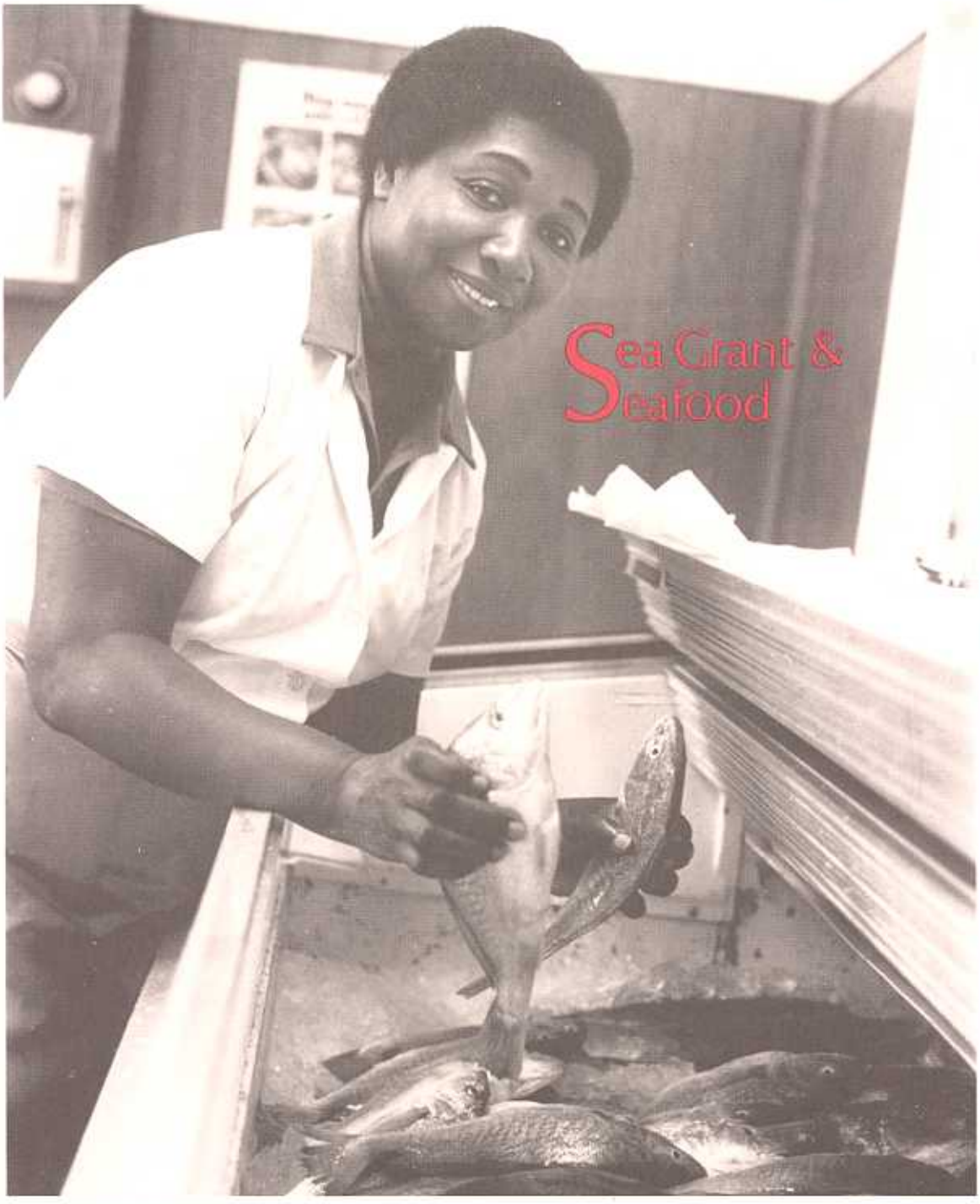
Marine Resource Bulletin

Vol. 18, No. 2 Summer 1986



Virginia Sea Grant College Program-Virginia Institute of Marine Science-College of William and Mary

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Vol. 18, No. 2 Summer 1986

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The Marine Resource Bulletin is a quarterly publication of Marine Advisory Services of the Virginia Sea Grant College Program which is administered by the Virginia Graduate Marine Science Consortium with members at **The College of William and Mary, Old Dominion University, University of Virginia and Virginia Polytechnic Institute and State University.** Subscriptions are available without charge upon written request.

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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.

Cover: Celia Williams displays croaker at the Chesapeake Bay Seafood Market in Hampton, Virginia. Photograph by Nan Brown.

CONTENTS

Sea Grant and Seafood

An Introduction

Twenty years of Sea Grant research have contributed to a better understanding of the many species of plants and animals which live in our waters. There is also more knowledge about the physical characteristics of the Bay and Virginia's productive continental shelf area. And twenty years of working with the men and women of our seafood industry have led to mutual respect and close cooperative efforts to the benefit of our natural resources and to the prosperity of the industry.

In 1966, the year Sea Grant programs began, few of us in marine science could have predicted that dietary changes on the part of the public would bring about a whole new era of interest and marketing possibilities for Virginia's seafood. We do know that the efforts of our Sea Grant educators and seafood specialists have taken advantage of the trends, inducing retailers to sell and the public to buy seafood.

Today our efforts continue in a variety of directions. Researchers seek the causes and prevention of diseases that effect shellfish production; while none of these diseases effect humans, they often deplete marine populations. Scientific research into the lives and habitats of marine organisms is also a vital component of preserving and enhancing our resources. Marine advisory specialists work daily with Virginia's fishermen and processors to help improve harvesting, processing, packing, transportation and marketing techniques. Also, new and better business practices are developed for the industry to help them compete in today's aggressive markets and rapidly changing business climate.

Through Sea Grant, education of the public and of school children who will be our future consumers and the caretakers of our marine resources continues to be a high priority. Literally hundreds of thousands of Virginia's school age children have been made aware of the value of our marine resources and our seafood industry.

Research, educational efforts and advisory services to the seafood industry on the part of the Virginia Sea Grant College Program Members, and the cooperation and dedication of fishermen and processors have helped increase stability and brought about technological advances for Virginia's fisheries. Newly formed organizations such as the Virginia Marine Products Board, the Mid-Atlantic and the Gulf and South Atlantic Fisheries Development Foundations and the Virginia Seafood Council have added their expertise and resources to assure Virginia's position as one of the largest and finest fisheries in the United States.

We take great pride in describing some past and present activities of our twenty years of dedication to the fishing industry. We look forward to a continued and increasingly bright future for Virginia seafood.

Dr. William D. DuPaul
Director of Marine Advisory Services for the Virginia Sea Grant College Program

The Virginia Seafood Industry

Virginians love seafood. They fish for it, buy it fresh or frozen, order it in restaurants and like most coastal residents, firmly believe that "Virginia" seafood is better than that caught or prepared anywhere else.

Shirley Estes Berg
Executive Director
Virginia Marine Products Board

The Virginia seafood industry is one of America's oldest industries. Back in 1607, starving Virginia settlers were taught by the Indians how to catch and cook seafood. From that humble beginning, the Virginia seafood industry has grown to what is now a $442 million-a-year business.

The people who work in the Virginia seafood industry, either directly or indirectly, number some 17,900. Together they make the Commonwealth the nation's third largest producer of seafood in total catch.

The Chesapeake Bay and its tributaries encompass 620,000 acres of water that teems with oysters, scallops and blue crabs, to name only a few of the species fished here. Since 1976, when the United States extended its territorial waters to 200 miles offshore, Virginia's seafood industry has grown well beyond the limits of the Bay.

Virginia is the nation's largest processor of fresh-shucked oysters and blue crabs and a major supplier of fresh sea scallops. But those are only a few of the 87 commercially valuable species within the range of Virginia's fleet. Seasonally, spot, clams, shad, croaker and sea trout add variety to Virginia's larder and the flounder is a year-round, abundant favorite. Some lesser known species such as monkfish and porgy are gaining in market acceptance, and species such as shark, squid and eel are strong export products.

Unlike most agriculture where farmland is usually privately owned, harvesting seafood occurs in waters owned by the public. Over the years, the waters of the Chesapeake Bay and its tributaries have come to be managed by a number of government agencies. Planning among agencies and industry is necessary for overall economic development of the industry.

In 1980, the seafood industry supported legislation to increase its licensing fees so that an agency responsible for marketing Virginia seafood products could be established. That agency is the Virginia Marine Products Board.

The goal of the Board is to create and maintain a distribution network in the retail marketplace. The objective for 1981 was to convince 1500 retail food stores either to begin carrying or to expand their sales of Virginia seafood products.

Instead of 1500, 5600 independent grocers and two national supermarket chains have expressed interest in selling Virginia seafood products. A major factor in that success was the initiation of an unusual seafood marketing program, the most comprehensive of its kind in the nation, that teaches retailers how to carry fresh seafood profitably.

The retail and food service markets for fresh, frozen or processed Virginia seafood were once restricted to the regional area. That market now stretches across the United States and into Europe and even Asia.

Researchers estimate that an additional 420 million pounds of seafood are within the fishing range of Virginia's fleet. Added to the present catch of approximately 574 million pounds annually, that potential increase offers long range industry growth for Virginia seafood.

1985 VIRGINIA LANDINGS -- TOP 10 SPECIES

	Pounds		Dollars
Blue crab	38,864,505	Sea scallops	13,354,698
Menhaden*	17,320,505	Blue crabs	9,119,642
Surf clam meats	13,393,286	Surf clam meats	7,403,033
Unclassified shellfish	6,206,574	Oyster meats	6,794,398
Fluke	5,036,803	Fluke	4,384,235
Oyster meats	4,478,059	Unclassified shellfish	1,863,392
Sea scallops	2,867,742	Hard clam meats	1,518,525
Croaker	2,168,762	Gray trout	1,083,492
"Bait" fish	2,140,073	Menhaden*	713,246
Gray trout	2,052,092	Spot	563,828

A Dynamic Combination:

Sea Grant Advisory Specialists and Virginia Fisheries

Nancy Chartier, VIMS' graduate student, examines pelagic fish.

Phil Cahill (1), gear specialist, helps local fishermen with net repair.

Virginia soft shell crabs are now being served in Tokyo's restaurants. Increasing numbers of seafood processors are working year-round, using the latest equipment technology and computerized business systems. Consumers in-state and across the country will soon have pasteurized seafood products at their local stores.

Aggressive export marketing, modernized process technology and business practices are the result of the cooperative efforts between Sea Grant and the Virginia fishing industry. At the Virginia Institute of Marine Science and at Virginia Tech (VPI-SU), Advisory Specialists apply their diverse skills and talents in response to the needs of the seafood industry and the desires of consumers.

Essentially, the fishing industry needs to compete effectively in the national and international seafood markets. Consumers want a continuous supply of high quality seafood. Sea Grant Marine Advisory Services was designed to help meet just those needs by identifying areas for growth and improvement; then working with the industry and the public to achieve those advances.

A major source of seafood for Virginians is the seasonal catch of recreational fishermen. At VIMS, marine recreational specialist, Jon Lucy, and Nancy Chartier are examining the quality of the recreational catch. Specifically, they are studying offshore, pelagic species such as tuna, one of the most popular finfish caught in Virginia's ocean waters.

This year and next, the scientists will be visiting fishing docks to examine tuna caught by recreational fishermen. Through interviews and trips on charter boats and private fishing vessels, they will document handling practices onboard and at the dock. In addition to scientific studies, Lucy and Chartier will develop informational programs to educate recreational fishermen on ways to improve the quality of the catch they bring home.

Quality improvement is a major thrust of Sea Grant Advisory work. Improved quality of catch can increase both consumers' desire for seafood and commercial fishermen and processors' profits. For the past five years, Tom Rippen has worked with Tech's Hampton Seafood Laboratory to improve the quality of pasteurized crabmeat. (See story of research on page 8.)

Rippen's job has been to monitor every crabmeat pasteurization plant in Virginia -- now about 20. Originally, the purpose of the monitoring was to help write standardized processing practices; but as VPI's research began to offer methods for technological improvement, Rippen, a food science specialist, became the intermediary between scientists at VPI and the coastal industries.

VPI also holds pasteurization workshops in Hampton for members of the processing industry. Because Tech's standardized practices text has become the national standard, the workshop includes processors and Specialists from throughout the mid-Atlantic region.

Economic stabilization of the various segments of the fishing industry will depend on several things. Expanding markets beyond Virginia will increase the amount of any product that can be sold. To assure that demand in those expanded markets remains high, the quality of the products must be maintained.

Advisory Specialists have learned that quality assurance begins with the catch. Phil Cahill is a gear specialist at VIMS who works with commercial fishermen on improving harvesting techniques and equipment. He and Tom Rippen of VPI are presently developing a quality improvement program for the commercial fishing industry. In addition to laboratory research, the two Specialists have enlisted the assistance of commercial fishermen for onboard experiments. This past spring, the *F/V Darana R* out of Hampton conducted experiments on regular fishing trips to compare the results of different methods of handling freshly caught fish. If the quality of seafood at sea is improved without a great increase in cost to the fishermen, the value of the catch will increase and the fish can be shipped to more distant markets.

Dr. Cameron Hackney, also with the Tech Seafood Lab in Hampton, hopes to send oysters to distant markets along with Virginia blue crab and finfish. The food micro-biologist is working with a seafood container manufacturer to assure high quality, pasteurized oysters. Hackney is also working to develop a national standard for traditional oyster packing. His research is part of a five-state study for the wholesale and retail packing industry.

Much of Virginia seafood is trucked to its destination. Locally, some processors have formed their own trucking companies to assure the quality of their products reaching local and distant markets. Truck vibrations are the focal point of another area of oyster research by Dr. Hackney. As the shipping of oysters has expanded to more distant markets, they are being received with a higher

percentage of liquid than is allowable in packing. Processors believe that it is the vibration during the long over-land trips that actually shakes extra liquid from the oysters, and they have asked Hackney to study the problem. He is examining these well-traveled Virginia oysters to see if the difference will effect the amount and the quality of the oysters or their shelflife.

While some Specialists are working with fishermen and others are helping to improve the quality of local and export seafood, another Sea Grant activity for the past several years has been directed toward expanding export markets. Dr. William DuPaul, MAS Director and VIMS' scientist, began evaluating the potential export market for Virginia seafood in 1981. Since then, he has met with representatives from such diverse areas as Hong Kong, Japan, Singapore, Australia, Nigeria, Egypt and the Netherlands. DuPaul's efforts, in cooperation with state and federal agencies and Virginia processors, has led to the very successful export of soft shell crabs to Europe and Asia. This program has led to the development of a potentially multi-million dollar export market.

By expanding the market and then assuring an increasing supply of high quality soft shells, the industry will be able to grow and establish economic stability. Mike Oesterling, commercial fisheries specialist at VIMS, has been helping soft shell producers meet the increasing demand for their product. Virginia production of soft shells has increased by 100,000 dozen crabs over the past few years through the efforts of Advisory Specialists working one-on-one with soft shell producers. Workshops and promotion have also encouraged new producers to enter the industry to assure long range growth.

In July, marine resource economist, Ron Grulich of VIMS, represented Virginia seafood at a Scandinavian trade exhibition in Denmark. Sea Grant hopes that the 22 million ardent seafood consumers in these countries can be sold on Virginia products. After making contacts at the exhibit, Grulich is now contacting Virginia producers to interest them in selling to Scandinavian buyers.

All of Grulich's efforts concern the business side of the fisheries. He is frequently asked to speak to professional fishing organizations and associations on specific topics related to their businesses such as taxes, insurance and software programs for business operations.

Studies have indicated that the ultimate success of the fishing industry depends on the consumer's perception of the products taste, ease of preparation and availability. And national surveys have shown that the majority of Americans are unsure when it comes to preparing seafood. The Virginia Marine Products Board has been very successful at presenting seafood to the restaurant trade, one of the largest purchasers of Virginia products.

For the home consumer, Sue Gammisch of VIMS has developed a particularly creative and popular method for educating consumers. In June, Gammisch and Donna Soul of VPI presented the first in a series of seafood education seminars for the public. "Tastes of the Chesapeake" was a six-part series of seafood dinners prepared by Virginia's most eminent chefs and served with the finest of Virginia wines. The series was so successful there was an immediate waiting list and Gammisch has planned two more series for the fall and winter.

In Virginia, Sea Grant Advisory Specialists and the fishing industry have proven a winning combination that promises a bright future for Virginia seafood lovers and the industry. Introducing the rest of the world to Virginia's seafood will help stabilize the once seasonal returns for fishermen and processors and contribute millions of dollars to the Commonwealth's economy.

Fisheries Specialist, Mike Oesterling, checks crab pots onboard Tommy Leggett's boat.

Donna Soul of VPI gives Shirley Berg (r), Executive Director of the Va. Marine Products Board, a taste of microwaved seafood. (Donna's recipes and instructions are on page 10.)

People on the water

Stacked cans of hand-picked crab meat ready for sealing.

Tradition *and* Change

The two faces of crab meat processing

The RCV seafood processing plant in Morattico, Virginia, offers a prime example of how much the industry has changed in the past fifteen years. The nearly year-round, spotlessly clean operation uses the latest in technology and science to assure a prime product. Due to active marketing, the crab meat is shipped long distances to consumers around the country -- a great change from the once seasonal, locally available only market.

Weston and Dorothy Conley, co-owners of RCV with Charles Chase and Martha Yeatman, are two of the most progressive and active leaders in Virginia's seafood industry. Mrs. Conley is the unofficial historian of the plant and can recite the names of owners since oysters were first processed at the location in the 1880s. Since 1935, both oysters and crabs have been processed continuously.

When Weston Conley joined the firm in 1970, Dorothy had been at RCV for ten years working for the three principles. Shortly after Weston joined the operation, a marketing survey sparked the beginnings of change. The survey confirmed that people did, indeed, associate seafood with the Chesapeake Bay and also as suspected, thought of crabs more than any other seafood. What shocked the Virginia industry, however, was learning that a very successful marketing effort on the part of Maryland over several years had led most of the marketing area to believe that those crabs and other seafood items came primarily from Maryland.

RCV SEAFOOD CORP.

Fortunately, Weston Conley had been in marine-related marketing for 15 years before joining RCV. Along with other major processors, Conley began pushing for a Virginia marketing agency to represent the state's industry. "Virginia has so many small businesses in this field," Conley said, "that no one could really afford the kind of massive

From the Bay to you

It's 10 a.m. and Jim Johnson is bringing his Chesapeake deadrise, "Lemon," into the RCV dock. Thirty percent of the plant's 20,000 pounds of live crabs per day come from independent watermen like Johnson who deliver by boat. The other 70 percent is trucked in from the surrounding counties.

Within a few minutes, Johnson is unloaded and off for home. His crabs are quickly cleaned and on their way into large metal crates which slide into pressurized steam cookers. Two thousand pounds of crabs at a time are cooked for 15 minutes at 10 PSI. Afterward, the crabs are allowed to cool to ambient air temperature and then placed in coolers at 38 to 40°F. RCV can store 45,000 pounds of cooked crab at a time.

The next morning the crabs are picked. The majority of pickers sit at tables in a large room picking the lumps of crab meat consumers love. In another room a small group of pickers use a mechanical picking machine which produces uniform pieces of crab meat. This meat is bought by large retailers for prepared dishes such as crab cakes and is referred to as "institutional quality."

Crab meat for immediate sale is placed in plastic containers, sealed and packed in specially treated boxes filled with ice. RCV trucks deliver the crab meat to clients to assure that the fresh meat is maintained at proper temperature throughout the process from live crab to consumer purchase.

About the time the processing cycle is completed, Jim Johnson is delivering another day's catch to the RCV dock. The processing begins again.

marketing effort we knew it would take to advance Virginia's seafood industry. We really couldn't have made the advances we have without the formation of the Virginia Marine Products Board; and the Board came into being because key state legislators fought for it."

In the early 1970s there were 31 crab processing plants in Virginia; as of May 1986, there were 65 certified crab processing plants employing from 3-75 pickers each. Conley believes the improved market which encourages new businesses is directly related to the joint industry/state efforts.

Technologically, Conley says that the pasteurization of crab meat has been the salvation of the industry and will allow them to continue to expand into more distant markets and to grow larger. Just as important, market expansion will help processors attract and keep the vitally important pickers. At present, pickers at RCV work ten months out of the year at a variety of tasks in addition to picking.

In the near future, processors will have new cans designed specifically for crab meat and in sizes that are most marketable from the consumer's viewpoint. The new cans will have welded seams and are manufactured by a company which specializes in seafood containers.

Even more exciting is the work being performed with computerized sensing (See story of research, page 8). A sensor attached to several of the cans during pasteurization will "read" the internal temperature of the crab meat. This sensor will feed information into a computer capable of controlling the timing of the process. The modern technology will assure that all canned crab meat has been properly pasteurized.

In addition, sensors attached to the same computer will "read" temperatures in cooling and storage rooms. If the temperature rises near unacceptable levels from power outage or from the door being opened too often or too much being added at one time, an alarm will sound alerting the plant manager.

All of these quality control devices will help assure that any consumer who purchases crab meat will receive a quality product. This assurance will, in turn, help maintain a year-round, reliable market which will provide the industry with economic stability.

Mr. Conley credits the Sea Grant programs at VPI and VIMS with providing the technological and scientific back-up necessary to expand the industry. "If it wasn't for the VPI and VIMS scientific research, bacteriological studies, and introduction of new technology," Conley says, "the industry simply wouldn't have any of this new information."

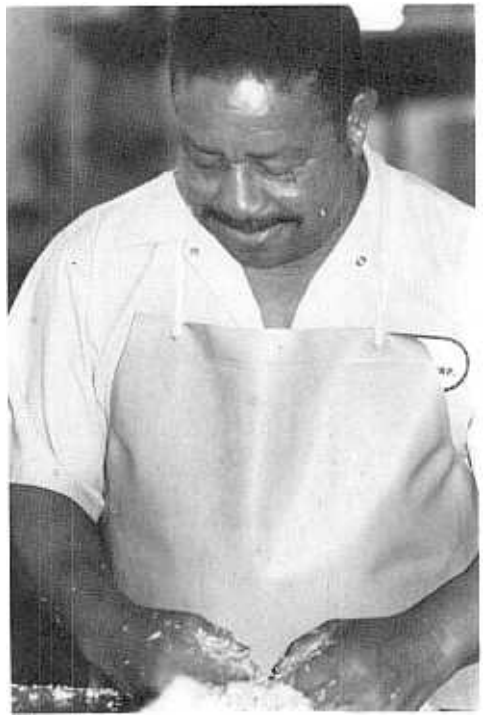
"The competition for seafood markets is changing rapidly," Conley says. "Today it is much more competitive, not just between areas of the U.S., but internationally and among different seafood products. For instance," he says, "in 1981 U.S. consumers bought only 6 million pounds of surimi; but last year that figure was 88.4 million pounds. With that sort of competition for the seafood market, we have to be aggressive and competitive."

Connie, Dorothy and Weston Conley (from left to right), manage RCV Seafood of Morattico.

Considering that Virginia is capable of harvesting 50 percent of the blue crab demand, the Virginia trade associations are working hard to attract and maintain buyers. Each year Virginia hosts a very successful two-day program for retailers. The marketing shows include tours of Virginia facilities, educational workshops and two days of seafood feasts -- the very best way to sell seafood. This year 60-80 retailers will attend the trade association show which will be held at the Chamberlin Hotel in Hampton. These programs and the Virginia Marine Products Board are supported by industry license fees.

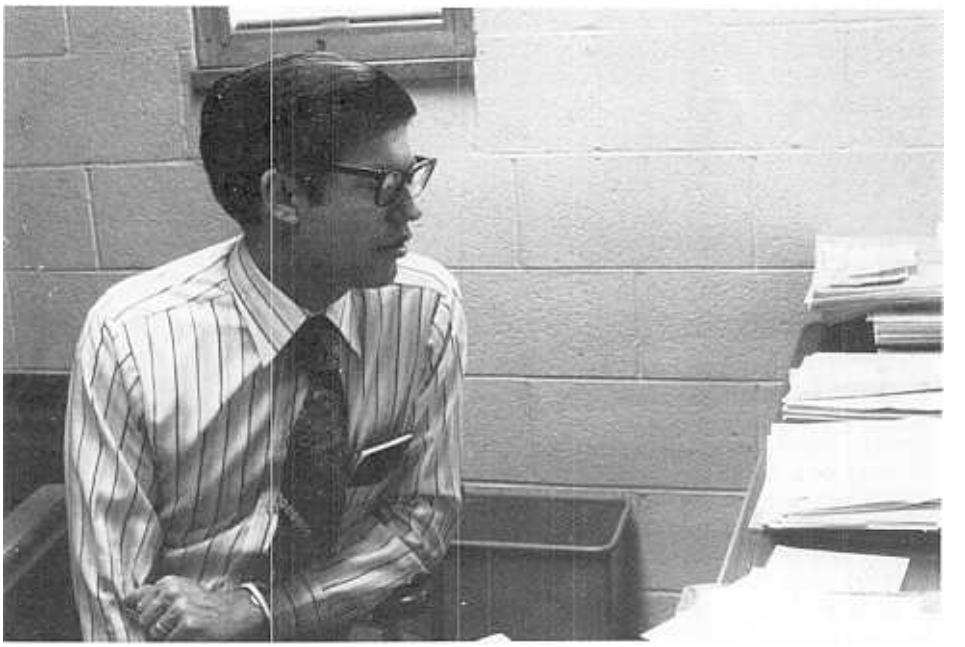
One element of the Virginia seafood industry hasn't changed since its beginnings -- family-owned operations. Dorothy and Weston Conley manage RCV Seafood together, and their daughter Connie has recently joined the operation.

After finishing college, Connie worked in Richmond for a while before returning to Morattico. She tracks the day-to-day business of RCV and associated companies by computer. The methods and technology Connie uses would be at home in any modern corporation anywhere in the world; but just outside that office, Virginia's independent watermen are still delivering fresh caught crabs to the dock on classic Chesapeake deadrises. In back, pickers are still working their skill and artistry by hand. Virginia's seafood industry has moved aggressively into the competitive world of the '80s, while managing to maintain the best of its traditions.



Mr. Harvey Smith picks crab meat at the RCV plant. Experienced pickers like Smith are vital to the processing business.

Tech's research advances seafood processing



Dr. George Flick, VPI food science and technology scientist, has led the development of crab meat pasteurization quality control.

In 1969, crab processors approached Dr. George Flick of VPI-SU with the sort of problem an expert in food science and technology loves -- develop a method to assure quality control in Virginia's pasteurized crab meat processes. Actually, the industry had a list of problems: lack of scientific information on pasteurization and storage, faulty processing equipment, inadequate quality control for containers and a need for industry organization and standards.

A Virginia Tech Marine Advisory Services team began addressing the problems by helping to reactivate the disbanded Tri-State Seafood Committee. This organization is composed of ten individuals from Virginia, North Carolina and Maryland and includes industry representatives, food technologists and state regulatory personnel. The group developed a standard for blue crab processing which provided a context for improving the industry.

In 1971, Mr. Frosty Seafood Company, Inc. requested that Tech develop a method for the bulk pasteurization of crab meat in non-metal containers. At the time, pasteurized crab meat was delivered to the company in one pound metal containers, 6,000 at a time. Each can had to be opened by hand and the packaging alone cost the company $1,200 not counting the labor required to open the cans.

Within a year, Dr. Flick's group had developed a bulk pasteurization process, new processing equipment and flexible film packaging which could be opened with a knife and cost $25.00. The packages hold six pounds instead of one, reducing labor costs even further.

Within the next two years, again working with Mr. Frosty, the Tech team developed a pasteurization process for institutional clam chowder containers and for the mixes and sauces used in stuffed crabs, shrimp and flounder. The system was so successful that the Tech team was soon recognized as the people to see for seafood pasteurization.

During the 1970s, as consumers' expectations increased and the seafood market expanded, VPI-SU produced a manual on the theory and practice of crab meat pasteurization and held a national pasteurization workshop in cooperation with the Shellfish Institute of North America. The meeting was attended by industry personnel, MAS specialists and health regulatory personnel from Maryland to Texas.

Now in the '80s, often referred to as the decade of micro-technology, the MAS team is once more in the forefront of crab meat pasteurization processing with a computerized monitoring program that may permanently solve quality control problems. Until now, pasteurization relied on time/temperature formulas for killing bacteria which eventually cause food products to deteriorate. These formulas were based partly on experience, partly on studies. The amount of moisture in a particular batch of crab meat, the outside temperature, the size of the containers -- any of these variables could alter the processing. What was needed was a way to monitor the internal temperature of any batch of crab meat in order to assure that temperatures were reached and maintained which would kill any bacteria present.

Although great strides had been made in pasteurizing crab meat, the industry wanted to change container sizes in order to respond to retailers' and consumers' desires. So at the same time the MAS team was examining technology to perfect processing, they were working with the Steeltin Corporation, a primary producer of seafood containers, to perfect cans in various sizes for the industry.

Beginning in 1984, the Tech team began working with the crab processing industry and with Keltech, Inc. to develop a compact, cost-effective process control system that would enable the adequate processing of blue crab meat in various container sizes, shapes and compositions, as well as monitor and control storage of properly pasteurized crab meat.

The process controller they have developed includes a microcomputer, printer, monitor and appropriate software. Thermo-couples are attached to selected containers of crab meat within a batch. The internal temperature of the crab meat is relayed via micro-circuitry through the computer which "monitors" the pasteurization process, automatically adjusting time and temperature to assure complete pasteurization.

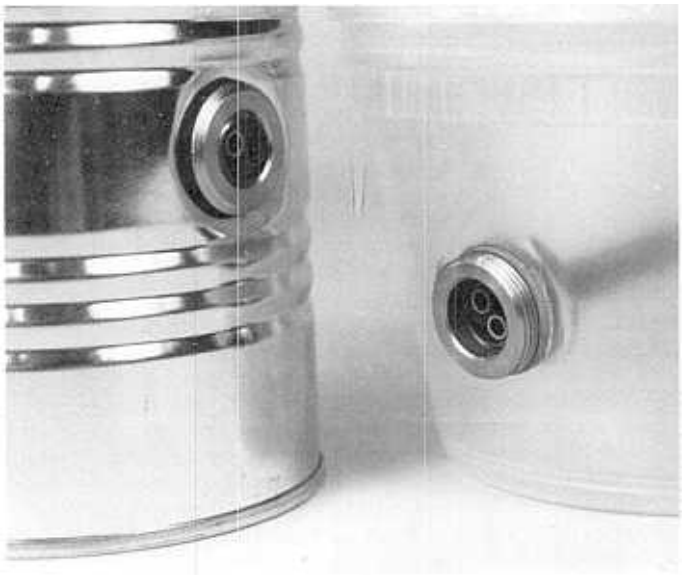
In addition, the same system also monitors cold storage areas to assure that the proper temperature is maintained at all times. If too much crab meat is added to a storage area, elevating the temperature, an alarm will sound alerting the producer to the problem.

The accuracy of computers, such as those being used in the experiments, results from their ability to send and receive information rapidly. This allows the computer to respond faster to changing conditions, thus insuring a smooth, stable process. Control of the pasteurization process is done by solving an algorithm known as the "lethality curve." Only a computer-based control system has the power to take data, perform a sophisticated analysis, then control the process to assure that temperature and time are sufficient to kill unwanted bacteria.

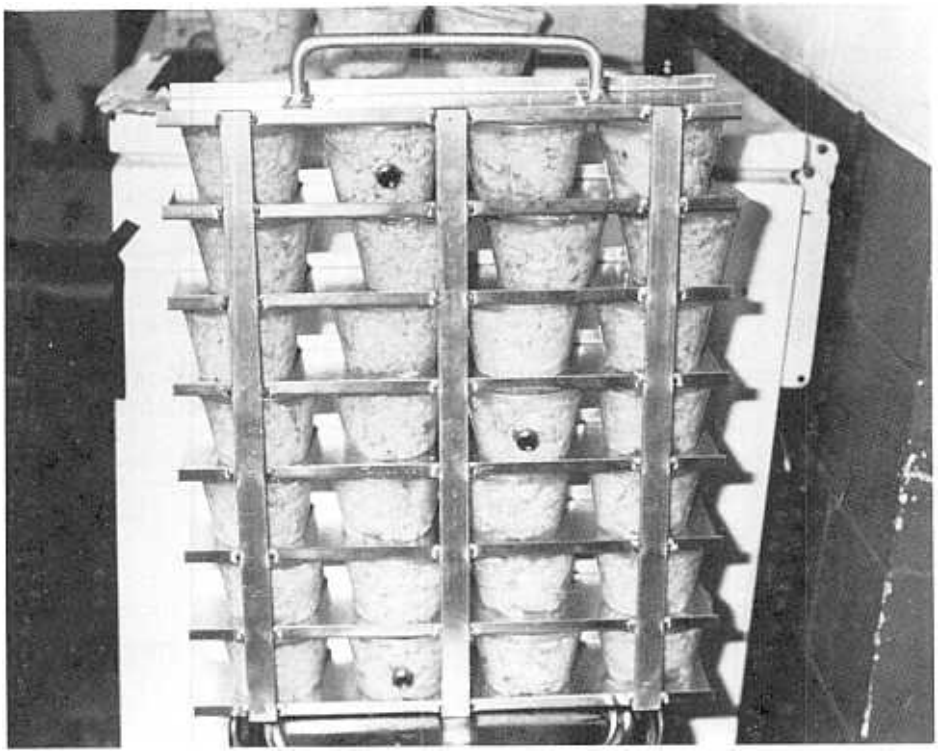
Producers will be able to expand the system by simple modifications to software and the addition of necessary sensors as required. The same basic system, using other software, will be able to handle the business-related needs of the producer.

At present, Dr. Flick and his team are working with several Virginia crab meat processors, testing the new systems. The processors are enthusiastic about the current results and the potential both for the industry and for the consumer.

Installation of a thermocouple in a metal can to enable plant managers to verify internal temperature of pasteurized crab meat.



Thermocouples in metal and plastic containers preferred by consumers.



Plastic containers with thermocouples in place ready to be pasteurized. Placement of selected containers allows for accurate processing of whole batch.

Fish house kitchen

Donna Soul
Sea Grant Seafood Home Economist

Microwaving Seafood

Microwave cooking and seafood were made for each other! It is no longer necessary to eat a dried-out fried flounder fillet. Seafood has a delicate texture and remains moist when cooked in the microwave. There is little or no connective tissue ("grissle") in seafood, which allows it to cook quickly. Added oil or fat can be reduced or eliminated when seafood is cooked in the microwave because the meat will not dry-out during the short cooking time required. This method also makes it easy to reduce total calories in a recipe without giving up flavor.

Probably the nicest features of the microwave oven are its cooking speed and efficiency. Furthermore, moist foods will cook more rapidly in the microwave than dry or frozen foods. The microwaves can be absorbed and converted to heat faster in moist-type foods. Therefore it is important to take special care not to overcook seafood (which holds true for any method of seafood cookery).

When microwaving frozen seafood it should be completely thawed to avoid uneven cooking. Thawing frozen foods is usually done at 30 percent power or on the defrost setting.

Most seafood will take 3 to 4 minutes per pound at full power. However, microwave ovens will differ in their cooking capacity so the dish should be checked after 2 minutes. When the fish is done it will be opaque and begin to separate when tested with a fork. Seafood should always be cooked for the minimum amount of time since it is easily overcooked; remember that cooking will continue even after the dish is removed from the microwave. When several meal items are being prepared the seafood entree should be cooked last; the dish should be covered so that the fish will remain moist. Larger and thicker pieces of fish should be placed around the edge of the dish for more even cooking. When cooking casseroles or recipes containing cheese, a lower power level may be desirable to keep the cheese from becoming rubbery.

Fish required for a recipe can be easily substituted for other types of fish. For example, snapper, flounder, perch, halibut and sole can be used interchangeably. Fish steaks can also be substituted for fillets but they may require slightly longer cooking and defrosting times.

Shellfish can be prepared in their shells. The cooking times for shellfish cooked in the shell will be the same as for fish cooked out of the shell since the shells do not absorb microwaves. Be careful not to overload the microwave because cooking may be uneven.

Favorite seafood recipes can be converted to microwave oven cooking times. Recipes in microwave oven cookbooks should be used as a guide. Find a similar recipe that is approximately the same size and includes a similar seafood. Most casseroles should be cooked covered, and can be started on full power for the first minute then reduced to 80 percent power for the remaining time.

Fish and Veggie Microwave Medley

2 lb. fish fillets
Italian Salad Dressing
1 Tbsp. margarine
1 medium sweet white onion, cut in half, then sliced
1 green pepper, chopped
1/4 lb. mushrooms, sliced
1 Tbsp. lemon juice
2 cups broccoli florets
2 tomatoes cut into wedges

Wash fillets and dry them with a paper towel. Marinade fillets in Italian salad dressing for about 10-15 minutes.

In a large microwave safe dish (13x9x2) combine margarine, onion, green pepper and mushrooms. Cover dish and cook on full power for about 2 minutes, stir mixture after 1 minute.

Remove dish from microwave, stir in lemon juice and spread vegetables evenly over pan. Place fillets in a single layer over onion mixture, then arrange broccoli and tomato wedges over fillets. Cook, covered, 5-6 minutes on full power. Rotate dish half way through cooking time. Meat will turn opaque and separate easily when tested with a fork. When dish is removed from microwave allow it to stand, covered, for 1-2 minutes before serving.

Serves 6.

FISH AND SEAFOOD DEFROSTING CHART

TYPE	PKG. SIZE	PREPARATION INSTRUCTIONS	DEFROSTING TIME	SETTING
Crab Claws	12 oz.	Make 1-inch slit in pkg. Turn and rearrange claws halfway through cooking time.	6 to 8 min.	Defrost*
Crab Meat	6 oz.	Make 1-inch slit in pkg. Turn halfway through cooking time.	3 1/2 to 4 1/2 min.	Defrost*
Fillets, Flounder, Cod, Sole, Haddock etc.	16 oz.	Unwrap pkg. and open. Turn fillets over through cooking time.	8 to 12 min.	Defrost*
Lobster Tail	16 oz.	Wrap in plastic wrap or waxed paper.	7 1/2 to 9 1/2 min.	Defrost*
Shrimp	12 oz.	Make 1-inch slit in pkg. Turn halfway through cooking time.	7 to 9 min.	Defrost*

*On models having dial timer, use Cookmatic Level 3 for defrosting.

Wavelet
MARINE SCHOOLHOUSE SERIES NO. 27

Valuable Visitors

Virginia's migrating finfish

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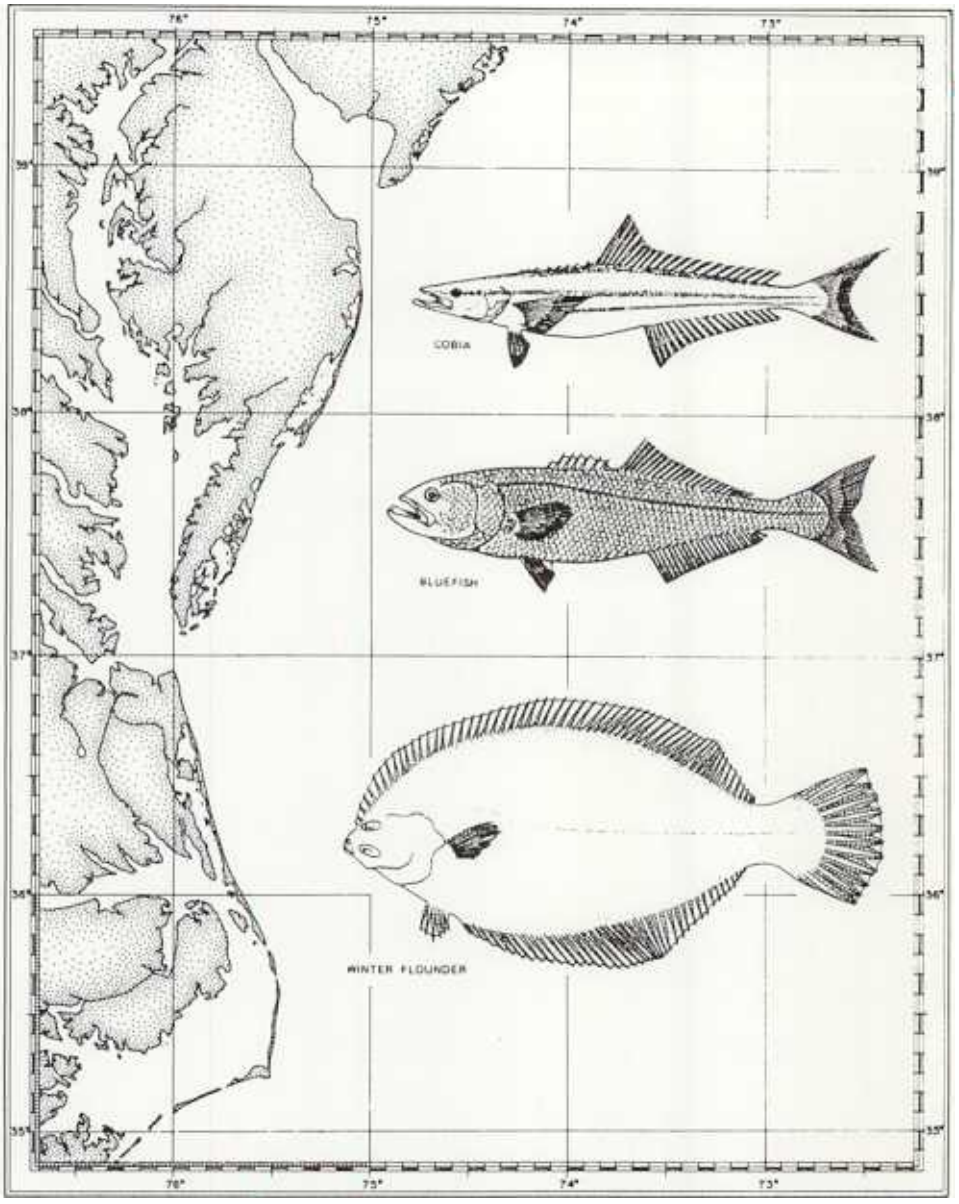

Use this map to track migration patterns of finfish.

There are about 300 species of finfish observed in the Chesapeake Bay and its tributaries. Less than ten percent of these species are permanent residents. Most of the Bay's finfish are visitors; and it is these migratory species that are most valuable to commercial fishermen.

Migration, simply defined, is the movement of organisms over considerable distances. In most cases these movements occur somewhat regularly in time and over familiar routes. Can you think of some reasons migrations take place? Seasonal changes in environmental factors, such as temperatures, currents, water density, etc., change the suitability of the environment for various species. Seasonal changes also influence the location and amount of food supplies. Many species of fish have different environmental requirements for various stages of their life cycles. Sometimes a change in location provides more safety for larval and juvenile stages. Other keys to migration are precipitation amounts, predation, and reproductive requirements.

Most marine fish tend to move north and south with the seasonal movmeents of surface water masses of a certain temperature. In this way, the fish can live in a temperature range they prefer or to which they are best adapted. They tend to move inshore and northward in the spring and summer and offshore and southward in fall and winter. Most ocean fish enter the Chesapeake in the spring and summer to feed and return to the ocean in the fall. These species generally spawn in the ocean, but the larvae and juveniles are carried or swim back into the estuary (flounder, mullet, menhaden, croaker). Summer flounder, for example, live off the Atlantic coast in the winter. In the spring and summer, they move into the Chesapeake to feed. In early fall they start back towards their offshore wintering grounds. In late fall, they spawn. Surface currents carry the eggs and larvae southward. In the early spring of the following year, the young flounder return to the Bay to feed and grow. Eggs, larvae and very young fish often travel hundreds of miles with the movement of coastal currents, tides, and subsurface circulation currents.

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Freshwater fish also migrate in and out of the Bay. Some freshwater fish can adapt to low levels of salt in the water. The older members of a population sometimes migrate downstream in the winter. In the spring they move back above tidal influence to fresh water and spawn. Sometimes the adults move downstream again right after spawning. Yellow perch, crappies, and some basses exhibit this type of migratory behavior.

Anadromous fish are those living in the ocean that must migrate to fresh water to spawn. Herrings and shads are examples. It is interesting to note that anadromous fish return to their own place of birth for spawning. Catadromous fish leave fresh water to spawn at sea. Eels, for example, travel from fresh water, through the Bay, and out into the Atlantic and spawn in the Sargassum Sea. After spawning, they die. The hatchlings are juveniles by the time they migrate back to and up the Bay to fresh water. Some spend anywhere from five to twenty years in the estuary before returning to the Atlantic. Striped bass are an interesting exception to both of these groups. Striped bass are only partly anadromous. They move from the brackish waters of the Bay, not the ocean, to fresh water to spawn. In spring after spawning, adults migrate downstream to feed. Young grow as they migrate from fresh to brackish waters.

Most of the migratory behaviors noted above occur regularly. We know when to look for certain species and at certain times expect to find a certain life stage. Some fish, however, wander into the Bay accidentally, such as jacks and pompanos.

See what you can find out about the migratory behavior of other Chesapeake Bay visitors. What is the most northern and the most southern points of their migrations along the Atlantic coast? In the Bay? What life stages do you find in the Bay at a given time? Develop a key to show species, seasons, migratory routes in the Bay, migratory routes along the coast, and life stages as related to migration. Use this key and the map to make a picture of the migratory behavior of five of the following commercially important fish.

menhadden
croaker
drum
winter flounder
bluefish
scup
butterfish
tauhog
cobia
eel
seatrout
shad

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