Virginia
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BULLETIN

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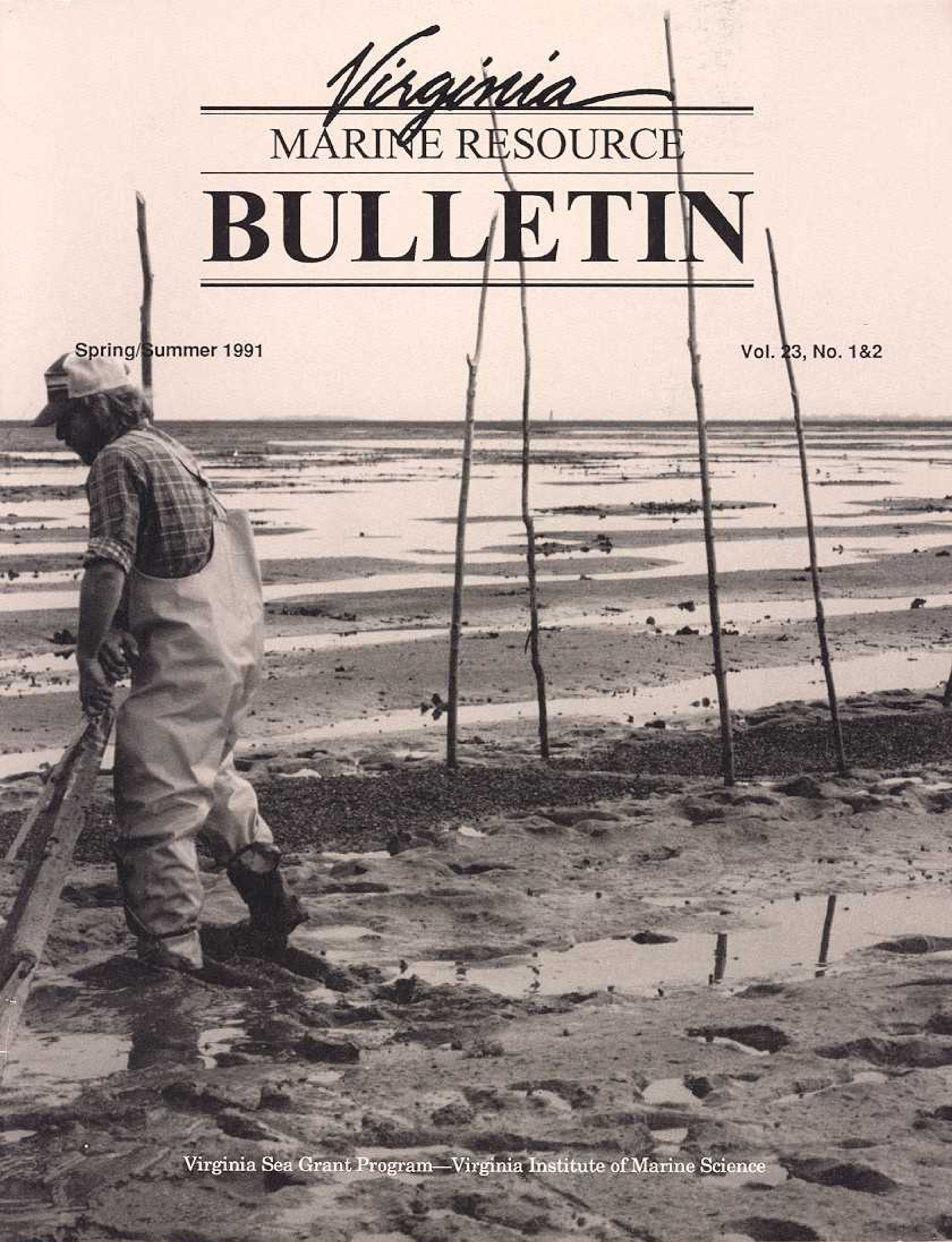

Virginia Sea Grant Program—Virginia Institute of Marine Science

Virginia
MARINE RESOURCE
BULLETIN

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Spring/ Summer 1991 **Vol. 23, No. 1&2**

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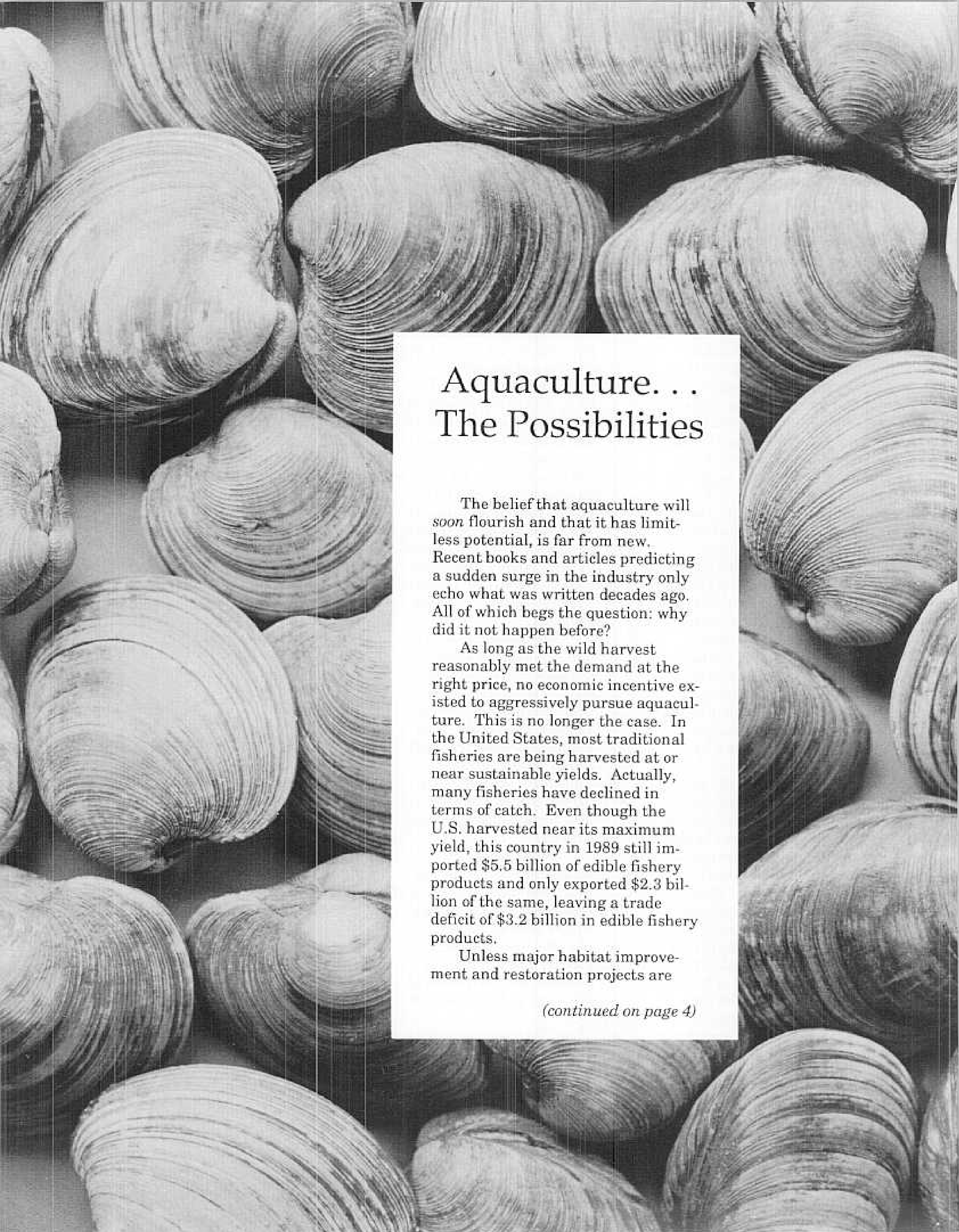
Sea Grant is a partnership of university, government and industry focusing on marine research, education and advisory service. Nationally, Sea Grant began in 1966 with passage of the Sea Grant Program and College Act.



Aquaculture. . . The Possibilities

The belief that aquaculture will *soon* flourish and that it has limitless potential, is far from new. Recent books and articles predicting a sudden surge in the industry only echo what was written decades ago. All of which begs the question: why did it not happen before?

As long as the wild harvest reasonably met the demand at the right price, no economic incentive existed to aggressively pursue aquaculture. This is no longer the case. In the United States, most traditional fisheries are being harvested at or near sustainable yields. Actually, many fisheries have declined in terms of catch. Even though the U.S. harvested near its maximum yield, this country in 1989 still imported \$5.5 billion of edible fishery products and only exported \$2.3 billion of the same, leaving a trade deficit of \$3.2 billion in edible fishery products.

Unless major habitat improvement and restoration projects are

(continued on page 4)

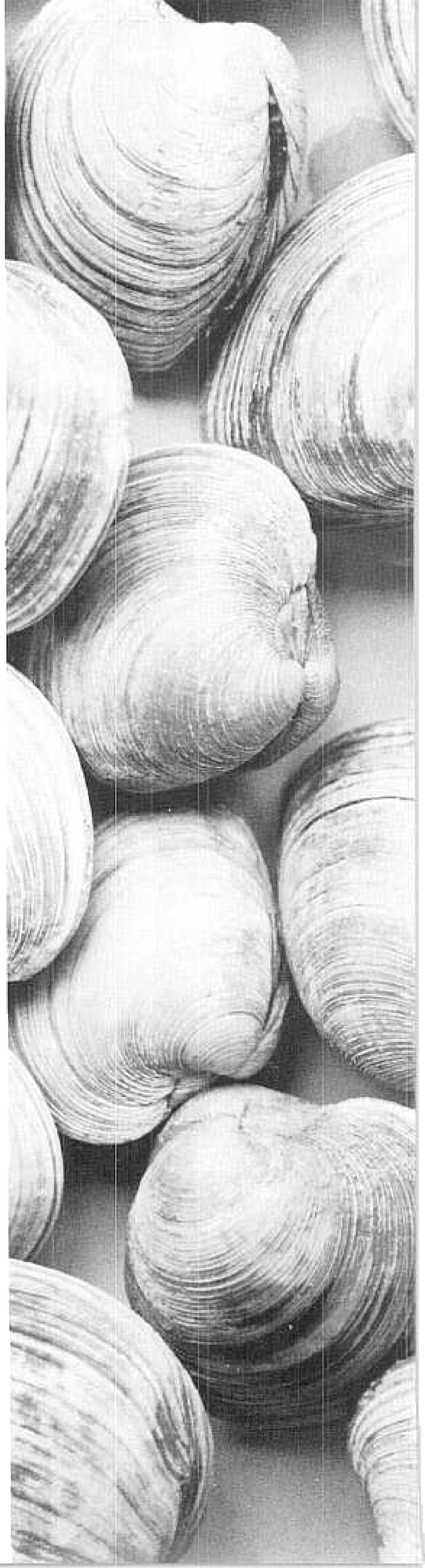
initiated, we are, as a nation, up against the limit for wild-caught harvest. The only other alternatives are to harvest nontraditional species—often considered undesirable by Americans; to import more; or to further develop the controlled growth of aquatic organisms. Economics has everything to do with the nation's choice. Aquaculture is only feasible if the costs are low enough so that producers can successfully compete with overseas suppliers, an issue that ultimately deals with labor costs or the introduction of technology which will replace the need for the type of inexpensive labor available, for instance, in parts of Asia. Additionally, markets and product channels need to be defined each step of the way to ensure that what is produced is utilized and that aquaculturists stay in business.

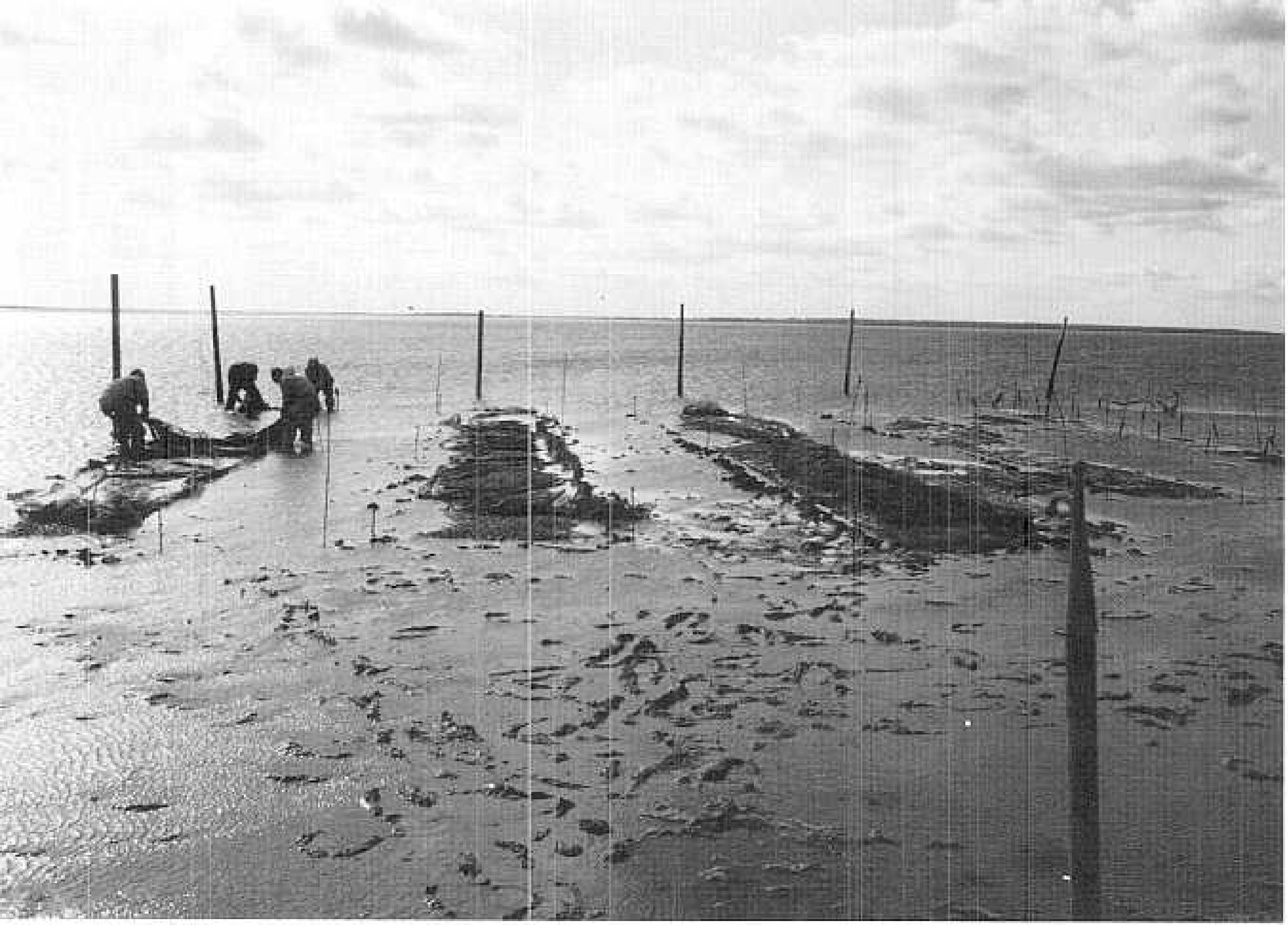
Add to this, the inherent difficulty of growing aquatic organisms, and it becomes apparent why aquaculture has not developed as rapidly as other forms of husbandry. Most fin- and shellfish—as opposed to a warm-blooded animal such as a chicken—experience much more dramatic physical changes from the time they hatch from eggs. In general, warm-blooded animals undergo extreme transformations while in the egg or in the uterus. For the cold-blooded aquatic organism, the changes take place in the water, and at each stage the animal may have different environmental and nutritional requirements.

Given the right economic setting and technological advances, the aquaculture industry may well flourish. A doubling of U.S. production is expected over the next 15 years. Since 1980, aquacultural production has increased annually by 20 percent, and this rate of growth is projected for the near future. The increases are expected primarily in catfish and crawfish production, but significant increases are also foreseen for marine shrimp, finfish and mollusks. Additional support of technology development in aquaculture could result in even greater gains and the availability of a much wider selection of marine products.

Virginia aquaculture and mariculture efforts focus on catfish, hybrid striped bass, freshwater trout, hard clams, oyster and soft shell crabs. Bay scallops (*Argopecten*), soft clams (*Mya*), surf clams (*Spisula*) and finfish culture in the coastal zone are also being explored as possibilities.

With the general population's growing sensitivity to the healthiness of seafood and the resulting rise in seafood consumption, the next few decades may well be the start of that oft-predicted boom of this form of husbandry. ❖





Men tending clam beds.

Clam Culture? Cultured Fish??

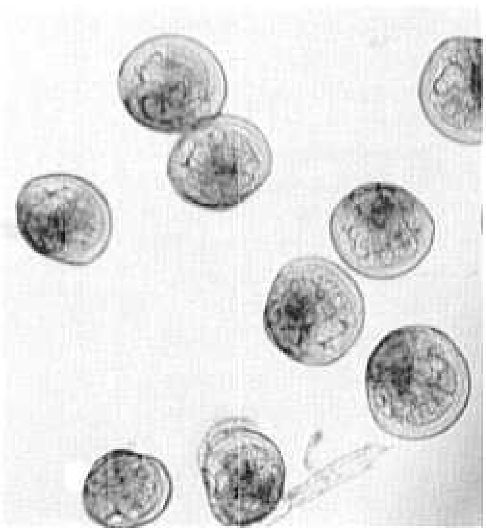
To someone outside the realm of marine science and fisheries, some of the jargon used in the field of aquaculture, such as "clam culture," might conjure some rather peculiar images. With that in mind, here is . . .

A Brief Lexicon of Aquaculture Terms for the Non-Technician

- **Culturing**—Cultivation of aquatic organisms.
- **Mariculture**—Fish farming in salt or brackish water. Most mariculture takes place in estuaries, very fertile areas where the sea meets fresh water. However, the physical, chemical and biological processes in an estuary are dynamic, meaning that the mariculturist must cope with the real possibility of rapidly changing temperature, salinity and pH.
- **Crab Shedding**—Commercial practice of producing soft shell crabs. A blue crab, like other crustaceans, grows by shedding its shell: the hard outer shell splits and the crab backs out of its old shell. Before the new shell hardens, this crab is known as a "soft shell crab," a delicacy.
- **Peeler**—A crab which is on the verge of molting, of shedding its shell. A crab shedder is able to tell how far off the molt is by the color of a line on the next-to-last segment of one of the crab's paddle fins. White means the crab will shed its shell in about two weeks; pink indicates a week; and a red line signals that the molt is one to three days in the offing.
- **Buster**—Crab in the shell-shedding process. A split develops under

the lateral spines and along the posterior edge of the shell. The crab will now back out of its shell.

- **Sook**—Mature female crab.
- **Jimmy**—Larger male blue crab.
- **Cage Relaying**—Clams and other bivalves can cleanse themselves of bacterial impurities relatively quickly when transplanted to higher quality water. This is sometimes done with cages to prevent loss.
- **Larva**—Free swimming clam or oyster shortly after emerging from the egg.
- **Veliger**—Refers to the stage where a clam or oyster has a velum, a swimming organ which allows it to swim and, as a consequence, capture food.
- **Pediveliger**—Late stage clam or oyster larva that has a foot and is close to settlement.
- **Seed**—Young clam or oyster which is considered, by aquaculturists, of sufficient size to plant for cultivation.
- **Fry**—A term normally used to refer to a fish which has just hatched from the egg and is only a few days old.
- **Fingerling**—A young fish which is considered the right size for stocking.
- **Recirculating System**—A self-contained system in which the water is continually reused. Water quality is maintained by using various filtering devices.



Oyster Larvae.

Types of Culture

The methods used in culturing depend on the type of animal, the location and the environmental conditions.

Oysters can be grown on racks, rafts, trays, suspended strings, or on bottom.

Open farm ponds, net pens and cage culture can be used with a number of species, including hybrid striped bass and catfish. Cage culture is sometimes employed, in the case of hybrid striped bass, to prevent the escapement of hybrids into natural freshwater environments or river systems which drain into Virginia waters on the Atlantic Ocean. Cage culture is also used to keep fish of different ages from competing with each other for food, or to cultivate small fish in a large pond. In Virginia, cage culture is somtimes a better option for aquaculturists using existing farm ponds. These bodies of water were not designed or built for culturing and may not be easily seined or drained; the fish are much more easily harvested when in cages.

It may seem fairly obvious what aquaculture entails, but then again it depends on who is defining it. Aquaculture can narrowly be described as simply the controlled cultivation of aquatic organisms. Others in the industry might include, under the umbrella of aquaculture, transplanting aquatic organisms such as clams, in higher quality water; and, in the case of blue crabs, containing them at a certain stage—when they are molting—and providing them with the necessary conditions until they can be harvested as soft crabs.

The terminology used in clam culture mirrors, in part, that used for farming on land. A bed is built. There are a number of ways to do that, but the method developed and advocated by the Virginia Institute of Marine Science calls for a bed of limestone aggregate. The limestone provides a refuge for the small clams; it is more difficult for predators to pick out the clams against this background. The bed is then

Seed clams.

planted with seed (small clams obtained from a hatchery). The bed is covered with plastic mesh, again to inhibit predators. Without some sort of protection, the planted clams resemble something akin to a smorgasbord to blue crabs. In some locations trays and in-bottom forms are used. Direct field planting without protection would result in too heavy a loss of the bivalves. Harvesting is done by hand or with bull rakes in Virginia.

Worldwide, the intensity of aquaculture efforts varies widely. Countries which have traditionally depended on seafood obviously have a great deal of incentive to develop new technology or expand operations.

What is cultured in any one country has much to do with the seafood preferences of the population. Americans tend to be somewhat conservative, seeking out a fairly narrow range of products with which they are familiar. In contrast, the Japanese consume a wide spectrum of seafood products and have every reason to actively promote many types of fish farming. A few of the products farmed in that country are, at least to many U.S. palates, quite foreign: sea urchins and sea cucumbers.

By 1985 Japan was managing an area of ocean floor which equaled all the land farmed in that country. Artificial reefs are often used in Japan to culture, for they can be designed to attract specific species. The type of artificial reef can range from rocks placed in soft sediments, to elaborate almost city-like structures.

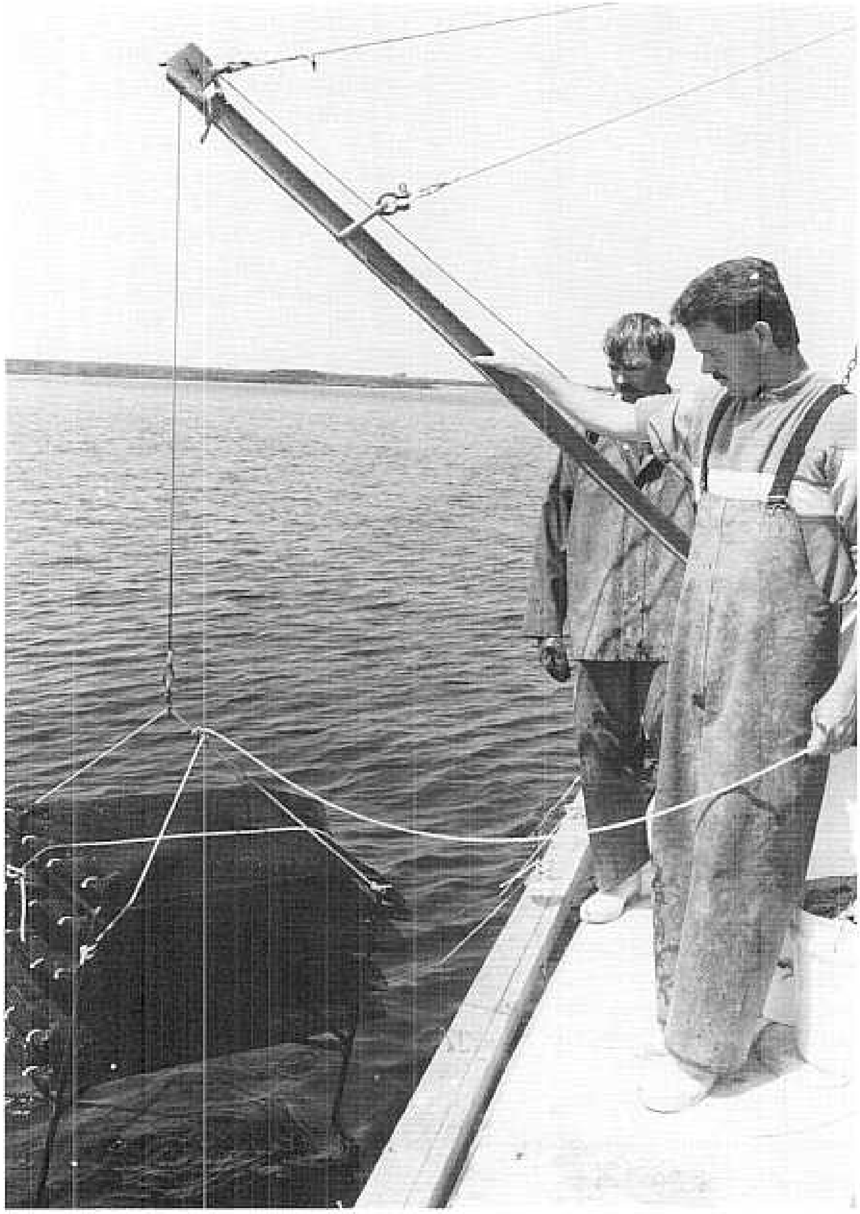
In parts of the world even the giant clams of legend, the tridacnids, are being looked at as a good candidate for culturing. Found in Indo-Pacific coral reefs, the largest of this species, *Tridacna gigas* can weigh up to 200 kilograms, 55-65 kilograms of which is living tissue.

The colossal growth of a tridacnid is believed by some to be due to the animal's ability to "farm" large numbers of dinoflagellates within its tissues; in this symbiotic relationship, the clam is able to derive many of the nutrients it needs. ❖

Aquaculture has long played a role in human history. There are accounts of it in the ancient world; however, the exact date when fish farming began is still a matter of conjecture. We do know that Wen Fang, founder of the Chou Dynasty in China, experimented with aquaculture during the years 1135-1122 B.C. Egyptian art from even earlier times portrays what appears to be pond culture. The Romans cultivated oysters and in all probability learned the skills from the civilizations which preceded them.

In far more recent history, the notion of controlling the growth of aquatic organisms interested at least one colonial—despite the fact that the New World, as it was called then, teemed with fish and shellfish in areas. During the mid-1700's, a man on the Eastern Shore of Maryland is believed to have at least dallied with oyster culture, long before oysters became popular and long before they became what they are now in the Chesapeake Bay, increasingly a sarcity.

Outrunning Oyster Pathogens



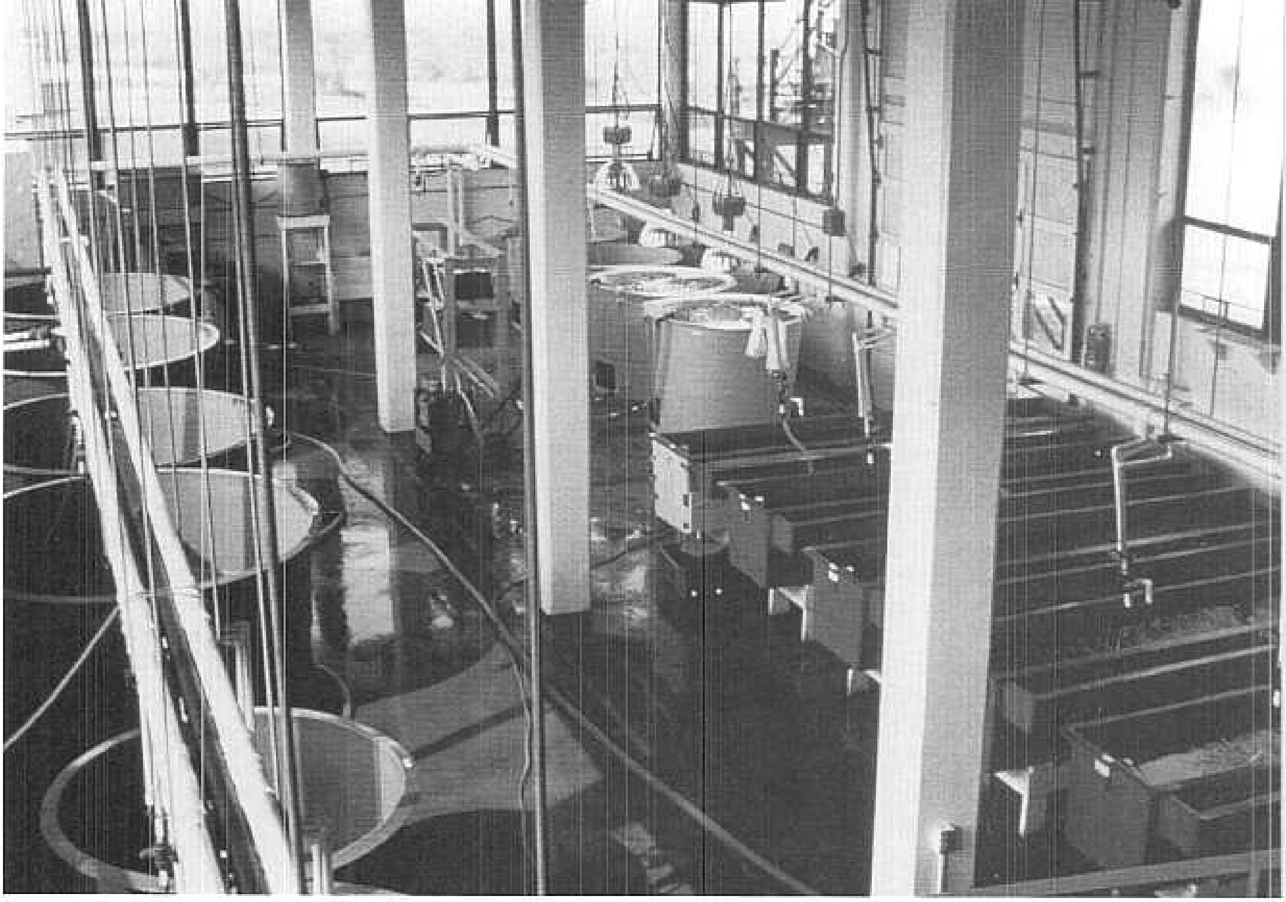
Susan Waters

Racks with oysters being deployed at the growing ground. Each rack contains five trays. Mesh bags keep the oysters in place.

If you were to travel near Pungoteague on the Chesapeake Bay, a wooden structure in the nearshore water would seem commonplace. Watermen have long cultivated the fertile water, harvesting soft shell crabs from floats and cultivating clams in the intertidal flats. One of the wooden structures at Pungoteague, however, is a bit different in its purpose. It is part of a concerted effort to aid the oyster industry as it is faced with the demise of its wild-caught fishery. Scientists at the Virginia Institute of Marine Science (VIMS) are attempting to outmaneuver two diseases which have been devastating to the once-plentiful oyster fishery.*

The diseases MSX (*Haplosporidium nelsoni*) and Dermo (*Perkinsus marinus*)—harmful to oysters, not humans— are pervasive in the Virginia portion of the Chesapeake Bay, an unpleasant fact that industry must contend with, and a situation which has prompted a great deal of scientific research. At the VIMS Wachapreague lab, Mike Castagna and Mark Luckenbach head research which is exploring ways to grow oysters to market size before they are affected by MSX and Dermo. The diseases ap-

**See pages 12-13 for more on the plight of the Chesapeake Bay oyster fishery.*



Bill Jenkins

Interior of the oyster hatchery, located at the main VIMS campus.

pear to affect oysters after they have been exposed for two summers. The strategem, then, at the Wachapreague lab is to outrun the pathogens, that is to grow oysters to size within 20-22 months and before that crucial second summer. Oysters are planted in Bay waters in late summer/early fall, are exposed to the disease one summer and then are harvested before the second full summer. Currently, researchers are planting oysters at all different time intervals to document growing conditions and perils during the year.

To achieve maximum growth requires good broodstock, favorable environmental conditions and off-bottom culture.

The broodstock used are hardy strains of the native oyster, *Crassostrea virginica*, from disease-endemic areas. Presently, the Mobjack Bay stock appears to have the most potential for resistance and growth.

The environmental conditions which influence growth vary widely in the Chesapeake, so researchers are testing a number of locations and times within the calendar year. First, the site must have the right salinity and not have a low dissolved oxygen problem.

If producing oysters quickly on racks proves to be economically feasible, the very fact that they are produced through culturing could even be used as a marketing advantage.

Then, consideration must be given to the quality and quantity of food. Oysters planted in late summer/early fall can take advantage of diatom (algae) blooms, all good nutrients for oysters. Summer, clearly, is a rich time for food production, both on the land and in the Bay, but not all food is alike in its nutritional value. Oysters, which stay in one place, might feed on dinoflagellates present in the water, but it has yet to be determined how much that food source contributes to growth. Detritus from *Spartina alterniflora* can be plentiful but is a low-quality food for oysters. The amount of organic carbon and nitrogen contained in the phytoplankton, the plant life within the water, is the key here. The exact location, how much food the current and tides deliver to the oysters is also part of the equation.

Off-bottom culture enhances production because the animal spends less time and energy filtering silt and mud. The oysters can be placed in a food-rich location and the mesh bags which contain the bivalves keep them out of the reach of some predators. Because the oysters are contained, they can be easily harvested.

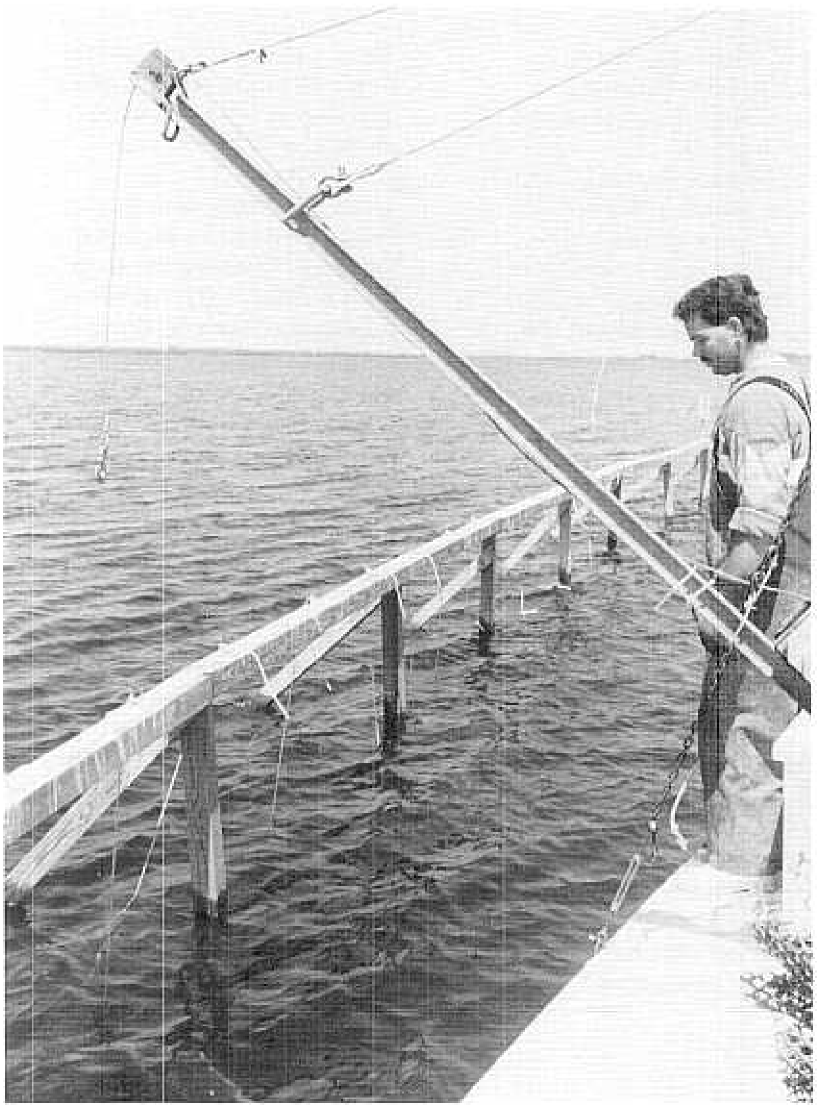
VIMS scientists have also been experimenting with triploids of the native oyster. Triploids, sterile animals with an extra set of chromosomes, do not expend all the energy needed to produce the next generation. In the field, the triploids have on an average been ten percent larger. The oyster meat itself has been twenty percent greater than the normal oyster.

A number of locations are being tested by Luckenbach. The rack at Pungoteague is the largest, some 30 feet long. Along the rack are 180 modules, with each module containing five trays. Oysters are kept in mesh bags, each containing about 250 oysters when they near market size (slow growers are discarded during each step of the operation). To date, oysters produced by rack culture did go to market. They were 17 months old and were three inches or longer.

If producing oysters quickly on racks proves to be economically feasible, the very fact that they are produced through culturing could even be used as a marketing advantage. Oysters grown under controlled conditions could allay the segment of the general public which is guarded about purchasing shellfish.

This project is part of a larger VIMS effort to assist industry and private growers. A hatchery, which Ken Kurkowski manages, is located at the main VIMS campus at Gloucester Point. The hatchery is capable of producing about 400 million larvae, to be used by industry and also in experiments. Ten million of the larvae make it to what is considered seed size by aquaculturists.

The VIMS/Wachapreague project is also supported by Virginia Sea Grant, which provided program development money to determine what exactly constitutes a good growing site. ❖



Susan Waters

VIMS technician along the oyster culture rack at Pungoteague.

Steamed Bay Scallops—
A Natural for Virginia's Eastern Shore

Meeting existing market demand is not the only purview of aquaculture. Products can be developed with a specific market in mind. At the Virginia Institute of Marine Science (VIMS) researchers are looking at a slightly different utilization of a traditional product, bay scallop (*Argopecten*). Instead of marketing just the adductor muscle—the round-shaped meat—fishery specialists hope to generate interest in the steamed product which is eaten whole like a steamed clam. The flavor is delicate and mild. The intended market would be white tablecloth, that is, upscale restaurants.

Whole, steamed bay scallops are being produced by several companies in the Northeast; however, to date, this product is not being commercially produced in the mid-Atlantic region.

Experiments with bay scallops have a long history within the Virginia Sea Grant program. Two decades ago Virginia Sea Grant investigated the possibility of cultivating *Argopecten*. Work performed by Mike Castagna and Bill Duggan at the VIMS Wachapreague lab, established the biological feasibility of rearing the bay scallop from egg to market size. Growing the bay scallop for only the adductor muscle, however, did not appear to have a good economic future. The whole product may have possibilities.

The first step in the current VIMS project was to grow *Argopecten* to market size, 45mm, within a year. Now that it has been established, researchers are assessing various growing strategies. Different growing densities are being tested as are culturing methods, according to Mike Oesterling, the Fisheries Specialist who heads the VIMS project.

The bay scallops are being grown at a hard-clam mariculture facility on the Eastern Shore of Virginia. A variety of methods for culturing are being used, including cages, nets and trays. Shallow water culture would be ideal since it is more available in Virginia. However, this method of culture has its own set of of complications: fouling and silt pose problems as can currents, which can, well, take possession by force. Grow-out in deeper water is also part of this demonstration project. Researchers hope to grow 50,000 bay scallops to market size this year. This project is part of a current state mariculture initiative with additional support from Virginia Sea Grant. ❖

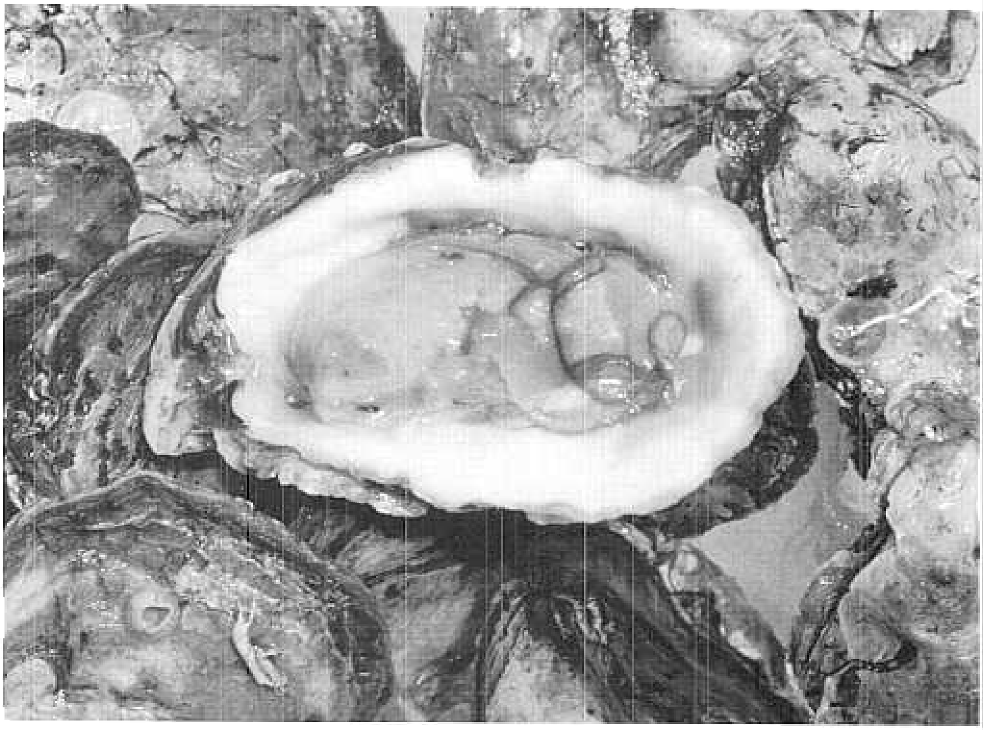
Mark Brotman

Fisheries Specialist Mike Oesterling with trays of bay scallops.

Developing a Disease- Resistant

"The abundance of oysters is incredible. There are whole banks of them so that the ships must avoid them. A sloop, which was to land us at Kingscreek, struck an oyster bed, where we had to wait about two hours for the tide. They surpass those in England by far in size, indeed they are four times as large. I often cut them in two, before I could put them into my mouth."

Francis Louis Michel
1701

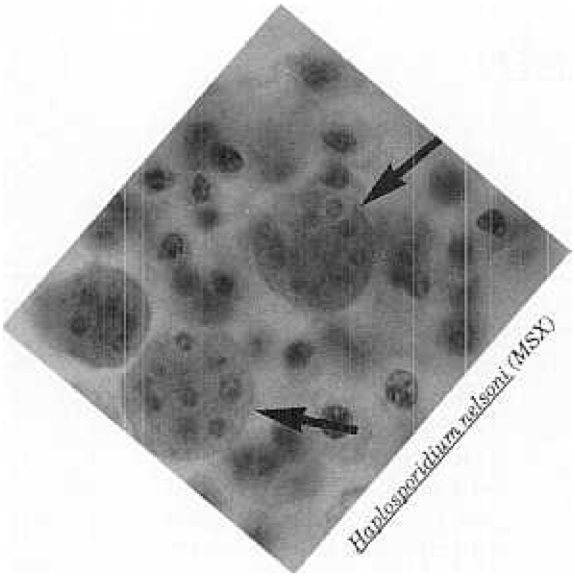


Bill Jenkins

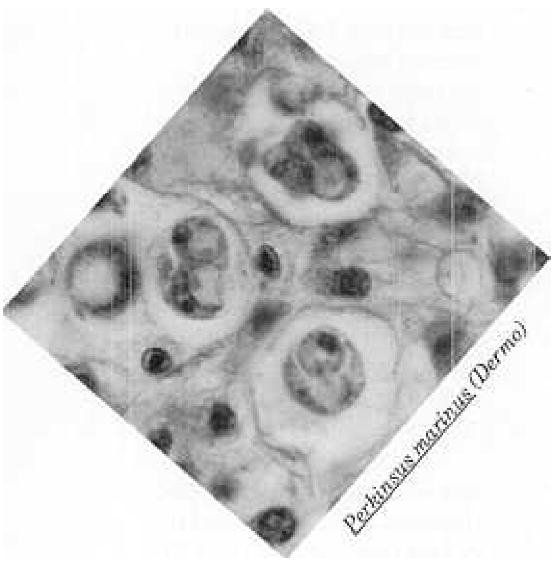
Sadly, the scene described by Michel only exists in written accounts. One of the great wealths of the Chesapeake Bay, the oyster fishery, has experienced a catastrophic decline in the last thirty years. Between 1950 and 1960, oyster production in Virginia averaged 3.2 million bushels annually. A substantial drop occurred during 1960 and 1986 when annual production averaged only about 900,000 bushels. From that point on, the numbers plunge: 1987/88—520,994 bushels; 1988/89—257,268 bushels; and the estimate for 1989-90 production is the most dismal of all. . .only 150,000 bushels, a mere shadow of former times.

What happened? For brevity's sake, suffice it to say that it was a combination of fishing pressure and two deadly pathogens, *Haplosporidium nelsoni*, popularly called MSX, and *Perkinsus marinus*, often referred to as Dermo. Although these pathogens do not harm humans, they can decimate oysters before they reach market size. The combined effect of both oyster diseases is sobering: the basic elimination of commercial oyster production from essentially all waters in the Virginia portion of the Chesapeake Bay,

Oyster



These two pathogens have taken a heavy toll on the native oyster population. Researchers are now attempting to develop a strain resistant to MSX and Dermo. Photos by Gene Burreson.



with the exception of a small area in the upper James River. Bleaker yet, these remaining grounds—about five percent of the total public oyster grounds—are being fished intensely and are in danger of being depleted below commercial densities.

> *The difficulty inherent in producing strains via selective breeding is that a long period of time elapses before the new oyster is capable of reproduction and can be bred.*

Research aimed at finding means to restore the state's oyster industry has been numerous and extensive. Recent efforts include genetic selection of oysters, a project funded by Sea Grant and conducted by Eugene Burreson, Roger Mann, Bruce Barber and John Graves, scientists at the Virginia Institute of Marine Science (VIMS). These researchers are trying to develop disease-resistant strains of the native oyster, *Crassostrea virginica*, from Delaware Bay and Chesapeake Bay stocks. Delaware Bay oysters were selected because they exhibit a resistance to MSX. Remnants of Mobjack Bay and lower James River stocks were chosen because they have been exposed to MSX and Dermo for approximately thirty years and still survived. The strains are being exposed to MSX and Dermo in the York River, Virginia, and further breeding experiments will be performed with the most disease-resistant oysters. The difficulty inherent in producing strains via selective breeding is that a long period of time elapses, about three years, before the new oyster is capable of reproduction and can be bred. Problematic, too, is the fact that scientists are attempting to produce an oyster which is resistant to two very different diseases. Dermo is readily transmitted from oyster to oyster, but MSX is not.

Given the length of time needed to generate the ideal Chesapeake Bay oyster through selective breeding, the testing of a non-native Japanese oyster, *Crassostrea gigas*, has begun at VIMS. *C. gigas* has been found to be quite resistant to Dermo in lab experiments. Since MSX cannot be transmitted in the lab, permission to expose the Japanese oyster in the field has been sought from the Virginia Marine Resources Commission.

The Japanese oyster interests researchers because it is disease resistant and has been highly successful in other parts of the world, notably France, a country which leads in oyster production. In a situation which parallels the Chesapeake Bay oyster fishery, natural stocks in France were considerably weakened by overfishing and disease. In the mid-1970s *C. gigas* was cultivated and now 98% of France's yearly harvest of 150,000 metric tons is attributable to that oyster.

❖ ❖ ❖

Disseminating Scientific Information to Aquaculturists

Information transfer has been, and will be a priority of the Virginia Institute of Marine Science (VIMS) and the Virginia Sea Grant program. Workshops, conferences, manuals and technical reports are some of the means employed to make that all-important interface between the world of research and the people who can benefit from technological information.

Numerous workshops on soft shell crab shedding have been conducted both in Virginia and in other states. A series of workshops in 1990 were conducted at VIMS, and at the Northern Neck and Eastern Shore of Virginia. In the same year, research on heating soft crab shedding systems was detailed at the East Coast Commercial Fishermen's Trade Exposition (ECCFTE), and a technical report on the same subject was produced by Virginia Sea Grant. This year an overview of soft crab production was presented at the ECCFTE's Ocean City, Maryland conference.

Every year an intensive, three-day workshop is conducted for clam culturists at the VIMS Wachapreague Lab. Conference participants travel from all parts of the U.S. to learn about the fine points of clam culture.

Newly available to clam culturists is *Investing in Commercial Hard Clam Culture: A Comprehensive Guide to the South Atlantic States*. This 128-page, Sea Grant guide was sponsored by the National Coastal Resources and Research Development Institute and written by economists and biologists from Virginia, North Carolina, South Carolina, Georgia and Florida.

The publication serves as a guide for people interested in making realistic economic decisions about investing in a hard clam culture system. In addition to summarizing the biology of hard clam culture, the publication emphasizes economic analysis and investment guide lines. Topics covered include basics of hard clam culture; beginning a new culture system; permitting and leasing conditions; culture techniques; nursery systems; growout methods; marketing the clams; and financing a clam culture operation. The financial feasibility of the following systems is also detailed: hatchery systems; upflow, field and raceway nurseries; pen, bottom net and soft tray growout; and integrated systems.

While some of the workshops focus on one species, others are broader in their approach. A 1988 two-day conference focused on culturing hybrid striped bass and financing mariculture ventures. A 1989 conference included an overview of aquaculture in the United States, Virginia initiatives, selective breeding of oysters at VIMS, fresh water trout and hard clam culture in Virginia, crawfish potential for the Commonwealth, as well as sessions on catfish, soft crabs and hybrid striped bass.

Each year at the Virginia State Fair, aquaculture exhibits give the general population more insight into different culture techniques and operations. The exhibits continue to highlight crab shedding and oyster and clam culture. The displays are coordinated by the Virginia Department of Agriculture and Consumer Services in conjunction with the state Aquaculture Initiative.

Virginia's growing aquaculture industry is also attested to by the formation of two associations, the Virginia Shellfish Growers' Association and the Virginia Fish Farmers' Association. By organizing, industry ensures that it has input when regulations are proposed. ❖

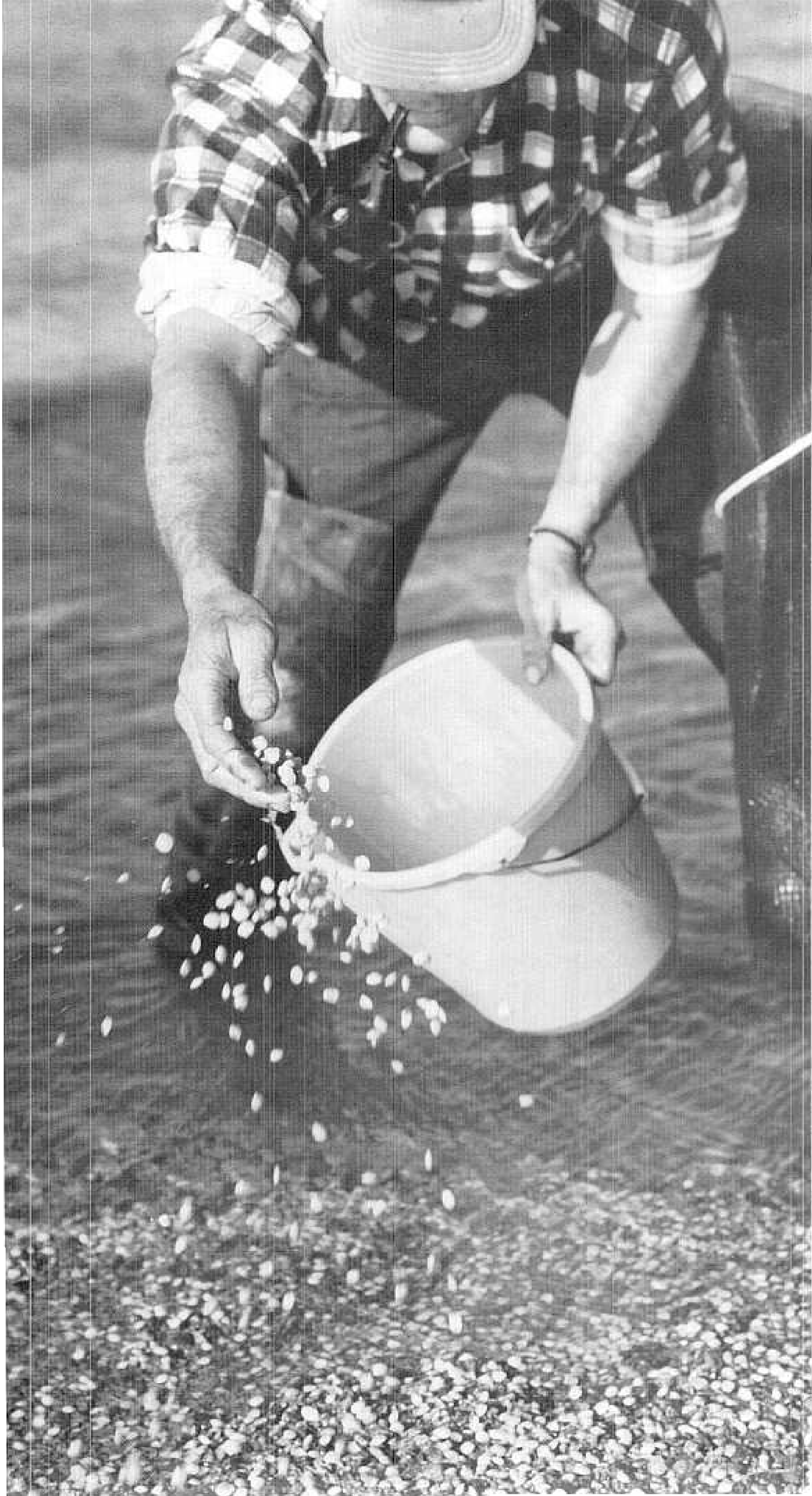
Mid-Atlantic Mariculture

Conference Planned

An intensive two-day conference on bivalve culture will be conducted on October 18th and 19th in Chincoteague, Virginia. The regional, mid-Atlantic conference will consist of one day of classroom sessions and another day of hands-on demonstrations and field trips to commercial bivalve facilities. Panels made up of both industry representatives and scientists will discuss oyster, clam and scallop culture. The classroom session will provide an overview of culturing options and will focus on market trends, financial options, business plans, identifying appropriate funding sources, sales alternatives and economic case studies.

The conference is sponsored by the Virginia Institute of Marine Science, College of William and Mary, and by Sea Grant Marine Advisory Programs within the mid-Atlantic region.

For additional information write Virginia Sea Grant, Marine Advisory Program, Virginia Institute of Marine Science, Gloucester Point, Virginia 23062, or call (804) 642-7170.



Waterman seeding a bed with clams.

Seafood Consumption In The Year 2000

The world's ever-present need to feed itself will not diminish in coming years. The world's population at the turn of the century is expected to increase by 16.7 percent, from 5.25 billion to 6.13 billion. Seafood consumption is also expected to grow, from 63.5 million metric tons to 94.5 million tons. Currently, the U.S. is fully tapping the wild-caught fishery for consumer-preferred products, leaving aquaculture as the viable option for meeting the demand for seafood.

Virginia Sea Grant has been heavily involved in developing technology and providing assistance to all parts of the aquaculture industry. This program-wide emphasis on aquaculture will undoubtedly be underscored in the coming decades.

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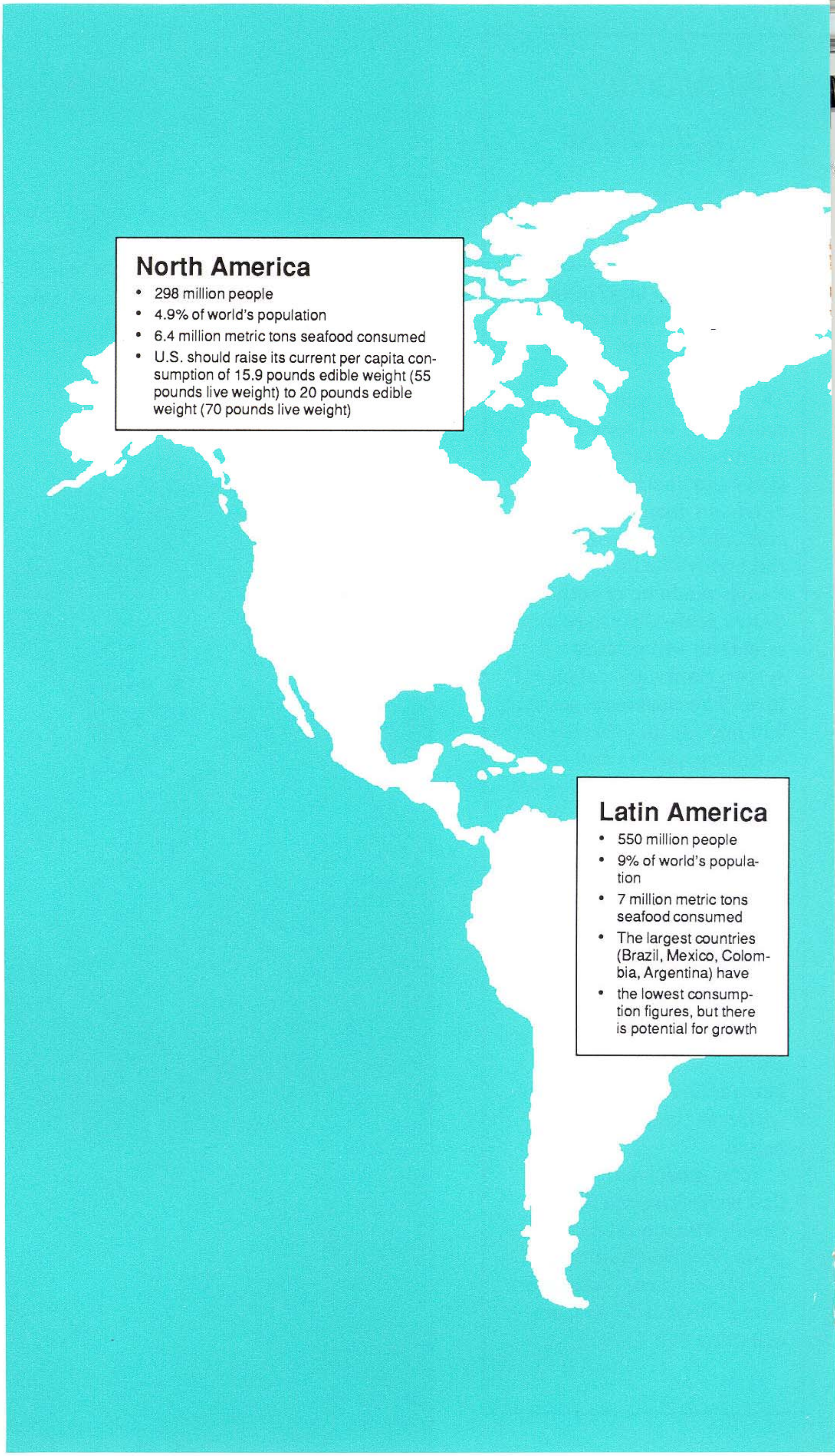



East Asia
• 1.47 billion people
• 24% of world's population
• 21.8 million metric tons seafood consumed
• Consumption is high just about everywhere in the region except in China, although China's total is expected to rise
Soviet Union
• 315 million people
• 5.1% of world's population
• 60 pounds per capita seafood consumed
• Current 65-pound per capita consumption is expected to slip as Soviets struggle through a decade of strife
Europe
• 513 million people
• 8.4% of world's population
• 10 million metric tons seafood consumed
• Newly united Germany will become Europe's largest country (76.7 million people) in 2000, while top seafood consuming nations will be France and Spain
Japan
• 127.7 million people
• 2.1 of world's population
• 140 pounds per capita seafood consumption
• As the Japanese, particularly the younger generation, discover foods from other lands, they will begin to ease off from their current 153 pounds per capita consumption
China (Including Hong Kong)
• 1.26 billion people
• 20.6 of the world's population
• 20 pounds per capita seafood consumption
• New trade opportunities, more fully exploited natural resources and higher per capita income should boost China's consumption by some 25%
South Asia
• 2.1 billion people
• 33.8% of world's population
• 30 million metric tons seafood consumed
• High per capita consumption in the Philippines, Malaysia, Singapore and elsewhere is offset by India's low consumption
India
• 961.5 million people
• 15.7 of world's population
• 7 pound per capita seafood consumed
• Despite its massive population, consumption is expected to remain low
Oceania
• 30 million people
• .05% of world's population
• 1 million metric tons seafood consumed
• Australia's 18.7 million people will eat about 16 pounds edible weight per person
Africa
• 877 million people
• 14.3 of world's population
• 12.7 million metric tons seafood consumed
• Widening drought, worsening famine and runaway overpopulation will keep consumption low in most countries

Callinectes sapidus, beautiful swimmer

The latin name for blue crab, *Callinectes sapidus*, only tells half the story: not only is *Callinectes sapidus* a "beautiful swimmer," it is also succulent fare. While most everyone is familiar with the sweet crabmeat picked from the hard crab, soft shell crabs have often been considered novel outside the Chesapeake Bay and Gulf states. This is changing. Soft shell crabs—crabs which, in the process of molting, have shed their hard shells—are reaching distant markets, both here and abroad.

This market expansion is the result of cooperative efforts by Sea Grant, commercial operators, researchers, extension agents, development foundations and government agencies in numerous states. Information exchange within the national Sea Grant network increased soft crab survival rates and profits, and of course cut down on the unnecessary duplication of efforts. Virginia Sea Grant has been a prime force in this area, contributing significantly in its research, extension work and

A "jimmy" crab, cradles a female as she emerges from her shell.

marketing efforts in Europe and the Orient.

Soft crab shedding has its own set of technological challenges. Floats were long considered a pragmatic approach to crab shedding: what the fisherman intends to harvest is kept in one place. Initially, nearshore floats were used; however, they were moved further from shore so that the crabs' physiological needs were met in deep water where tidal currents provided better conditions for survival. Even though use of these floats culminated in better results—more soft crabs—they did not offer protection from predators, and a producer had to not only travel to the floats, but also lean over the boat's side to tend the crabs, all physically taxing work. Also, pollutants discharged near or upstream from the floats could cost a season's worth of work.

Advancements in the growing soft crab industry have, over the years, consisted of shore-based, flow-through floats or tanks, and finally closed, recirculating shedding systems. The later, essentially self-contained system, frees producers from the necessity of either owning or having access to waterfront, an option increasingly important to shedders as the price of waterfront dramatically rises. In a closed system, environmental conditions, such as water temperature, salinity, dissolved oxygen and the elimination of waste products can be controlled for optimum results.

Virginia Sea Grant has been instrumental in both soft crab research and advisory services, ranging from the design and construction of shedding facilities, to advice on actual shedding procedures. Virginia Sea Grant also assisted in the development of biological filters which convert nitrogenous waste products into less toxic forms; skimming processes to remove dissolved organic products; and improved aeration of filters and tanks. A great deal of this information reached shedders through direct contact, workshops, technical reports and a manual for both the novice and experienced shedder, *Manual for Handling and Shedding Blue Crabs (Callinectes sapidus)*, by Mike Oesterling, Fisheries Specialist at the Virginia Institute of Marine Science.

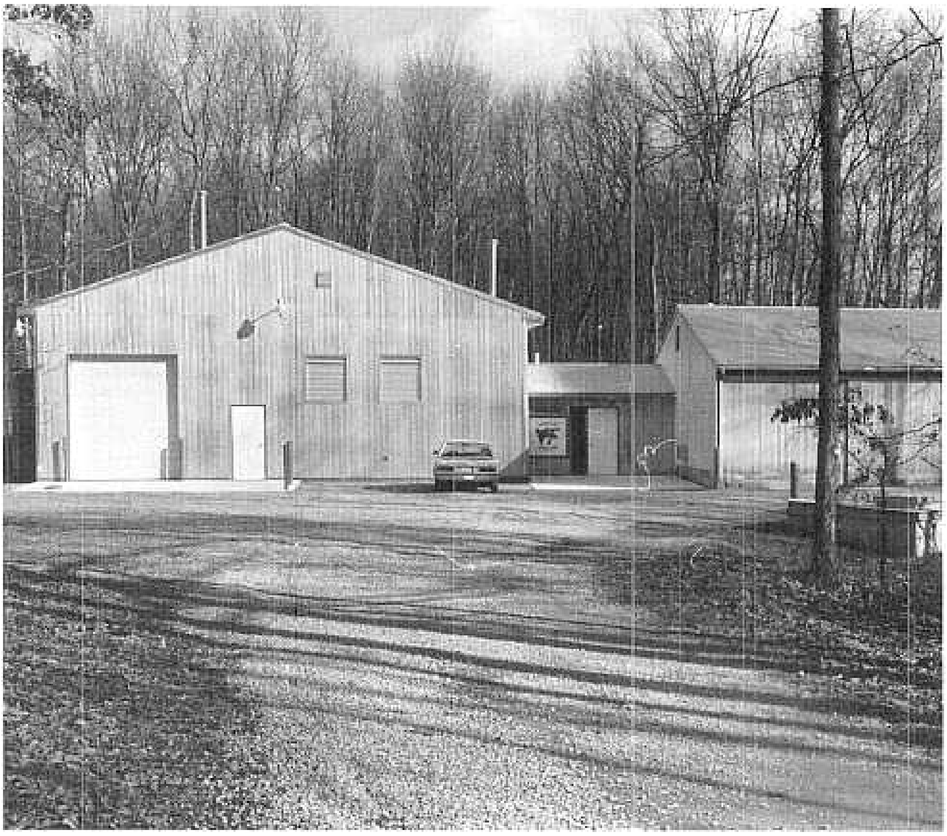
Most recently, the feasibility of heating water in closed systems was explored by Oesterling. Producing soft crabs earlier in the season can give Chesapeake Bay producers more of a competitive edge; higher prices are offered for early spring soft crabs. A delicate balance, however, exists between production, market size and price. The information gleaned from this recent research was disseminated through workshops and a technical bulletin which concentrated on specific problems caused by fluctuating water temperatures, detailed options for heating methods, as well as costs and returns.❖


Mike Oesterling

Soft shell crabs on the way to market.

Growing Fish Anywhere

This unpretentious structure, located in the woods bordering the main Virginia Polytechnic Institute (VPI), may well house the technology of the future for aquaculture. The high-density, recirculating system inside this building in Blacksburg, Virginia, has the potential of freeing aquaculturists from what is now a major constraint: limited growing options because of geographic location.



The Aquaculture Center at the Virginia Polytechnic Institute.

Just as agricultural crops are limited by climate, so are aquaculture efforts. Additionally, some geographic areas are able to maintain a corner on the market simply because they are able to grow two, even three crops as opposed to one. This is true of shrimp farming in parts of Central and South America where climatic conditions allow for multiple crops.

Ideally—and this involves overcoming the attendant technological hurdles inherent to growing each species—recirculating systems would allow the culture of warm and cold water fish *anywhere*. With latitude and longitude no longer dominating the equation, facilities could be located near high population centers, cutting down on the cost of transporting the product to market. Recirculating fish farms could even be located to take advantage of low-cost geothermal energy, or near facilities which produce heat during an industrial process.

Closed systems also require far less land; two acres of a high-density, closed, catfish facility is equivalent to approximately 1,000-1,400 acres of pond area in Mississippi.

While the future of this technology seems exceptionally promising, the present is a matter of obtaining the information which will make large-scale, closed-system aquaculture possible. This is what the workday entails at VPI's Aquaculture Center, believed to be the largest government-owned, recirculating system in the nation. George Libey, professor at VPI, runs the facility.

This labyrinth of wires, tubes and tanks is where the fish are grown.

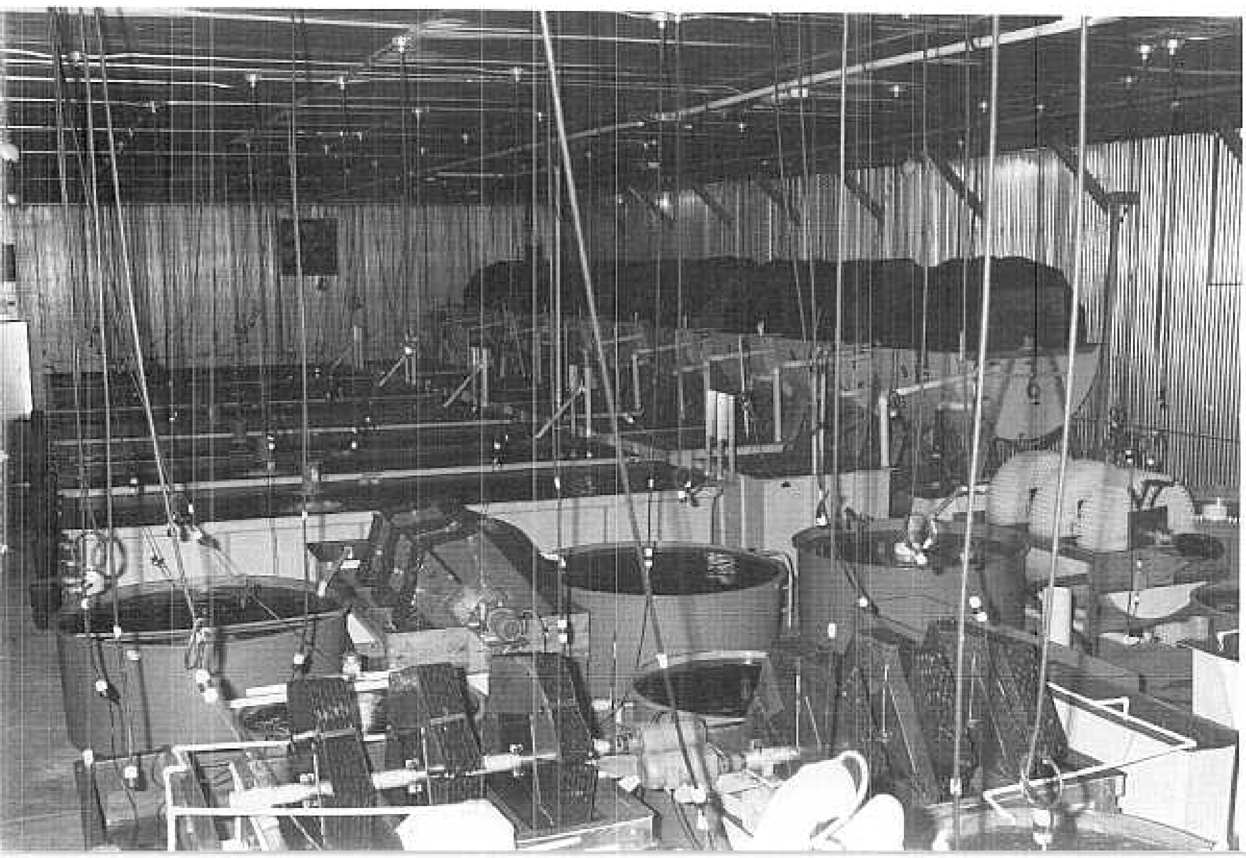
The species of choice here is hybrid striped bass. It is a well-accepted species with a mild flavor. The facility contains 8,500 square feet of floor space. Seven conditioning cubicles are used to induce, basically trick, the broodstock into spawning out of season. Accelerating the rate at which the fish spawn obviously means more fish. The basic strategy is to reduce the time between spawns to nine, then six months. Water temperature and light conditions are controlled in each cubicle and are tied to a computer model which duplicates Chesapeake Bay environmental conditions—except here, time is faster paced. A gradual increase and decrease in light is incorporated in the conditioning rooms to mimic the way in which the sun actually rises and sets. The gradual increase in light is important. Libey, at another facility, was once in a cubicle when the lights suddenly switched on; the startled fish nearly jumped out of the tank.

So far, the deception has worked on hybrid striped bass. As of January 7th or 8th, they spawned—in six months and in the middle of winter. This early spawn of hybrid striped bass may be the first of its kind.

The survival rate of newly hatched fish in protected conditions is predictably much better than in the wild. The fish are not subjected to dramatically changing water temperature and oxygen levels, food is plentiful and predators are no longer a menace. One four-year-old female, weighing seven or eight pounds, will produce 200,000-400,000 eggs. A ten percent survival rate is reasonable in the lab. That translates into 20,000-40,000 fish. In the wild, the chance or survival is astronomically low—perhaps a hundredth of a percent, Libey said.

In another area of the building, almost tropically warm and humid, nine production-scale systems are used for tests. The concept here is to experiment in large systems so that the results can be applied to commercial-size facilities (results from smaller tanks may or may not be applicable to large ones). Libey and his associates are looking for the best conditions to produce maximum growth, a simple enough sounding goal, but not an easy one since the technology for large recirculating/high-density systems is for the most part unproven.

As with animal husbandry, close quarters can present problems; diseases can be transmitted readily, the correct amount of food must be available, waste must be removed from the



growing water, and a multiplicity of variables which could affect growth and health must be brought under control. Additionally, culturing fish in high density can be stressful to the animals, making them susceptible to disease. (These diseases are not transmittable to humans.)

Genetic alteration is also being explored at the VPI lab. Ten pairs of smaller tanks are used in these experiments. The ideal fish that researchers are attempting to produce would be tolerant of a high degree of crowding, higher water temperatures and degraded water quality (the latter trait would cut costs because the aquaculturist would not have to filter the water as intensely). Toward that end, researchers crossed striped bass with white bass, and striped bass with yellow bass. Both crosses are being tested to see which has the most promise.

Work at the VPI lab does not end with induced spawning, technology enhancement and genetic alteration. Researchers are also teaming up with economists to analyze the fiscal pros and cons of recirculating systems and how receptive the market is to various forms of the product.

Even the waste from the facility will not go to waste if Libey's plans for the future become a reality. It could be used as a side dressing for corn and hay, and it could be utilized for hydroponics, the growing of plants in a nutrient solution as opposed to soil.

Although high-density recirculating systems have great potential, Libey cautions that significant unknowns still exist. From a technological point of view, aquaculture significantly lags behind the poultry and pork industries, by some 40-60 years, said Libey. It will take time and money before aquaculturists, using high-density/recirculating systems, have the poultry or pork farmer's ability to produce massive amounts of protein in a cost-effective manner. ❖

Lab technicians with broodstock.

George Libey, director of the Aquaculture Center.

Blue Ridge Fisheries On the Cutting Edge

Being on the cutting technological edge, as Bill Martin is with Blue Ridge Fisheries, can be both exhilarating and nerve-wracking. Martin heads Blue Ridge Fisheries, the largest privately-owned recirculating system in the United States, if not the world. The facility is located in Martinsville, Virginia.

Recirculating systems, ones which are basically self-contained, have great promise. Martin's 85,000 square foot facility houses the equivalent of 1,000 acres of outdoor ponds. Because environmental conditions are controlled, theoretically any type of fish could be cultivated—salt- or freshwater, cold- or warmwater. This may not sound revolutionary to someone outside fisheries science or aquaculture, but in a way it is. Fish farmers could meet market demand as opposed to being subjected to the changing whims of the marketplace or being restricted to growing a species because of location.

Martin started first with catfish, then hybrid striped bass and tilapia. While all three species grew at prodigious rates, Martin intends to pursue the tilapia market. Tilapia (*Oreochromis mossambicus*) display characteristics which would endear them to any fish farmer: they grow very rapidly, are disease-resistant and highly tolerant of high-density conditions. Although tilapia is relatively unknown in North America, the fish feed large numbers of people in Asia and Africa. In the U.S. a large Asian market for tilapia exists, a market which Martin will tap. In June all of Blue Ridge Fisheries will be restocked with the fast-growing fish.

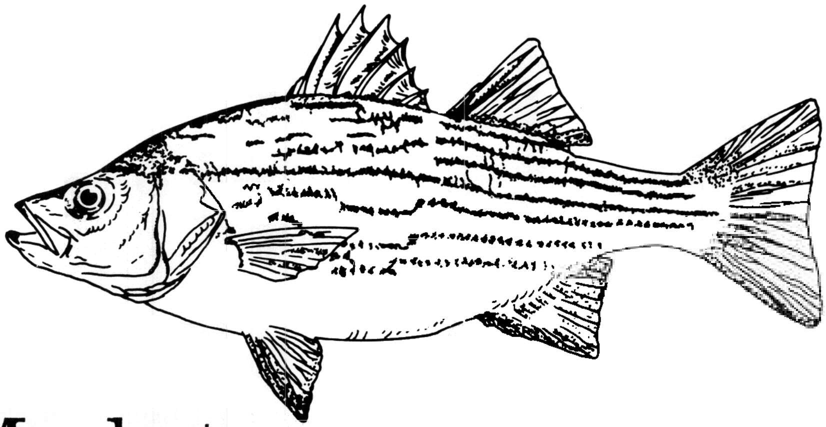
Blue Ridge Fisheries is an impressive facility with 42 tanks, each 60 feet long and five feet deep. Large biological filters remove natural waste from the water continuously. Each tank is capable of producing 50,000 catfish or tilapia. In a surgically clean processing room, automated equipment can process about 40 fish, or 80 filets a minute. The journey from tank to processing and ice is rapid, ensuring a fresh, high-quality product. Martin goes a step beyond what is required of processors and provides continuous inspection, enabling him to market a Grade A fish all of the time.

While Martin is currently focusing on fish for the dinner table, he is also interested in cultivating endangered species for restocking. This could even lead to supplying young fish to supplement the wild fishery, especially since current fishing pressure may reduce the numbers of now plentiful species.

While the possibilities are tantalizing, being on the cutting edge has its unsettling side. An innovator must contend with the unknown; how each species will biologically respond to close conditions, how the environmental conditions will differ from open pond culture—are questions which can only be answered in an actual operation. Martin and others like him are providing a baseline of information which will be valuable to future fish farmers.

Martin, long a successful entrepreneur, became interested in growing fish when he lived in the deep South, a region which figures prominently in catfish culture. Currently, said Martin, 75-80% of all catfish are raised in five counties in Mississippi.

Aquaculture, believes Martin, has the potential of revitalizing Virginia's traditional industry, seafood production. Intensive technology development, however, is crucial. Talking about the nation's support of aquaculture research, Martin said, with characteristic humor, that in a time when chickens are being fitted with contact lenses, when hogs live indoors and milk cows produce gargantuan amounts of milk, more effort should be invested in bringing aquaculture up to the same technological level as plant and animal husbandry. ❖



Assessing the Market For Hybrid Striped Bass

Rural communities are often economically vulnerable; when businesses move or close, the options for employment can decidedly narrow. While rural aquaculture ventures should not be construed as a cure-all for economic difficulties, given the right circumstances they could help diversify the economic base in some areas.

As a state, Virginia has taken significant strides in recent years toward exploring and developing the potential of aquaculture, starting with a study, "The Future of Agriculture, Forestry, Food Industries and Rural Communities in Virginia." That report, commissioned by then Governor Gerald Baliles, culminated in a recommendation that the Commonwealth encourage small businesses and production by supporting educational programs, market development and applied research. A further commitment by the state resulted in funds being allocated for research and extension work at Virginia State University, Virginia Polytechnic Institute, the Virginia Institute of Marine Science and the Virginia Department of Agriculture and Consumer Services.

Not only are state agencies taking steps toward aquaculture development, they are also exploring the existing market for aquaculture species.

. . . While the research indicated a potential market for hybrid striped bass, it also indicated that this market will require extensive work on the part of potential growers and state officials.

In a joint effort by the Virginia Department of Agriculture and Consumer Services, the Graduate School of Business Administration at the College of William and Mary and the Virginia Institute of Marine Science, the actual market potential for hybrid striped bass was explored and assessed. The results were summarized in a report entitled *Hybrid Striped Bass Aquaculture Survey and Market Potential.** Hybrid striped bass were the focus of this study because they seem an ideal aquaculture product. They exhibit both a high growth and survival rate over a wide range of environments, making them well-suited to Virginia's climate.

The authors of the aquaculture potential report were concerned not only with the market acceptability of aquacultured seafood products, but also the price that growers could expect. The preferred purchase form and size of hybrid striped bass were

Future Hybrid Striped Bass (HSB) Offerings

	Are you familiar with HSB?			Would you offer HSB in the future?		
	Yes	No	%	Yes	Would Consider	No
New York	76	279	21%	150	186	16
Pennsylvania	32	109	23%	45	85	10
New Jersey	30	79	28%	42	57	11
Virginia	22	70	24%	25	54	14
Massachusetts	15	69	18%	37	44	3
Maryland	17	48	26%	28	35	2
Connecticut	6	40	13%	21	24	2
Washington, D.C.	9	24	27%	15	16	3
Rhode Island	3	18	14%	7	13	1
Delaware	3	10	30%	9	4	0
Totals	213	746	22%	379	518	62

Survey results indicate that restaurants have limited familiarity with striped bass.

studied, as were the potential problems with the market. While the study is primarily marketing-oriented, it also covered the economics of production and capital financing for start-up operations.

Information was obtained from wholesalers in Virginia, Maryland, Washington, D.C., New York and Pennsylvania, and from white linen tablecloth restaurants in the states just mentioned, as well as in New Jersey, Massachusetts, Connecticut, Rhode Island and Delaware.

Is there a market for hybrid striped bass? Yes, tentatively. At one time, wild striped bass were a staple in restaurants along the eastern seaboard. Unfortunately, that was over ten years ago. Since the restaurant industry is noted for its high turnover rate, it is not unreasonable to assume that many of today's restaurant owners and chefs have never heard of, eaten, prepared, or served striped bass (see above table). This obviously translates into low customer awareness of the product. So, while the research performed indicated a potential market for hybrid striped bass, it also indicated that this market will require extensive work on the part of potential growers and state officials.

Restaurants in New York, Pennsylvania, New Jersey and Virginia were most familiar with hybrid striped bass and should be targeted by growers, according to the researchers. Before additional expansion is possible, growers would have to work together to bring hybrid striped bass to the public's attention. This would involve garnering media interest, advertising in trade magazines, providing sample testing of the product and offering price incentives to restaurants and retail establishments on a first-time purchase basis.

The newly re-opened wild striped bass fishery is also bound to influence the market since aquaculturists would have to compete with the wild-caught fishery.

Before any potential grower rushes into a venture, researchers highly suggest that a wide variety of current data be studied.

**This 77-page report is available through the Sea Grant Marine Advisory Program, Virginia Institute of Marine Science, Gloucester Point, Virginia 23062. The cost is $15.*

Solving Technological Headaches. Reducing Off-flavors In Cultured Fish

Many people think that humans do not have as highly a developed sense of smell and taste as animals. Not necessarily. It depends on the compound. In some instances, humans can detect minute amounts of a substance, practically molecules, for example, in the spray left by a skunk. People are sensitive to sulfur and nitrogen compounds and often use their ability to detect these substances to determine if a food product is still "good."

The problem is, consumers often equate an off-flavor in fish with spoilage, poor water quality or the health of the fish. In truth, some flavors occasionally found in cultured fish are disagreeable to our palates and mean nothing more. Geosmin and methylisoborneol (MIB) are often the culprits when fish taste muddy, the compounds imparting the same type of earthy flavor we sometimes associate with beets. Humans are acutely sensitive to these metabolites, organic compounds produced by metabolism. Actually, of the whole range of flavors we can sense, these metabolites are among the most potent, with studies documenting detection thresholds of 0.05 ppb in water.

Eliminating, or at least minimizing, these flavors in cultured fish would clearly alleviate one technological headache of aquaculturists, a challenge taken up by Virginia Sea Grant researchers George Libey and George Flick at the Virginia Polytechnic Institute (VPI) in Blacksburg. This project follows a seven-year U.S.D.A. grant in which VPI researcher Harold Dupuy developed rapid methods of pinpointing the compounds in water and fish. Libey and Flick will now apply the technology to fish grown in recirculating (basically, self-contained) systems.

Interestingly enough, as straightforward as a taste test sounds, it is highly subjective; the sensitivity of any one person to a particular flavor, can differ incredibly.

The off-flavors Geosmin and MIB that Sea Grant researchers are attempting to eliminate or reduce, are partially the result of growing fish in close quarters, at a much higher density than in the wild. The actual manner in which Geosmin and MIB production is triggered is unknown at this time. While Geosmin and MIB flavors are continually a headache to catfish farmers, the flavors are not just found in one species. Rather, the problem applies to most if not all cultured species, giving the results of this study industry-wide application.

In Libey and Flick's study, which will focus on catfish, two methods will be used to pinpoint the offending flavors: objective and subjective analyses. The objective part of the project involves using a gas chromatography mass spectroscopy, an instrument which separates and analyzes mixtures of chemical substances. Clearly, the presence of the compounds has to be documented to give any credence to the second half of this segment of the study, the subjective analysis. This part entails a process much more within the lexicon of the general population: taste tests.

Interestingly enough, as straightforward as a taste test sounds, it is highly subjective; the sensitivity of any one person to a particular flavor, can differ incredibly. To illustrate how different our taste buds are, Flick related a story about another series of tests conducted at VPI. Some members of the panel were able to tell which *river* the fish had lived in. All of which points out another difficulty in reducing off-flavors:

Food scientist George Flick and lab technician Janet Webster look at read-out from a gas chromatograph, an instrument used to isolate and identify compounds.

when should attempts to reduce off-flavors end, and to what extent is it economical? If ten percent of consumers can detect geosmin is that low enough? If it isn't, then producers have to determine if it is within their economic means to eliminate it.

After identifying the compounds responsible for the off-flavor, Libey and Flick will explore various approaches to control it. Means for reducing the compounds will include altering the environment, that is placing the fish in a clean water aquarium near harvest. This technique is used with many species; often the flavor is eliminated within a few days or weeks. Other ways which will be tested include using filtered water or treating the water with ozone; and using fractionators, apparatus which separate liquid components. Even the biological filters on the closed systems will be examined since it is possible that the unacceptable compounds emanate from microorganisms attached to the filters.

Other approaches to reducing off-flavors, but not part of this Sea Grant project, have entailed chemical treatment (analogous to a farmer using pesticides). A somewhat novel approach to the problem of off-flavors in pond culture, has been to increase the turbidity (muddiness) of pond water through mechanical agitation or with bottom-feeding fish. The end result is that phytoplankton growth is suppressed.

While a good portion of the Sea Grant project will take place at VPI's new recirculating aquaculture facility, tests will also be performed at a large commercial facility to ensure that results from the small system are applicable to larger facilities.

❖ ❖ ❖

For commercial and recreational fishermen

Highlights from The Fisherman's Forum

The overriding message at the recent Fishermen's Forum at Virginia Beach was that many fisheries are in trouble and more stringent management is certain to be in the offing. Underscored at that meeting, too, was the fact that fishermen need to become involved in the management process.

A number of issues and developments were discussed at the February Forum, some of which are highlighted on these pages.

Artificial Reef Program, Virginia Marine Resources Commission

To provide more structure for tautog fishermen, approximately 3,000 tire-in-concrete units were added to the Cape Charles (Cherrystone) Reef. Additionally, 1,050 units were deployed at The Cell north of the reef. During the fall of 1990 two barges were sunk at the Light Tower Reef off Virginia Beach.

A new reef is planned for 1991-1992 in the area off the mouth of Back River inside the Chesapeake Bay. More materials will also be added to the Gwynn Island Test Reef site just south of the Rappahannock River mouth. The latter site, although small, has been shown through a study by the Virginia Institute of Marine Science (VIMS) to be more productive for fishermen than was anticipated when the site was first established in 1984.

1991 Virginia Saltwater Fishing Tournament

Spanish mackerel (minimum weight of five pounds) was added to the citation list. Release citations will be awarded for sharks six feet or longer and only for killed sharks weighing a minimum of 200 pounds—a continuation of last year's effort to promote conservation of the shark resource. Minimum release citation length for amberjack was increased to 48 inches. Cobia of the same minimum size were added to the list of fish eligible for release citations. For false albacore, the citation weight minimum was increased to 17 pounds.

The increasingly popular Junior Angler awards (15 years and younger) are available for persons documenting release of any six species recognized under the State Record Program. Angler of the Year (resident and nonresident) awards will be determined based primarily upon the total number of different species qualifying for citations.

Flounder Fishery, A Source of Concern

The outlook for the flounder fishery continues to be a source of concern for fishermen and managers alike. Trawl surveys by VIMS netted a mixed forecast. A major decline in recruitment occurred from 1987 to 1989, as indicated by a downward trend in young-of-the-year (juvenile) flounder. On the other hand, the trawl surveys also showed that a moderate year class of fish was spawned in the winter of 1989/90.

Difficult management decisions are ahead; a harvest reduction of approximately 73% must be achieved over the next five or ten-year period. . .

Harvest levels are five times what they should be if the stock is to maximize its production potential, according to the Virginia Marine Resource Commission (VMRC). Only two to three percent of potential spawning stock presently remains intact—not nearly enough to sustain the fishery under current fishing pressure. Currently, 80% of the stock is being fished out each year.

Numerous management alternatives for restoring the stock are being considered by the Mid-Atlantic Fishery Management Council. Some of the options being considered range from closing down the fishery for awhile, to 14-inch size limits coupled with limited catches (3-6 fish per person per day) for recreational fishermen and catch quotas for commercial fishermen. The charter fishery on Virginia's Eastern Shore would likely be significantly impacted by such limits, along with the trawler fishery.

Difficult management decisions are ahead; a harvest reduction of approximately 73% must be achieved over the next five or ten year period, according to the VMRC.

Striped Bass Limited Season, A Success

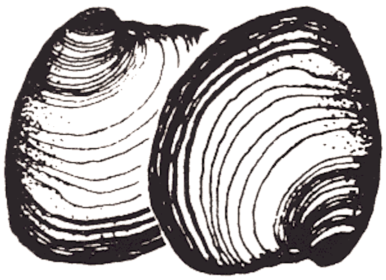
Open for the first time in almost two years, the striped bass fishery operated in 1990 under a commercial quota, recreational size and bag limits (recreational anglers were permitted to keep two fish, 18 to 36 inches, per person per day). Crucial to the success of the limited season was the VMRC's role in tracking catch rates and in enforcing regulations.

The commercial fishery, operating under a 211,000 pound quota, quickly caught its allotted fish in five days and was shut down. The commercial fishery exceeded its quota due to the rapid fishing rate and the time required to notify fishermen that the quota was filled. Finalized commercial landings, available in April, indicated the fishery caught approximately 264,000 pounds of striped bass (gill nets, 63%; pound nets, 36%; haul seines, 1%; and fyke nets, 0.5).

Preliminary estimates of the recreational catch provided by the VMRC showed the expected problems associated with only a portion of fishermen returning catch logs. Preliminary data received by the VMRC indicated that fishermen caught, or caught and released, 70,000 fish or 326,000 pounds of fish. Final figures provided to the Atlantic States Marine Fisheries Commission (ASMFC) in April showed an estimated 56,740 fish caught, or caught and released; this translates into 162,870 pounds of fish kept.

The health of, and fishery potential for, striped bass is routinely measured through the young-of-the-year index. The index is calculated in Maryland and Virginia from 100 foot beach seine surveys taken along numerous shoreline stations where juvenile striped bass, approximately two to four inches in length, seem to congregate. Maryland's index for a three year running average exceeded 8.0 for the first time in 1989, triggering limited opening of the striped bass fishery in 1990, under regulations cooperatively implemented by states and the ASMFC. Maryland's Chesapeake Bay index of 25 in 1989 sparked considerable controversy since the high number resulted primarily from one large seine catch in the Choptank River, which is historically highly erratic in its striped bass young-of-the-year abundance levels. Maryland's 1990 index dropped sharply to 2.1, indicating to fishery scientists that serious problems may continue to exist in the upper Bay regarding spawning and recruitment potential for striped bass. On the other hand, and although it was the lowest index recorded in four years, Virginia's 1990 young-of-the-year index averaged 7.3, still above the 17 year database average (5.1). The lower Bay, therefore, appears to continue to produce good spawnings of striped bass while the upper Bay's erratic productivity indicates that the fishery is not yet consistent in its rebound. ❖

Aquacultured products can obviously be used in any seafood recipe. The following recipes were featured at the Seafood Education Seminars, sponsored by the Sea Grant Marine Advisory Program, and are by Bob Marcelli, of Stripes / Bob's Mason-Dixon Cafe in Norfolk.



Cultured Clam Soup With Virginia Fall Vegetables

1 oz. olive oil
4 oz. smoked Virginia bacon, diced
1 medium onion diced
1 small jalapeño pepper, seeded and diced

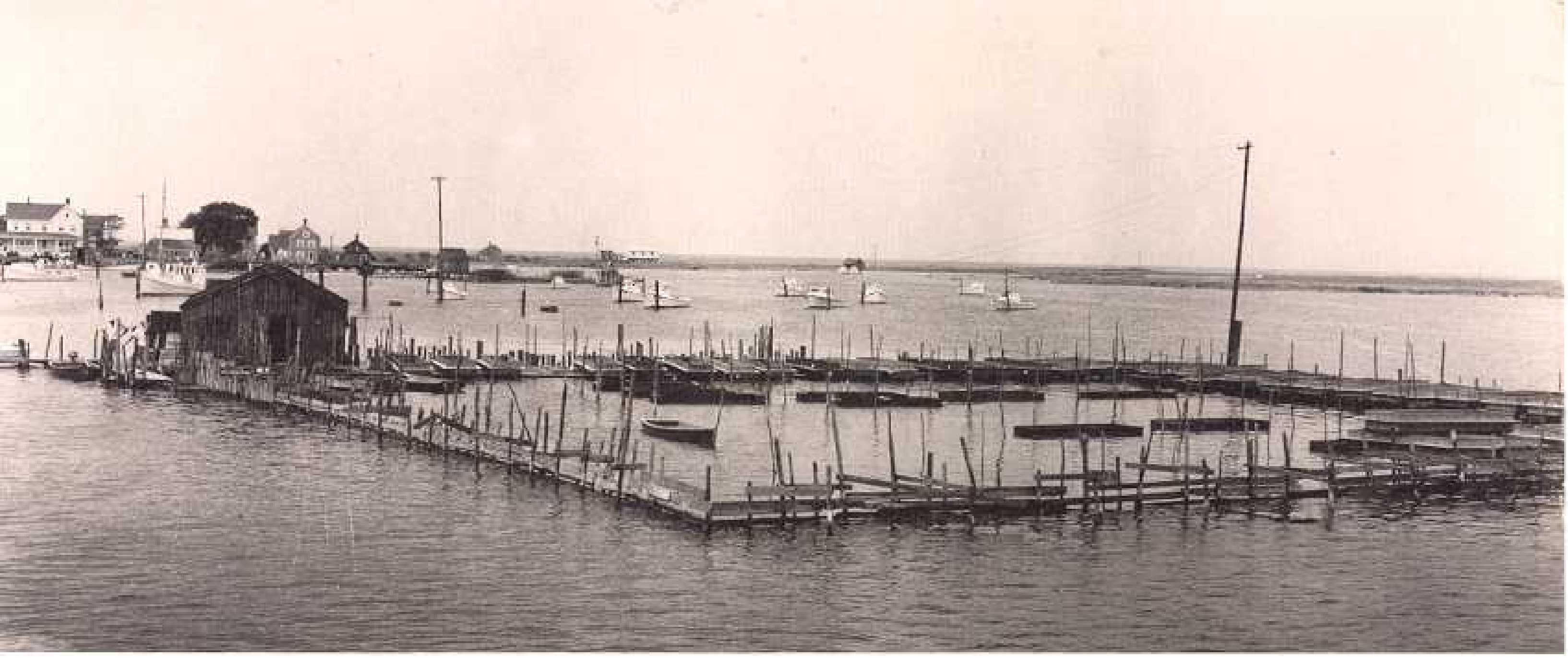
1 T. chopped garlic
4 tomatoes seeded and chopped
1 oz. cultured clams, washed
6 oz. white wine
2 qts. rich chicken stock
1 med. sweet potato, diced
1 ear shucked corn
1 cup green beans cut in 1 in. pieces
1 T. fresh thyme
1 T. fresh marjoram

In a heavy bottomed saucepan cook bacon in oil, add onions, pepper and garlic. Cook for about 1-2 minutes. Add tomatoes and clams, then wine. Cover pot, steam until clams open. Remove clams from pan and reserve. Add remaining ingredients. Bring to a boil, then simmer gently for about 10 minutes or until potatoes are soft. Place cooked clams in bowls and ladle hot soup over clams.

Sesame Crusted Roasted Striped Bass

2 hybrid bass filets
4 oz. melted butter
salt and pepper to taste
2 T. chopped fresh herbs, tarragon, thyme, oregano
1/2 cup sesame seeds

Place filets on an oiled baking pan. Brush with melted butter. Quickly sprinkle on herbs and sesame seeds and season with salt and pepper. Place in a pre-heated 400° oven. Cook for about 8-10 minutes or until done.



Above: historical photo of crab shedding floats
on the Eastern Shore of Virginia.
On the cover: waterman pulling nets over clam beds.

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Gloucester Point, Virginia 23062

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