities of food in a small amount of time.

Results of research under Delaware's Sea Grant mariculture program are pointing in that direction. Oysters and clams are being grown in a controlled, recirculating seawater system, simulating nature but accelerating the growth process tremendously. Economic feasibility of an environmentally controlled system such as this, when proven, could mean that oysters, clams and perhaps other shellfish and fin fish will soon be raised and marketed 1500 miles from any ocean.

Research also continues into the availability of a small estuarine fish (the mummichog) as food for higher-order species. Prospects appear quite good for cultivating commercial species using the mummichog as a food fish.

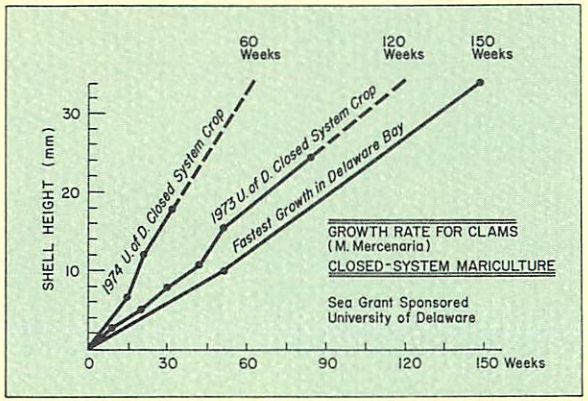
Mariculture Demonstration

Charles E. Epifanio

Working during the past year with hard clams *(Mercenaria mercenaria)* and oysters *(Crassostrea virginica),* Delaware's Sea Grant mariculture team has successfully demonstrated that these animals can be hatched and grown to maturity in a recirculating seawater system.

While the fastest-growing clams in Delaware Bay reached an average shell height of 34 mm in 150 weeks, the 1973 Sea Grant crop, thriving on algal diets, has been growing for about 70 weeks at a rate nearly twice as fast as nature.

Oysters, too, are doing better in the mariculture system than they do in the sea. The interdisciplinary



Delaware team of biologists, an engineer, and a chemist, has achieved a growth rate for oysters that will bring them to market size in two years after spawning, compared to three or four years needed in nature.

Nutrition of the young clams and oysters is a primary part of the mariculture research. Investigators have fed the animals eight combinations of different algal species as well as a few manufactured feeds, and were able to define more optimal diets. The diet which seemed to support the fastest growth was a mixture of four algae species: *phaeodactylum tricornutum* + *isochrysis galbana* + *carteria chuii* + *cryptomonas sp.* Still a major stumbling block, however, is the culture of large quantities of high quality algae for use as food. To demonstrate economic feasibility – to operate on a commercial scale – the mariculture research team must find a way to solve this problem.

Chemical monitoring was carried out on the existing closed mariculture system. A water quality laboratory and techniques for monitoring were developed so that factors such as temperature, salinity, pH, sedimentation, food supply, dissolved oxygen, pollution, and disease can be controlled within acceptable ranges. Mathematical modeling of proposed systems also has been undertaken in conjunction with water quality considerations.

The progress made in the past year, encompassing everything that has been learned during Delaware's mariculture research, is now being channeled into the design and construction of "economic prototype" production systems. The next step is demonstrating the economic feasibility of the closed cycle mariculture system. Several private industries as well as the National Marine Fisheries Service have shown interest in Delaware's progress – an indication that the program's direction is the right one.

Engineering Support of Demonstration Project: Seawater Purification

Charles E. Epifanio
Gary D. Pruder

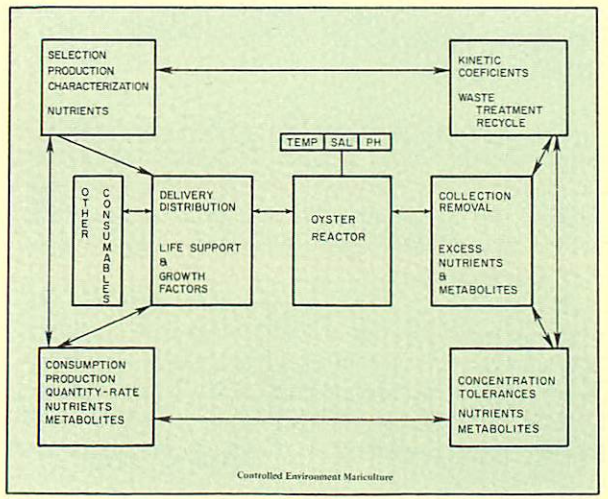
The controlled environment process and hardware system is the heart of the Delaware Sea Grant mariculture effort. Efficient maintenance of suitable physical, biological, and chemical conditions is essential to the reliable and economic production of desirable shellfish.

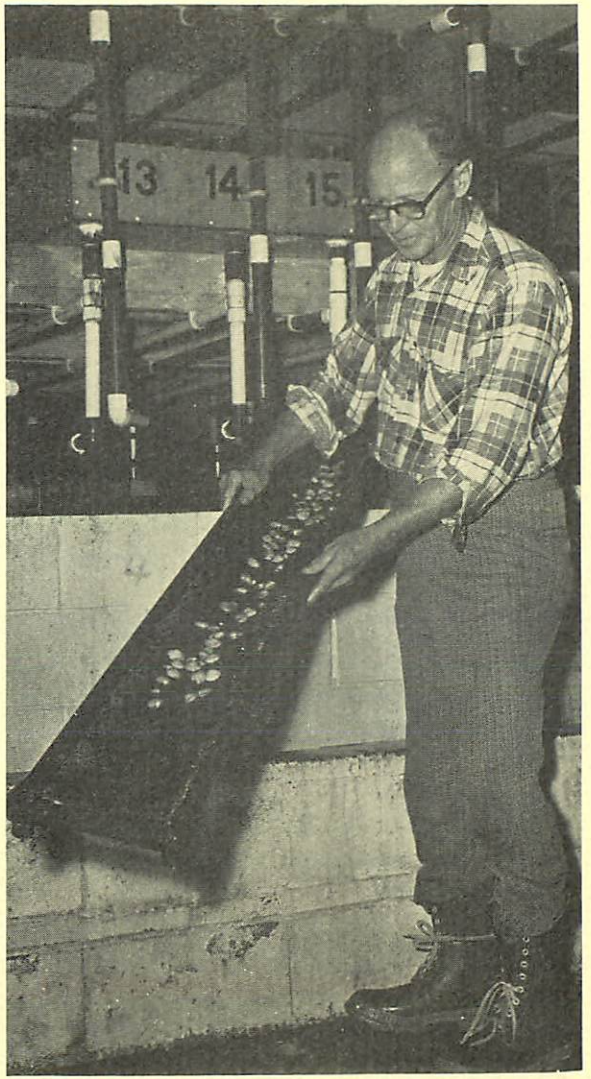
The process engineering approach used by the Delaware team stresses the importance of reaction rates and concentrations, and tolerances in the design of a controlled environment mariculture system. Shellfish will degrade the environment in a finite time through consumption of food and oxygen, excretion

of metabolites, and other growth factors. Therefore, the system must maintain acceptable environmental quality by providing counteracting forces to balance the effects of the shellfish activity.

The interrelationships that are under investigation in this support project are shown in the block diagram. The center block is the reactor, or mollusk growing tank. Support requirements are to deliver and distribute life support and growth factors, to collect and remove metabolite and excess food, and to maintain the proper physical and chemical conditions. The critical information needed to design hardware to meet these requirements is represented in the corners of the diagram. In the top left is the nutrition input, including evaluation production and characterization of oyster food. The top right corner represents waste characterization and treatment input, including alternate methods to prepare the waste for recycling or disposal. Shellfish and algae tolerance to various environmental conditions is represented in the lower right corner and the lower left corner represents input concerning nutrient consumption/metabolite production for shellfish in a mariculture environment.

The results of investigations in each of these areas were incorporated into the design of a four-bushel controlled environment system.





Investigation of Potentially New Food Products In Delaware Bay

Victor A. Lotrich

Man currently makes use of only a minute amount of the valuable food resources in the rivers, creeks, estuaries, bays, and oceans. Clams, oysters, and crabs are harvested as well as flounder, bluefish, and sea trout. But much of the other marine life is dismissed as worthless for human use. However, as the exploitation of some resources becomes less advantageous, man must identify others which might offer beneficial alternatives.

As a step in this direction, a small fish found in Delaware's tidal marsh creeks has been the object of a three-year investigation into potentially new food resources in Delaware Bay. *Fundulus heteroclitus* Linnaeus (the mummichog) is abundant in marsh areas and plays an important role in the food web of the marsh. Research into its biology was initiated to determine the fish's significance in estuarine ecosystems, and to evaluate its potential as a fishery or cultivation species. The mummichog may have several possible uses including chicken or cattle feed additives, crop fertilizer, oil extract products, forage base for other cultivated fishes, mosquito control, etc.

In the study, which was done in the lower portion of Canary Creek (Lewes, Delaware), individual mummichogs were found to maintain a summer home range of only about 36 meters along the creek bank. Fish were distributed along the entire five km length of tidal creek in the summer. However, in the winter, as the water temperature and amount of daily sunlight decreased, most of the population moved to the upper one-third of the creek, where salinity was significantly lower than downstream areas.

Population estimates in early summer showed 43,000 fish per kilometer while late summer estimates showed only 26,000 fish per kilometer. The decrease did not represent predation on the mummichog, but rather some other cause of natural mortality. The decrease occurred before the observed upstream movement of fish in the fall. This decline period may indicate a time when the mummichog can be harvested without significant effects in future mummichog pop-

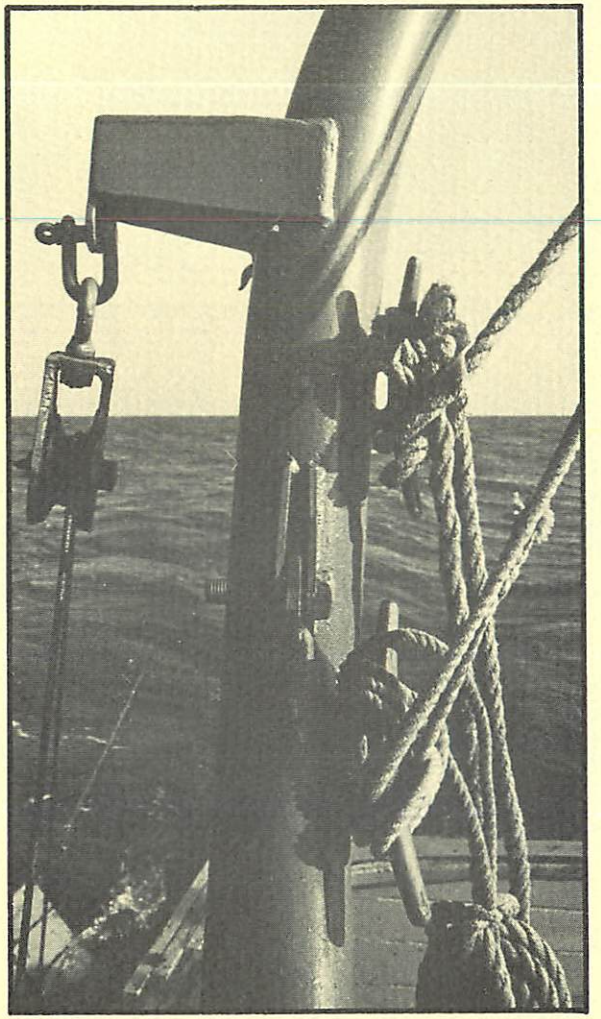
ulations, since most spawning has already taken place.

Summer growth rates under natural conditions showed one-year-old fish to grow about twice as fast as two-year-olds and about three times as fast as three-year-olds. Most mummichogs do not live more than three years.

Annual production of mummichogs per square unit of creek surface was estimated to be 40.7 gm/m^2/yr. This is one of the highest single-species values recorded for fish in temperate waters and indicates promise for its cultivation. At least 78% of the total production occurs in fish less than one year old, the fastest growing age group.

Annual mortality rates for one, two, and three-year-old fish were estimated to be from 51 to 57%. The mortality rate from egg to age group I was estimated to be 99.5%. Cultivation techniques could enhance egg and juvenile survival, increasing an already naturally high production. Spawning behavior and regularity, coupled with the adult mummichog's hardiness and limited space requirements are other attributes indicating promise for its culture.

Several subsequent projects have been generated from this study. Researchers are investigating the physiological mechanisms and adaptive significance of the mummichog's upstream movement in autumn. Another project examining the nutritive values of several diet components is nearing completion. Predation pressures on the mummichog have been incorporated as part of a new Sea Grant study concerning salt marsh ecology and man-induced disturbances.



Systems Engineering

Engineering research during the past year has been concerned with effluent design standards for industrial operations along Delaware's coastline. Specifically, the investigators have looked at thermal and chemical pollution of the ocean by industrial plants. The results of their study will be important to designers of industrial outfall lines in providing better standards from which to judge the polluting effects of discharged waste water.

Local Thermally Convective Flow in the Ocean

Frederick A. Costello

Industrial plants, especially power plants and sewage treatment facilities, frequently use the ocean as a receptor for their wastes. This Sea Grant project pertained to the discharge of these wastes from submerged outlets. In particular, the behavior of the waste stream as it approaches the ocean surface was analyzed.

In this third and final year, efforts were made to predict the temperature and concentration of pollutants in a plume as it rises to the surface. Design charts showing the predictions have been developed. The charts will be published for use by designers of outfall lines and ocean floor structures to predict the thermal and chemical effects of the structures on ocean flow and pollution levels.

Socio-Economic Aspects

The social and economic forces which affect a region are not always the most visible. While wave erosion and wind and storm damage produce effects which can be readily detected, an economic upswing in a particular coastal industry or the conversion of farmland to a mobile home park may not show any immediate consequences.

Yet the socio-economic characteristics of the coastal zone may well be just as important as natural characteristics in studying development options. Delaware Sea Grant researchers have been investigating primarily land-use and economic activity patterns along Delaware's coast, to identify past trends and to make future predictions with respect to coastal zone development in the state. This will provide valuable information to planners who will develop coastal zone management plans for the future.

Assessing Delaware's Coastal Zone Economy

Dennis K. Smith

It's not only the Delaware beachfront property owner who is concerned about the economic future of the shore area. Naturally, he's got a very real stake in the coastal zone. But, at the same time, the summer visitor to Delaware's beaches, while he doesn't own seashore real estate, is also affected by changes in the economic activity levels there. The recreation activities available are the tourist's main concern. Finally, state legislators and planners and local planning officials, in the course of setting down policies and programs, are continually faced with problems and questions concerning development in the coastal zone.

It's obvious that the dynamic process of economic change which pervades Delaware's coastal zone region affects nearly everyone. The crucial questions that are asked about the coastal zone need answers. But before those answers are formulated, some basic

information is needed—a complete picture of the economic structure of the coastal zone is needed.

This research program undertaken by Delaware Sea Grant is aiming to provide that picture. Using secondary data sources, benchmark characteristics have been compiled for a study area. (For purposes of this investigation, the coastal zone study area encompassed the eastern half of the state from approximately Bowers Beach south to the Maryland border.) Information which the researchers obtained included demographic, income, labor force, employment, and housing characteristics.

These benchmark socio-economic data can be used in formulating meaningful coastal zone development policies and programs. Required for the formulation of such policies are two things: the identification and quantification of the present economic structure of the coastal zone economy; and the subsequent evaluation of the economic impacts of alternative types of economic change. To look at economic change impacts, investigators are currently constructing an inter-industry model using income and expense profiles for approximately 25 industrial sectors in the coastal zone. When that is completed, planning officials and policymakers will be able to more accurately predict the effects of alternate courses of action.

Effect of Evolving Land-Use Patterns in the Delaware Coastal Zone as Perceived Through Aerial Imagery

Dennis K. Smith
Vytautas Klemas

State planners and coastal zone management specialists in Delaware are continually faced with the prospect of making decisions about land use. Development of the coastal zone is a major part of their concern. They must know how past development decisions affected the coastal and marine environment, and they must be able to predict the impacts of any future decisions.

Of particular importance is the changing use of land for agriculture, industry, and recreation purposes. Until recently, it's been difficult to make significant statements about how land use has changed because there has been a lack of information about the pre-development stage.

In the case of this Sea Grant project, however, it was possible to compare past and current ecological conditions. A study of fish fauna and water quality done 15 years ago was duplicated this year.) Also, aerial photographs of the Lewes area dating from 1938 provided data for comparing land-use changes.

Two test sites were chosen—the White Creek estuary, where investigators studied the impact of changing land-use patterns on ecological processes, and the Lewes area, where resulting changes in economic activity were studied.

At the White Creek estuary, Sea Grant researchers duplicated an extensive fish and water quality survey done in 1957 by the Bureau of Commercial Fisheries (now the National Marine Fisheries Service). They looked at the fish fauna from several aspects (species diversity, graphical distribution of individuals among species, total species, etc.) and compared past and recent aerial imagery for land-use changes. Conclusions were that no change had occurred in the nearshore fish community of White Creek despite increased land usage or other perturbation. Also, these results reflect conditions in nearby small bays and along the Atlantic coast.

In the Lewes area and along the coast, aerial and ground teams collaborated to develop a technique for land-use mapping. The resulting maps can be compared with earlier aerial imagery to distinguish development-related, land-use patterns. Investigators using this technique have mapped an area along Delaware's shoreline from Lewes to the Maryland state line measuring 9 miles by 21 miles, with errors of less than 100 feet.

Categories identified on the maps include: agricultural cropland, beaches, commercial and institutional, bays and estuaries, forestland, industrial, man-made ponds and reservoirs, agricultural orchards, pastures and fields, permanent residential, mobile residential, streams, transportation and utilities, and wetlands.

The mapping technique involves interpreting land

uses from aerial photographs onto basic governmental topographical maps and then coding the uses by color and letter. Eventually, investigators will be able to look at any number of overlay maps at one time, showing data from 1938 to present. Thus, changes in land use over the years can be systematically studied.

Analysis of the changing patterns will involve looking at the influences of natural, economic, and institutional forces on land-use changes. This will help define methods to plan and guide desirable future development patterns.

Exploratory Resource Development

Opportunities for developing virtually untapped marine resources find their outlet in this functional group. New products from the ocean, new methods of using what we do have – these are the directions taken by Delaware Sea Grant in expanding the base of marine resource knowledge.

Criteria are set for judging whether a project should be included here: is the activity performed or the product used in the coastal zone for economic reasons? does the proposed result have low environmental impact? is there a demand for the product? The two projects in which researchers were involved this year meet these requirements.

Utilization of Renatured Crystalline Chitin

Paul R. Austin

Crabs, lobsters, and shrimp are potentially more valuable animals than one may think. As a food source, of course, they are rich in protein, vitamins, and minerals, and low in calories and sodium. But what happens to the rest of the crab or shrimp once the edible part is taken? Until recently, most of the shellfish waste in this country was treated as just that–waste. It was dumped into the ocean where "nature took care of it." In the past few years, however, a new use for shellfish waste has come to light. The structural support material in the exoskeleton of shellfish–chitin–is a potentially valuable marine resource. Chitin, a cellulose-like material (in its pure form) has been shown to have the ability to form filaments and films, and to absorb dyes. But it is extremely difficult to dissolve for purification.

Several Sea Grant groups are currently engaged in chitin and chitosan (a chitin derivative) research, directed toward applications to paper, non-woven fabrics and water clarifiers. Delaware's research approach is aimed at standardizing and characterizing the preparation of purified chitin and precipitating dissolved chitin to yield renatured unsupported films and continuous filaments.

Using new solvent systems they developed, the Delaware investigators, during the past year, have prepared strong films and fibers and have demonstrated the orientation of filaments by careful elongation. This procedure is practiced with most man-made fibers to develop properties such as high tensile strength. The physical structure of the fibers and filaments appears to be very similar to that of natural chitin.

Initial steps have been taken to patent these findings.

The newly developed solvents for chitin minimize degradation and permit its solution, filtration, and reprecipitation as crystalline, renatured fibrillar material. However, these solvents are not the final panacea. More research will be needed to find better non-degrading and non-corrosive chitin solvents.

An important aspect of Delaware's chitin research program is the cooperative work now underway with a New York-based pharmaceutical research firm. Sea Grant researchers are sending prepared chitin test samples to the company for evaluation of the purified crystalline chitin as a clinical wound-healing agent. The firm currently supplies a bovine cartilage material for clinical wound-healing tests.

As well as its wound-healing possibilities, chitin has potential in the food wrap, surgical sutures, and paper-making businesses. Development of markets such as these for chitin would increase substantially the value of seafood processing waste. Subsequently, new values for these waste products will contribute to shellfish industry profits and will alleviate some of the pollution problems.

In efforts to stimulate commercial interest, Delaware's chitin research was reported at the 1974 Earth Environment and Resources Conference held in Philadelphia. Contacts have also been initiated with pharmaceutical, film, and fiber firms.

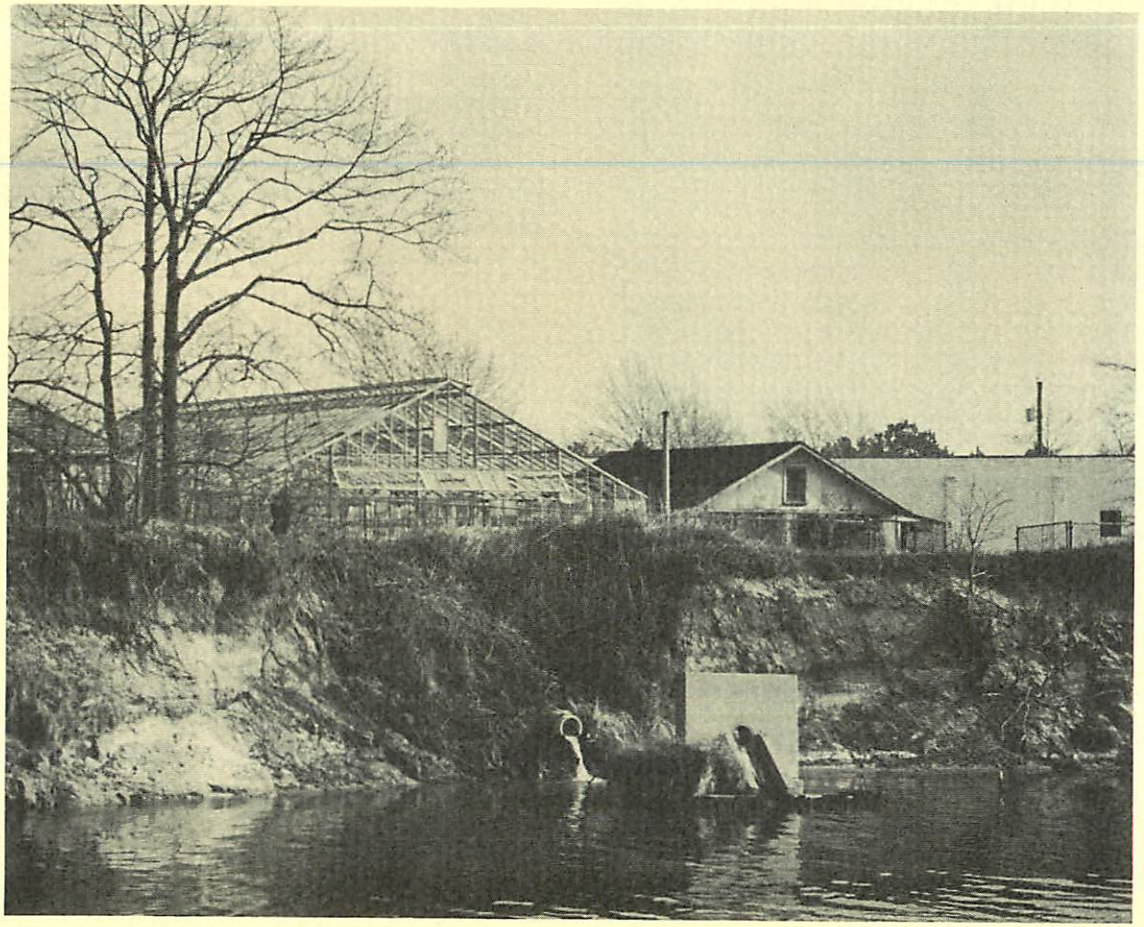
Genetic Control of Algae in the Estuarine Economy

Conrad N. Trumbore
Marjorie P. Kraus

How do marine organisms adapt when their environment becomes polluted? The photosynthetic plankton in the ocean are the very basis of higher forms of life—so it is here in the area of primary productivity where the question of adaptation can first be addressed.

In investigating this problem, our Sea Grant researchers turned to the host/virus system of the primitive, photosynthetic blue-green algae. They found that such a system was an efficient monitor to viral content and pollution load in water and also a good indicator of rich nutrient/deficient oxygen conditions. But beyond serving as just a monitor of sewage pollution, the investigators have discovered that intestinal viruses can cross-infect into the blue-green algal system and thus this host/virus system participates in and is a useful model of general principles and mechanisms of how viruses are transferred in water. Understanding the behavior of viruses is a necessary basic study for those involved in mariculture, sewage treatment, and water re-use for recreation, spray irrigation, or food production.

From host/range tables developed in the past year, the researchers have proposed a method for examination of fish kills, hatchery epidemics, and involvement of oysters in hepatitis outbreaks. They've also developed a radiation technique for the separation and biochemical and biophysical assay of gene products and of the DNA comprising the genes. This development is particularly noteworthy with respect to viral transfer. Often a virus may be present but undetectable in a carrier host. A virus, thus incorporated into a host confers immunity on the host, making the alga virus-resistant. Virus-resistant hosts may take part in numerous virally-maneuvered operations allowing environmental adaptation, *e.g.*, host genes may be virally transported to another host! Also, under environmental and ecological stress, the carrier host may release virus. By the newly-developed methodology, many of these types of non-virulent virus activity can be discovered.



Information gathered through this project is expected to be used to devise a more significant and specific assay than *E. coli* counts in determining when shellfish beds should be closed for public health reasons. The information will also be helpful in identifying virus hazards in sludge dumping either on land or at sea.

One of the related problems in this research effort is public understanding of viral pollution. The American Chemical Society has cooperated with the Delaware Sea Grant program in this respect by holding virus workshop courses for teachers and high school students. Other cooperating agencies were the Delaware Public Health Department, the Chester (Pa.) Soil Conservation District, and various industries, especially in the virus analysis of sludges and sediments.

Coastal Zone Management

The allocation, control and development of coastal zone resources is what coastal zone management is all about. Making rational decisions in these areas calls for expert knowledge, and Delaware Sea Grant is working to provide that knowledge.

Right now there is conflict in the coastal zone—recreation wants to exist, industry wants to exist, and conservation wants to exist. The bay coast is an area of conflict between conservation and industrial interests, while along the ocean coast, recreation is up against conservation. To cope with these conflicts, management tools are being developed.

Specifically in the area of conservation, work was begun on ways to regenerate salt marshes on intertidal land which has been disturbed by man's intrusion.

Coastal Zone Co-existence Alternatives

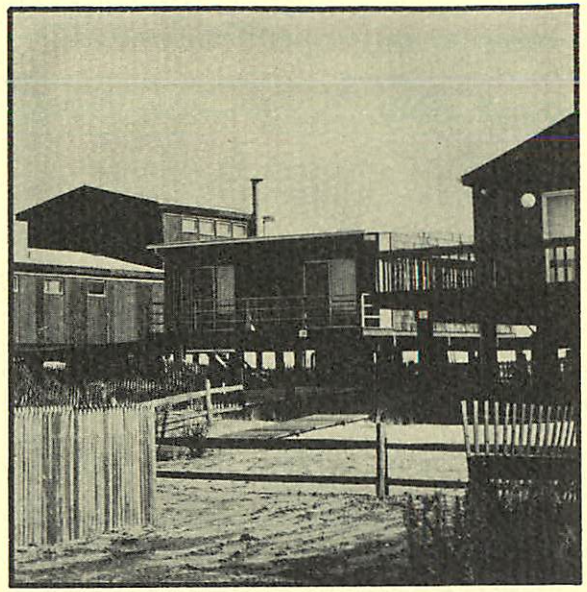
Joel M. Goodman

There is no question that the Delaware Bay and River and the adjoining coastal lands have been, and continue to be, a focal point for marine transportation and industrial development opportunities in the region. *The Coastal Zone of Delaware*, written in 1971 by the Governor's Task Force on Marine and Coastal Affairs, acknowledges this and addresses it in detail. But industry is only one use of the coastal zone. Recreation and conservation also compete for space.

Resolution of these conflicting needs can take place in several ways. The Delaware Sea Grant program has moved to explore and better define some of the answers to the question, "how can industry, recreation, and conservation best be accommodated in the Delaware coastal zone?"

Still in its early stages, the project intends to put together complete descriptions of a development option, showing social, economic, and political characteristics, design possibilities, and design specifications. A scenario will help evaluate the technical feasibility and impact of a particular option. When furnished to the state and county planning offices, this scenario will be a source of information for making decisions regarding land use allocations.

The task is complex, and work is now progressing on improving the method itself as well as the quality of the data base.



Evaluating Techniques for Redevelopment of Degraded Salt Marshes

Jonathan E. Taylor

Saltwater marshes are great sources of energy and nutrients for estuarine communities as well as good nursery grounds and shoreline protectors. It is the vegetation of the marsh which provides a large amount of material to the estuary system as detritus (loose organic fragments and particles). The detritus is broken down by a host of decomposers and the nutrients contained in the grasses are then released and made available to other organisms.

Because of the rapid rate at which marsh areas are being altered through development and dredging, the possibility of regenerating a marsh on already disturbed intertidal land is quite intriguing. Great losses in productive marsh are evident because of development of coastal areas. Many marshes, while not completely destroyed, are often so affected that they become very unproductive or lose the characteristic vegetation altogether. Usually this occurs when conditions typical of the marsh have been radically changed. Dredging areas and piling the spoils in the marsh, for example, often change water flow patterns of the marsh, which are very critical to the existence of the species found there. That could lead to the disappearance of such species.

Although work is being done on restoring marshes with natural marsh grasses, some areas just have not retained sufficient tidal marsh conditions to allow that. Delaware Sea Grant, therefore, is working toward finding other species capable of restoring productivity to degraded salt marshes. In this vein, researchers have begun investigating the role of *Phragmites communis,* the common reedgrass, as a potential replacement species.

Phragmites is a perennial grass which often colonizes spoil banks and low marsh areas which have received some disturbance and have lost more natural tidal marsh vegetation. In comparative studies with *Spartina* (a natural marsh grass), the investigators found *Phragmites* to be very productive and a potential source of detritus which, in the marsh system, decomposes at least as quickly as *Spartina.* Production and breakdown of several *Phragmites* stands were monitored. The differences which were recorded could be related to the age of the *Phragmites* group and whether it was naturally growing or had invaded a recently disturbed area.

Much of the information which the Delaware Sea Grant researchers collected will be useful in evaluating whether or not *Phragmites communis* growth in degraded marsh areas should be encouraged. However, many questions remain to be answered–How easily can an estuarine community be manipulated? How useful is the *Phragmites* detrital material to other trophic levels in the estuary? What problems could a large estuarine community present?

EDUCATION

The education dimension in Delaware's Sea Grant program has incorporated three basic approaches.

A marine environment curriculum collection, developed last year under a Sea Grant project, is now being used in thirty Delaware schools. Nine other states have purchased this set of 65 "learning experience" folders or packets of teaching materials, which is designed to relate specific problems of the marine environment to general fields of knowledge and study. Continued and expanded use of the collection will help to increase general awareness and understanding of the marine environment.

In the area of professional education and training, Delaware has made significant progress with the development of a marine affairs curriculum and the establishment of the Center for the Study of Marine Policy.

A two-year survey of marine technician training programs in the United States was concluded this year and a report issued which details the outlook for opportunities in that area of vocational training.

Development of an Integrated Marine Affairs Curriculum and Research Center

Gerald J. Mangone

"... To distinguish 'marine sciences' from 'marine affairs', marine affairs has been defined as the application of history, law, political science, economics, and other social science disciplines to the oceans, the seabed, and the coastal zone."

Mangone, **Marine Affairs and Higher Education**

As a conceptual description these words have set the stage for developing the marine affairs curriculum as an integral part of the University's College of Marine Studies academic plan. A two-year Sea Grant project has helped to pave the way.

In the first year of research, investigators surveyed 57 universities across the country to achieve a baseline analysis of the state-of-the-art of marine affairs. At the same time they collected readings, syllabi, and curricula which were analyzed to improve Delaware's marine affairs program.

During the second year, current teaching and research programs in marine affairs were examined, and results of that extensive study were published last year in *Contemporary Research in Marine Affairs.* Complementing the first year's state-of-the-art analysis, *Contemporary Research* brought together in one place the kinds of marine affairs research that are current in the U.S. Specific areas mentioned were national security policy, merchant marine and port policy, mineral policy, fisheries policy, pollution policy, and coastal zone and general policy issues.

With the appointment of a marine resource economist to the faculty of the College, in addition to an historian, a lawyer, and a political scientist, new courses have been added, thus strengthening Delaware's marine affairs program.

The establishment of the Center for the Study of Marine Policy was another significant step forward in the development of the College's marine affairs curriculum. The Center was established in order to conduct research on the political, legal, economic, and social considerations of marine policy at the state, national, and international levels, both to assist public understanding of contemporary issues and to enhance and reinforce the marine affairs curriculum. The Center is now an effective vehicle to attract and conduct research in a variety of areas.

Marine Technician Training

Leonard Mitchell
Joel M. Goodman

Just as the national concern over proper use of the nation's resources is a relatively recent phenomena, so is the development of marine technician training programs in the United States.

In 1965, one institution offered a two-year course in marine technician training. Today, there are 34 such institutions. Yet during those years of expansion, questions on future needs were raised and couldn't be answered. There were no accurate surveys on a national level, and local polls showed a definite lack of understanding of what a marine technician is. Program planners needed an overall picture of the marine technician training community and they just didn't have it.

When Delaware Sea Grant began its reassessment of marine technician training programs, no one had actually defined the term "marine technician." The 34 programs which were in operation included technical training in areas such as wastewater treatment, oceanographic research, diving, marine instrumentation, commercial fishing, aquaculture, marine electronics, ocean engineering, underwater welding, and vessel operations. When the study was done, it appeared that the schools might be preparing students for marine-related jobs that employers do not recognize.

The researchers went into the study to answer the question, "Where does the country stand today with respect to training and employment of marine technicians?" thus providing the Office of Sea Grant with guidelines for future program management decisions. An overview and assessment was completed and the results presented to a meeting of the Interagency Committee on Marine Science and Engineering (ICMSE).

Delaware's investigators made four recommendations to the committee:

- Invest in improving the data base from which supply and demand can be predicted.
- Let the supply of students lag demand by controlling federal grants for program continuance or initiation.
- Initiate cooperative efforts with industry to create a more credible picture of demand. Since a major purpose of marine technician training programs is to fill a declared need of the user, then the user, in good faith, should be willing to provide the needed data.
- To alleviate short-term student placement problems, ICMSE should identify job opportunities within the federal establishment.

ADVISORY SERVICES

In 1968 with the first Sea Grant funding, Delaware's advisory services program focused primarily on commercial and sports fisheries—acting as a liaison for commercial fishermen with government agencies and the university, helping in the design and construction of an artificial underwater reef, and making fishermen aware of the practical applications of current research.

However, in recent years, the advisory services component of the Delaware Sea Grant program has broadened considerably to include work with the recreation industry, and more attention to coastal zone management concerns and regional public education. The small size of the state has been a prime factor in the ability of advisory service specialists to establish a one-to-one relationship with these marine resource users.

One of the most successful methods of getting to know who's who in what industry, identifying their problems and taking their concerns back to the researchers, has been the "town hall" meetings, in which advisory specialists interact with such groups as campground owners, commercial hard clammers, marina operators, commercial oystermen, commercial lobstermen, and charterboat captains. Five such meetings were held this year with commercial watermen and party boat captains to discuss fuel problems and tax reporting problems.

Cooperating with county agricultural extension agents, one Delaware advisory specialist presented eight seafood cooking demonstrations in Maryland, Pennsylvania, New Jersey and Delaware, using sharks, squid and mussels. Over 600 persons attended the demonstrations, where they learned ways of preparing these rarely used foods from the sea. Advisory services also worked with a restaurant owner to obtain mussels to put on his menu and several other interested parties have since made inquiries.

Another popular service provided during the summer months is the "Fisherman's Hotline," a daily one minute phone message on local fishing and weather conditions. In its third year of operation, the hotline, which can be called toll-free from any point in Delaware, was called more than 90,000 times from May through October. In addition, it was taped daily

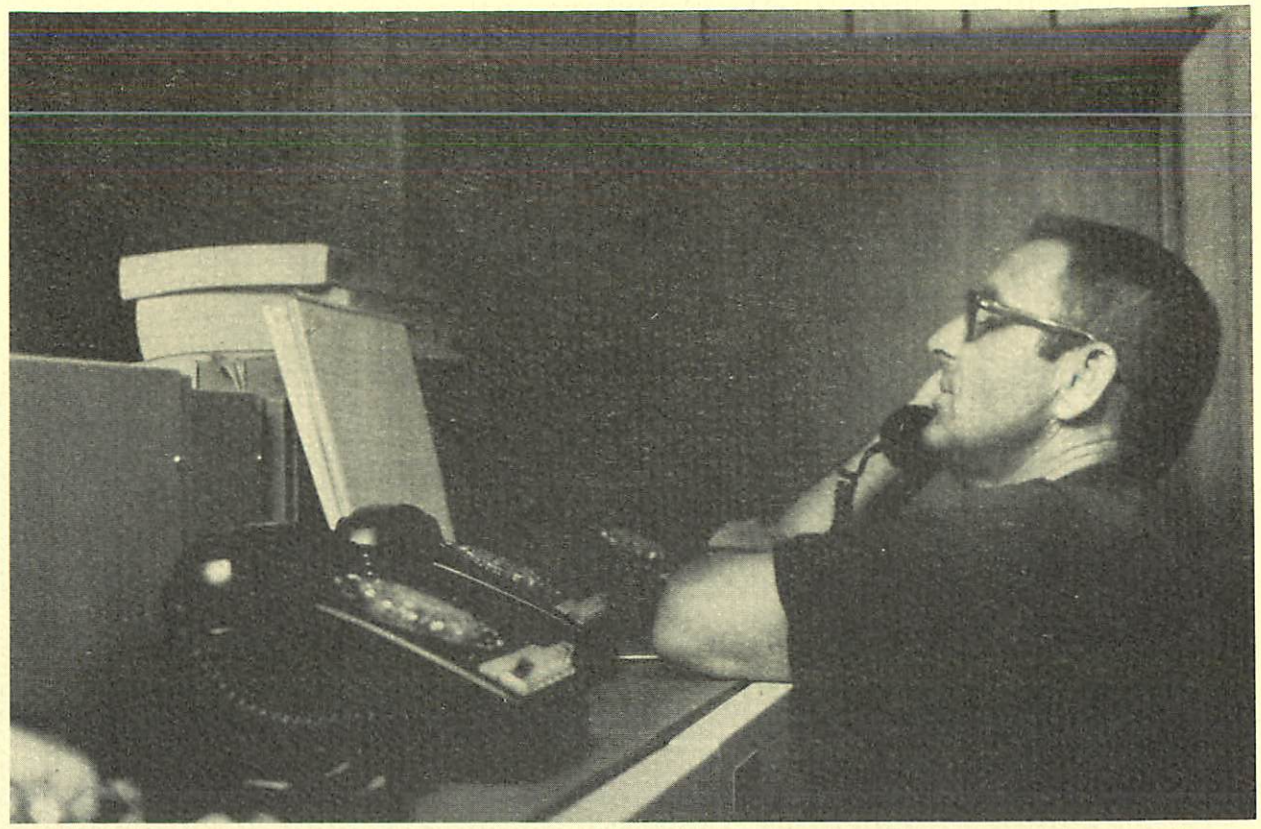
on six radio stations and printed in two newspapers. Information for the messages is obtained from local bait dealers, marina operators, and party boat captains.

Work also was initiated with local codfishermen in demonstrating gillnetting techniques. Lobstermen were assisted in identifying an infestation of Gould's ship worms as the cause of a total destruction of lobster pots in Delaware Bay.

Members of the advisory services staff also have been active in providing assistance to state government agencies and in serving on Sea Grant Association Committees. The program was represented on two Governor's Committees–the Wetlands Action Committee, which drafted recommendations for strong protective legislation and public management of the state's wetlands; and the Committee on Shellfish Quality, which planned measures for improving the shellfish harvest in Delaware waters. In addition, advisory service specialists cooperated with personnel from the Department of Natural Resources and Environmental Control on fisheries resource problems.

One advisory service agent was a member of the Sea Grant Association Marine Advisory Service Steering Committee and assisted in formulating advisory service coordinating mechanisms. As a member of the Sea Grant Association Public Affairs Committee and the Sea Grant Communication Steering Committee, the Delaware representative helped in developing a national directory of Sea Grant communicators and helped to lay the groundwork for a national Sea Grant communication plan. The Director of Advisory Services was a member of the Sea Grant Association Education Committee which provided additional perspective for the Delaware broad-based public marine education program which included:

- Conducting guided field trips and tours of Delaware's marine research facilities;
- Presenting lectures to civic and educational groups;



EXTENSION SPECIALIST Howard Seymour records message on "Fisherman's Hotline."

- During the summer months, conducting a series of six public lectures on the marine environment, which drew 100-125 people per lecture;
- Supplying marine animals for the Department of National Resources and Environmental Control "Touch and Feel" Tank, which was displayed at schools, fairs, and shows throughout the state.

The Advisory Services communication staff provided "Seascapes," a series of 20 articles on the marine environment, for a weekly summer newspaper published for residents and vacationers in the coastal zone. The Marine Advisory Service Bulletins were continued with the publication of a bulletin on horseshoe crabs. A directory of Delaware's marinas was published–a result of extensive fact-gathering by an advisory specialist. The directory was well-received and plans are afoot to update it for next year.

In summary, the Delaware MAS program was quite varied and was designed to provide the maximum dissemination of marine information to the audiences of the Delaware region.

Program Development

	FY72	FY73	FY74
PROGRAM MANAGEMENT			
Leadership and Coordination, M/M-1	C	C	C
FOOD FROM THE SEA			
Mariculture Demonstration, R/A-4	R	C	C
New Species for Mariculture, R/A-1	R	T	
Mariculture Controlled Systems, R/A-2	R	C	C
New Food Resources, R/B-1	N	C	T
Systems Eng., Oyster Production, R/M-4	T		
SYSTEMS ENGINEERING			
Factors in Coastal Storm Damage, R/C-1	N	R/T	
Shoreline Rates of Change, R/G-1	N	T	
Shoal Development Processes, R/G-2	C	R/T	
Port Development, Management, R/T-3		N/T	
Concentration of Trace Metals, R/G-3	R/T		
Sedimentary Organic Matter, R/G-4	N/T		
Heavy Mineral Distribution, R/G-5	N/T		
Sediments in Delaware Estuary, R/G-6	N/T		
Local Convective Flow, R/T-2	N	C	T
Strategies for Engineering Development, R/T-1	N/T		
SOCIO-ECONOMIC SYSTEMS			
Economic Changes in the Coastal Zone, R/E-1	N	C	T
Analysis of CZ Industry, R/E-2	N	R/T	
CZ Land Use Patterns, R/E-3a		N	T
Seashore Recreation Options, R/S-1	C	T	

	FY72	FY73	FY74
EXPLORATORY RESOURCE DEVELOPMENT			
Role of Algae in Tidal Marsh, R/N-3	N	T	
Blue-green Algal Viruses, R/W-1	N	C	C
Renatured Chitin, R/N-4		N	C
COASTAL ZONE MANAGEMENT			
CZ Development Options, R/M-1	N/T		
CZ Laboratory Concepts, R/M-3	N/T		
Redevelopment of Degraded Salt Marshes, R/N-5			N
CZ Co-existence Alternatives, R/M-6			N
ENVIRONMENTAL IMPACT			
Ecological Warning System, R/W-2	N	T	
Local Control of Biting Flies, R/W-4	N	T	
EDUCATION			
Ocean Eng. Lab, Course Work, E/T-1	T		
Marine Affairs Curriculum, E/T-2		N	T
K-12 Marine Environment Studies, E/Z-1	C	T	
Marine Technician Training, E/T-3		N/T	
ADVISORY SERVICE	C	C	C

N=New Project
C=Continuing Project
R=Restructured Project
T=Terminated Project

Budget

	Sea Grant	Matching
PROGRAM MANAGEMENT		
Program Administration (Including Information and Publications)	$ 69,810	$ 51,589
MARINE RESOURCES AND DEVELOPMENT		
Living Resources other than Aquaculture	7,166	5,095
Marine Biomedicinals and Extracts	13,110	6,564
MARINE TECHNOLOGY RESEARCH AND DEVELOPMENT		
Ocean Engineering	141,138	39,972
MARINE ENVIRONMENTAL RESEARCH		
Coastal Zone Management Decisions	67,436	17,499
Ecosystems Research	22,412	15,100
MARINE EDUCATION AND TRAINING		
College Level	45,183	73,818
Marine Technician Training	24,600	
ADVISORY SERVICES	78,936	25,363
	$469,791	$235,100

Classified by Office of Sea Grant categories.

	Sea Grant	Matching
PROGRAM MANAGEMENT (Including Information and Publications)	$ 69,810	$ 51,589
RESEARCH		
Food From the Sea	134,664	35,367
Systems Engineering	13,640	9,700
Socio-Economic Systems	41,636	12,061
Exploratory Resource Development	35,522	21,764
Coastal Zone Management	25,800	5,438
EDUCATION	69,783	73,818
ADVISORY SERVICES	78,936	25,363
	$469,791	$235,100

Classified by University of Delaware program categories.

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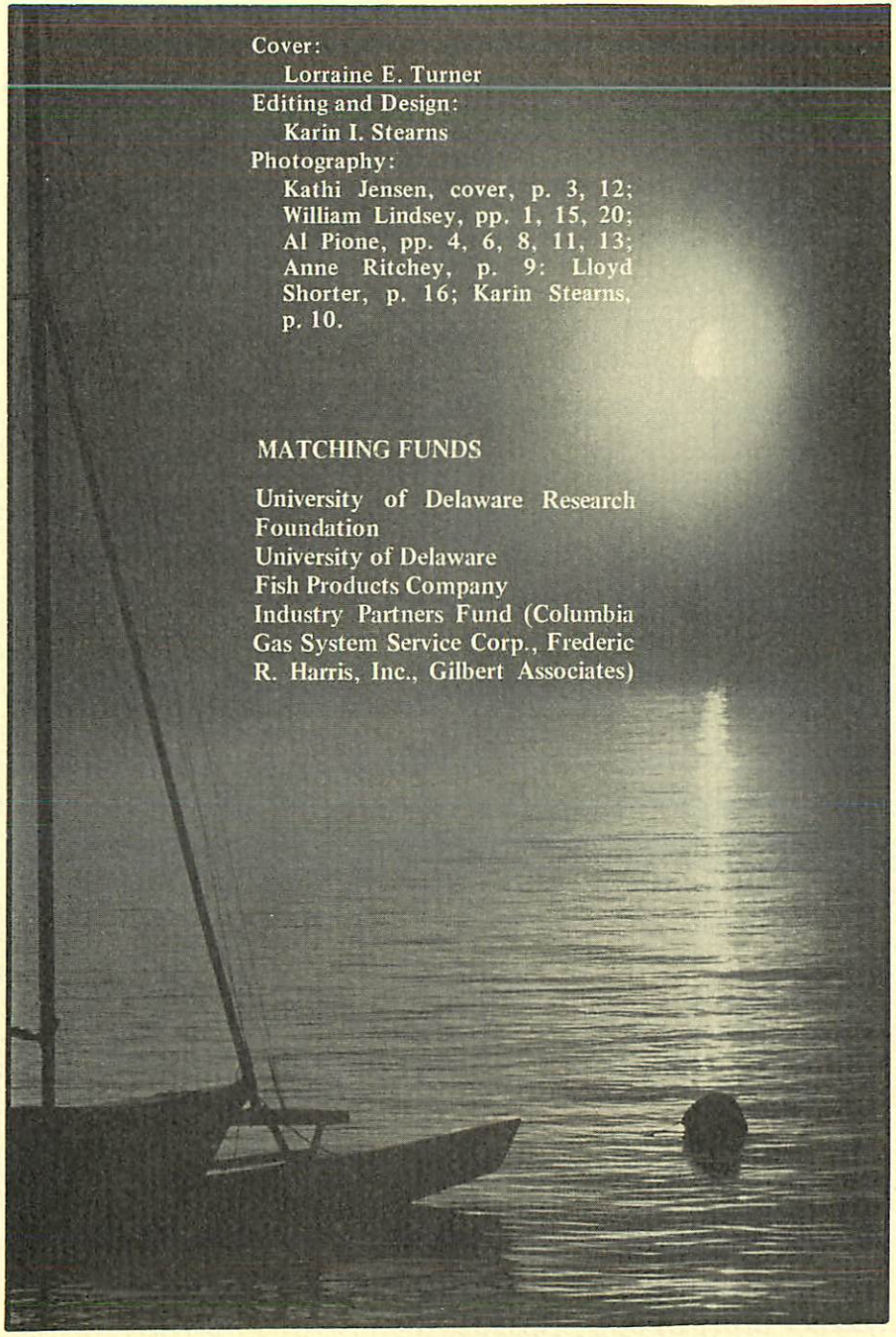

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