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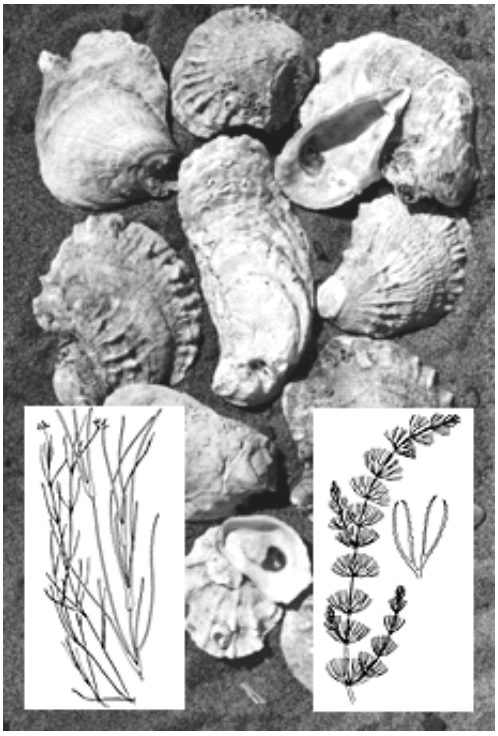
In This Issue:

Improving Bay Water Quality – The Role of Oyster Reefs



Merrill Leffler, Maryland Sea Grant

Historically, the Patuxent River in Southern Maryland supported a thriving commercial fishery for finfish, oysters and blue crabs. As in other tributaries of the Chesapeake Bay system, the Patuxent's mosaic of habitats was characterized by acres upon acres of marshes, oyster reefs and underwater grasses. These habitats provided productive food webs that supported the abundance of commercially important species. Oyster reefs and grass beds (often referred to as submerged aquatic vegetation, SAV) were key components, particularly because of their interdependence. "Both seagrasses and oyster beds function as 'the kidneys' of the Bay," says Walter Boynton, a scientist at the University of Maryland Center for Environmental Science (UMCES) Chesapeake Biological Laboratory. "They cleanse the water of impurities that allow the rest of the ecosystem to function normally."

Vast numbers of oysters cleared algae from the water, thereby reducing turbidity caused, in part, by dense blooms of algae that with suspended sediments block the penetration of light to bottom-dwelling grasses. Vertical reefs in some areas may also have served as storm-surge barriers, protecting the near-shore SAV beds from pounding by waves and strong currents. At the same time, the leaves of dense underwater grasses swaying with water currents helped dampen the energy of these currents, so that sediment particles settled to the bottom, out of the water column. Flourishing grass

beds could better compete with algae for nutrients and in doing so provided extensive habitat for young crabs and fish, as well as a rich food web of microscopic and sediment-dwelling organisms.

Decline of Water Quality

Is it a coincidence that decline of water quality in the Patuxent became evident with the near-disappearance of bay grasses and oyster reefs? The impact of losing oysters throughout the Bay system was first dramatized by Roger Newell in a 1988 article, "Ecological Changes in Chesapeake Bay: Are They the Result of Overharvesting?" A scientist at the UMCES Horn Point Laboratory, Newell estimated that oysters at the beginning of the 20th century could have filtered the entire Bay in six days; in 1985, according to his calculations, it would have taken more than a year. (See www.vims.edu/GreyLit/crc129.pdf for a copy of Newell's paper.)

Since the 1987 Chesapeake Bay Agreement, a key goal of the Bay restoration program has been reestablishment of submerged vegetation, particularly by slashing nutrient flow 40 percent (from 1985 levels) and curbing sediment runoff. Though there have been improvements in various parts of the Bay, water quality throughout the system is a long way from recovery. Still, even if nutrient source reductions of 40 percent could be achieved, they might not be sufficient to improve water clarity enough for light to penetrate bottom waters: this is because of high turbidity from erosion, resuspension of sediments and nutrient cycling (for further uptake by algae). Furthermore, underwater vegetation in many bottom regions is plagued by epiphytic growth, microscopic plants and other organisms that colonize leaves and further shield them from the light they need for photosynthesis.

Achieving significant improvements so that light can better penetrate bottom sediments may require something more – the capability for reducing turbidity from suspended solids and algal growth from regenerated nutrients. That "something more" may be greatly expanded oyster reefs in order to take advantage of the capacity oysters have for filtering algae and inorganic mineral particles.

Bay oysters, however, are still beset by problems, which could make such large restoration problematical. To begin with, parasitic diseases, particularly Dermo, are nearly everywhere in the upper bay. Even if disease were not as pervasive as it is – or if disease-resistant strains bred in the hatchery prove to be successful – the costs of restoring oyster reefs so that they can actually make a difference in reducing turbidity and improving the clarity of water could be immense. To get some idea of those costs, consider that the construction of just a one-acre sanctuary reef in the Rappahannock River, 8- to 10-feet high, surrounded by 25 acres of 10-inch deep oyster shell, was estimated by the Virginia Marine Resources Commission at some $380,000.

Costs are a major reason why rebuilding oyster reefs as a complement to source reduction efforts for improving water quality will depend on choosing sites that have a high probability of success. Choosing good locations to reconstruction reefs and plant SAV is critical, says Newell. He and his Horn Point Laboratory (HPL) colleagues Evamaria Koch and Raleigh Hood, have been conducting studies on the interrelationships between oysters and SAV in order to develop predictive models that will relate increases in light penetration to oyster feeding under different environmental conditions. If successful, the models could then be used to help select optimum sites where oyster populations could best filter algae and suspended particles from the water so that enough light can get through to the bottom. (To read more about this project, see "Oyster Reefs: Key to Restoring Bay Grasses?" *Marine Notes,* www.mdsg.umd.edu/MarineNotes/Jan-Feb01/index.html)

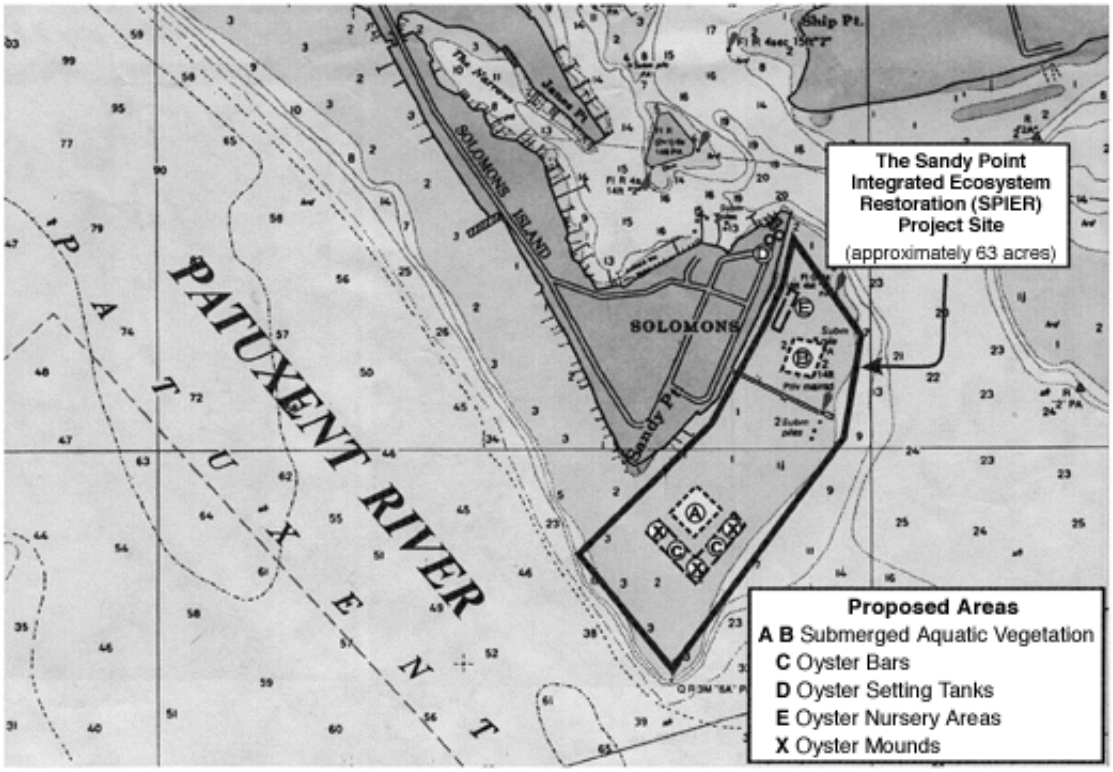
Rebuilding Reefs and Planting Grasses

The Chesapeake Biological Lab is now proposing to link the reconstruction of oyster reefs with SAV restoration in the Sandy Point Integrated Ecosystem Restoration (SPIER) project. The focus is 63 acres of severely degraded aquatic habitat at the mouth of the Patuxent River. "Our goal," says CBL researcher Dennis King, "is to use what we have learned from pilot-scale restoration in a full-scale restoration effort that should then enhance fish spawning and feeding habitat, bird foraging habitat and benthic communities." The proposed restoration will take place on approximately eight acres of the 63-acre area. King and his colleagues envision the project as a community partnership of scientists, economists, managers, watermen, the public and its elected officials.

CBL researchers will oversee reestablishment of the oyster reef and bay grasses and document the development of the organisms associated with the reef and SAV habitat. Oyster spat will come from the Horn Point hatchery (see "Oyster Production at the Horn Point Laboratory," *Maryland*

Aquafarmer, www.mdsg.umd.edu/Extension/Aquafarmer/Fall00.html#2). Once the new habitats are established, there are plans to work with local watermen in testing habitat-friendly tonging as part of sustainable aquaculture of oyster reefs. Working with the Maryland Sea Grant Extension Program, an integral part of this project, will be the development of K-12 educational programs that address the importance of bay grasses, oyster biology restoration ecology techniques, and wise resource management of Bay resources.

The CBL project could be an important first-step in exploring how well oysters and their reef habitats can be used for ecological purpose. However, related undertakings will be necessary in other areas if we are to determine to what extent reefs can serve as an important complement to the goals of the Chesapeake Bay Program for restoring underwater grasses and, over the long-term, to significantly improving water quality.



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Oyster Exploration on the Sea Grant Website

Adam Frederick, Education Specialist

The Oyster page on the Maryland Sea Grant website (www.mdsg.umd.edu/oysters) offers valuable information for students, teachers, and others who are interested in the history of oysters in the Chesapeake, key issues related to disease, hands-on learning about oyster ecology and oyster gardening for restoration. Here is a brief synopsis.

Oysters in the Classroom. Here are lessons and ideas for teachers and students that are sure to make the study of oysters a popular subject in the science classroom. Some lessons are interactive tutorials that can be performed on-line, while others give tips and techniques for laboratory exercises. All lessons have been matched to the appropriate Maryland State Department of Education Goals. Check out each section to learn more.

Oyster Gardening. This is the place to begin learning about raising oysters for restoration. The Oyster Gardening Program is a cooperative effort of the Oyster Alliance, which includes the Chesapeake Bay Foundation, the Maryland Sea Grant Extension Program, the University of Maryland Center for Environmental Science and the Oyster Recovery Partnership. The program brings together scientists and citizens to help enhance the Chesapeake Bay systems' stressed oyster populations. The Oyster Alliance

offers participants an opportunity for a hands-on role in oyster restoration in Maryland. This web site provides you with basic information on setting up and maintaining your oysters in the best manner given the environmental conditions for your location.

Restoring Oyster to U.S. Coastal Waters. This magazine-style report covers progress of the National Oyster Disease Research Program, with particular emphasis on the problems of disease in coastal waters throughout the U.S., breeding disease resistant oysters, managing around disease and new tools for diagnosing MSX and Dermo.

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Clam Aquaculture in Maryland

Don Webster, Eastern Shore Marine Agent

From Massachusetts to Florida, the hard clam industry is the most successful example of molluscan aquaculture on the east coast. These operations, which involve numbers of former shellfish harvesters, illustrate how hatcheries have been employed to help build a commercial industry – hatcheries produce seed stock that are grown to a large enough size where they are planted in protected coastal areas. Compared with other states, Virginia especially, Maryland is a late-comer to clam *(Mercenaria mercenaria)* culture, though it has now begun to grow. Maryland's Sea Grant Extension Program (SGEP), in cooperation with producers and government officials, has been helping the industry to grow in the state's seaside bays; this began several years ago with a small-scale nursery operation that was just starting up (see *Aquafarmer,* Winter 1999, www.mdsg.umd.edu/Extension/Aquafarmer/Winter99.html).

Steve Gordon, a local seafood processor, set up a shoreside upweller system and has been producing clam and oyster seed in increasing numbers annually. Working in partnership with SGEP faculty, he was able to obtain a Maryland Industrial Partnership grant. During 2000, he totally redesigned and renovated his pump system, greatly increasing the capacity of water available to grow the clams. Once again, he sold his production to local growers, who have come to rely on the delivery of high quality seed for their leased grounds.

A reference study on the prevalence of the clam disease QPX, funded by the Maryland Sea Grant Program, was completed during the year (see *Aquafarmer,* Winter 2000, www.mdsg.umd.edu/Extension/Aquafarmer/Winter00.html#3). No instances of disease were found in any of the samples taken from either the natural populations of clams in the seaside bays or from those obtained from aquaculture operations. Cultured clam populations will continue to be assessed through monitoring. In the case of the original sampling, Maryland watermen were very helpful in obtaining samples from clam grounds from as far north as the St. Martins River all the way down to the Maryland/Virginia border. A recent article in the Maryland *Waterman's Gazette* gave credit to all those captains who assisted in gathering representative samples of the clam populations.

Several growout trials of clam aquaculture have been initiated. In addition to bottom planting with predator nets, different populations have been grown using hard plastic mesh bags as well as the soft bags favored by Florida growers. Samples will be monitored throughout their growout cycle and the attitudes of growers towards these different techniques will be judged to see which methods are most suitable for local conditions.

SGEP faculty have assisted prospective growers with assessments of potential clam grounds and have helped to chart several areas for lease applications to the state. This assistance has allowed the researchers to work closely with industry in setting up aquaculture businesses while building a log of knowledge concerning good growing areas in the seaside bays. Aquaculture should be seen as a compatible, environmentally friendly enterprise that can be of significant value in enhancing the biological diversity of these areas. It has been noted in several areas that the introduction of hard clams into the bottom can actually lead to an increase in the important submerged grasses such as *Zostera,* or eelgrass. It is thought that the clams remove nutrients from the water, binding some of them in mucous before expelling them to the bottom, where they are more readily available to the roots of submerged aquatic grasses.

This past year, Jerry Redden was appointed as the Director of Economic Development for

Worcester County, Maryland's only seaside county. Redden has had a long involvement with agriculture and aquaculture and was a part of AquaMar, a recirculating aquaculture business that raised tilapia, until recently. He left to pursue development of a cooperative that would bring together many of Maryland's aquaculture producers in common marketing approaches. He immediately supported the developing clam farmers in the county and led the way in obtaining a grant from the Lower Shore Development Center at the University of Maryland Eastern Shore. This funding has been used to assist small-scale clam farmers in purchasing their initial seed with minimal economic exposure. When the clams are grown, the cooperative will help market them; a portion of the income will be used to pay for the initial clam seed. In this way, both the local growers are assisted in their startup businesses and the Gordon Shellfish nursery has a ready market for seed.

One local grower is experimenting with oysters in off bottom culture. While the seaside area used to be home to natural populations of oysters, there are few today. The parasitic diseases MSX, Dermo, and SSO (seaside organism) all exist in that environment and kill most oysters before they have a chance to grow to market size. Currently, the off-bottom techniques help in accelerating the growth of the animals so that they can attempt to reach the legal market size of three inches hinge to bill before they are killed. In doing so, however, the additional labor costs usually make the operation uneconomical, as many former growers have found out. New techniques that will minimize that labor are currently being developed and tried in order to bring positive finances to this operation.

Plans for 2001 are ambitious but should assist in moving the hard clam industry further towards success. Gordon Shellfish will again upgrade their seawater system in order to gain maximum flow for their seed. Additional upwellers are being placed online; the utility of floating upwellers will be gauged with the construction of one or more units that can raise large numbers of seed economically.

Growout trials will continue and the first market size product will be heading off for sale. Growth and survival data will continue to be gathered so that a comparison of grounds can be made. Different equipment has been made available to the industry in an attempt for them to try various methods. SGEP is encouraging growers to share results through meetings and educational programs.

Some public programs will be developed that will help citizens understand that shellfish aquaculture is an industry that can also help in restoring local water quality. Far from being destructive, the addition of shellfish can help to filter, fix, or translocate nutrients as well as provide habitat for benthic organisms and other beneficial animals. For this reason, and the strong markets that exist for quality shellfish, there should be a bright future for development of the hard clam industry in Maryland's seaside bays.

For more information, contact Don Webster, (410) 827-8056; webster@mdsg.umd.edu.

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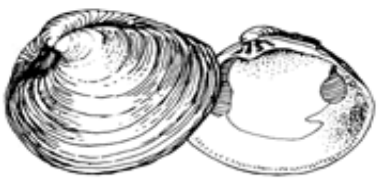

Clam Farming in Virginia

Merrill Leffler, Maryland Sea Grant

Clam farming in Virginia is big business – the biggest among east coast states – and has been for nearly twenty years; clams are the primary reason that Virginia ranked tenth in the nation for total aquaculture sales, according to the first-ever census in 1998 by the U.S. Department of Agriculture. Although clam aquaculture began taking off in the early 1980s, says Mike Oesterling, aquaculture specialist at the Virginia Institute of Marine Science (VIMS), its beginnings go back to 1958 when Richard Kelly set up a clam hatchery in an oyster house in Atlantic, Virginia. Hatcheries are critical for seed production,. Unlike oysters, commercial quantities of wild seed are seldom available. Though Kelly's hatchery production was sporadic, it was "reasonably successful," says Oesterling, "the problem was that "field plantings were a complete failures, most likely because of predation."

In the years following, VIMS scientists developed techniques to better the chances for successful growout of clams, especially ones to protect small seed clams from predators. With such techniques, potential aquaculturists had the tools they needed. Growth of the industry, however, still had to contend with other problems, environmental ones especially, but regulatory, social and economic constraints as well. Environmental impediments include those related to the need for

good water quality, proper substrate, the absence or reduced presence of predators and appropriate water current flow patterns, says Oesterling. There were also regulatory restrictions in Virginia, as there are in most states, let alone capitalization problems – there was simply "a reluctance for private lending institutions to fund culture activities," Oesterling points out. Despite these constraints, Virginia clam farming got underway with growers such as Cherrystone Aquafarms in 1983 and J.C. Walker Brothers, which had been growing clams before then. Since then, the industry has continued to expand.

There are at least 40 clam culture facilities in Virginia, including the largest, totally-integrated operation in production on the east coast. Clams from farming Virginia's coastal waters far exceeds the value of the wild harvest.

For more information on clam aquaculture in Virginia, contact Mike Oesterling at (804) 684-7165; mike@vims.edu.

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State of the Soft Crab Market

Douglas Lipton, Marine Economics Specialist

Over the past decade, observers of the East Coast fishing industry have noticed a proliferation of crab shedding systems and the increased availability of fresh and frozen soft crabs in the marketplace. In attempting to document this change and understand the economic forces behind it, we learn more about the quality of fisheries data than about how the soft crab market is progressing.

Federal and state efforts to collect fisheries data are clearly better at landings than the data collected further up the marketing chain. In the case of soft crab, the resource itself presents unique problems in reporting. To begin with, states vary in their classifications: some report harvests as soft crab, some as peeler crab and some as a combined soft and peeler crab; meanwhile, some states report landings in all three categories while others report everything in the combined category. For these reasons, it is difficult to interpret prices that watermen received since an ex-vessel price (the price paid to a fishermen) is higher for soft crab than peeler crab, more than twice as high. Since we cannot differentiate the number of peeler and soft crabs in the mixed category, we must resort to looking at only prices in the single product category to determine what is going on economically.

With these caveats, we examined trends in landings and prices for soft and peeler crabs for the 1990-1999 period. Landings of soft and peeler crabs peaked in 1995 and have stayed at a fairly high level since: from 1990-1994, the average landings were 4.6 million pounds; since 1995 landings have averaged 6.3 million pounds. This trend is apparently not driven by overall blue crab abundance as average annual landings of hard crabs were 224.6 million pounds in the 1990-1994 period, but fell to an average of 213.3 million pounds for 1995-1999. In the 1990-1994 period, soft and peeler crabs made up about 2 percent of the annual harvest of blue crab by weight; by the end of the 1990s, that average catch had climbed to 2.9 percent of the total catch.

The increased production of soft and peeler crabs is likely a response to increased demand created by marketing efforts, especially expansion of the export market. Evidence of increased demand would be revealed in higher product prices at the same time that production is increasing, and this is precisely what occurred in the soft and peeler market. In contrast, although price increases for hard blue crabs also increased over the entire period, this increase was accompanied by declining production. After adjusting for inflation, peeler crabs were worth 56 percent more in 1999 compared with 1990 while hard crabs were worth 54 percent more. Interestingly, the reported value of soft crab landings increased only 4 percent. Thus, as shedding systems have improved, the price paid for peelers has grown closer to the price paid for harvested soft crabs.

While many crabbers sell soft crabs directly to restaurants and other markets, a substantial quantity of soft crabs are sold to processors for market preparation, freezing and distribution to other marketing channels such as the export market. Unfortunately, when looking at the processing data collected by the National Marine Fisheries Service (NMFS) and the export data collected by the

Bureau of the Census, it is impossible to discern any trends in soft crab production. The problem with the NMFS processing survey is that participation by processing firms is voluntary so that year-to-year changes in production figures may reflect changes in participation as opposed to actual changes in production. For soft crab in particular, many of the larger processors are not participating. According to the 1999 figures, only some 250,000 pounds of the almost 6 million pounds of harvested soft and peeler crabs are shown as being processed. The problem with the export data is that there is no distinct reporting category for soft crabs, so they are lumped in with any kind of fresh or frozen crab product.

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Consumers and Crab Meat: The Choices We Make

Tom Rippen, Seafood Technology Specialist

Over the past few years crab products and sources of supply have increased dramatically. Differences in product sensory profiles are known to exist for the wide variety of species, market forms and global sources; however, these sensory differences have not been characterized. The Sensory Working Group, composed of seafood specialists from Atlantic and Gulf states, developed a white paper which outlines research needs related to sensory qualities. As a first step, the Sea Grant programs in Maryland, Virginia and North Carolina sponsored a study based on a series of focus groups to determine consumer perceptions of crabmeat products.

Nine focus group sessions were held, three each in Annapolis, Maryland; Hampton, Virginia; and Morehead City, North Carolina. Focus group members were selected by a survey based on demographic balance and crabmeat consumption. The individuals were regular crabmeat consumers, averaging at least one crabmeat meal per week, either at home or in restaurants; they also live in coastal communities where crab consumption is high historically. These requirements were necessary in order to establish a baseline for determining factors that condition crabmeat buying patterns, though they may not indicate the needs of less experienced consumers or those in new markets such as Midwest cities.

The study was based on a series of focus groups that the Maryland Department of Agriculture (MDA) Seafood Marketing Program, conducted in 1999, in which participants were asked to identify the strengths and weaknesses of two crabmeat samples, one domestic and one foreign. The aim was to try and determine specific sensory qualities that consumers look for when making a purchase decision. Two imported pasteurized products were compared to domestic, locally produced, pasteurized and fresh products. All samples were special (flake) crabmeat. Both the MDA and Sea Grant studies also assessed crabmeat packaging and labeling on purchasing decisions.

Although the focus group transcriptions are still being analyzed, some interesting opinions were expressed that should prove helpful in future marketing efforts.

- Participants generally preferred the flavor of domestic products, while some preferred the whiter color of the foreign samples.
- Participants expressed a philosophical preference for crabmeat produced in their home state but held virtually no brand loyalty.
- Participants purchase decisions were more often related to a favorite retailer, and the brands they happen to carry, than to companies that pack the products.
- Participants had the perception that pasteurized products are more highly processed and inferior to fresh (actual results from tasting the samples showed no relationship to processing method).
- Participants preferred clear or plastic packaging to metal cans.

Findings from the focus group study could help improve the success of a seafood company's product development and marketing programs. Consumer testing in various markets may show regional differences in perceptions and preferences, leading to product introductions targeted to those needs. For example, while yellowish colored crabmeat suggests quality and sweet crab flavor to consumers experienced with preparing their own crabs, the color may be viewed as a

defect by others.

Sensory analysis and its role in marketing will be presented at the International Boston Seafood Show, Wednesday, March 28, 1:00 - 2:30 pm. Speakers from the National Marine Fisheries Service sensory section, Virginia Tech and University of Maryland will discuss methods and practical examples at the seminar. For a copy of the Sensory Working Group publication, "A Plan to Improve the Competitiveness of the Blue Crab Processing Industry and the Quality of Crab Meat Products in the U.S. Marketplace," contact Sea Grant publications at Virginia Tech, 540-231-6965. Request publication VSG-00-03.

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Sensory Analysis: A Science and Tool to Improve Market Success

Tom Rippen, Seafood Technology Specialist

Most new products introduced into the marketplace fail. Competition is often intense and even gaining access to supermarket display space is often difficult or very expensive. The difference between success and failure may be a seemingly minor feature of the product, such as selection of a conventional versus tamper-evident package. Even for an existing product, demand may wain if features don't meet the changing expectations of consumers. Assumptions about customer preferences should be carefully assessed to avoid unnecessary costs or disappointing sales.

Many food processing companies use a variety of sensory techniques to identify product attributes important to consumers. Sensory testing and other market research are often contracted to consulting firms experienced in their use; however, depending on a company's objectives, several sensory tools can be performed in-house with success. Larger companies mostly use trained taste panels. The panelists commonly develop a set of descriptors for various characteristics of a product that are related to appearance, odor, flavor and/or texture. Panel members are tested and standardized to recognize the presence and intensity of these characteristics. The panel can then discern changes that may occur in the product over time, during storage, or after formulation changes.

However, a trained taste panel is not used to determine preferences or consumer buying habits. For that, consumer panels (sampling sessions with at least 150 consumers) or large surveys, when properly designed, produce far more valid results. Focus groups are another tool and are gaining in popularity. A focus group brings together a small number of carefully selected individuals who represent the target group a company hopes to market to. Typically, ten participants are asked a series of questions designed to elicit opinions or to identify buying behaviors. Product tasting can be a valuable focus group activity. Focus group results cannot be extrapolated to the general population; that is, the opinions of the group may differ from those of the broader consuming public. Hence the importance of selecting focus group members who are familiar with products of the type a firm wishes to market and whose opinions are important to a successful marketing plan.

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Maryland Sea Grant Launches New Web Site

www.mdsg.umd.edu

With Maryland Sea Grant's newly-designed and reorganized web site, you can easily navigate through a wealth of information about the Chesapeake Bay watershed, research, extension and education. You will find extensive materials on such topics as blue crabs and oysters, exotic species, aquaculture, water quality, seafood technology, marine biotechnology, bay history and culture – there is considerably more. The site now includes expanded research information with a searchable database of past and current Maryland Sea Grant research projects, as well

as pages on interactive education, publications and videos.

Readers of Aquafarmer will be especially interested in the Extension home page (www.mdsg.umd.edu/Extension/index.html) with comprehensive links to our programs in Aquaculture & Fisheries, Seafood Technology, Pond Management, Economics, Exotic Species, Water Quality, Biotechnology and Education. We have been getting education briefs and other publications on-line so that they can easily be downloaded; these include the series of finfish workbooks and publications related to non-indigenous species and contaminants. Check out the website – we would appreciate your comments, critical and otherwise. Merrill Leffler, leffler@mdsg.umd.edu.

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Microbes for Hire Workshop

Adam Frederick, Education Specialist

This summer, 15 Maryland middle and high school science teachers will be enrolled in the Microbes for Hire Workshop at the University of Maryland Biotechnology Institutes at the Center of Marine Biotechnology (COMB) from July 23-27, 2001. The Microbes for Hire Workshop sponsored by the Pfizer Foundation, The Foundation for Microbiology and Bell Atlantic-Maryland is designed to translate the applied microbial research at COMB into laboratory activities for teachers and students in Maryland. Teachers will gain applied laboratory skills and enhanced content knowledge on topics including:

- Bioremediation and the Effectiveness of Biosurfactants
- Bioluminescense and the Application of Biosensors
- Bacteria and their relationship in the Marine environment
- Bacterial Biofilms and Their Relationship to Biodiversity
- Microbial Screening Techniques for Identifying Bioactive Compounds
- The Science of Winogradsky Columns and Marine "Microbial" Sediment
- The Role of Bacterial Biofilms in Biological Filtration for Aquaculture
- Digital Imaging and Microscopy in the Classroom, The QX3, by Intel
- Microbes on the Web

Each topic will be presented in collaboration with a COMB scientist or graduate student to provide the essential background of the research and will be followed-up by a "hands-on" lab that exposed teachers to new techniques, laboratory materials and ideas for the classroom. Teachers will earn two credits from the Maryland State Department of Education. For more information, contact J. Adam Frederick (410) 234-8850; frederic@mdsg.udm.edu.

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