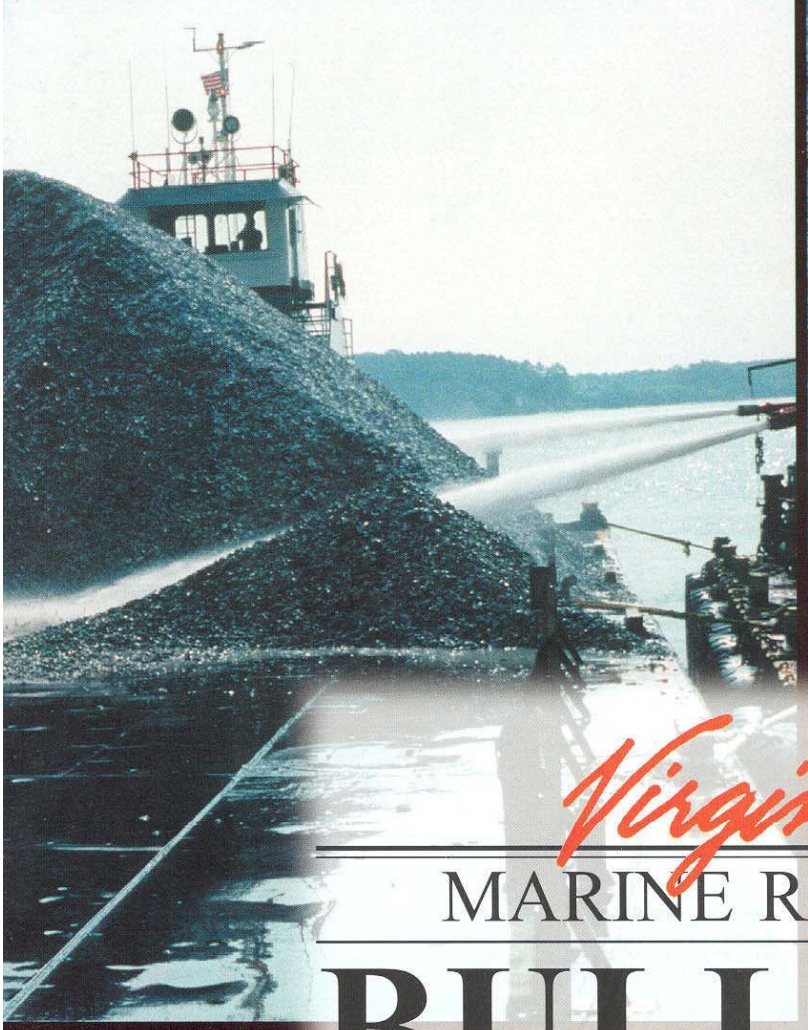
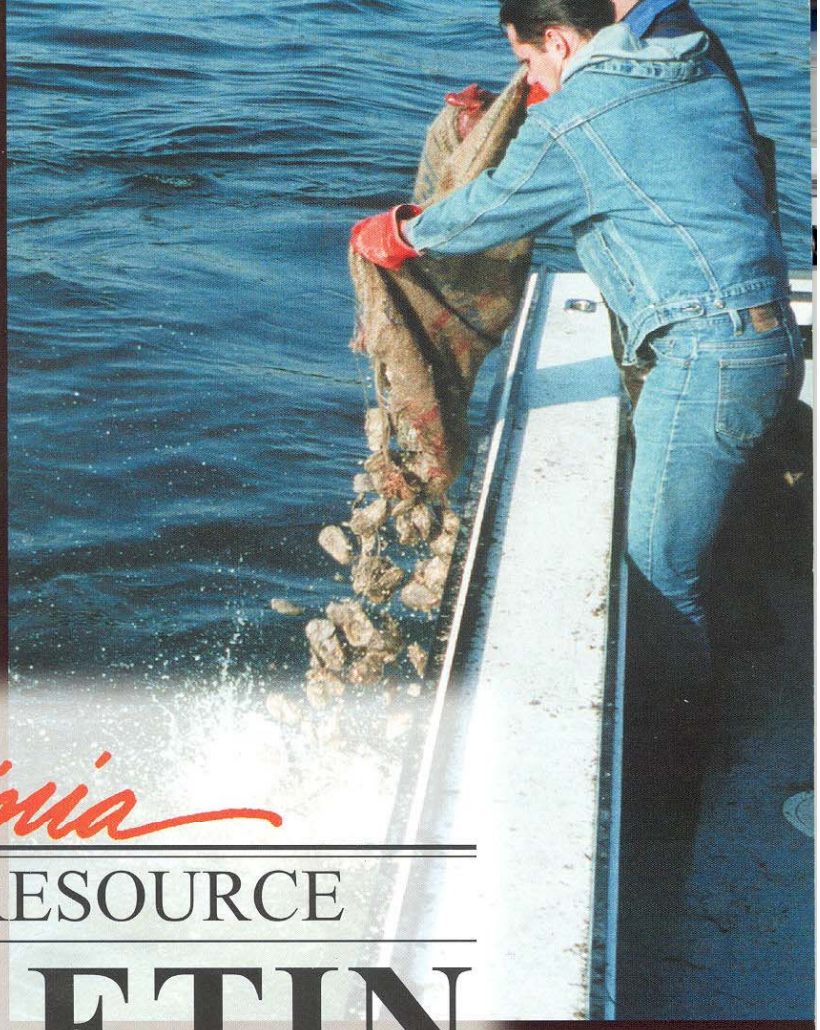
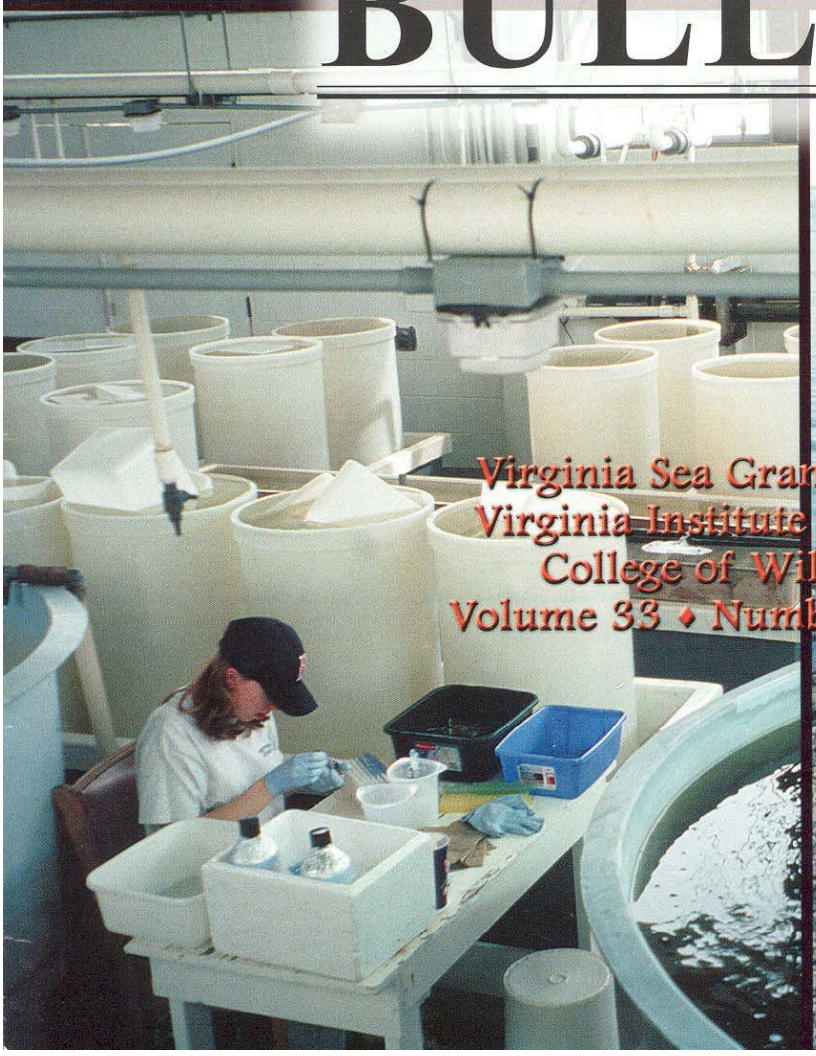
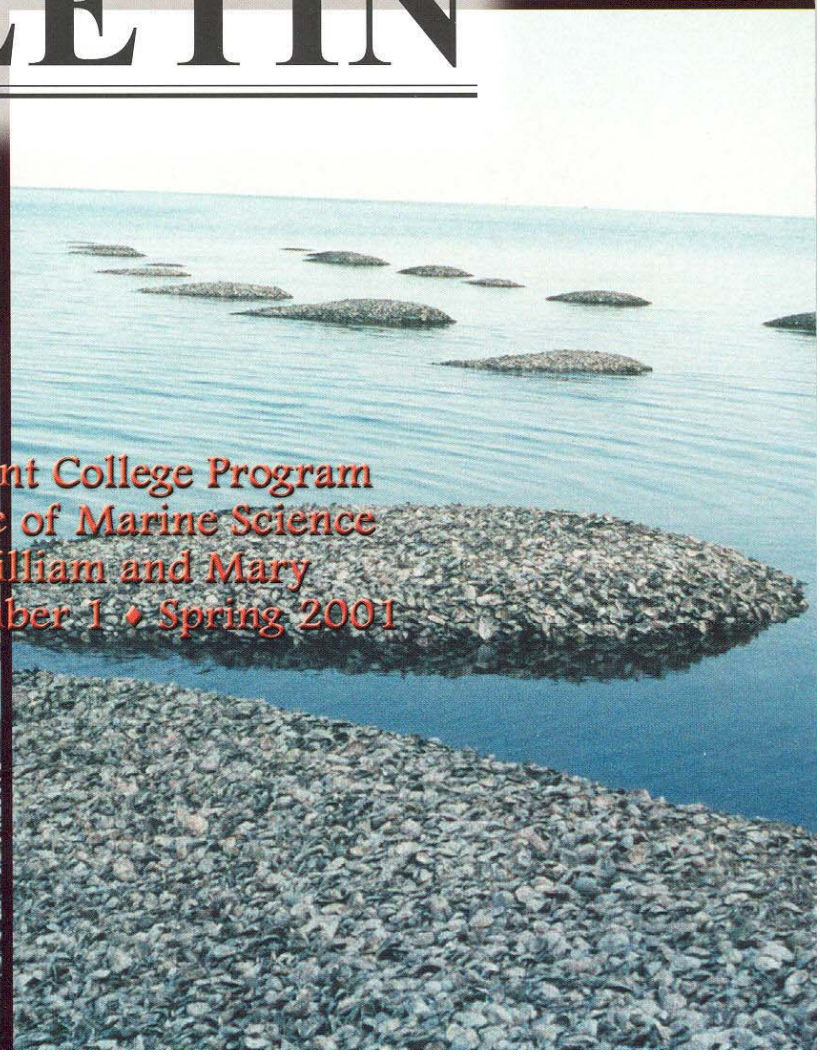




Virginia MARINE RESOURCE BULLETIN





Virginia Sea Grant College Program
Virginia Institute of Marine Science
College of William and Mary
Volume 33 ♦ Number 1 ♦ Spring 2001

For many living within Virginia's borders and beyond, the plight of the Eastern oyster strikes a personal chord. From the earliest days of settlement, oysters have been a staple of the Tidewater diet. Some 200 years later during the desperate days of the Civil War, oysters often stood between a soldier and starvation, as revealed by historians offering personal accounts. Later still, the Eastern oyster brought Virginia notoriety and lucrative business opportunities when demand for the bivalve from crowded markets in the Northeast peaked during the 19th and early 20th centuries.

Against these rich accounts of plenty, we are now faced with a challenge of the highest order as we seek ways to help the Eastern oyster re-establish itself in Virginia waters. The articles within offer a sketch of the broad-reaching efforts both within the research laboratory and on the ground by citizens of the Commonwealth to meet that challenge, but the picture is by no means complete. For example, a colorful array of tales might accompany this edition, told by veteran watermen and motivated oyster gardeners who apply practical knowledge and grit to ongoing restoration work day in and day out. A lengthy index of research projects might also be included.

For those of you looking for more in-depth coverage of the current state of Sea Grant-funded research on the Eastern oyster, a list of abstracts is provided in a companion newsletter, *Tideline,* published in Charlottesville. The newsletter is available by calling (804) 924-5965. It is hoped that between these offerings you will develop a greater appreciation for the groundswell of support for oyster recovery – and the reef habitat that oysters provide – as well as the breadth of associated research that has taken place since we last reported on *Crassostrea virginica* in the Bulletin five years ago.

Cover photographs: clockwise from upper left to lower right, courtesy of Jim Wesson, VMRC; lower left, Nate Geyerhahn, ABC.

Virginia
MARINE RESOURCE
BULLETIN

Volume 33 ▲ Number 1 ▲ Spring 2001

CONTENTS

Sea Grant Virginia

WILLIAM & MARY VIMS
VIRGINIA INSTITUTE OF MARINE SCIENCE
SCHOOL OF MARINE SCIENCE

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

DR. L. DONELSON WRIGHT
Dean and Director
Virginia Institute of Marine Science
School of Marine Science
The College of William and Mary

DR. WILLIAM RICKARDS
Director
Virginia Sea Grant College Program

DR. WILLIAM D. DUPAUL
Director
Marine Advisory Program

SALLY H. MILLS
Editor

◆◆◆

The *Virginia Marine Resource Bulletin* is a publication of the Marine Advisory Program 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, the Old Dominion University, the University of Virginia, and the Virginia Polytechnic Institute and State University. Subscriptions are available without charge upon written request. Comments and questions may be directed to the editor at (804) 684-7167 or by e-mail to mills@vims.edu.

The *Bulletin* is intended as an open forum for ideas. The views expressed do not imply endorsement, nor do they necessarily reflect the official position of Sea Grant or the Virginia Institute of Marine Science. Sea Grant is a partnership of university, government, and industry focusing on marine research, education, and advisory services. Nationally, Sea Grant began in 1966 with passage of the Sea Grant Program and College Act.

The *Bulletin* is printed on recycled paper.

This work is the result of research supported in part by the NOAA Office of Sea Grant, U.S. Department of Commerce, under Grant No. NA56RG0141 to the Virginia Graduate Marine Science Consortium and the Virginia Sea Grant College Program.

Coaxing Back a Bivalve

By Sally Mills

When researchers at the Virginia Fisheries Lab heeded the warnings of Dr. Donald Davis of the College of William and Mary in 1949 and sought to help the seafood industry recover one of its prize performers, *Crassostrea virginica,* they could hardly have anticipated where the efforts would lead. The fate of the Eastern oyster was high on their list of worries and, in fact, helped galvanize financial support for the lab, later to become the Virginia Institute of Marine Science. During those days, scientists were struggling primarily with controlling the oyster drill. Ten years later, they would face a new challenger in the disease, MSX.

Today, focus on the oyster continues but against the backdrop of a collapsed fishery unable to recover on its own. Oyster work proceeds within the framework of a large, regional effort—the magnitude of which is unparalleled in recent history. It involves significant federal and state funds and attention, as well as collaboration with many notable research schools. But it has also brought to bear the strength of the individual looking to make a tangible contribution, to help an ailing Chesapeake Bay. When all is said and done, the desired endpoint is an improved estuary held in check by this linchpin bivalve—the grandest of filter feeders.

Researching disease

Since that perilous year in the late 1950s when the disease, MSX, began its treacherous assault upon oysters in the bay, researchers at the Virginia Institute of Marine Science (VIMS) have been struggling to understand its pathogenicity while outwitting its ad-

vances by culturing oysters to grow faster. Many faculty members and graduate students are engaged in further unlocking the mysteries of our native disease, Dermo, and relative newcomer, MSX. Key understandings about the environmental conditions in which the diseases thrive are now commonly held among the marine science community.

We know, for example, that salinity plays a critical role in disease dynamics—specifically, the ability of parasites to grow and survive. Oysters in higher salinity zones from the Potomac River south are more vulnerable to the devastations of disease episodes. Rising water temperature plays a part, too. Modeling suggests that, for aquaculture purposes, early spawning and planting by spring, along with harvesting by late summer, can help ward off the worst attacks of disease during a year of normal rainfall.

But what about periods of drought that push salinity northward in the bay? Or the effects of human activities and sediment loads upon circulation patterns in shallow areas where reefs were once prevalent? Even our best models cannot anticipate the full scope of threats that serve to thwart our efforts to manage around oyster disease.

Other research seeks to identify how parasites attack the immune system of the Eastern oyster, how disease spreads between individuals, and the specific traits that make an oyster more disease resilient. These unknowns are exacerbated by the occurrence of many different strains of *Perkinsus marinus* (Dermo) in the natural environment that may have varying intensity, or virulence. Still, studies on disease organisms from around the world – New Zealand, Spain, Australia, and France, for example – are yielding new insights. Dr. Kimberly Reece at the institute has developed DNA probes to diagnose different strains of *Perkinsus marinus* for all affected species, including oysters and clams, and now has the tools to investigate variability in virulence among different strains.

Dr. Kimberly Reece loads samples into a DNA automated sequencer. Left, aerial view of newly planted reefs at Fisherman's Island.

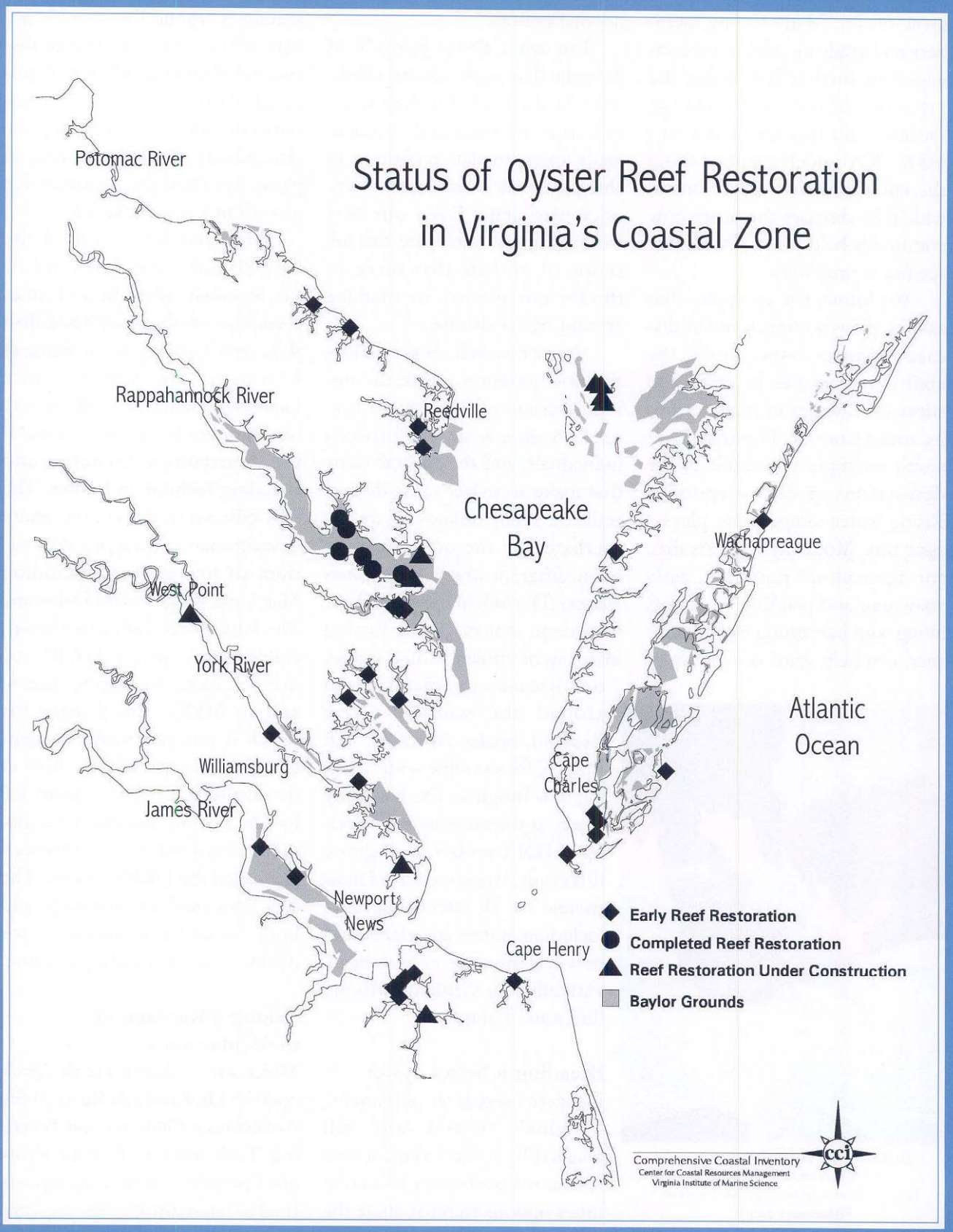
Breeding a better oyster

Despite research advances, Virginia's oysters are still plagued by disease and for that reason scientists have looked at other options to rehabilitate the fishery. In collaboration with researchers around the country, geneticists here have developed disease-resistant strains that incorporate the best attributes of the Eastern oyster while tolerating its parasitic adversaries. Two lines, in particular, show great promise for growth in Chesapeake Bay.

The first line – called the CROSBreed – was developed by Dr. Standish Allen, Jr. and other researchers at the Haskin Shellfish Research Laboratory at Rutgers University. Dr. Allen has since joined the faculty at VIMS, where he continues his genetics work at the Aquaculture Genetics and Breeding Technology Center. The CROSBreed oyster is now under development through a consortium of universities, including Maryland, Rutgers, and Delaware. The CROSBreed appears considerably more resistant than the native *C. virginica* to Dermo disease and to MSX—the disease for which it was genetically "toughened" in the first place. Also at the institute, a research team led by Dr. Eugene Burreson has developed a genetically enhanced line called the DEBY oyster. The two lines perform similarly, and both are under investigation for use in restoration and aquaculture.

Taking advantage of molecular tools

Molecular markers recently developed by Dr. Kimberly Reece at the Aquaculture Genetics and Breeding Techonology Center show great promise for tracking oysters bred to resist disease. She explains


Status of Oyster Reef Restoration
in Virginia's Coastal Zone
Potomac River
Rappahannock River
Reedville
Chesapeake
Bay
West Point
York River
Williamsburg
James River
Newport
News
Cape Henry
Wachapreague
Atlantic
Ocean
Cape
Charles
Early Reef Restoration
Completed Reef Restoration
Reef Restoration Under Construction
Baylor Grounds
Comprehensive Coastal Inventory
Center for Coastal Resources Management
Virginia Institute of Marine Science
cci

that the markers serve as tags for finding different regions of the DNA. According to Dr. Reece, "The inheritance patterns of a collection of markers can be followed through various crosses to generate maps and enhance our understanding of the genetic make-up of the species. Some markers are particularly beneficial for breeding programs because they identify or tag genes affecting particular traits. This enables individuals carrying those genes to be easily distinguished, and guides breeding programs to more efficient crosses that lead to high quality brood stock."

The use of genetically enhanced strains has immediate implications for a number of commercial hatcheries growing oysters for stock replenishment. Teaching hatchery managers the correct procedures to maintain the genetic health of the oyster stock by maximizing parental contribution is critical to long-term viability. Mating techniques such as "pairwise crossings" and more attention to the genetic implications of hatchery practices are critical.

In agreement, Burreson adds, "When you conduct a spawning event you have to ask, how many parents are contributing to the spawn? If only one or two sets are participating, you are creating, in effect, a genetic bottleneck." The idea is to create an *effective population size* by using as many spawners as possible in equal ratio of male to female and attempting to keep family sizes equal. Once introduced in the bay, oysters bearing such markers will enable scientists to trace the genetic path down the oyster line, from brood stock forward – and monitor the spread of larvae and spat containing the traits of interest.

This is where science is leading rehabilitation efforts. Genetically marked CROSBreeds and DEBYs will be planted on reefs in contained systems within the bay – small creeks where any offspring will remain in close proximity – for the express purpose of documenting gene transfer in the wild. There are many variables to consider, notes Allen, as well as questions to answer: Will the enhanced lines spawn at the same time as wild stocks? Will they interbreed? How far will they travel? All of these answers will help Allen and other scientists determine how to best use disease-resistant stocks in restoration.

The work proceeds in close communication with others, including members of governing agencies, as well as commercial aquaculturists, seafood industry leaders, and the Chesapeake Bay Foundation. According to Allen, "We expect more hatcheries to spawn CROSBreed lines before long. Eventually, we would like to see a panoply of resistant lines available for reef planting and for the consumer, gardener, and oyster aquaculturist alike."

Dovetailing knowledge with reef construction

Research on the Eastern oyster has immediate, real-life application in Virginia waters where, at 30,000 bushels harvested annually, the native fishery is estimated to be less than one percent of its historical peak. When it comes to applied research, VIMS has a long history of working closely with the Virginia Marine Resources Commission (VMRC), and in no case is this partnership more visible than in the realm of oyster restoration.

Under the guidance of Dr. James Wesson, who heads up the commission's *Shellfish Replenishment Program,* the creation of functioning oyster reefs bay-wide has been at the forefront of Virginia restoration work since the early 1990s. It was in 1993 that the VMRC began down this road – building reefs that would attract oysters which would, in turn, provide offspring in perpetuity.

The VMRC first directed efforts in small rivers and creeks where, according to Wesson, "We hoped we could see a response signal." For the ensuing five years, restoration sites were chosen based upon what managers knew about circulation patterns and other physical parameters, and where citizen support for reefs was strong. Reef sites were also picked where floating larvae were present in the water column and therefore might be coaxed to settle nearby.

Oyster restoration has since been lent a helping hand by grassroots organizations, school children, and citizens young and old across tidewater Virginia, who have raised young oysters for reef planting. Theirs is no small contribution. This year alone, Vir-

ginia oyster gardeners are expected to provide 1.5 million oysters solely for restoration purposes (see related article, page 10).

In 1999 the VMRC teamed up with the Department of Environmental Quality (DEQ) in a campaign blitz to educate virtually every citizen of the Commonwealth about the value of this keystone species. The *Virginia Oyster Heritage Program* seeks to expand the work begun by the VMRC and recreate oyster reefs on the original footprints of public oyster grounds where feasible to do so.

Notes Wesson, "That's exciting, because we've raised enough money to do reef restoration on a grander scale. Now, we can look at a 10-mile stretch of river, put 8 to 10 reefs there, and hopefully make a difference."

Viewing the program as a mandate for public education about the value of oysters to Virginia, DEQ staffers have traveled the Commonwealth telling school children and adults about the bivalve through a live exhibit that demonstrates its unique filtering capabilities. The DEQ has been instrumental in raising awareness and, in the process, raising funds for reef restoration. According to director Dennis Treacy, "Virginia is at a critical threshold to make this happen. The success of the oyster restoration effort will require participation from everyone who appreciates the oyster for its critical role as a natural water purifier and the oyster reef as a crucial habitat to many other coastal species."

Through the Oyster Heritage Program, six reefs were constructed in the Rappahannock River last summer and two more completed on the seaside of Virginia's Eastern Shore. Much of the construction funding has come from the Army Corps of Engineers, but Wesson has taken care to include Virginia watermen at every step in this process, leaning on their expertise to help move spat and juveniles from existing reefs to newly built sites. Construction of a large-scale reef project is planned for Tangier Sound this summer. Four, one-acre reefs will remain off-limits sanctuaries, but approximately 100 acres of surrounding shell will be available for harvesting.

This model is now considered a template for how future reefs should be managed bay-wide. Across the estuary, resource managers have set an ambitious goal of increasing ten-fold the biomass of oysters by the year 2010 (determined by a baseline population in 1994). It is one strategy of a multi-tiered management plan that recognizes the tremendous ecological services provided by the oyster – not only to water quality, but to the provision of habitat for a host of other living resources.

Shell shocked

While reef restoration appears to be moving forward at a healthy pace, it has not been without its hurdles. Currently, the VMRC is struggling to find enough oyster shell to use in constructing its three-dimensional, mounded structures. Three-dimensional reefs offer oysters the best hope for successful fertilization and reproduction, while better protecting juveniles from predation. Mounded structures promote faster growth as well, due to increased food supply and reduced sedimentation near the surface. The hitch: a one-acre reef alone consumes approximately 100,000 bushels of shell, and that is getting harder and harder to come by. The problem is not new, but affordable sources appear to be dwindling.

The situation has led Wesson and others to consider alternative base material that can be capped with oyster shell for its superior ecological benefits. What appears

Researchers deploy a substrate basket to collect samples at an oyster reef.

to be defining long-term reef success are the nooks and crannies, or "interstitial" spaces, that persist between oyster shells and that disappear among other types of shell and composite materials, due to erosion and resulting compaction. These pockets provide sanctuary for juvenile oysters and are particularly beneficial at 5 to 10 centimeters below the reef surface, according to Dr. Mark Luckenbach of the VIMS-Eastern Shore Laboratory.

Above, students sort and tabulate aquatic creatures found in an oyster reef. Left, a pair of horseshoe crabs visit an oyster reef.

Shell shortage has prompted several creative research projects at the VIMS School of Marine Science that compare the impacts of different building blocks – clam shell and a fly ash/concrete mixture, for example – on reef habitat use. Most recently, Wesson has been considering the merits of using ground-up vitreous china (frequently used in bathroom fixtures) as base material because it contains calcium carbonate – the essence of the oyster shell – and would naturally attract spat. But concerns remain over its use in the bay; specifically, the long-term impact of a kiln-treated product that does not naturally break down in the water column. Finding the right material remains central to reef construction plans, and Wesson would like to test a few substrates, at least on an experimental basis.

The ecological advantages of using oyster shell cannot be overstated. Surveys conducted at several reefs in the Piankatank River by Dr. Roger Mann and Dr. Juliana Harding of VIMS have quantified the community associations that occur as reefs grow and mature. Their findings confirm that a diverse assemblage of pelagic and benthic predators visit reefs, feeding upon gobies and blennies, finfish lower in the food chain (see chart, next page). Menhaden have long been known to feed at oyster reefs. Four other pelagic species collected in abundance are valuable to both commercial and recreational fishermen: Atlantic croaker, bluefish, striped bass, and spot. The types of data collected in the Piankatank provide important insights about trophic interactions on restored oyster reefs and will serve to gauge the success of future reef restoration work.

Reef architecture

The idea of people restoring oyster reefs is a bit off-base, notes Dr. Mark Luckenbach, adding, "Humans cannot restore reefs – only oysters can do that. It is a biogenic process." He adds, "What we *can* do is provide additional substrates, provide brood stocks where appropriate to do so, and leave the reefs alone." Rebuilding population structure takes time and must occur over multiple generations; thus, the need for patience.

Luckenbach is heartened by the growing public appreciation for reef rehabilitation. "Oysters are no longer viewed as a fishery service only. They are now recognized for the ecological services they provide – from filtration, to

Oyster Reef Trophic Monitoring

Fish Species	Ginney Point (Oyster Shell Flat)	Roane Point (Sand Bar)	Palace Bar Reef (Intertidal Reef)
American eel			X
Atlantic croaker	X	X	X
Atlantic menhaden	X	X	X
Black Sea bass	X		
Blueback herring	X	X	X
Bluefish	X	X	X
Butterfish			X
Carp		X	
Cownose ray			X
Hogchoker	X		X
Naked goby			X
Oyster toadfish			X
Silver perch	X	X	X
Skilletfish			X
Speckled trout	X	X	X
Spot	X	X	X
Striped bass	X	X	X
Striped blenny			X
Summer flounder	X		
Weakfish	X	X	X

Fishes collected during 1997 with gill nets, crab pots, and nest substrates in the Piankatank River, Virginia; table provided courtesy of Harding and Mann, VIMS.

water quality improvement, to nutrient reduction, to habitat for other species." Reeling off a litany of contributions made, he stresses that living reefs exhibit a more diverse assemblage of organisms in greater numbers than any other natural structure in the bay. Macro-algae are just one example, abundantly available due to nutrient cycling that occurs on the reef.

With heightened awareness comes an obligation to dovetail monitoring into reef construction projects. Wesson concurs, adding, "We are now designing our reefs to ask questions along the way, to monitor as we go forward."

Luckenbach underscores the importance of monitoring regularly and early in the process: "Monitoring reefs early for siltation, for example, gives you the flexibility to raise the reef structure if necessary, before the reef dies." That saves money over the long term. Luckenbach calls it *adaptive management,* and emphasizes that it is central to any large-scale restoration effort. And while monitoring for habitat use, researchers will be solving other questions that remain about reef architecture, namely: What is the optimal size of a reef reserve; at what horizontal scale and vertical relief should we build reefs?

On the Rappahannock River, where reef construction has begun through the Oyster Heritage Program, the opportunity exists for a large-scale experiment to answer these questions. The project incorporates large, medium, and small reefs – all designed to study the role of reef size as it affects oyster recruitment, survival, and growth rates. While these architectural parameters may seem straightforward, designing reefs well does not necessarily guarantee success. Luckenbach is quick to point out that this is new science, that we don't yet know all the answers.

Everyone is scrambling, hopeful that a rehabilitated oyster population will "jump-start" the ecological turnaround of the bay. One thing is quite apparent: given the level of research and funding commitments involved, the answers can't come soon enough.

Chesapeake Bay Foundation Sets Ambitious Goal

At the end of a narrow lane on a postage-stamp spit of waterfront land, Tommy Leggett and Amy Blow are busy packing 2-mm mesh bags with seed oysters. The sealed bags are then placed on holding trays and loaded onto the Spat Boat I to be ferried just up the creek for planting. It is November – not the warmest of days for working on the water – but this project managed by the Chesapeake Bay Foundation (CBF) needs to be wrapped up. Today's load represents the tail end of a planting effort that began back in June, aimed at placing one million oysters back into Virginia waters.

The CBF project is distinct, according to Leggett, because, "We are employing commercial techniques but using this study purely for *restoration* purposes. At 1.1 million seed oysters, this is a moderate-sized farm, but unlike other growers, we're not selling." In fact, Sarah's Creek is just a temporary holding ground for the bivalves. It is now spring and the oldest and largest oysters here will be transferred to sanctuary reefs throughout Virginia. If all goes well, they will become long-term habitat for a budding population of new oysters and a rich array of other aquatic species throughout the Chesapeake.

Most of the oysters planted by CBF thus far are of the Lynnhaven variety. Historically, it's been a popular choice for Virginians who eat oysters, due to its salty taste. Other oysters to be tested include the Plantation Creek and Mobjack varieties, grown by commercial hatcheries in the area, and the CROSBreed and DEBY lines—disease-resistant varieties developed by researchers at the Virginia Institute of Marine Science. They will be supplied by Walker Brothers Seafood and Middle Peninsula Aquaculture.

What makes this particular planting site unique are the towers of stacked trays suspended off the bottom. As Leggett explains, stacking keeps most of the oysters above the substrate and therefore less vulnerable to the suffocating siltation that storms and strong currents leave behind. They still need plenty of tending, however. Leggett and Blow visit the site daily and pressure-wash the trays several times a week to prevent fouling. Although still early to make any predictions, these oysters appear to be thriving and grow-out has been phenomenal – about a 20-fold increase in just 4 to 5 months' time.

But keeping pace with seed demand has proven difficult for the handful of commercial hatcheries in Virginia. As one of several large seed buyers, CBF has set some very challenging restoration goals for the oyster. According to Dr. Rob Brumbaugh, fisheries scientist at CBF, seed supply can become an issue from year to year, depending on weather conditions during early grow-out. "It's just the nature of the business," he cautions, noting that Maryland hatcheries have experienced similar shortages during unusual weather-related circumstances.

Referencing the large-scale oyster restoration efforts underway, Brumbaugh notes, "We are beginning to see success where the right resources are being applied." But that naturally leads us to the following questions: how many oysters should we be producing; how will we meet that goal; and, who's going to pay for it? These are the discussions taking place right now among scientists and resource managers.

As temperatures thaw, CBF is indeed geared up to start the process all over again. Amy Blow explains that she's been busy grading the animals in the trays and culling out the larger bivalves so the smaller ones will have a shot at optimum growth. Reef planting has begun and the larger oysters are leaving Sarah's Creek, making space for a new crop to take their place. The entire cycle repeats itself beginning in July. The goal in 2001: an ambitious doubling of oyster seed into Sarah's Creek. That should go a long way toward meeting the organization's long-term mission of achieving a ten-fold increase in the oyster population across the bay by the year 2005.

Leggett and Blow do not appear daunted by the challenge. In fact, when they're not running their boat up and down the creek, they plan to share what they've learned with anyone interested in helping the oyster recover. Workshops for potential growers and field trips for legislators and industry leaders, as well as the people who make policy decisions, are just a few places you'll find them during their "down" time.

Tommy Leggett loads oysters to ferry up the creek.

Oyster Gardeners: A Formidable Force

By Shawn Stickler & Dr. Standish K. Allen, Jr.

In 1995, a few landowners on the Corrotoman River, a tributary of the Rappahannock River in Virginia, wanted to do their part to help the Chesapeake Bay. With guidance from hatchery personnel at the Virginia Institute of Marine Science (VIMS), the landowners began raising oysters in dockside floats. The idea was that the oysters would filter the water and help clarify it, and the gardeners would have some oysters to eat. From that modest beginning, oyster gardening has grown to over 1,000 participants in the bay watershed, ranging from Virginia Beach to the Choptank River in Maryland. In Virginia alone, gardeners purchased over 1.5 million oyster seedlings for their gardens last year. But oyster gardening has become more than an environmentally friendly hobby. Oyster gardeners represent an unanticipated resource in the effort to restore oyster populations, heighten overall awareness of the importance of oysters for the bay, and even help evaluate new oyster strains.

The most interesting evolution of oyster gardening has been in reef restoration. While oyster gardening was getting started, the Virginia Marine Resources Commission (VMRC) initiated a program to construct oyster reefs – large intertidal heaps of old shells built in areas of traditional abundance. Oyster diseases, particularly MSX and Dermo (caused respectively by *Perkinsus marinus* and *Haplosporidium nelsoni*) have made restoration difficult, because oysters rarely survive long enough to reach their full spawning potential. Consequently, several new reefs were seeded with large, presumably robust (e.g., disease tolerant) oysters harvested by and re-purchased from Virginia watermen. Soon, however, demand for seeding these reefs exceeded supply. Oyster gardeners responded by donating a portion of their seed, usually as 1–2" juveniles. More and more, these hatchery-derived seed are spawned from selectively bred, disease resistant brood stock. Through gardening associations and the Chesapeake Bay Foundation, gardeners became the main source of seed for a number of new reefs. Today, there are 20 reefs in Virginia, seeded for the most part by oyster gardeners. Several of these reefs have exceeded expectations, with area spatfalls (setting of larval oysters on shell) reaching levels 10,000 times greater than those in pre-reef years. Reef building continues and oyster gardeners will likely provide much of the juvenile oyster population to jumpstart this effort.

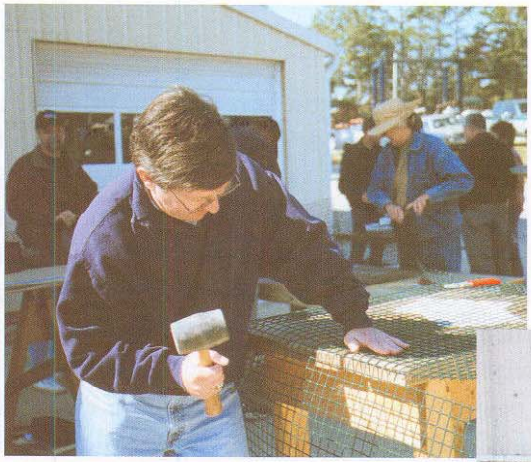
A new breed of gardeners has sprouted all along the Chesapeake Bay coast as elementary through

secondary schools have begun their own oyster gardens. Teachers use the experience of oyster gardening as a hands-on teaching method in ecology classes. For example, the Science/Ecology Club at Mathews High School has acquired seed, floats, and equipment through local fundraising efforts to grow out 50,000 seed oysters. These seed oysters will be put on a local reef constructed by the VMRC. Far more valuable than the seed itself, oyster gardening is giving a new generation of Chesapeake Bay residents a heightened awareness of the cornerstone role that oysters play in the estuary.

A thousand strong and widely distributed, the network of gardeners provides a unique opportunity for research. From inception, gardeners have used their sites to generally evaluate performance of seed and test the feasibility of gardening in various locales. But these trials were largely unorganized. This, however, changed with the 1997 creation of the Aquaculture Genetics and Breeding Technology Center (ABC) at VIMS, with a mandate to develop new shellfish strains in support of a growing aquaculture industry.

As ABC began developing new lines for testing, we realized what a resource gardeners represent. The Gardener Research Extension Network (GREEN) was formalized, enabling gardeners to participate in various grow-out trials with us. Although many are eager to contribute, gardeners are generally selected to participate in GREEN on the basis of site conditions. For one test, site conditions might require low salinity in the absence of MSX, but not Dermo; for another test, the absence of disease (to the extent possible) may be key; for a third, a full range of conditions might be desirable.

Today, ABC has over 75,000 oysters undergoing testing at more than 20 sites in Virginia. Projects include studies of natural Dermo resistance, the development of genetic markers, and a comparison of genetically altered sibling oysters.



The center's current goal is to organize GREEN collaborators through a Geographic Information System database. With funding from the Virginia Chesapeake Bay Restoration Fund, we are initiating a network of water quality monitors among oyster gardeners. In addition to collecting relevant environmental data, gardeners will grow "sentinel" oysters provided by the ABC hatchery. For example, some may be sentinels with known relative susceptibility to one disease or another. At present, test sites are selected with little empirical information, but by monitoring these oysters over time, we can infer conditions at various sites and create a database for future testing needs.

Since developing GREEN in the spring of 1998, the network has become an integral part of field research at ABC. The center views GREEN as new paradigm for cooperative research with citizens of the bay. And oyster gardeners have clearly demonstrated their commitment to the Chesapeake Bay community through their interactions with scientists and many others working to restore the oyster.

Over 60 people attended a training workshop in Kinsale on Virginia's Northern Neck last fall. Here, gardeners are building floats to grow oyster seed for reef replenishment purposes.

A Safer Oyster

By Angela Correa

As a commodity, oysters have been hit hard from all sides. Populations have been decimated by decades of intensive harvesting. Oyster disease has swept through the oyster colonies of the Chesapeake Bay, further reducing their numbers. And finally, recent warnings against consumption of raw oysters by elderly or immunocompromised persons have made many potential consumers wary of the product altogether.

Virginia's annual harvest of oysters *(Crassostrea virginica)* is approximately 30,000 bushels per year. Each season, the bay area's oystermen have had to work harder to bring in this catch, and there is strong indication that these harvest levels are not going to be sustainable unless there is a change in the way that the fishery is managed. The work being done to restore oyster populations to the Chesapeake Bay watershed and regulations intended to allow oysters to rebound on their own are both vital to the ultimate success of the bay's oyster fishery. However, on a more basic level, the success of these efforts will also depend on widespread support from consumers, who will show by their expenditures the level of confidence they have for the safety of the oyster supply.

Oysters are no more or less prone to harbor human pathogens than are other bivalves. Clams, mussels, and scallops are all potential carriers of pathogens such as *Cryptosporidium parvum*, or various types of marine *Vibrio* species. The difference is that oysters are commonly eaten raw. Research is underway to make oysters safer for public consumption and two studies currently going on at Virginia Tech should go a long way toward achieving this goal.

Vibrio parahaemolyticus has a high infectivity rate, especially for immunocompromised individuals. The illness progresses with fever, body aches, gastroenteritis, and diarrhea, but is rarely life threatening. *Vibrio vulnificus* infections are rare, but can lead to septicemia (blood poisoning), a condition that can be fatal.

Fortunately, *Vibrio* spp. are sensitive to a variety of stresses, a characteristic that can be exploited when finding ways to remove the threat of infection from a food

product. Scientists at Virginia Tech are currently exploring ways to eradicate *Vibrio* spp. while still being able to offer a raw product.

In their study, Drs. Kumar Mallikarjunan, Michael Jahncke, and Jaehon Koo of Virginia Tech are challenging oysters inoculated with *V. vulnificus* and *V. parahaemolyticus* against a variety of treatments. The new treatments being evaluated are HHP (high hydrolytic pressure), irradiation, and microwave. Initially, the treatments will be applied individually, but further research may produce a new protocol for raw oyster meat processing that uses two or more of these processes in conjunction. This work is being performed in partnership with Louisiana State University and Oregon State University.

Another study will assess the presence and public health significance of *Cryptosporidium parvum*. *C. parvum* is a common protozoan pathogen with worldwide distribution. Waterborne transmission of this parasite has led to large outbreaks, which have occurred with increasing frequency since the 1980s. One of the largest outbreaks occurred in Milwaukee, Wisconsin in April 1993, and involved the infection of 400,000 individuals. Over 100 people died as a result of that outbreak. Many other smaller outbreaks have been reported in the United States and Canada, and as a result, *Cryptosporidium* has become recognized as the most important biological water contaminant in the United States.

C. parvum-associated *cryptosporidiosis* causes acute diarrhea and gastroenteritis in immunocompetent humans or life-threatening illness in immunocompromised or immunosuppressed individuals. It has emerged as a global human health problem facilitated in its spread by zoonotic, waterborne, and foodborne transmission of the parasite. *C. parvum* is ubiquitous in most water bodies.

The study will determine the effects of various customary unit processing operations, such as depuration, heating, or freezing, on the presence of *C. parvum* in processed oysters. Also to be analyzed are alternative oyster processing methods, including microwave, irradiation, or HHP. A preliminary phase of the study has confirmed that, as expected, *C. parvum* was found in all oysters sampled from a number of sites along the eastern U.S. Knowing this, researchers at Virginia Tech will utilize PCR (polymerase chain reaction) testing and IFA (immunofluorescence antibody-based assay) to analyze hemolymph and gill washings from Eastern oysters that have been subjected to conventional and alternative processing operations.

These studies will make it possible for processors to provide oyster meat products that meet a higher standard for quality and safety, and will provide regulators and industry advocates with sound data on which to base goals and new regulations. In turn, increased reliability of the oyster supply will translate into increased use and greater support for conservation and restoration efforts in the Chesapeake Bay and beyond.

Angela Correa is the Virginia Sea Grant communicator based at Virginia Tech.

Ensuring a safe product is tantamount to consumer confidence in oyster purchases.

A Passing Legacy?

By Charlie Petrocci

Lining the walls of this maritime museum are historic black and white photographs of watermen perched on boat gunnels, holding long-shaft tongs and poised like stilt walkers above the water. Another photograph exposes rough men in oil skins hauling a net, standing knee-deep in shad. Yet another shows a long line of oyster shuckers barely visible among a growing mound of oyster shells. Nothing is out of the ordinary about these old photographs except for the fact that all the men in the pictures are Black and the photos are part of an exhibit dedicated to the cultural heritage of the African-American Chesapeake Bay fisherman.

"I've been working around these docks doing odd jobs since I was 8 years old," reminisces waterman Greg Stratton. "I started out cleaning fish for customers from the charter boats. I've cut 'n cleaned every fish imaginable, from blowfish to huge tuna. Matter of fact I'm still doing it, working the sportfishing season from spring through early fall. It's been good to me these past 38 years," he added. Stratton of Wachapreague, Virginia, still likes to work around the waterfront. "When I'm not cutting fish, I'm gillnetting for striped bass, spot, or croaker. Then I'll dig clams and oysters through the winter and go back to shad fishing in the spring, until the sports show up again for flounder season," he said. "You got to do what you can around here to stay on the water, because I can't work on land. It ain't for me," he added.

Stratton is one of only a handful of African-American watermen who still fish and work the back creeks and rivers of the Chesapeake Bay and the coastal Eastern Shore. Their numbers have been slowly dropping off. Today you would be hard pressed to find more than a bushel full of "next generation" Black watermen seeking a future in the commercial fisheries industry. After several generations, their role has shifted off the water and more into the processing end of the industry. But African-American fishermen have left an indelible mark on the history of seafaring and commercial fishing along Virginia waterways.

One who will always be remembered is Sammy Smith, of Wachapreague. People recall how he would come down to the docks to reminisce and stare out across the marshes, his face lined and cracked from years of working the shallow bays and seaside marshes. He once told me, "It seemed Black watermen always had problems, especially with getting good gear to work with. Matter of fact, good gear for us was hand-me-down gear from someone else. It was the best we could hope for. I did some haul seining for spot and also fished croaker and trout as well. But I started out hand oystering and

clamming and finished hand oystering and clamming."

It wasn't only the men who worked the water, making their mark in the historic Virginia seafood industry. Legions of black women honorably served as seafood workers throughout tidal Virginia, creating nationally recognized, value-added products. It was their hard labor in the shucking houses, crab picking houses, and fish processing businesses that allowed Virginia seafood to become synonymous with high quality seafood throughout the country. Though their presence is still an important component of the state's seafood industry, their numbers are waning due to outside economic forces: closures of processing houses and new employment opportunities.

African-American women have contributed significantly to the success of seafood packing houses. Left, Greg Stratton and brother, Milton, hold a day's catch.

Cultural heritage

African-American settlement around the Chesapeake Bay region began with slavery early in the 17th century. Many slaves came to Virginia already skilled as fishermen, since they were brought from the coastal countries of Sierra Leone and Liberia where fishing was an important part of their tradition. Quite often slaves were sent by landowners here to harvest fish from local creeks and bays to help supplement food sources. Various fish and shellfish provided food for slave families and income for slave owners. Haul nets, fish traps, and fyke systems were all utilized by a Black fisherman.

"In the winter, when we wasn't crabbin' or oystering, we'd go haul seining for shad and carp," related 80-year-old retired waterman, Thomas Winstead of Kilmarnock. "Times were tough on the water in the old days. Could never get the right gear to work with, so we had to improvise as best we could. We'd do anything we could just to make even 5 cents a day more, and that sometimes meant fishing illegally up in back creeks. In those days, whether you were White or Black, everybody did a little illegal fishing and everybody knew it. It was honor among thieves, you might say," he added.

Just after the Civil War and leading up into the beginning of the Depression, African-American men and women of the Chesapeake served as watermen and oyster shuckers or crab pickers for the many seafood processing facilities that were gaining national recognition for excellent products. The Eastern Shore at one time supported one of the largest and earliest free Black populations in the country.

Blacks not only worked as oyster tongers, but also served as dredge crew on skipjacks and deadrises. They piloted schooners and bugeyes up and down the bay, hauling seafood, farm produce, and other supplies to and from small waterfront communities. Some of the finest oyster tongs found on the bay were crafted by African-American blacksmiths, and there were many skilled workers who made sails, built boats, and owned seafood companies.

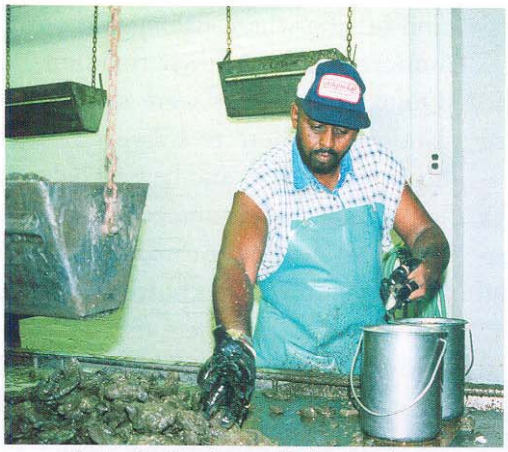
"For 11 years I worked as a navigator on bunker boats fishing off of New Jersey and Delaware," stated Winstead. Very few Black men on bunker boats worked in other areas besides deck labor. But as a navigator there was a hell of a lot of responsibility for the wages I received. So I quit in 1966 and went back to working on the water for myself." The bunker fishing boats, such as those found around Reedville, Virginia, are one of the last bastions for Black fishermen today. Known for their hard work and chorus songs while hauling nets, Black crews on bunker boats represent an era that is slowly disappearing.

It was in the post Civil War era that Chesapeake Bay seafood – especially oysters – really began to grow as an industry. This national oyster craze may have been the residual effect from thousands of prisoners, both Confederate and Union, who were fed local fish and shellfish during the war. Oysters were cheap, fresh, and readily available. Many prisoners, like those

Confederates held at Fort Point Lookout on the Chesapeake Bay, frequently foraged for their own oysters "until we were sick of them," as one soldier later wrote. Even front line troops were served canned oysters. After the war many soldiers from distant states took their newfound seafood tastes home, creating future demand.

During the heyday of the oyster boom in the late 1880s, there were over 1,500 Black watermen working on Virginia oyster boats alone. It was the Black oyster shuckers who were the backbone of the industry. They came each oyster season to the Eastern Shore from North Carolina, New York, and New Jersey. They carried their clothes in carpet bags, pillowcases, and tied up in blankets. Good oyster shuckers were prized by any good oyster packing house, and they were frequently rewarded with seasonal gatherings of fried oysters, beer, and music. A good shucker could open an oyster in under five seconds. Profits were high for packers and competition, even higher for good workers. Otis Taylor, a retired shucker, said, "We would start around 5 A.M. and work until 11 or 12 o'clock. During breakfast and breaks we would gather by the pot-bellied wood stove and eat sandwiches and tell jokes about each other. It was great comraderie." To the passerby, singing could often be heard echoing from the cold, damp shucking house rooms.

In the 1880s, Black watermen made good money, especially in an age when the average yearly income was $500 no matter what color you were. But this economic gain for a dangerous job sometimes came with a heavier price – injury or even death. And too often there were times when Black watermen did not get the same deal as their White counterparts. Explained Sammy Smith, "Sure, sometimes we knew we weren't always getting the best deals, but this was the seafood industry and no matter what color you were it seems you never got what you thought you deserved. Markets were always terrible and I don't think that has changed, even today."



Oyster shucking by capable hands is key to a profitable packing operation.

An uncertain future

Now, there are not many African-American waterman left working on the Chesapeake Bay. Some have gone because the fishing has dropped off, while others have left because they couldn't afford to stay in it any more. "To be a fisherman these days, you have to have a certain amount of finesse," noted retired waterman Winstead. "You also have to have some money to get into it. And no matter how you look at it, it's a tough business."

Seafood packer Dallas Taylor added, "Most Blacks today want to be inside working where it's a lot warmer. I can't blame them because I remember those days of wearing cotton gloves and beating the ice off and having to put them back on until they froze up again."

Stratton added, "My father was a waterman. He used burlap bags as sails when he was oystering. I've done okay so far, but I don't want my son to be a waterman. I put him in college and he helps me during the summer months. I just hope it doesn't get in his bones though."

Waterfront towns grew during the heyday of seafood cultivation on the Chesapeake Bay. Many of these small towns were home to Black watermen who held positions of public leadership and eventually started their own seafood businesses. The continued survival of these enterprises depends not only on vigorous marine life, but on the future ranks of new watermen. Whether the jobs will be filled by African-Americans is yet another question. But there is no doubt that the Virginia seafood industry has thrived over the years largely because of the hard work and contributions made by African-American men and women. *They* are the legacy.

Fishermen: Bring Us Your Best Ideas

By Tom Murray

The Virginia Fishery Resource Grant Program (VFRGP), initiated by the Virginia Legislature in 1999 to "protect and enhance the Commonwealth's coastal fishery" has been continued. The program is based on the simple approach that experienced fishermen come up with ideas to improve their productivity or reduce costs everyday. Typically, attempting such an idea or change entails a cash outlay that is too big of a risk for an individual to justify, particularly if any benefits of the idea would also be gained by his competition. The VFRGP was created to fund just those costs associated with such a change in a fisherman's operation, so that he or she does not bear all the risk and expense for improving industry-wide productivity.

The VFRGP invests in the ideas generated by the fishing public through fair and competitive methods. To be eligible under the VFRGP, a proposal must involve Virginians who are active participants in a fishing industry; that is, commercial fishing activities related to coastal or offshore fishery resources, aquaculture/mariculture, or the processing or handling of fish products.

Building upon its successful start-up, the Legislature has continued funding of the VFRGP for 2001-2002. A series of workshops will be held to explain the program during the late spring (a notice and request for new projects was issued in April). Following formal outside reviews and recommendations from the Industry Advisory Panel, it is expected that final project funding decisions for the new VFRGP projects will be completed by July 2001.

Individuals who previously submitted projects will automatically be included in informational mailings and notified of scheduled meetings, unless they request to be removed from the VFRGP mailing list. Those who have specific questions about the VFRGP projects funded or other questions about the program may contact:

Thomas J. Murray, Marine Business Specialist
Virginia Institute of Marine Science
P.O. Box 1346
Gloucester Point, VA 23062
Phone: 804-684-7190/Fax: 804-684-7161
E-Mail: tjm@vims.edu

Nine grants awarded in 2001

After a successful first year, a second round of proposals were submitted by fishermen in response to a *Request For Proposals* issued last fall and considered for funding by the program at the end of last year. The proposals were quite diverse and each project idea was subjected to three expert reviews outside of Virginia. The reviewers completed their assessments during December and following the holidays, a project selection meeting was held at VIMS with the industry advisory panel in January. From that meeting, the decision to fund nine projects was reached and the work on each has now been initiated.

The work covers many areas of Virginia's commercial fisheries, and projects funded include:

- *"Raising Spot (Leiostomus xanthurus) Commercially for Sale as Live Bait in the Commonwealth of Virginia"* Ward Oyster Co., Ware Neck
- *"Efficiency of Haul-Seine Cull Panels - A Comparison of Size Selectivity and Relative Release, Second Year"* C.H. Hager, Hayes
- *"Scallop Trawl Improvement Program"* Old Point Packing Company, Newport News
- *"Control of Mud Blister Formation in Oysters"* Dennis Gryder, Hampton
- *"Enhancement of Seed Oyster Recovery and Redeployment, Second Year"* W.S. Magann, Chesapeake
- *"Portable Anchor Trap Net Designed with Large Mesh to Harvest Cownose Rays"* Douglas Jenkins, Sr., Warsaw
- *"Taylor Float Tidal Flow Regulator"* Brad Knight, Saxis
- *"Crab Pot Marking Tags"* Diana Gadwill, Kinsale
- *"Comparative Study of Four Popular Oyster Grow-out"* Jack White, New Point

Get Ready, Get Set, Grow!

By Sally Mills

If the Eastern oyster could pick an advocate to fight for its survival, it would be well served by Jack White. As an oyster grower and purveyor to fine restaurants, White's passion for the bivalve is apparent in every business move he makes.

The recipient of a Fisheries Resource Grant award this year, Jack White is busy analyzing oyster growth in a variety of mediums intended to also compare predation and long-term costs. Specifically, he will evaluate the Taylor float, the Oyster King – as well as a suspended version of it, and the Circle C float, using a comparable volume of starter seed. All four floats cost about the same to build – running about $50-60 in materials – and use wire mesh around a PVC frame, but differences in size, access points, and placement in the water column differentiate the four grow-out methods.

Jack White holds up the "Circle C" float, which capitalizes on the oxygen and plankton available at the water's surface.

Running trials at his Horn Harbor site in Mathews County, White will rate each grow-out system on ease of handling, fouling, oyster growth, and overall performance at the one-year benchmark. He will continue to monitor oysters during year two, and plans to evaluate second year mortality rates as well. In recent years, cultured oysters have exhibited much greater risk to mortality after the 18-month mark.

While too early to make any predictions about the outcomes of this project, in other experiments White has witnessed a 50% drop in mortality for oysters placed in the Oyster King/off-bottom rig when transferred after the first year from a Taylor float. The Taylor float, by contrast, appears to enhance first year growth because, as a surface float, it allows more light and food to reach the bivalves.

The information gleaned from this project will benefit not only Jack White and his Captain Jack's Seafood Company, but a host of oyster gardeners who are positioned along the docks and shallows of Chesapeake shores, growing oysters for replenishment purposes. The commitment by this cadre of oyster stewards excites White, who believes that – while not a panacea – a healthy oyster population is key to a healthy bay.

He also sees the need for private industry to "step up to the plate" to help meet the pressing need for culturing oyster seed. Noting that the ecological benefits of a large-scale oyster replenishment effort are well known, White believes that those services should be *marketed* and, ultimately, would create commercial value.

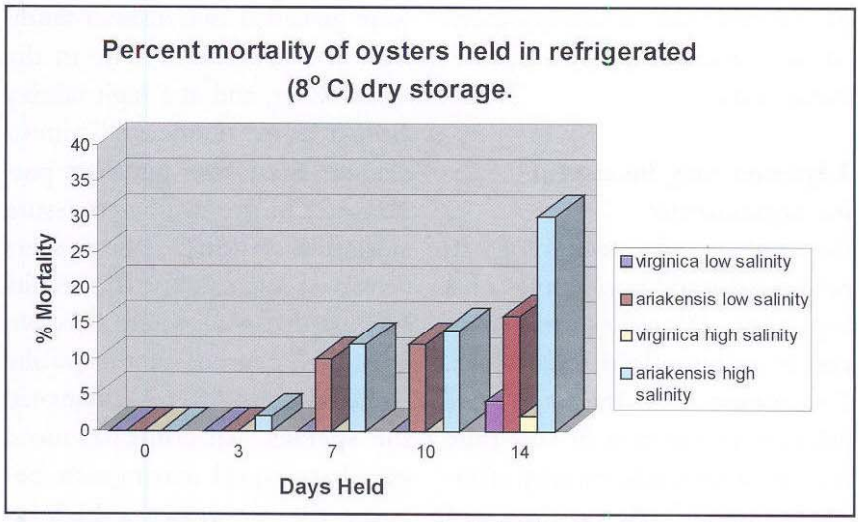
He works hard these days to overcome natural resistance to Chesapeake Bay oysters within the marketplace. White delivers a pathology report with each order to certify the animal's clean bill of health. It is just one strategy he uses to ameliorate client concerns about oyster disease and safety. Other challenges he faces center upon perceived inconsistencies and unreliability in supply.

"It's a constant battle. You have to be committed to taking that extra step, to bending over backwards to get market share back," he cautions. If enthusiasm is any measure, Jack White appears well on his way to doing just that.

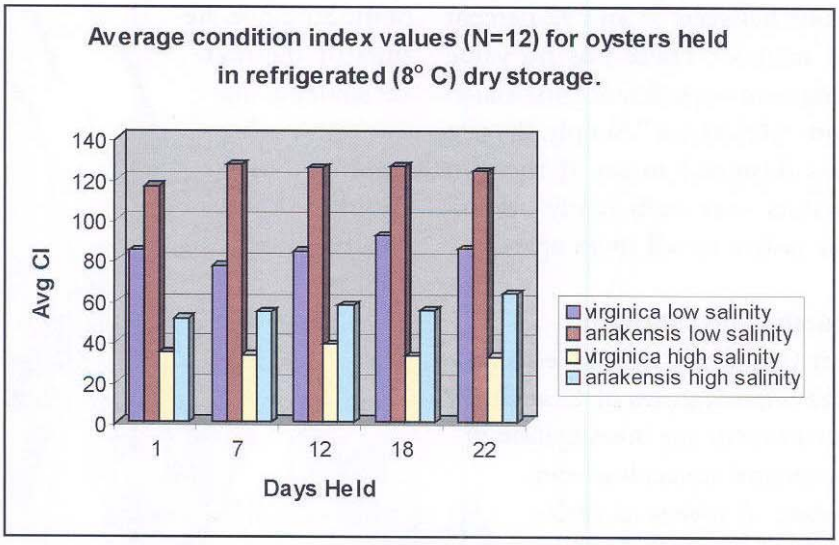
Investigating the Potential of the Suminoe Oyster

By Dr. Standish K. Allen, Jr.

The Suminoe oyster, *Crassostrea ariakensis,* was inadvertently brought to North American waters in the 1970s in shipments containing another Asian import, *C. gigas,* from southern Japan. The Suminoe survived, grew well, and provided the basis of brood stock for hatchery propagation on the West Coast. Presumably, there have been no other imports of wild-type brood stock to complement these original introductions, so the genetic variability of the Suminoe oyster is unknown. The Aquaculture Genetics and Breeding Technology Center (ABC) at the Virginia Institute of Marine Science is currently investigating the population genetics of the Suminoe, anticipating the need for new brood stocks. The center currently has three stocks from southern Japan, northern China, and southern China, which are under-



Graphs by Robert Fisher, Commercial Fisheries Specialist



Recent shelf-life studies reveal, in part, that C. ariakensis *sustained higher mortalities than* C. virginica *during refrigerated storage. The condition index, measuring meat yield, remained relatively constant for both species during the first 22 days of testing.*

going testing for their potential use in the Chesapeake Bay.

Normally, introduction of a non-native for testing or anything else entails considerable risk that the animal will colonize. No one can predict the outcome of colonization. However, for the tests previously described, triploids (a genetically modified oyster) were used. Triploids have too many chromosomes and therefore reproduce unsuccessfully. Triploids are produced in the ABC research hatchery at Gloucester Point. As long as *only* triploids are used in the bay, the risk of environmental harm from non-natives is virtually zero.

Triploids may be useful for aquaculture

We now have the technology to produce triploid non-natives on a large scale. We refer to this innovation as tetraploid technology. Tetraploids allow the large-scale hatchery production of very pure broods of triploids, thereby offering industrial scale quantities of "neutered" seed. Under these circumstances, it is reasonable to imagine a strong aquaculture industry using triploid non-natives, especially *C. ariakensis,* in Chesapeake Bay in concert with restoration attempts such as reef building and continued development of disease resistant native oysters. This diversified strategy makes good business sense, and with the benefit of Sea Grant funding, we continue to evaluate the opportunities and risks associated with triploid *C. ariakensis* aquaculture.

Can you taste the difference?

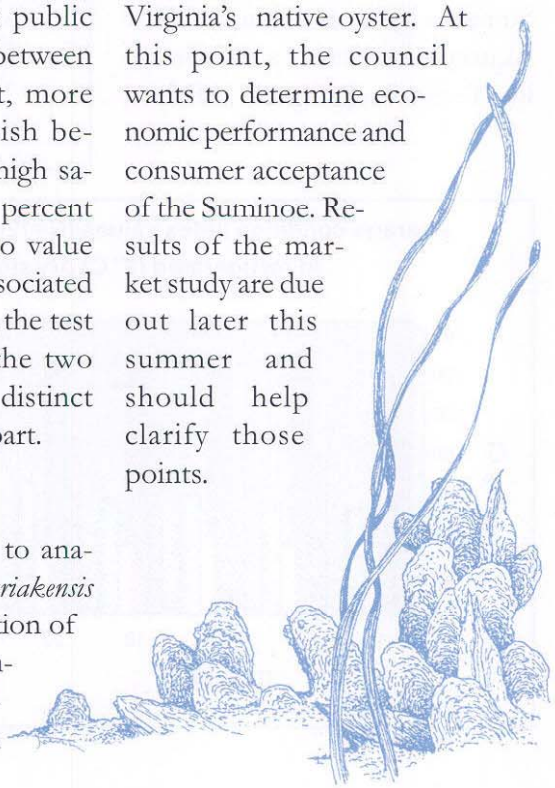
The Sea Grant Marine Advisory Program and the ABC convened a taste panel last May to answer this question. Panelists were volunteers who appreciated oysters, and therefore represented oyster consumers in the general public. Each panelist was presented with three oysters to taste: either one *C. virginica* and two *C. ariakensis,* or two *C. virginica* and one *C. ariakensis.* They were asked to determine which one was different from the other two.

For contrast, both species were grown at two distinct salinities: at a low salinity site in the Coan River, and at a high salinity site in Tom's Cove in Chincoteague. Sixty-four panelists participated in the tasting to assure statistical validity. For oysters grown at low salinity, the results suggest that somewhere between 3 and 32 percent of the public could taste the difference between the species. In contrast, more panelists could distinguish between the two grown at high salinity: between 33 and 92 percent of tasters. There was no value judgment or preference associated with "difference." Simply, the test was designed to see if the two oysters were sufficiently distinct for tasters to tell them apart.

Further investigation

Sea Grant staff continue to analyze other features of *C. ariakensis* germaine to any investigation of a potential aquaculture candidate. A review of shelf-life indicators reveals, in part, that *C. ariakensis* sustained higher mortalities than *C. virginica* during refrigerated storage, while the condition index (a measure of commercial quality, or meat yield) in both species remained relatively constant through 22 days (see graphs, page 19).

A broad study to gauge consumer reaction to other Suminoe attributes is currently underway in the marketplace. Factors such as shell and meat appearance, texture, and flavor will be evaluated. The information is being gathered on behalf of the Virginia Seafood Council, whose members support the continued examination of *C. ariakensis* as a harvestable oyster in Chesapeake Bay. According to executive director Frances Porter, the Virginia Seafood Council continues to follow oyster research closely and views *C. ariakensis* as a strong alternative to Virginia's native oyster. At this point, the council wants to determine economic performance and consumer acceptance of the Suminoe. Results of the market study are due out later this summer and should help clarify those points.



Chesapeake Bay Oyster Reefs: Living Classrooms

By Vicki Clark

"Once upon a time in the Chesapeake Bay, the Eastern oyster formed reefs so large that Captain John Smith had to guide his ships carefully between and around them. Oysters were so plentiful that they could filter the entire volume of the Bay in only three days!"

This is not the beginning of a fairy tale; it's one of many historic and scientific facts that have drawn educators into a "vortex" of activities at the Virginia Institute of Marine Science since 1998. VORTEX (Virginia's Oyster Reef Teaching EXperience) is an educational program designed to provide teaching resources, field experiences, and laboratory activities for science teachers and other educators who want to learn more about oysters and reefs in the Chesapeake Bay. Designed by scientists and educators at VIMS, the VORTEX project has included a series of summer and school year workshops, web-based information, and multimedia teaching resources including print publications and a CD-ROM.

VORTEX participants may find themselves knee-deep in oysters in the Piankatank River with Dr. Roger Mann and Dr. Juliana Harding, watching the activities of blennies, gobies, blue crabs, and other residents of a living oyster reef. Or they may be aboard a VIMS vessel analyzing currents, water quality, and tidal circulation patterns to determine the best place in the river for a new oyster reef restoration site. In VIMS labs and classrooms, educators study the basic anatomy of the oyster, learn about the importance of oyster reefs to the Chesapeake's ecology, fisheries, and water quality, trace the history of commercial oystering in the bay, and practice activities that they can use back in the classroom with their own students. All activities are correlated specifically to selected Virginia Standards of Learning for biology and life science, but there are applications to mathematics, physics, chemistry, and social studies as well.

The goal of VORTEX is to provide educators with information and resources to help them teach students and the public about the Chesapeake's oyster reefs, and to encourage their in-

BRIDGE
Oyster Information

November 1999 Data Tip of the Month
Aquaculture: A Cornucopia?
Learn more about aquaculture and how it is being used to help the burden the seafood industry is placing on wild stocks. With the data exercise, compare the United States' oyster aquaculture production rates to those of Canada.

Great Oyster Links

- Oyster Stew
www.wsg.washington.edu/oysterstew/OysterStew_intro.html
A smorgasbord of information on oysters, this site has everything from oyster biology to aquaculture to nutritional information.
- Oysters
www.mdk12.org/practices/support_success/hsa/biology/oysters/index.html
A Maryland Sea Grant resource with information on restoring oysters, oyster gardening, the oyster farming vs. oyster hunting issue, and a collection of classroom resources including background information, labs, and experiments.
- The American Oyster
www.ifmt.nf.ca/mi-net/fishdeve/oyster.htm
Learn about the biology of the oysters including the anatomy, life cycle, distribution, and behavior.

volvement in and support for reef restoration research and activity. Over 100 educators have participated in VORTEX workshops, and VIMS staff members have given presentations about the VORTEX program at numerous scientific and education conferences.

The VORTEX program is co-sponsored by the VIMS Department of Fisheries Science's Molluscan Ecology program (http://www.vims.edu/fish/oyreef/reef_page.html) and the Virginia Sea Grant Marine Advisory Program (http://www.vims.edu/adv). The Virginia Environmental Endowment and the Chesapeake Bay Restoration Fund Advisory Committee have provided funding support, and the Virginia Marine Resources Commission's Fisheries Management Division provided assistance with field activities.

The initial VORTEX program was completed in the spring of 2000, but future workshops are on the horizon. For more on professional development opportunities for teachers at VIMS, contact the Virginia Sea Grant Marine Advisory Program office at (804) 684-7170.

Teachers head out to oyster reef.

Selected VIMS/Virginia Sea Grant Resources for Teaching and Learning about Oysters and Oyster Reefs

For ordering information, see the VIMS Molluscan Ecology Program website (www.vims.edu/fish/oyreef/reef_page.html) or call 804.684.7170:

◆ Oyster Reefs in the Chesapeake Bay: A Brief Primer
Harding, J.M., R. Mann, and V.P. Clark
A nine-page illustrated booklet describing oyster biology, reef ecology, history of the Chesapeake oyster fishery, and restoration efforts.

◆ Shell Games
A 20-page illustrated booklet for life science and biology teachers that includes classroom activities and information on molluscs and oyster reefs.

◆ Oyster Reef Communities in the Chesapeake Bay
http://www.vims.edu/fish/oyreef/orccb.html
A CD-ROM with extensive information and illustrations on oyster biology, reef ecology, the fishery, and restoration efforts.

On-Line Resources:

◆ VIMS Molluscan Ecology
http://www.vims.edu/fish/oyreef/reef_page.html
This site describes oyster reef monitoring programs, research projects, and restoration activities ongoing at the Virginia Institute of Marine Science.

◆ The Bridge: an Ocean Sciences Resource Center for Teachers
http://www.vims.edu/bridge/
See "biology" section for links to teacher-friendly websites on oysters and other molluscs.

◆ Maryland Sea Grant: Oysters
http://www.mdsg.umd.edu/oysters/
See "oysters in the classroom" for laboratory activities.

Volunteer Opportunities:

◆ Chesapeake Bay Foundation's Student Oyster Corps
http://www.cbf.org/education/restoration.htm
Students, teachers and interested citizens grow and monitor oysters that are used to stock sanctuary reefs in Virginia & Maryland waters.

Virginia contact:
Laurie Sorabella
757.622.1964; lsorabella@savethebay.cbf.org
Maryland contact:
John Rodenhausen
410.268.8816; jrodenhausen@savethebay.cbf.org

◆ Virginia Department of Environmental Quality
Oyster Heritage Program
http://www.deq.state.va.us/oysters/homepage.html

◆ Tidewater Oyster Gardeners Association
http://www.oystergardener.org/

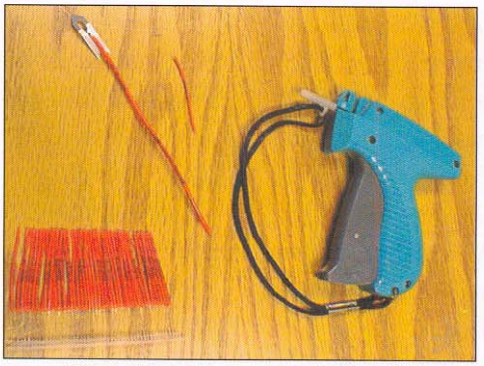
Anglers: Consider the Re-release

By Jon Lucy

Trained anglers in the Virginia Game Fish Tagging Program tagged just over 7,500 fish during 2000, similar to 1999's effort. Concentrating on ten targeted species, participants have tagged over 34,500 fish since 1995. With an overall recapture rate of 9.5%, the program currently focuses on tagging summer flounder and sheepshead (both added in 2000), red and black drum, speckled trout, black sea bass, tautog, spadefish, and cobia. Anglers who report tagged fish recaptures receive a cap as a reward.

The program only produces data if vigilant anglers serve as the program's "eyes" and report recaptures of tagged fish. Orange program tags may lie along either side of the base of a fish's top (dorsal) fin. You should always examine both sides of your catch for tags. Report tagged fish information without delay (including tag number, length, place/date caught) by calling the telephone number on the tag, or 757-491-5160.

Rather than remove the tag, we encourage you to write down the recapture information (plus the telephone number); then re-release the tagged fish. Double check that you are accurately recording the tag number. A wet cloth or towel placed over the head of the fish will calm the fish and keeps its gills moist, and help you to get an accurate measurement. If possible, measure the fish from the tip of its jaw to the farthest extension of its tail while laying it flat on a ruler (often on cooler tops) or measuring tape.



Either of these tag types may be found in targeted recreational species.

By re-releasing a tagged fish, you join the initial tagger in having a personal stake in the fish, and help contribute to perhaps the most useful type of tag return information. Compared to a single recapture event, multiple release-recaptures better document short- and long-term residence and movement patterns of fish over periods of weeks, months, or even years.

Multiple releases of tagged cobia, for example, are documenting that individual, spawning-sized cobia return annually to the lower Chesapeake Bay. Repeated releases also confirm that, after entering the bay, flounder remain around specific fishing piers for weeks to several months, something not previously known. We are learning that black sea bass, tautog, and spadefish can stay associated with given structures for weeks to even months, and some individuals survive being caught more than once in the same day or week.

With the aid of longer, stainless steel dart tags, the program is now able to focus more tagging effort on large red or black drum, and cobia. And releasing one of these tagged fish does more than just benefit the tagging program: You can earn a *release citation* for the fish (if 44 inches or longer) by submitting an application to the Virginia Saltwater Fishing Tournament. Smaller, T-Bar tags -- which are primarily used on fish up to about 20 inches long -- may also be found on larger fish. Carefully check your catch for either tag type.

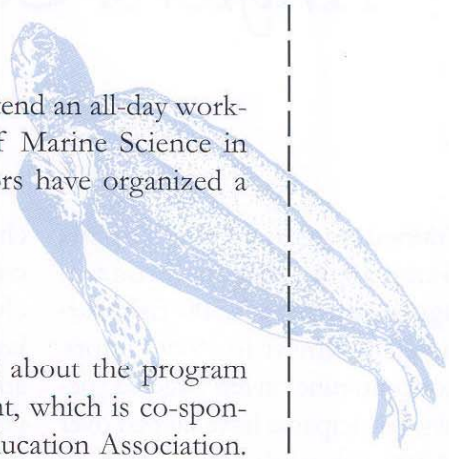
Announcements

Attention Educators!
Sea Turtle Workshop

Interested in learning more about sea turtles? Plan now to attend an all-day workshop on Wednesday, June 27th, at the Virginia Institute of Marine Science in Gloucester Point. Sea turtle biologists and marine educators have organized a fun, educational day featuring:

- Information sessions
- Tours of the sea turtle greenhouse
- Classroom and computer activities to take home

Contact Lisa Lawrence at ayers@vims.edu for more details about the program and associated costs. Pre-registration is required for this event, which is co-sponsored by Virginia Sea Grant and the Mid-Atlantic Marine Education Association.



VIRGINIA CLEAN MARINA

The Virginia Marina Technical Advisory Program began its first series of workshops aimed at providing marina owners and operators with technical advice on marina related issues. Workshops in March and April were held at: York River Yacht Haven in Gloucester Point, Washington Sailing Marina in Alexandria, Windmill Point Resort in White Stone, and the VIMS Wachapreague Campus on the Eastern Shore. Topics covered included the Virginia Clean Marina Program, the Boating Infrastructure Grant Program, Virginia stormwater laws and permits, and derelict boat issues. Speakers from the Virginia Department of Game and Inland Fisheries, the Virginia Department of Health, and the Virginia Department of Environmental Quality all made the workshops a success. More programs are planned for the fall of 2001 and spring, 2002.

The Virginia Sea Grant Marine Advisory Program has placed a temporary hold on seafood seminars at VIMS while kitchen renovations are completed.

Virginia Places 6 Out of 19:
National Ocean Sciences Bowl

The Consortium for Oceanographic Research and Education hosted the finals of the National Ocean Sciences Bowl competition on April 2 & 3, in Miami. The first place prize in this academic competition went to Lexington High School, Lexington, MA. The champions will fly to England and visit scientists at the Southampton Oceanography Centre and then on Gothenburg, Sweden, to sail aboard one of the Volvo 60 racing yachts. Second place went to Contoocook Valley Regional High School, Peterborough, NH. These students will join scientists aboard Royal Caribbean International's Explorer of the Seas, the largest cruise ship in the world. Third place went to Cranston High School West, Cranston, RI, and they are off to Catalina Island and the University of Southern California's Wrigley Institute. Fourth place went to Irmo High School of Columbia, SC. They will be traveling to Michigan to visit the Great Lakes Environmental Research Laboratory. Virginia's team from Catholic High School in Virginia Beach placed 6th out of 19 teams and received a $500 gift certificate to purchase scientific equipment or ocean science resource materials for their schools. Congratulations to all!

"When Captain John Smith visited the Chesapeake shore of North America in the seventeenth century, he observed that the Indians were well acquainted with oysters and valued them highly. The Nanticoke Indians, for example, were fond of raking up large piles of fresh oysters from creek bottoms with forked sticks and indulging in feasts that sometimes lasted for days. The largest oyster midden left by the Indians in the Chesapeake Bay region covered nearly thirty acres of land near Pope's Creek on the Potomac River. Similarly, history records a mound containing eight million cubic feet of oyster shells near an Indian village on the Damariscotta River in the state of Maine. British colonists first tasted Chesapeake oysters in 1607. While at Cape Henry, Captain John Smith and his men discovered an Indian campfire in a wood clearing and found several baskets heaped high with oysters. They ate some raw and roasted others, and Captain Smith found them 'large and delicate in taste.' Oysters were so plentiful in the Bay during this period that occasionally ships would run aground on oyster beds like the huge 'oyster reef' at the mouth of King's Creek on the Virginia shore."

Excerpted from
The Oyster Wars of Chesapeake Bay
by John R. Wennersten

Sea Grant Communications
Virginia Institute of Marine Science
Post Office Box 1346
Gloucester Point, Virginia 23062

NONPROFIT ORGANIZATION
US POSTAGE PAID
NEW HAVEN, CT 06511
PERMIT NUMBER 1411

Address Service Requested