1-1-1972

Sea Grant Annual Report 1971

Virginia Sea Grant

Recommended Citation
Virginia Sea Grant. (1972) Sea Grant Annual Report 1971. Special Reports in Applied Marine Science and Ocean Engineering (SRAMSOE) No. 36. Virginia Institute of Marine Science, College of William and Mary. http://dx.doi.org/doi:10.21220/m2-z47c-1781

36

SEA GRANT ANNUAL REPORT 1971

Virginia Institute of Marine Science
Gloucester Point, Virginia 23062

Introduction

The Virginia Institute of Marine Science (VIMS) is situated on deep water near the mouth of the York River. It is 33 miles from the Atlantic and 35 miles downriver from fresh water. Its research area encompasses the transition between land and open ocean and it includes the lower Chesapeake Bay (largest and most important estuarine system in the United States), tributaries of the Bay, and the coastal and shelf waters of the Virginian Sea. A variety of environments are accessible to scientists from the main laboratory at Gloucester Point and the Eastern Shore branch at Wachapreague.

From its earliest days, the Institute, which is the principal marine program of the Commonwealth and its coastal zone laboratory, has been involved in resource research, advisory services and education. With the advent of P.L. 89-688, the VIMS administration felt that there was an excellent opportunity to accomplish tasks long recognized, but for which there had been insufficient funds. Motivation for seeking Sea Grant support arose from needs of the Institute to strengthen its ability to carry out those of its functions which involve goals common to Sea Grant and local needs.

The Institute's Sea Grant Coherent Projects, begun in December 1968, have had as long-term goals:

- Understand current uses of estuarine resources and their interactions.
- Evaluate effects of human activities on the environments (habitats) of useful organisms.
- Develop improved methods of managing estuarine resources.
- Improve methods of rearing, processing and marketing commercially valuable species.
- Explore for new resources. Domesticate and improve, through selective breeding, useful wild stocks.
- Disseminate knowledge acquired.

Of the goals, those receiving the heaviest support to date from Sea Grant funding are: "Improve methods of rearing, processing and marketing commercially valuable species", "Explore for new resources", and "Disseminate knowledge acquired".

Thus, some goals and areas have been more adequately supported by the Sea Grant Program than others, a condition we hope will disappear as the program progresses, as new ideas are added and as other goals close within our grasp. We anticipate that orderly progression from project to project, area to area, and goal to goal will fill some of these programmatic gaps. We also expect that greater Sea Grant support will enable us to expand the program and make it more complete.

Coherency in the VIMS Sea Grant Program becomes most apparent when one views results across individual project lines and takes into account interactions of the Sea Grant Program with the whole spectrum of activities of the Institute—all this over a sufficient span of time. The Advisory Services projects, for example, focus the spectrum of results on the ultimate users and have the ability to assess the value of research and development activities to the users. Many projects at VIMS that are not specifically supported by Sea Grant find their outlet to users through Advisory Services activities, which receive their heaviest funding from Sea Grant.

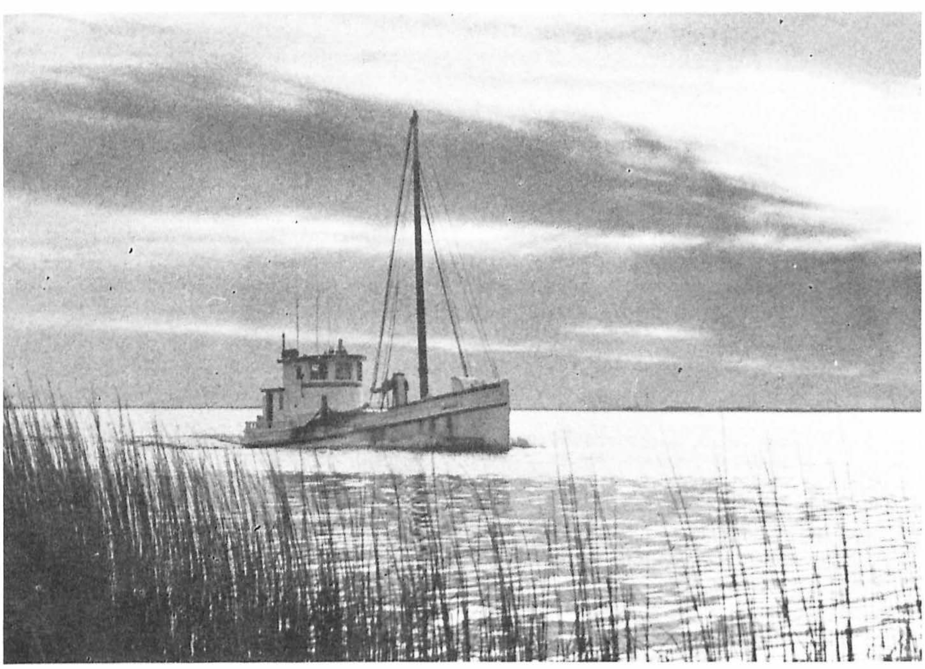
Thus, new links between government and marine-related industries are built, and more productive pipelines between marine research institutions and the resource users are established by Sea Grant through its member institutions. At VIMS this means but one thing—relevancy. Research and other programs have been keyed to this one word since 1959, and Sea Grant has made it possible to multiply the effort and speed research results and know-how in meaningful language to users in Virginia and elsewhere.

With this annual report and the ones which will follow, we hope to demonstrate the value of those new links and to show how relevant information is reaching the users, and, more importantly, improving their lot.

Dr. William J. Hargis, Jr.

Dr. Hargis, director of the Virginia Institute of Marine Science since 1959, is principal investigator and overall program manager of VIMS' Sea Grant Program.

Table of Contents



Advisory Services

Marine Extension Service

The Marine Extension Service at VIMS provided a channel of communication between the marine-oriented public and marine science and technology. Through this communication system, information was brought to the attention of the public which lead to better utilization of manpower, equipment and resources and which enhanced the public's effectiveness in dealing with resources and environmental problems. Principal tools used by the marine extension agents were individual contacts, demonstrations, workshops, meetings, VIMS' Sea Grant publications and the news media.

The Virginia Institute of Marine Science has been involved in extension work since its inception in 1940, but development of a formal field service was delayed until 1970 when a full-time marine extension officer was added to the staff, financed by the Sea Grant Program. The first objectives were to meet individuals at all levels and in each segment of the fishing industry, to determine how this program could be of the most value to them, and to contact other groups involved in marine extension work and learn from their experience.

In June 1971, a second marine extension agent was employed to assist in the development of the commercial and recreational fishing industries in Virginia. The main objectives of the recreational project were:

1) To introduce the VIMS Extension Service to members of the sport fishing industry;

2) to identify major problems faced by members of the industry, and

3) to determine how VIMS could best aid in the solution of these problems and thus assist in the development of this important fishery.

Personal contact was deemed the more satisfactory method to establish rapport with members of the sport fishing industry, to identify the leaders and innovators, to define the problems, and to establish priorities for the solution of problems. The development of trust between the industry and VIMS was essential to the project's success. Characteristics such as a demonstration of a willingness to help, positive action, and frequent contacts played an important part in the initial development of this trust.

Operators of marinas, boat-rental firms, charter and head boat captains, fishing pier owners and local and out-of-state fishermen were contacted and introduced to the VIMS extension service. In some cases information was supplied, such as the distribution and seasonality of some marine sport fishes and locations of sport fishing facilities in the state.

More contacts are necessary before more complete problem definition is attained and priorities established. However, there was general agreement among those contacted that more information was needed on the distribution and seasonality of species of importance to sports fishermen. Also, some people—especially charter and head boat operators — felt that environmental improvement by means of artificial fishing reefs would be desirable.

Other work of the extension agents involved introducing gear and methods of culture new to this area, assisting packers and processors with their problems (including a means for handling and utilizing by-products of fish processing), assisting seafood dealers with marketing, and providing information to governmental planning and regulatory groups.

During 1971, extension agents made 1,800 contacts with members of the seafood industry, state and federal agencies and academic personnel. Meetings of the Virginia Marine Resources Commission, the Virginia Seafood Council, the Virginia Oyster Growers and Packers Association, the Virginia Crab Processors and the Tri-State Seafood Committee were attended on a regular basis.

Visits were made to observe technological advances in oyster shucking and harvesting, clam grading and counting, black sea bass potting, and pound net fishing. The extension agents also attended workshops on seafood processing, marketing and packaging, extension methods, and proper methods of applying for permits to discharge liquid wastes into navigable waters.

Information on the new water discharge permits was distributed to Virginia watermen via the *Marine Resource Information Bulletin* since many in the fishing industry were not aware of the government's decision to enforce the Refuse Act of 1899. The Virginia Seafood Council invited all interested persons in the seafood industry to attend a meeting where procedures for filing applications necessary to comply with the Refuse Act and the Water Quality Act of 1970 were explained by licensing and enforcement agencies. This meeting was brought to the attention of many in the seafood industry through announcements by the VIMS extension staff which also assisted in filling out applications.

In the first of several programs aimed at improving the fish processing industry, a fish processing machine that separates flesh from bones was demonstrated in Hampton to seafood interests, jointly sponsored by the National Marine Fisheries Service and the Marine Extension Service at VIMS.

A widespread occurrence of pink oysters in the Chesapeake Bay during late 1970 and early 1971 posed a serious economic threat to the oyster industry of the region. For example, in early 1971 the Federal purchasing agency for the U.S. armed services rejected shipments of fresh-frozen oysters sent to them by Virginia oyster processors because the oysters exhibited a pink color upon thawing. An investigation of the effects of the coloration on oysters was conducted by the VIMS extension staff in cooperation with local oyster processors and revealed that the pink color in no way affected the wholesomeness and palatibility of the oysters.

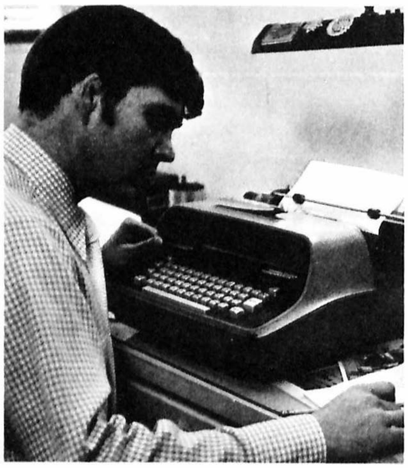
Results of the investigation were immediately publicized and in March of 1971 the purchasing agency reversed its earlier decision and accepted the initial shipments of oysters. It also agreed to accept future shipments of pink oysters if the cans carried a label stating that any coloration that might develop in the pack would disappear upon cooking and would not affect the wholesomeness of the product.

Other processors besides those selling fresh-frozen oysters to the armed services also benefitted from the pink oyster investigations since some have been able to convince the private buyers of the wholesomeness of the product.

Extension personnel also devoted over two months to interviewing seafood interests in Accomac and Northampton Counties to update economic information of the industry as well as to assemble and prepare a report. Other activities included investigation of crab kills, studies of the effectiveness of selective planting to minimize oyster damage caused by cownose rays, and an investigation of high mortalities of hard clams during transplantation from the James River to Chincoteague on Virginia's Eastern Shore which led to a means of minimizing losses.

Advisory Services

Publications; Information and Education



In concert with the Marine Extension Service and the various research personnel, the VIMS Department of Information and Education carried out certain of the Advisory Services Project functions. Emphasis was on the use of publications and news media in order to broadly disseminate Sea Grant information. To interpret and extend research information to those who obtain their livelihood and recreation from the sea, the advisory publications unit produced and distributed the *Marine Resource Information Bulletin* and the *Marine Resources Advisory Series*.

Information was presented in the *Marine Resource Information Bulletin* in easily understood language, designed to transfer technical or scientific information to educators, legislators, marine editors, environmental columnists, radio producers, watermen and the man in the street concerned about the future of marine resources.

The *Bulletin* was produced and duplicated in the Department of Information and Education and distributed by direct mail in 1971. During the report year, 19 issues of the *Bulletin* were mailed.

The *Marine Resources Advisory Series* was produced when a subject required more detailed treatment than that first reported in the *Bulletin* or the news media. "Spawning and Rearing the Bay Scallop, VIMS Laboratory Method," the fifth leaflet in the series of advisories, was published and distributed in August 1971.

Information relating to use, development and replenishment of marine resources was mailed regularly to some 1,800 recipients in 28 states and six foreign countries during the report year.

In order that information designed for special users reach the people it could best serve, the mailing list was divided into categories including News Release, News Media, Generaly Assembly, Sea Grant, MRI Bulletin, Advisory Series, and Wholesale Dealers in Fishery Products in Virginia. The VIMS computer center provided mailing labels for any combination of categories requested.

Since effort was made to present information in the form and through the media most appropriate to subject and audience, issuance of news releases was also an important phase of the advisory services. Articles pertinent to marine resource users and managers were distributed to approximately 600 recipients, including newspapers, technical periodicals and interested agencies and individuals. Photographs were often included with news stories or feature articles. Our news releases appeared in Virginia, Maryland and Washington, D.C. newspapers, as well as in more widely distributed periodicals such as *Commercial Fisheries Review*, *Shellfish Soundings*, *The Sou'wester* and *The American Fish*

Farmer and World Aquaculture News. Some radio producers also indicated use of our information.

Inquiries and requests for specific information or services were received almost daily and were either handled by the Information and Education Department or referred to scientists on the staff qualified to handle the reply. The majority of inquiries came from industry; others were from institutions, governmental agencies and news media. Three hundred thirty-one (331) information requests and services were recorded by the Sea Grant publications editor during the report year.

We further added to the advisory services program by conducting tours through VIMS and by setting up exhibits at indoor and outdoor fairs and shows. We found that these channels provided an opportunity to explain the VIMS operation and tell how research information obtained by scientists is passed on to users of marine resources with the help of Sea Grant.

The purpose of the education program was to provide the public with marine science information. Slide presentations on research at VIMS, lectures on ecological problems in Virginia's Coastal Zone, collecting programs, research vessel demonstration cruises and tours of VIMS' facilities were made available to college, high school and elementary school students who visited the VIMS complex. Educational programs were presented to 203 separate groups containing 8,399 individuals during 1971. In addition, four exhibits were set up at public events.

VIMS personnel also traveled to various parts of the Commonwealth to make presentations to various school, civic and business groups. A total of 51 programs were presented in this category.

Management of Larvae — Supply of Algal Food

The development of hatchery techniques for commercial production of the American oyster began with the report by W.K. Brooks in 1879 that eggs could be developed in the larval stage in the laboratory. Many workers had attempted to rear larvae in the laboratory, but it was not until 1920 when W. F. Wells demonstrated successful rearing and setting of oyster larvae in Long Island, N. Y., that refined techniques for hatchery operations were able to be developed.

Since 1961 the Virginia Institute of Marine Science has been involved in the spawning, rearing and setting of oyster larvae for research purposes. In 1969 a major effort was started to spawn southern oysters, and to rear and set the oyster larvae on a year-round basis. Work on this project was continued in 1970 and 1971.

The major problems which had to be overcome in order to achieve the objectives of spawning, rearing and setting oysters were:

- Develop a technique for conditioning oysters to spawn upon demand at any time during the year.
- Develop the ability to raise the oyster larvae on a year-round basis to set-

ting in about 14 days which included the isolation and growth in culture of a combination of local algal species for use as food.

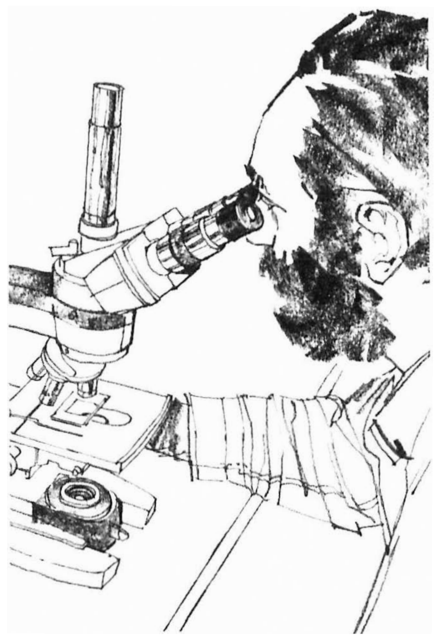
• Develop a technique or techniques which would allow this laboratory to obtain cultch-free spat or single oysters of three quarter to one inch size for planting.

• Develop the application of this knowledge to the design of a commercial hatchery which could operate on a year-round basis and produce sufficient quantities of oyster seed for planting on a commercial scale.

These objectives were achieved with the exception of the completion of the hatchery which is to begin its operation in January 1973. It is certain that problems will arise in the operation of the hatchery and that minor modifications of some of the procedures will have to be made; however, no problems of major proportions are expected. Preliminary work has demonstrated that oysters can be spawned, that larvae can be reared to setting and that set oysters will grow to three quarter to one inch in three months utilizing our techniques in the locality where the hatchery is planned.

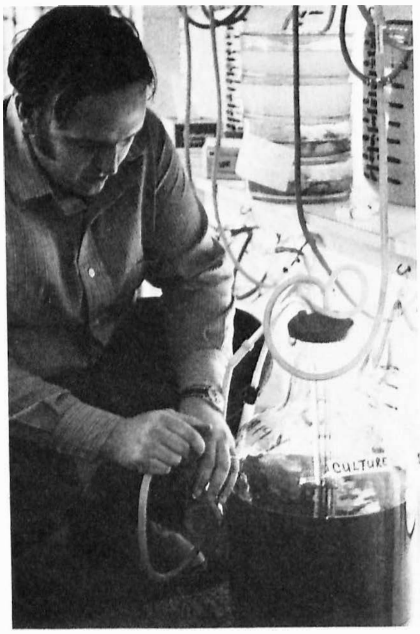
In contrast to reports by many workers that northern oysters were easily conditioned and spawned on a year round basis by the manipulation of the temperature range, oyster stocks from Delaware Bay and the south appeared to be refractive to most attempts by investigators to induce spawning and produce larvae throughout the year. Some investigators obtained spawning in September, October and January by retarding spawners in 15C water; others reported successful conditioning and spawning of southern oysters that were in good condition.

Our objective was not only to be able to condition oysters that had ample glycogen reserves and/or gonad present, but to have the ability to increase the glycogen reserves in oysters in poor condition, and subsequently induce spawning. Furthermore, we wanted the ability to manipulate conditions to yield "ripe" oysters at any time during the year, especially during the first five months of the year when ambient Bay water temperatures are too low to allow "natural" development of gonads in oysters. The procedure which allowed us to achieve this was the design of new tanks to hold the broodstock populations, and to control temperature, the rate of water flow, and the rate of feeding starch and algae.



BROODSTOCK HOLDING TANKS

The four broodstock tanks were fabricated from fiberglass with dimensions of 6 inches deep by 15 inches wide by 10 feet long. Each tank held 60 oysters on a false bottom made of Vexar and framed by split 1-1/2 inch PVC pipe with 3/4 inch PVC pipe as cross bars. This arrangement allowed frequent and easy cleaning by a fresh water hose, and kept feces and pseudofeces from collecting around the individual oysters. The tanks had removable baffles. The baffle on the incoming end allowed mixing of the added food and created a relatively fast-moving surface layer of sea water, about 3 inches deep, flowing over and around the oysters. The baffle on the outgoing end aided in keeping the laminar flow and upon removal,



allowed a fast and efficient method of cleaning the trays in a few minutes after the removal of the two 1-1/2 inch stand pipes at the outgoing end. These two stand pipes, which are a half-inch lower than the baffle, insured that there was a layer of water over oysters in case of pump failure.

CONDITIONING PROCEDURE

Crassostrea virginica pumps an average of 7 to 11 liters/hour of river water at 16 to 28 C. Based on this information, the flow rate in our conditioning tanks was regulated to 10 liters/hour per oyster of 17 to 20 o/oo untreated river water at a temperature of 19 to 21 C and subsequently at 23 to 24 C. Care was taken to remove insoluble gases by aeration since ambient river water temperatures ranged from 6 to 14C during the greater part of our conditioning time.

Our observations showed that failure to remove insoluble oxygen and other gases would have resulted in the oysters being saturated with air emboli in the tissues and intestinal tract, leading to eventual death.

Haven (1965) reported that cornstarch fed to oysters greatly increased their glycogen content though he observed that growth was not significant. A cornstarch solution was, therefore, metered into the conditioning tanks to give a final concentration of approximately 0.2 ppm in the conditioning tanks during the fattening and conditioning period.

In addition to the starch, 500 ml per hour of mixed algae (*Dunalliela tertiolecta* and *Paheodactylum tricornutum*) per 60 oysters was also metered into the conditioning tanks to give a final concentration of approximately 5×10^6 cells per liter of raw river water in the tanks (Dupuy, 1963). This was done in order to add a supplemental protein source in addition to that food which was present in the raw river water.

Though some of the conditioned oysters spawned with only thermal stimulation, most broodstocks also required chemical stimulation. Our spawning procedure was to place the oysters to be spawned in a small flume (similar in design to conditioning tank) with running filtered river water. During the first hour, the temperature was brought from 24C to 30 C. If the oysters were pumping but not spawning then sperm stripped from a male of the same group, placed in the flume, was added. Spawning usually occurred in the first two hours; however, one group took four hours. Once spawning had begun, oysters were removed and placed individually in spawning dishes containing filtered river water at 30 C where they were allowed to continue their spawning.

We have had 100 percent success in getting different groups of conditioned oysters to spawn with the procedure. During the early part of the 1969 spawning season, other conditioned groups placed directly into spawning dishes failed to spawn; yet when put in running filtered river water, they were spawned easily.

OYSTER LARVAL CULTURE

In the past, our laboratory utilized the cultured algal feeding method of Loosanoff and Davis (1953). Since 1970, however, we have gradually replaced the combination of *Monochrysis latheri* and *Ischrysis galbana*, which Loosanoff and Davis proposed, with a combination of *Pseudoisochrysis paradoxa*, *Pyramimonas virginica*, *Nannochloris oculata* and *Chrysophaeropsis planktonicus* locally isolated from the York River in Virginia.

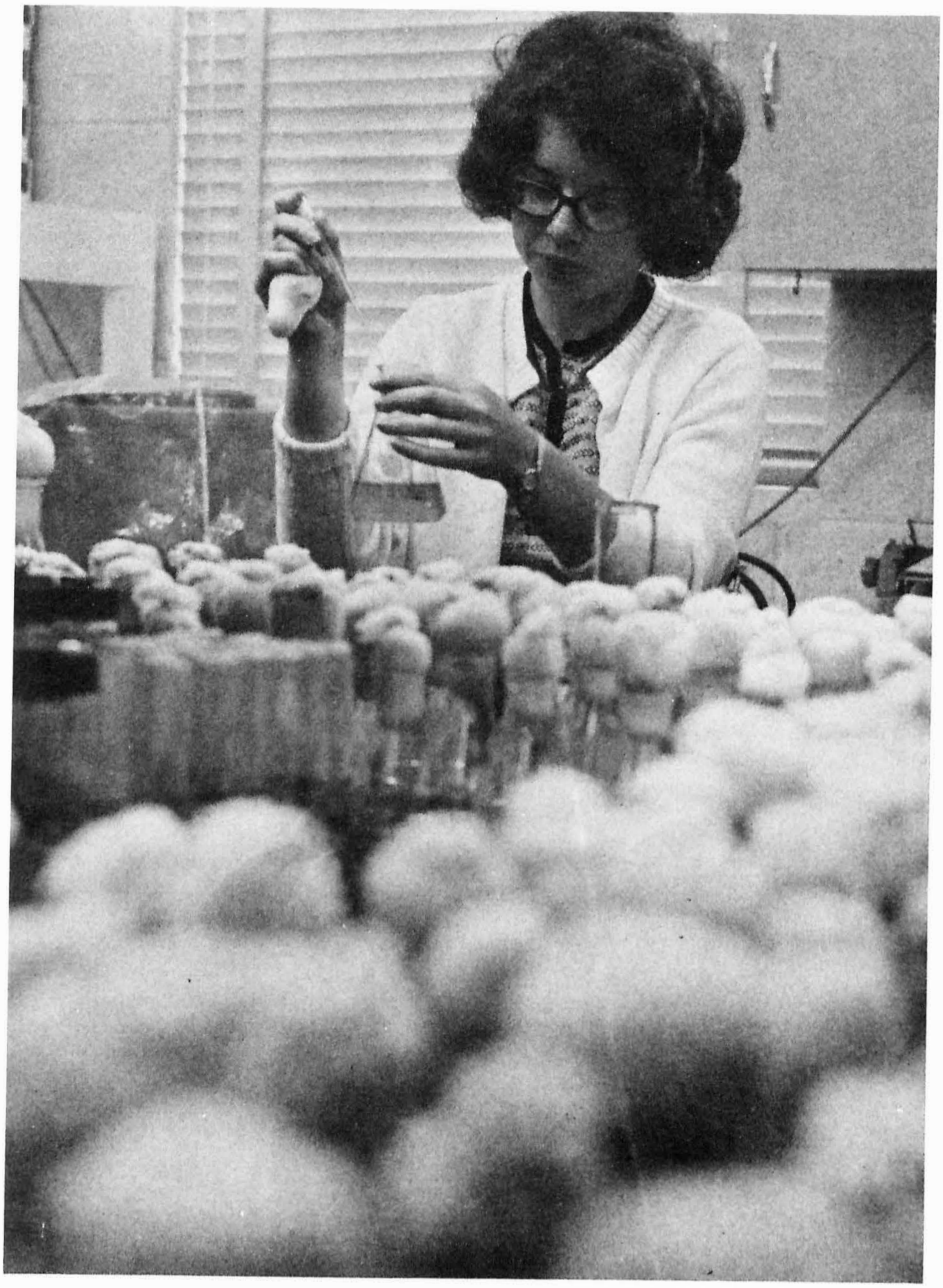
Such combinations are utilized at different times and in different volume during the eleven to fourteen day larval period of the oyster. A standard procedure of feeding algae every day and renewal with filtered river water of the larval culture every three days was followed. This procedure has allowed us to produce cultch-free spat for 12 consecutive months.

OYSTER LARVAL SETTING

The traditional methods of collecting oyster spat in the laboratory, hatchery, and in the field have been at best a laborious and expensive task requiring cleaning and handling of oyster and clam shells when used in shellbags and on suspended strings.

Recently many types of setting materials, ranging from suspended automobile tires to plastic discs on strings, have been used in estuaries to catch natural set by a large number of mariculture companies on the east and west coasts of North America.

The announcement in 1967 by W. W. Budge of the Pigeon Point Laboratory (Pacific Mariculture of Pigeon Point, Pescadero, California), that he was producing "cultch-free spat" gave impetus to the development of techniques by various other companies in the oyster industry to produce free spat.



Regardless of the manipulations to achieve free spat, a natural sequence of morphological and physiological changes which begin at the pediveliger stage (eyed larval oyster) must take place. The critical point is the discharge by the pedal gland of an organic matrix (usually for temporary attachment), and a commitment by the oyster larva to lose its foot and velum and to begin development of the gills.

FIRST METHOD

In the first method, it is important that oysters be removed before sufficient new shell for permanent attachment has been produced. Larvae which have reached the eyed stage and size of 290μ or above should be used for optimum efficient setting in the shortest possible time. This minimizes the effort involved in removing large numbers of spat and resuspending those which have not set so that they may be reused.

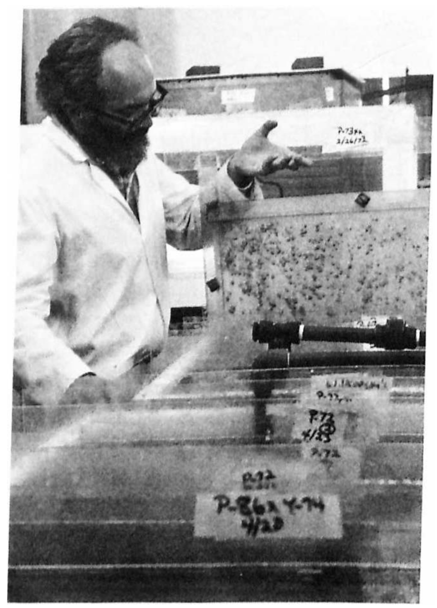
A strong stream of river water yielded cultch-free spat when applied to the bottom surface of the setting tray containing river water and pediveliger larvae, at intervals of one to two hours. Microscopic examination showed that moderate water pressure tore the temporary organic matrix attachment, releasing the spat before any new shell could be deposited but after metamorphosis had begun. This modification appeared to be more efficient for obtaining free spat. In areas where heavy organic detritus and silt loads were present, the problem of handling these tiny cultch-free oysters appears insurmountable, unless some practical method of pre-treatment of river water can be achieved.

SECOND METHOD

The second method was designed to manipulate newly set oyster spat where siltation and fouling are serious problems. This method delays the removal of the newly set spat from the substrate for 18 to 21 days. Setting is induced on Frosted Mylar or Herculene, 0.0003 inch thick, with matte on one side only. A new setting tray, holding frames, and tank were designed to efficiently manipulate setting, growth, and removal of spat.

The removal of 19- to 21-day-old spat from Mylar sheet was accomplished by shaking over a container of river water. The sheet was then put into a container of river water and dipped up and down, washing the loose oyster spat off the Mylar sheet.

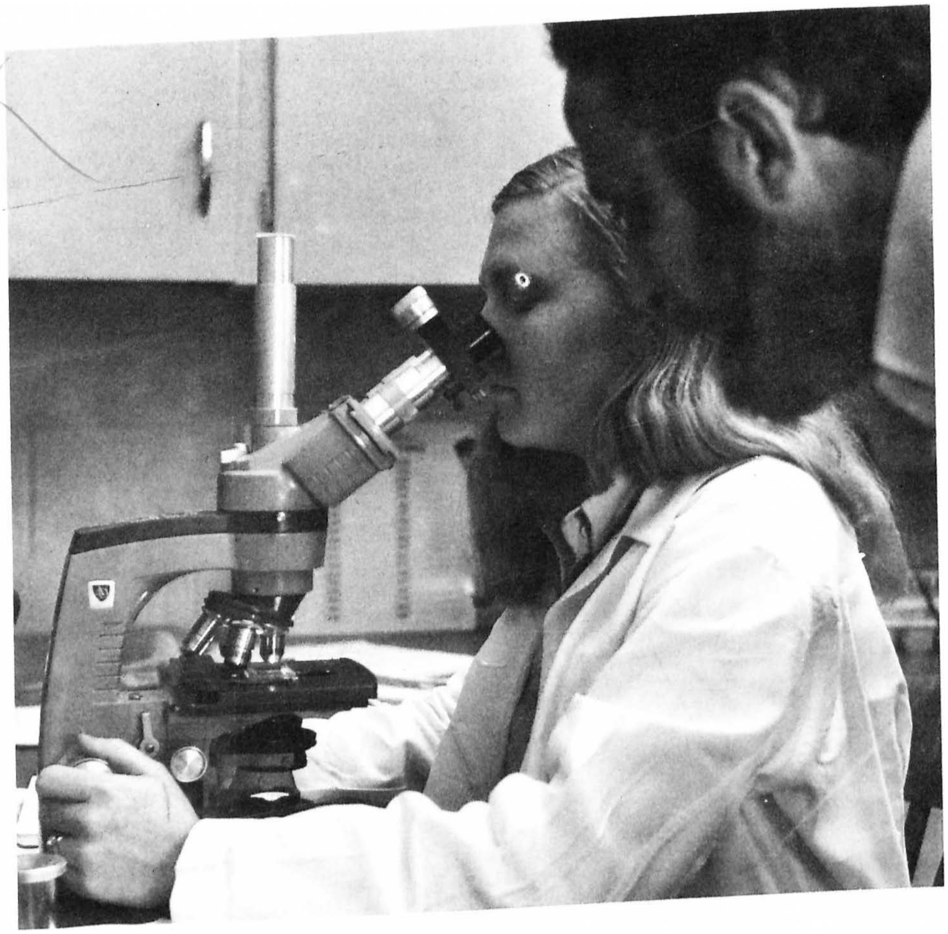
Through trial and error, we have observed that the optimum number of spat per 20 inch x 25 inch Mylar sheet is approximately 5,000. Factors such as growth rate, ease of removal, and damage of spat during removal have determined the optimal density of oyster spat per Mylar sheet. Growth rate of oyster spat at this density averaged 8 to 10 mm in 19 to 21 days from May through July. The size range of these spat was 3 to 17 mm. Though the Mylar sheets containing 6,000 spat at the end of 21 days were almost a solid sheet of oysters, there were three advantages that became apparent as a result of crowding:



First, because of crowding, the individual oysters deposited calcium carbonate along the edge of the left valve which allowed removal without damage to the shell. Many oyster spat (3 to 17 mm) that grow without crowding produce a paper-thin left valve which may be torn upon removal. Repair of damage, if damage is not too extensive, usually occurs in two to three days, resulting in only moderate losses of damaged spat.

Secondly, with this type deposition, the oysters which had grown together came apart singly upon removal.

The third advantage was that the pressure exerted as oysters grew against each other loosened their attachement to the Mylar sheet allowing easy removal of the oyster spat by shaking.



LITERATURE CITED

BROOKS, W. K. 1879. Abstract of observations upon artificial fertilization of oyster eggs and embryology of American oysters. *Amer. J. Sci.* 18:425-527.

DAVIS, H. C. 1953. On food and feeding of larvae of the American oyster. *Crassostrea virginica. Biol. Bull.* 104:334-350.

DUPUY, J. L. 1963. Pumping rates of oysters in relation to different concentrations of algae. Masters Thesis, Rutgers-The State University, New Brunswick, N. J.

HAVEN, D. S. 1965. Supplemental feeding of oysters with starch. *Chesapeake Sci.* 6(1):43-51.

LOOSANOFF, V.L. 1950. Rate of water pumping and shell movements of oysters in relation to temperature. *Anat. Rec.* 108.

WELLS, W. F. 1920. Growing oysters artificially. *Conservationist* 3:151.

Improvement of Fisheries for Crustaceans

Research was conducted on several crustacean problems during 1971, each of which had economic significance not only in Chesapeake Bay and adjacent offshore waters, but also along some parts of the North Atlantic and Gulf coasts.

The long-term objectives of the program were to identify the physical, chemical and biological conditions necessary for increasing the commercial production of soft blue crabs *(Callinectes sapidus)* to obtain basic data for future effective management and harvesting of hard blue crabs, and to determine the potential for commercial exploitation of the rock crab *(Cancer irroratus)*. Each objective was divided into subprojects.

In addition, a study to determine the effect of stress conditions on metabolism and survival of blue crabs was begun in September 1971.

SOFT BLUE CRABS

The study to improve seawater laboratory support facilities involved the design of a recirculated water system which could provide adequate treatment of water for prolonged use of a given unit of water and a favorable medium for holding and shedding blue crabs.

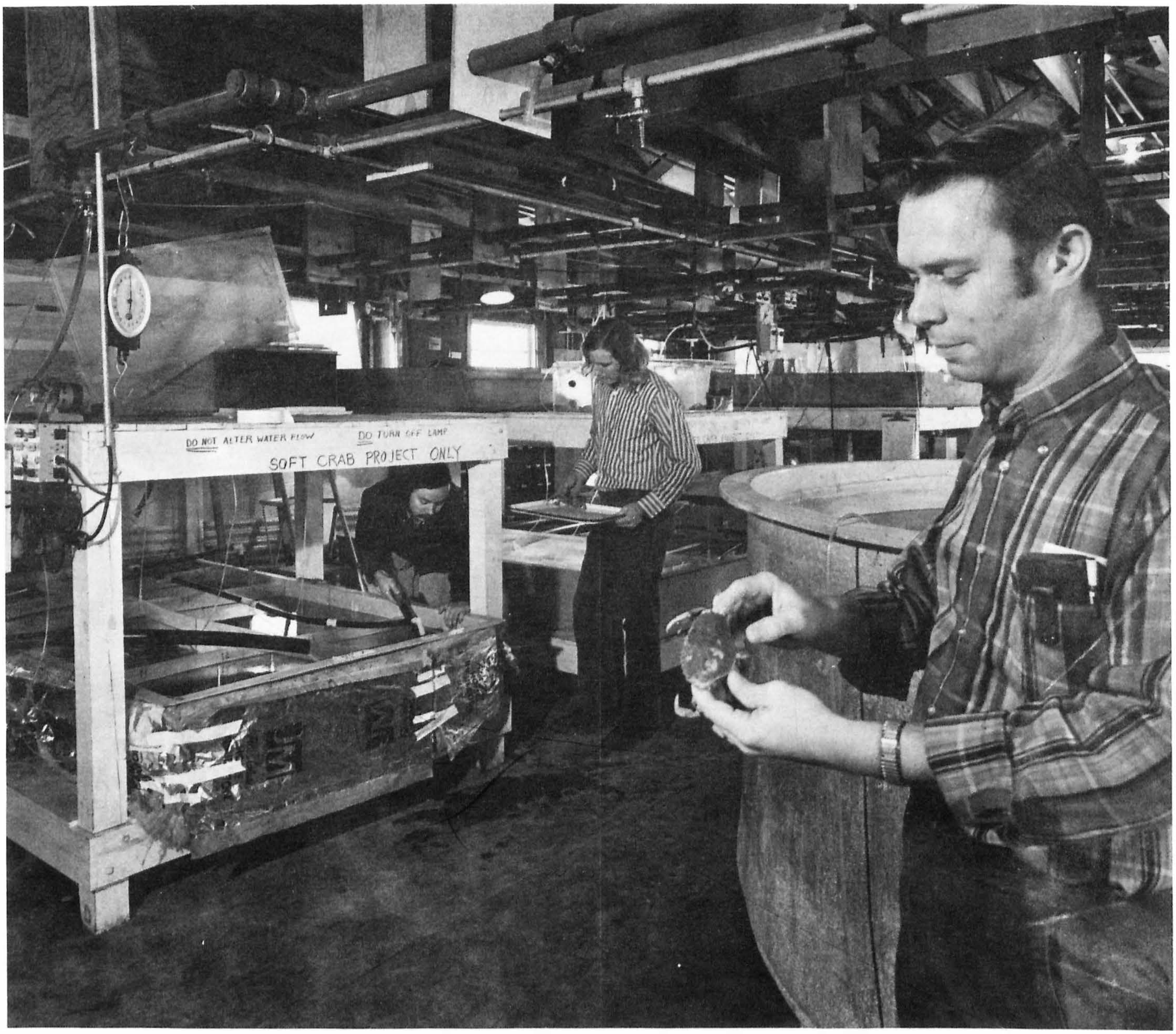
Attempts to standardize ratios of water volume to filter capacity and biomass load were largely unsuccessful. Peeler crabs were obtained from widely separated sources including the Eastern Shore and the York and Rappahannock rivers. Laboratory yields of soft crabs were very low but similar low yields were obtained by commercial shedding houses in the three source areas.

Although generally poor success was the theme of 1971, the data rather convincingly showed the futility of attempting to molt green-sign peeler crabs under the same conditions as those used for rank peelers. Such advice has been put forth since biologists first began studying the problems of the industry, yet green crabs continue to be caught and delivered in shedding houses with the hope of producing soft crabs from them. Unless they are fed and held in less dense concentrations, the attempts will result in economic loss.

Numerous causes of stress can be cited as possible contributions to the higher than normal mortality among peeler crabs during the report year. Depressed dissolved oxygen, high temperatures and sudden changes in salinity occurred in the Chesapeake Bay in the summer of 1971. Reduced nutrition may have occurred since a large yearclass of crabs was present. Excess handling of crabs in the laboratory, nicking, confinement in baskets (in transit) and crowding in tanks may have occurred.

Examination of crabs for evidence of gray crab disease, caused by the protozoan *Paramoeba perniciosa*, was negative in 1971. The possibility of another type of infection was explored. A bacterial disease, caused by *Vibrio parahaemolyticus*, had been identified as the cause of death of peeler crabs in a Maryland commercial shedding house in 1968. Continued work showed that the bacterium was endemic in Chesapeake Bay and that healthy crabs and oysters harbor the organism in low but detectable numbers. Weakening of the crab, by infection, malnutrition or through environmental changes, allows this bacterium to invade rapidly and fatally.

Bacterial cultures, isolated from moribund peeler crabs obtained from the Rappahannock River on July 28, 1971, were used to infect healthy crabs which subsequently succumbed. Subcultures sent to Dr. Rita R. Colwell, Georgetown University, were identified as *Vibrio parahaemolyticus*, K32 serotype.


DO NOT ALTER WATER FLOW
DO TURN OFF LAMP
SOFT CRAB PROJECT ONLY

A manuscript entitled "A Review of Methods of Handling and Shedding Blue rabs" was prepared and disseminated to a variety of people for comments and suggestions. It summarized the problems common to the soft crab industry and presented guidelines for the installation of seawater systems for holding and shedding crabs. It was intended for release as an information bulletin.

A paper, "The Use of Elastrator Rings for Binding Crab Claws", has appeared in Chesapeake Science 12 (3): 182-184, as VIMS Contribution No. 337. The paper describes the use of rings and piece of wood for securing the crab claw as an alternative to the injurious method of fracturing the dactylo-propodal joint.

A paper on 1970 results was presented to the American Association of Advancement of Science in December 1971. An abstract appeared in the November 1971 issue of American Zoologist 11(4) as VIMS Contribution No. 409.

SOFT ROCK CRAB

Another major research effort involved a study designed to determine the feasibility of shedding rock crabs *(Cancer irroratus)* during winter.

Crabs obtained in mid-December 1970 and mid January 1971 from boats dredging for blue crabs in the lower Chesapeake Bay were placed in the laboratory in tanks receiving a constant flow of York River water.

Nearly all crabs were males ranging from 2 to 4 inches in width. A few had limb buds, but none had other proecdysial signs characteristic of blue crab peelers. The crabs were not fed during the study. Of 77 crabs obtained on December 15, only two died in the next 27 days. Crabs shed at the rate of less than one per day. However of 150 crabs obtained on January 12, 32 shed within five days.

The water supply to both lots of crabs was changed on January 20 from an open flow to a recirculated system. An additional 17 crabs of the mid-January lot shed in the three days after the recirculation system was set up.

Although of simple design, the experiment demonstrated the rock crabs would shed in winter in either an open-flow or recirculated water system. The observation that crabs caught in January shed at a faster rate than crabs caught in December verified field observations that most crabs caught in December were hard while most caught during January and later were soft or papershell.

The only explanation for the failure of crabs to shed in early December that could be offered was that the rock crabs were not in an advanced proecdysis stage at the time of capture and that laboratory conditions possibly inhibited the normal cycle of development. Several inhibiting factors were suggested: constant illumination, crowding, lack of substrate in the tank, lack of food too early in the shedding cycle, or lower salinity in the tanks compared with that in the field.

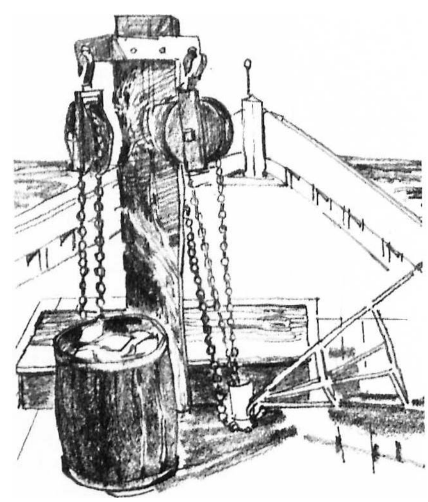
Studies of increments of growth in width and length of male crabs that shed were compared with data on the blue crab. In addition, blood samples from twenty-four rock crabs (peeler, papershell, intermolt, healthy and dying) were analyzed for chlorides, protein, total ninhydrin positive substances and osmoconcentration.

Too few blood samples were taken to draw conclusions, but the data suggested trends to look for in future work:

a) a change of blood osmoconcentration and protein occurs with changes in the stages of shedding cycle;

b) there is a noticeable difference in blood chloride and osmoconcentration between the samples taken on December 29, 1970 and samples of January 25, 1971. The difference could be due to starvation, temperature, salinity or a combination of the factors.

The potential for a hard rock crab fishery and for shedding peeler rock crabs was described in the *Marine Resource Information bulletin* Vol. 3, No. 4, February 26, 1971. Following our recommendations, a blue crab shedding house which normally closed in winter produced 25 dozen soft rock crabs in the winter of 1970-71 and larger quantities in the winter of 1971-72. Total landings for the



winters of 1970-71 and 1971-72 are unknown, but 540 pounds (155 dozen) worth $69 was estimated as the combined January and February, 1972 Virginia production of rock crabs in Current Fisheries Statistics bulletins of the National Marine Fisheries Service.

HARD ROCK CRAB

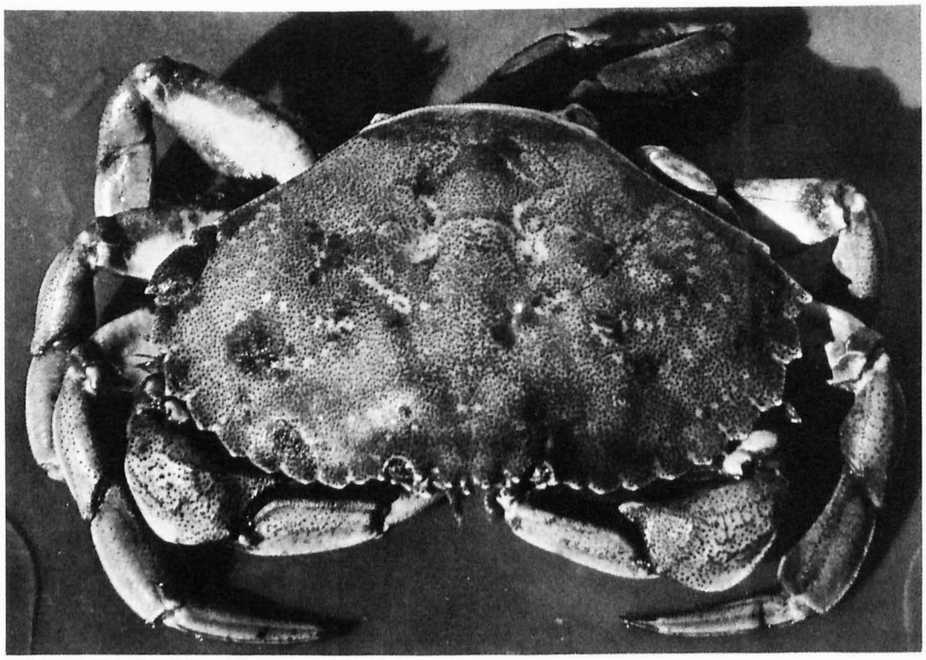
Studies were designed to determine aspects of the general biology and ecology of the rock crab in the Chesapeake Bay in winter and in the continental shelf waters off the coast of Virginia the year around. The aim of these studies was to determine whether a potential fishery for hard rock crabs exists and to have some biological basis for recommending regulations for its control.

The geographic separation of the two areas and the differences in type and seasonality of the commercial fisheries were the bases for dividing the research effort between two graduate students. Master's degree theses were being prepared and information in this report must be considered preliminary and subject to change until completion of the theses.

A seasonal inshore-to-offshore migration probably occurs. Rock crabs within the Bay and along the coast out to 12 miles were more abundant in winter than in other seasons. Crabs were taken by dredge and trawl in the Bay and nearshore, and farther offshore by unbaited pots, set to catch seabass.

Soft and papershell crabs were caught after mid-December and papershells were common through May. This latter observation suggested that the rock crab shell hardens at a slower rate after shedding than blue crab shells.

In Chesapeake Bay, a female rock crab mates in the soft shell stage, as indicated by the presence of sperm plugs in the vulvae of soft and papershell females and their absence in hard shell females. Mating of females in the hard shell stage has been reported but, if true, it is a rare event.

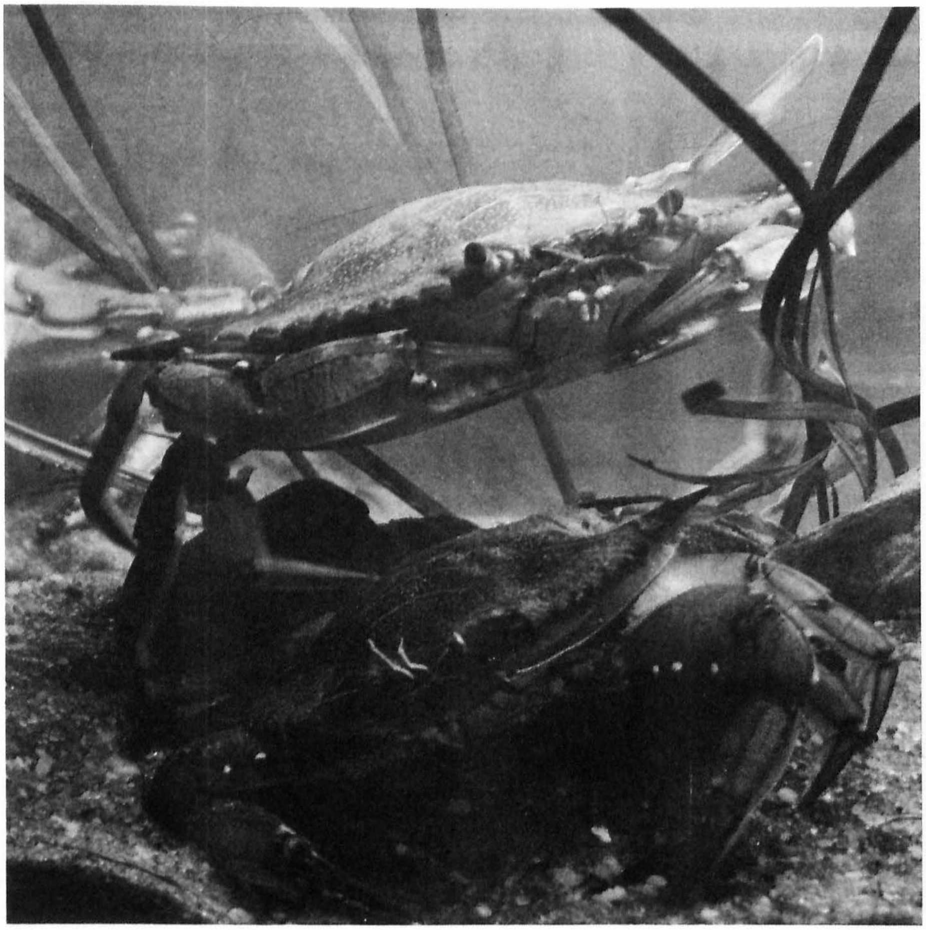


The spawning season for female rock crabs occurs from late winter through spring. Ovigerous females were taken in Chesapeake Bay in February and April, at inshore trawl stations from February through mid-April, and at offshore pot stations from April until mid-June. Small rock crabs (1/5 to 1/2 inch) were first found among the fouling organisms on offshore pots in September.

Within the Chesapeake Bay, 96 percent of the 2,375 crabs collected were males, ranging in size from 1.9 to 5.4 inches in width. Mean width varied with location and time of sampling, being smaller (3.1 inches) in December near the mouth of the Bay, and larger (4.3 inches) in January and February at stations north of the 37° N latitude. The difference in size may be due in part to growth between the time periods. Females were smaller in size than males (range, 2.0 to 3.7 inches; mean, 3.0 inches).

Approximately 77 percent of the near-shore trawl catch of 1,864 rock crabs were males, ranging in width from 1.2 to 5.2 inches. Two size groups of females were caught: a small number ranged between 0.8 and 1.7 inches in width; and the remainder between 1.85 and 3.8 inches. Reference to size is to the lower limit of 1/5 inch groups. The largest number of females, 213, which was 31 percent of the catch, was caught in March.

In the offshore seabass pot catch of 1,307 rock crabs, 90 percent were males, ranging in size from 3.0 to 5.35 inches. Females had a smaller range of size, from 1.97 to 3.9 inches. The largest number of females, 33, which amounted to 18 percent of the catch, was caught in April.



HARD BLUE CRAB

Improved knowledge of stocks of blue crabs is an important phase of studies for improvement of fisheries for crustaceans. During the calendar year 1971, three yearclasses (1969, 1970 and 1971) of blue crabs were present in Chesapeake Bay waters.

The 1969 yearclass supported the commercial fishery from September 1970 through April 1971. In forecasts given in November 1969, when the crabs were only 1/3 to 1-1/2 inches wide (Marine Resource Information Bulletin, Vol. 1, No. 4), and in May 1970, when the crabs were 1 to 2-1/2 inches wide (MRI Bulletin, Vol. 2, No. 5), the commercial catch from the 1969 yearclass was expected to be below the recent 10-year average of 75 million pounds. On Oct. 2, 1970 (MRI Bulletin, Vol. 2, No. 12), when the crabs were 5 inches wide and larger, the forecast anticipated the combined Virginia-Maryland catch to be only about 50 million pounds. In another forecast on May 25, 1971 (MRI Bulletin, Vol. 3, No. 8), a below-average catch for the year was predicted. However, the actual catch during the "biological year" from September 1970 through August 1971 was about 68 million pounds, 36 percent larger than the predicted catch and only 9 percent below the 10-year mean.

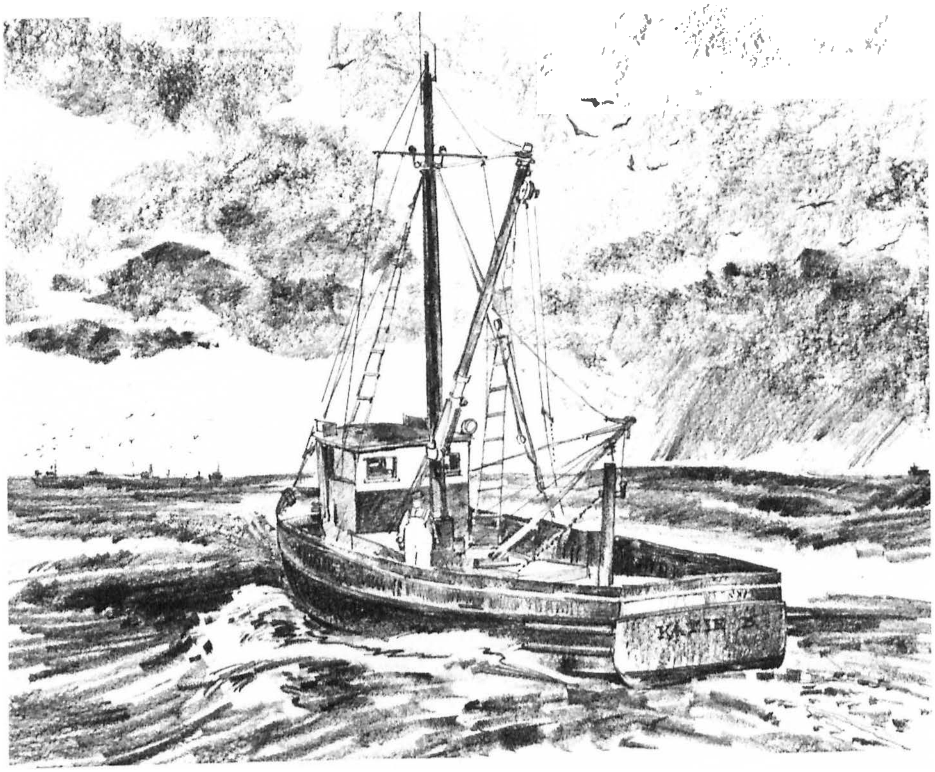
The 1970 yearclass was expected to support a commercial baywide catch of more than 75 million pounds from September 1971 through August 1972 (MRI Bulletin, Vol. 2, No. 12, Oct. 2, 1970 and MRI Bulletin, Vol. 3, No. 19, Dec. 6, 1971). Actual catch for the 12-month period was slightly over 75 million pounds, exactly as forecast.

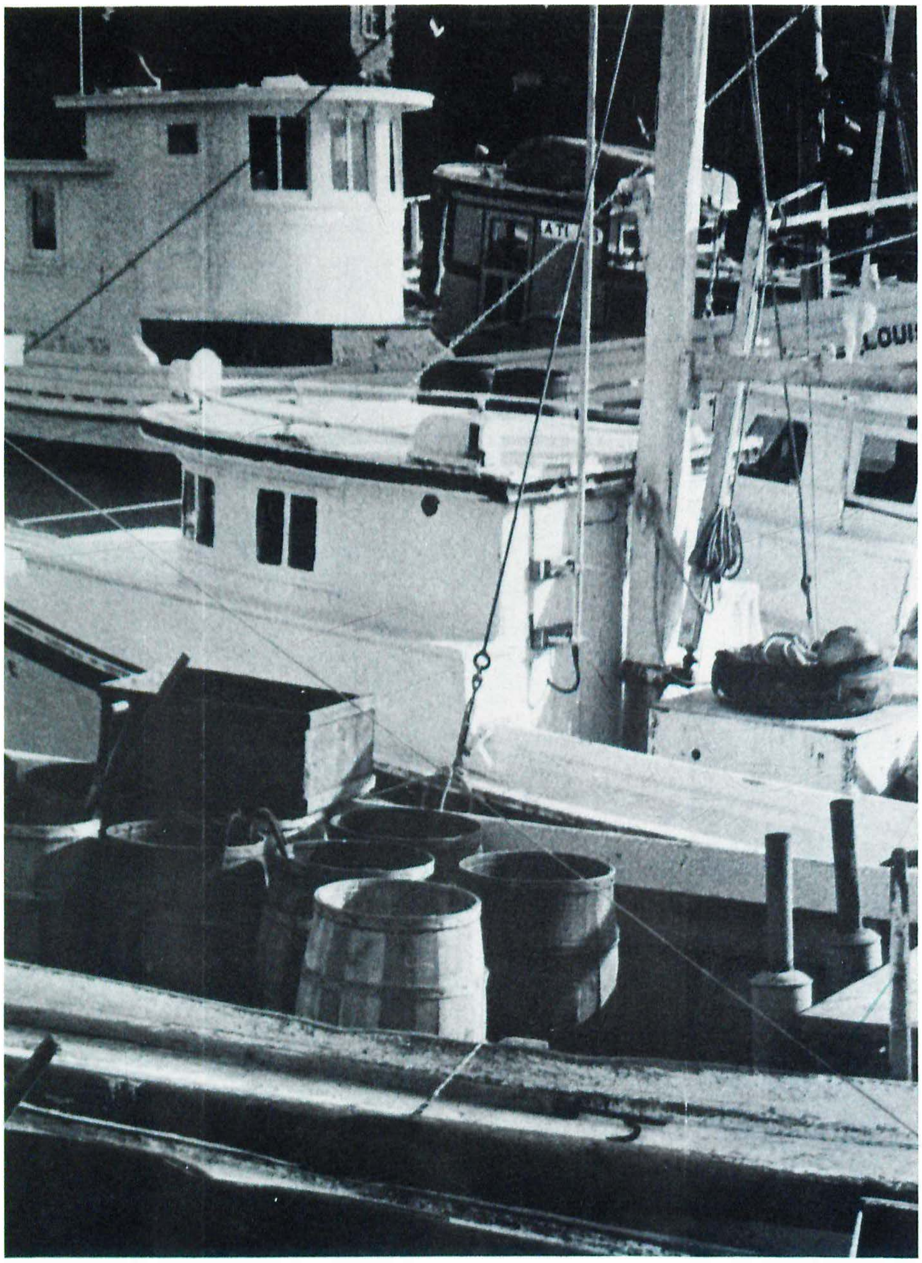
In the fall of 1971, the quantity of juvenile crabs from the 1971 yearclass was estimated to be equal to that of the 1970 yearclass, and expected to be the basis for a 75 million pound catch from September 1972 through August 1973 (MRI Bulletin, Vol. 3, No. 19, Dec. 6, 1971).

Long-term trawl survey data were analyzed to describe the distribution of blue crabs in the James, York and Rappahannock rivers, to evaluate the effects of salinity, temperature and dissolved oxygen on crab distribution, and to evaluate the effects of tidal conditions on crab catches. An extensive report was included in the Sea Grant Progress Report of August 1971.

Highlights of the analysis were:

- Annual blue crab stock fluctuations were similar in each river although catches were consistently lowest in the James River.





• Salinity conditions appeared similar in the chief nurseries of each river. The chief nurseries lie between 5 and 20 o/oo salinity. A few blue crabs extend upriver even to fresh water. Upriver sections of the chief nursery areas are subject to fresh-water flooding in each river, suggesting that this might cause severe mortality at times. However, residual plots against salinity showed no relation. This suggests that even marked temporary salinity decrease does not materially affect the usual abundance of blue crabs at any station. Duration and magnitude of low salinity levels may determine the effects of salinity on distribution and abundance because comparatively few blue crabs occur where the mean "annual" salinity is less than about 5 o/oo.

• Dissolved oxygen levels as low as 1.2 mg/liter at the bottom occurred several times within the chief nursery in the York River system but there was no apparent depression of catches, suggesting blue crabs have enhanced ability to survive low dissolved oxygen.

• Temperature affects catches. Temperatures lower than about 13 to 17 C decrease blue crab catches so that catches in early spring and late fall may be strongly influenced. An interesting pattern in the catch-temperature relation occurred in each of the three rivers. At a given temperature, catch seems much higher in the spring than in the fall. This may be due to incomplete vulnerability of new yearclasses to the gear in the fall or may involve the general phenomenon that acclimation to low and decreasing temperatures takes longer than acclimation to temperature increases.

- Blue crab catches in about 600 trawl tows were examined for relationships between residuals and tidal conditions but none were apparent.

It is our original belief that these long-term data could be used to develop mathematical models for predicting the potential catch.

Large variations in the number of crabs caught by sampling have made it difficult to estimate population size of each year-class. These variations need to be reduced or explained. Reviews of sampling techniques and programs of gear evaluation have been conducted for several years. The results of one study have been presented in a manuscript, "Effects of a Tickler Chain and Tow Duration on Trawl Catches of the Blue Crab, *Callinectes sapidus*," by Mark E. Chittenden, Jr. and W. A. Van Engel, and will be published in the Transactions of the American Fisheries Society. Since this study was completed, a tickler chain has been used on all trawls, and hauls have been limited to five minutes.

The winter dredge fishery for blue crabs in Virginia waters of Chesapeake Bay was studied during the 1970-71 season.

A parent-progeny relationship had not been estimated in the blue crab. Available evidence suggested that parent stock size accounted for little of the variation in progeny stock size. Total annual landings showed a long-term upward trend since the inception of the fishery. Great fluctuations have occurred and are to be expected, because of the very short life span and high reproductive potential of the blue crab. There was no evidence that Chesapeake Bay blue crabs were being overharvested.

EFFECTS OF STRESS CONDITIONS ON METABOLISM AND SURVIVAL OF BLUE CRABS

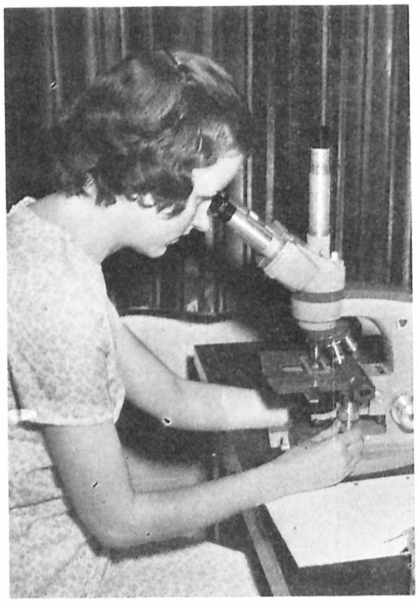
A flow-through system was to be used in which oxygen content of water was to be measured before entering and after escaping from a plexiglas respiratory chamber containing the crab. Because polarographic oxygen electrodes were not immediately available, pre- and post-chamber water was monitored for oxygen by the Winkler method.

Several factors combined to make this design impractical. The Winkler method, when applied to the flow-through system, was extremely time consuming. Water to be analyzed had to stand so long that the accuracy of the method suffered. Temperature controls were found to be unsatisfactory because they created an electrical hazard. Also, the mortality rate of crabs brought in from the winter dredge fishery was very high, presumably a result of poor quality of the crabs and the long period of time the crabs had to be kept out of water in cold air temperature.

Two oxygen probes were acquired, and it was decided that recorded measurement of oxygen depletion by a crab in a closed chamber was more practical than the manipulation of the open system. Preliminary experimentation compared the accuracy, interpretability, efficiency, and practicality of these two systems. The results from the open system were slightly easier to interpret than those from the closed system, but adjustments in the size of the closed respiratory chamber should eliminate this difference. In general, all other things being equal, the closed system seems to be better for the proposed study, because the determinations take significantly less time.

The study was carried out by a graduate student for a master's degree thesis and will be continued in 1972. Plans are now being made to change the respirometer from an open system to a closed system.

Improvement of Fisheries for Molluscs



The biological feasibility of raising clams and scallops has been established. The purposes of this program were to develop commercially applicable methods for growing clams and scallops from egg to market size, then instruct the industry in the use of these methods and to furnish them with seed stocks to allow them to test the methods we propose. Hopefully, if the methods are successful and the industry can prove to themselves the feasibility of the methods and the economic potential, they will develop a new industry to supplement the wild harvesting presently used.

Clams (*Mercenaria mercenaria*) were cultured by the methods described by Loosanoff and Davis (1963). The "Wells-Glancy method" of supplying food was used, as opposed to unicellular culture.

In the "Wells-Glancy method" natural seawater is clarified or filtered, then stored in large containers in a greenhouse for 24 to 36 hours to enhance the phytoplankton growth. This method was chosen because, although it does not lend itself to controlled larval production experiments, it is an inexpensive, efficient way to produce large numbers of clams. A highly technical and expensive part of the procedure was thereby eliminated. It is also a method industry could utilize without special training. Although larval culture could be improved, this is not the problem area in clam culture, and until some of the more pressing problems are solved, this method will serve adequately.

Using the present methods we were able to produce about 7 x 10^6 clams, although culture unit has a much greater capacity.

After the clams leave the culture lab, they are held in flowing seawater until they are large enough for the field. Then they are planted in plots where shell, gravel or other materials, referred to as aggregates, have been spread over sand or mud bottoms. The use of aggregate makes it possible for these tiny clams to be grown on bottoms instead of in trays.

Some of the first experimental plots gave phenomenal results, but later ones were often complete failures. It was suspected that currents, especially wind-driven currents, were causing this by washing the clams out of the bottom and moving them.

Plantings in deeper water or protected from winds by a section of marsh did better than those exposed to a greater fetch of wind. Also, clams on soft muddy bottoms gave better results. Soft mud bottoms indicate a low current velocity. It was believed that some method of baffling currents could be used, and further experiments to test this were under way.

We carried out joint experiments with 13 industry members on the Eastern Shore of Virginia and on the Chesapeake Bay. Most of these experiments were unsuccessful, but three will have high yields. Further experiments were planned to correct the problem of clams being washed out of the bottom, and if a successful method is established, the industry members will be informed and new joint experiments established.

We furnished clams to other research agencies to test these methods in other areas.

In research on the scallop (*Argopecten irradians*), information on optimum depth and density at which to hold scallops from seed (approximately 15.0 mm) to market size (approximately 50 - 55 mm) was obtained during the summer of 1971. From the data collected, it was believed that scallops will grow and survive equally well at all depths tested and at densities up to at least 25/ft^2 if held in an area with a relatively hard mud-sand bottom and little chance of high concentrations of sediment being stirred into the water and if fouling could be prevented or controlled.

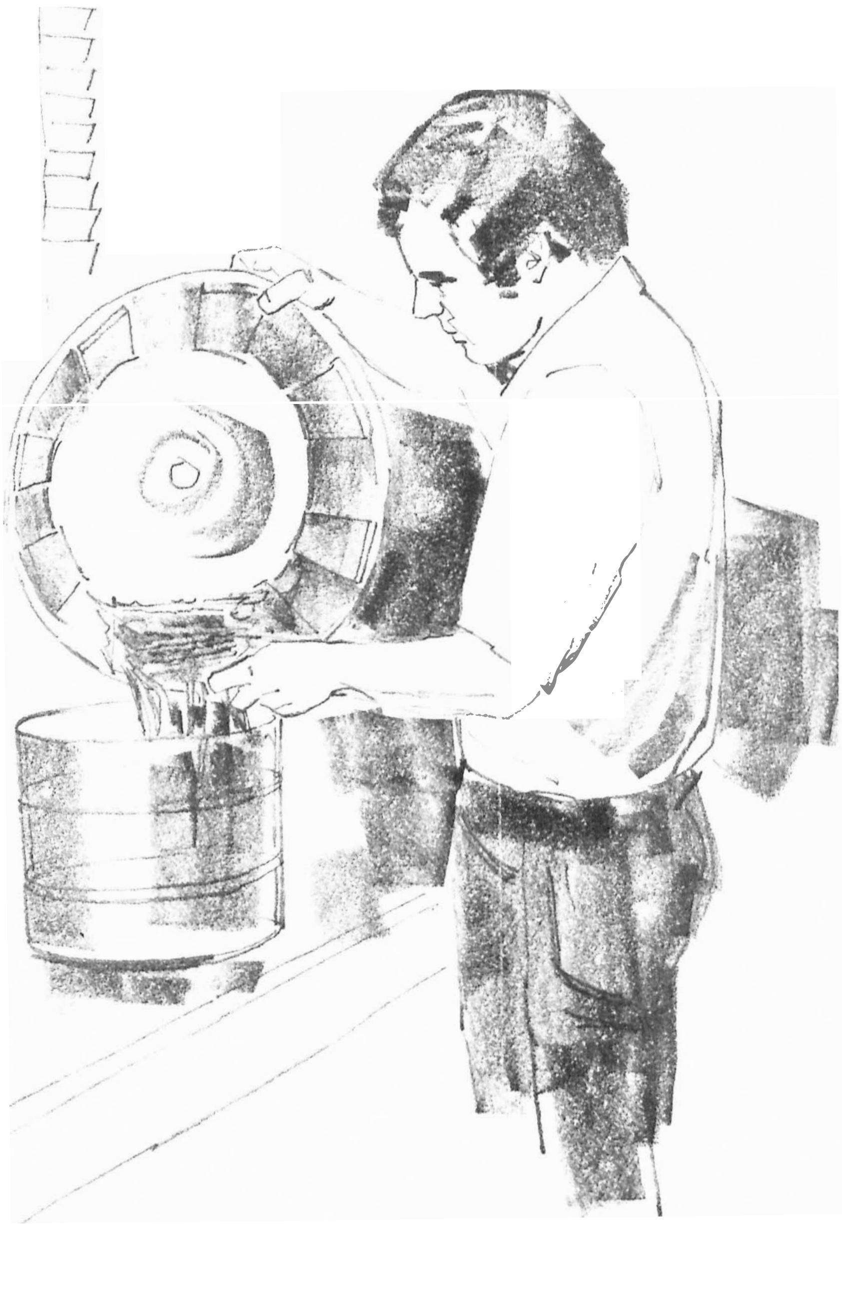
We also felt that scallops held directly on the bottom in pens, naturally enclosed bodies of water, or in off-bottom trays would grow and survive better than if held in surface enclosures since they would not be exposed to mechanical disturbances which affect them when held in surface enclosures. The use of pens, naturally enclosed bodies of water or off-bottom trays may also allow densities higher than 25/ft².

A method of rearing juvenile scallops three-dimensionally was successfully tested. The method is based on increasing the surface area of the holding troughs by the addition of numerous vertical surfaces. The surfaces run the length of the trough. The scallop larvae set on the surfaces, attaching with byssal threads. When large enough, they were removed and moved to the field.

LITERATURE CITED

LOOSANOFF, V. L. and H. G. DAVIS. 1963. Rearing of bivalve mollusks. *Advan. Mar. Biol.* 1:1-136.

PRICE, K. S. and D. A. MAURER (Editors). 1971. Artificial Propogation of Commercially Valuable Shellfish. University of Delaware. p 6 and 115.



SEA GRANT
ACTIVITY BUDGET - 1971

	Sea Grant Funds	VIMS Matching Funds	Totals
Marine Resources Development			
Aquaculture—Molluscs	$ 62,600	$ 45,300	$107,900
Marine Technology Research and Development			
Commercial Fisheries—Technology	$ 77,300	$ 49,300	$126,600
Advisory Services			
Extension Programs, Publications and Other Advisory Services	$ 86,500	$ 30,200	$116,700
Program Management and Development			
Program Administration	$ 23,200	$ 13,300	$ 36,500
Totals	$249,600	$138,100	$387,700