Chesapeake Quarterly

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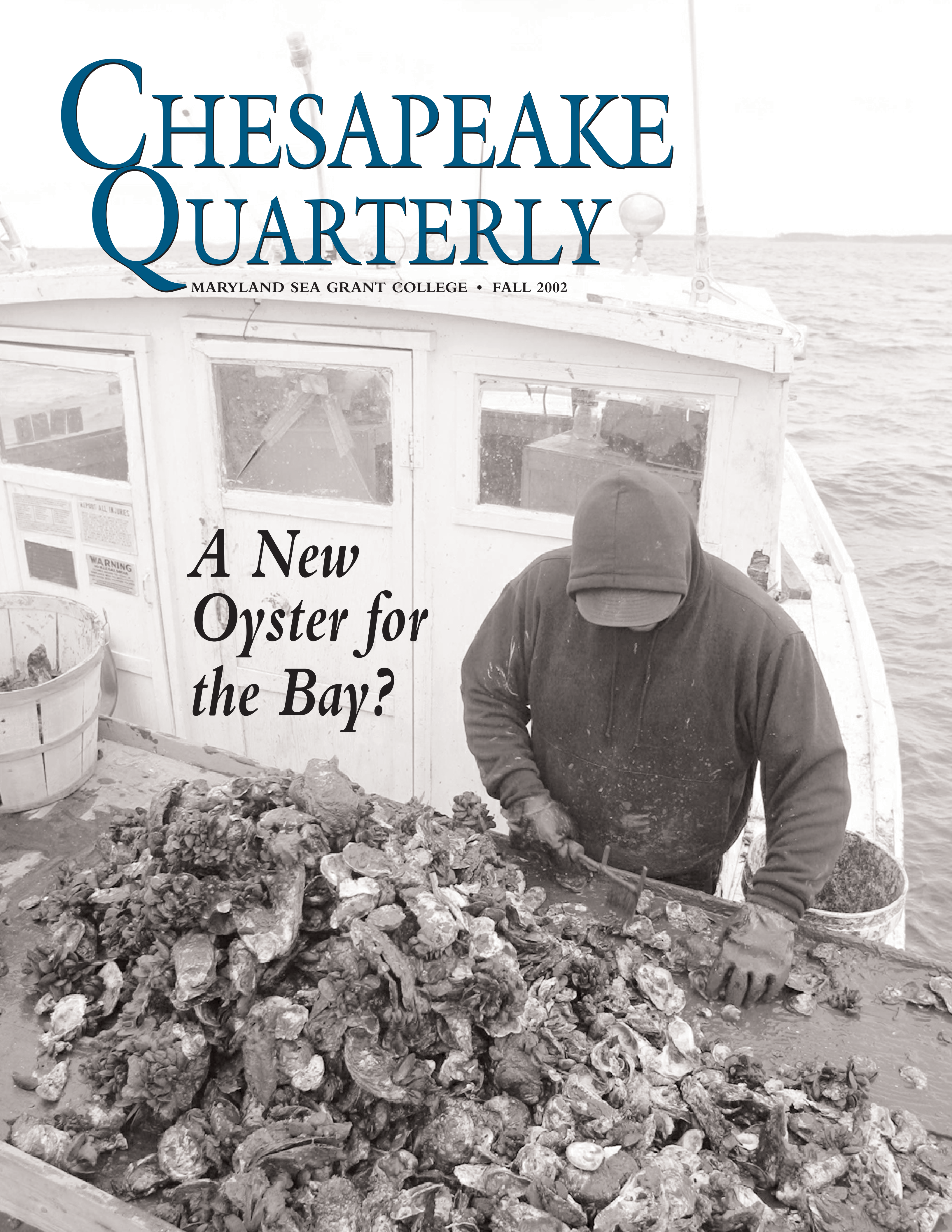

A New Oyster for the Bay?

Contents

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Photos: *(Cover) Early morning aboard the* Miss Eleanor, *waterman Alton Brown culls through piles of shell he has tonged to retrieve oysters at least three inches in length. (Above) Brown prepares to lower his tongs over the side and into the Chester River. Photos by Skip Brown.*

Crisis and Controversy Does the Bay

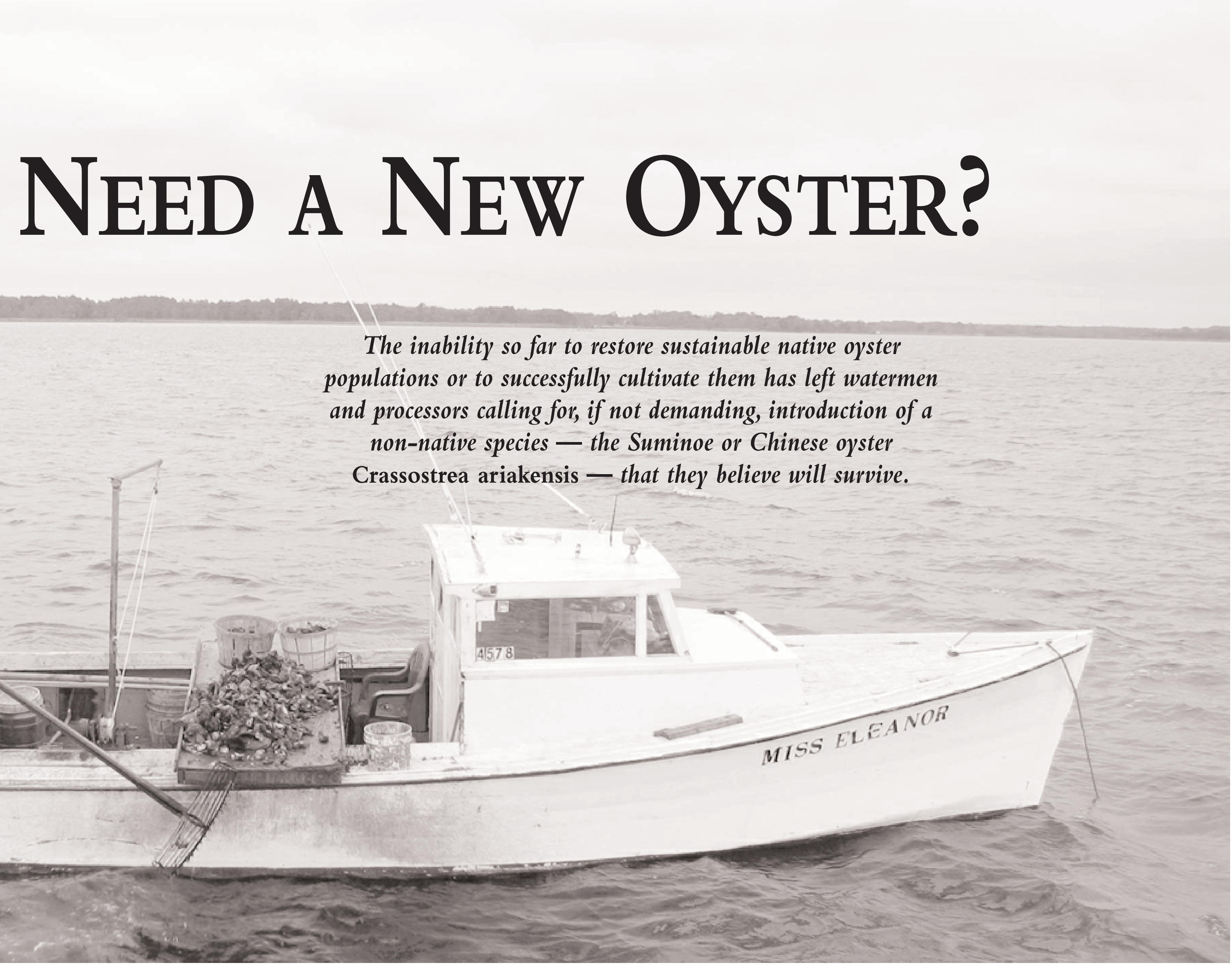
By Merrill Leffler

Years of parasitic disease have left Chesapeake Bay oysters and the industry that has depended on them a faint shadow of what they once were. In 1982, the Maryland Department of Natural Resources (DNR) issued nearly 5300 licenses to watermen who had been hauling an average of 2.5 million bushels of oysters a year from public grounds. The speculation is that harvesters this year may be lucky to bring in 50,000 bushels. Virginia watermen have been considerably worse off. Before MSX disease began killing oysters in the lower Bay in the late 1950s and Dermo in the 1980s, Virginia's private leaseholds and public grounds had yielded more than four million bushels — in 2000 and 2001, the yield has sunk to 20,000.

Many in the Bay industry feel that *Crassostrea virginica*, the Bay's native oyster species, is on the verge of failure, at least as far as the traditional oyster fishery goes. "This could be the year that we declare the economic extinction of the Chesapeake Bay oyster fishery," says Pete Jensen, former head of Fisheries for Maryland DNR. It is because of the inability so far to restore sustainable oyster populations or to successfully cultivate them that watermen and processors are calling for, if not demanding, introduction of a non-native species — the Suminoe or Chinese oyster *Crassostrea ariakensis* — that they believe will survive. Given the state of the native oyster, the question of whether or not — let alone how — to introduce a new species to the Chesapeake is one that poses complex challenges that have ecological and social implications.

NEED A NEW OYSTER?

The inability so far to restore sustainable native oyster populations or to successfully cultivate them has left watermen and processors calling for, if not demanding, introduction of a non-native species — the Suminoe or Chinese oyster **Crassostrea ariakensis** *— that they believe will survive.*



The Crisis: Desperate Efforts to Restore the Native Oyster

Reef Building

Millions of dollars are being spent to try to restore reproducing populations of native Bay oysters. "Reproducing" is the operative word. In Maryland so far, disease-free oyster seed (called spat) planted in low salinity locations often will contend with disease and eventually reach harvestable size, says Kennedy Paynter of the University of Maryland College Park. However, he is quick to add, oysters in these regions sometimes grow slower and recruitment of young oysters, or spatfall is infrequent. Historically, Virginia's high salinity waters provided richer conditions for oyster spawning — in the James River, the Great Wicomico and elsewhere. Seed oysters from these rivers provided state growers with spat that they could purchase and plant on their leased grounds. Those once abundant seed grounds have largely fallen victim to MSX and Dermo.

The Chesapeake Bay Program is committed to a tenfold increase in oysters by 2010 (over the base year of 1994) as part of the Chesapeake 2000 agreement, a broad range of targeted goals that state and federal officials have officially signed on for. The signatories include the governors of Maryland, Virginia and Pennsylvania; the Mayor of the District of Columbia; the head of the U.S. Environmental Protection Agency; and the Chesapeake Bay Commission, a tri-state legislative body. The commitment to restoring oyster populations gives focus and a deadline to efforts that were already underway in Maryland and Virginia, particularly to help rehabilitate their fisheries.

A decade ago, the Virginia Marine Resources Commission (VMRC) began large-scale construction of oyster reefs in the mainstem Bay and its tributaries. Once a structural feature of the Chesapeake, oyster reefs were virtually leveled over the nineteenth and twentieth centuries by harvesting techniques; they were then silted over by runoff and the remaining oyster populations have been battered by disease. Based on historical records and scientific studies, it was reasoned that broodstock planted on

What's Killing the Native Oyster?

SKIP BROWN

MSX, which is caused by *Haplosporidium nelsoni*, is present throughout Virginia's portion of the Bay — in years of low rainfall such as the last several, higher salinities push further up the Bay into Maryland waters as does MSX virulence. The disease is often deadly above 15-20 parts per thousand salt (ocean water is 32 ppt). Recent studies by Kim Reece and Eugene Burreson at the Virginia Institute of Marine Science (VIMS) make a convincing argument that MSX arrived in the Chesapeake in the 1950s along with the Pacific oyster *Crassostrea gigas* that growers and researchers along the east coast were then considering for its commercial value. At the time, no one knew about MSX and for some years, scientists couldn't correctly identify its genus. (It was named MS was for the appearance of a multispheric nucleus and X for unknown.) While *C. gigas* may have MSX, it can fend off infections — the Bay's native oyster *Crassostrea virginica* cannot.

Dermo disease is the result of *Perkinsus marinus*, a protozoan like MSX; originally identified as the genus *Dermocystidium* (the shortened version has hung on), it has long been a resident in the warmer waters of the Gulf of Mexico, though over the years it has spread along the east coast and caused havoc to oyster fisheries there and elsewhere. Whether Dermo entered the Chesapeake with oysters originally brought in from the south is unknown. Regardless of how it arrived, it now persists on most public oyster grounds throughout the Bay.

reconstructed three-dimensional reefs would help oysters once more produce sustainable populations.

Like other *Crassostrea* species, *C. virginica* reproduces by "broadcasting," or releasing, millions of eggs and sperm directly into the water; the fertilized eggs then become free-swimming larvae. Large reefs, with spawning oysters in close proximity to each other, would increase the probability of many more larval oysters. It is those larvae that after two or three weeks of feeding and swimming search for a hard surface — preferably other oyster shells — on which to cement themselves.

The Virginia Oyster Heritage Program is a more recent initiative that, under the direction of VMRC's Jim Wesson, has been building three-dimensional reefs (six- to eight-feet tall) with the concept that they would serve as breeder reefs: stocked with broodstock, larvae might set on the reef or in surrounding 25-acre area of deep layers of shell.

Maryland Department of Natural Resources (DNR), too, undertook new approaches for promoting oyster recovery by developing sanctuary sites and managed harvest reserves. Sanctuaries, which are off-limits to harvesting, were developed with the idea that they would function as breeder reefs, some of which have been planted with disease-free oyster seed (see "Don Meritt: The Hatchery Connection") and others with natural seed that DNR moves from public grounds that historically have gotten good "strikes" of spat.

> *"Most of those native oysters will die before they reach market size.… It's worse than playing the stock market when you put oysters in the Bay."*

The reserves, by agreement among DNR, the Maryland Watermen's Association (MWA) and the Oyster Recovery Partnership (ORP), a non-profit organization that develops and implements restoration projects, are closed to harvest until oysters reach four inches (Maryland's legal minimum is three inches). The reserves are to be monitored regularly — if disease is found to be impacting under-four-inch oysters, the reserves will be opened to immediate harvest. If the oysters reach four inches, then "a predetermined percentage of harvested oysters will be allowed before each site is again closed," says Charles Frentz, ORP director. Managing for sustainability is a new idea in Maryland — whether or not it will work depends on getting oysters to survive.

The sanctuaries and reserves are well and good, says waterman Larry Simns, president of the MWA, "but most of those oysters will die before they reach market size.… It's worse than playing the stock market when you put oysters in the Bay." Again, this has been especially so in Virginia where Jim Wesson has overseen the construction of 50 reefs that have held so much promise. "We get high spat set on the reefs," says Wesson, "but the oysters just don't survive to become marketable adults." There are oysters that do survive, of course, animals that have an inherent genetic make-up that enables their immune system to fight the withering effects of MSX or Dermo.

Over enough generations, survivors of each spawn might theoretically rebuild their own populations naturally. How many generations would that take?

Twenty-five? Fifty? One hundred? For those in the industry, it is not soon enough. The same goes for those who are working to restore oysters for their ecological value. In the meantime, the reefs themselves could collapse because oysters are not surviving and building shell faster than they are falling apart from erosion, sedimentation and other physical processes, and from predators such as boring sponges and oyster drills.

"What we're trying to restore is ecological and economic function," says Wesson. "That goal of a tenfold increase in Bay oysters is a just descriptor. What we're really trying to get back is a tenfold increase in services that oysters provide — in filtration, in habitat reconstruction and in harvest. The only way we can get that," he says, "is with an adult oyster that survives." With an estimated cost of $350,000 for each one-acre reef and 25 acres of surrounding shell, and with oysters not surviving to harvest size, it is no wonder that he and others have become so discouraged.


SKIP BROWN

Tongers like Alton Brown, *who has been oystering on the Bay for more than 30 years, have found it nearly impossible to haul in enough to meet their bushel limits.*

ODRP has assisted researchers in designing predictive models to manage around disease and particularly in furthering the development of hatchery-bred strains of disease-resistant oysters. "We've had pretty decent results with breeding oysters resistant to Dermo and to MSX," says Standish Allen of the Virginia Institute of Marine Science (VIMS), "though getting resistance to both is the trick." Allen is a geneticist who has been leading the development of strains known to scientists as CROSBreeds and DEBYs, two of several that are being tested in Chesapeake and Delaware bays. With ODRP support, Allen has been working with researchers in Maryland, Delaware and New Jersey on field studies to compare these strains with local oysters and those from elsewhere on the east coast, particularly from Gulf coast waters in Louisiana where Dermo has been present since at least the 1940s.

"Our original intent was to develop superior strains of oysters for aquaculture," says Allen, "but there is a different intent now, which is to use them for restoration." Is it appropriate, he asks? Can they be used for the ecological "services," such as filtering and habitat construction and for enhancing the fishery as well? "In Virginia, there's not much of a choice," he says. "If we use wild stocks, we simply will not get survival. So we are doing both."

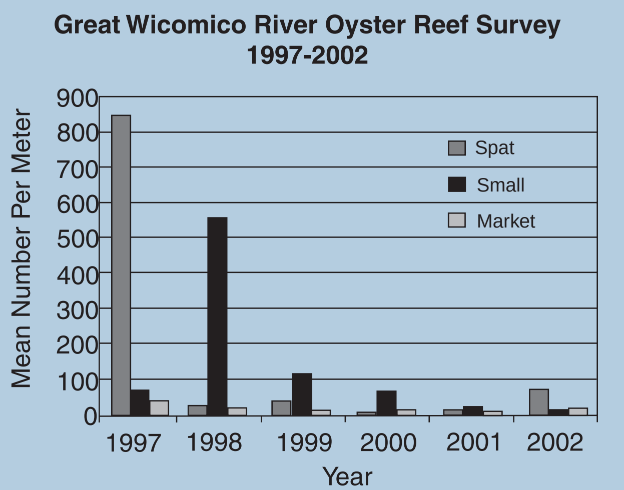
CROSSBreed and DEBYs are being planted on reefs, though not yet in large numbers. What is the appropriate planting density on a reef? How many reefs are necessary in a particular river system? What dimensions? Where should they be located? With all that is known about

Managing around Disease

When it comes to Chesapeake Bay oysters, one waterman says, disease is in the driver's seat.

More than a decade ago, the recognition that disease was the overriding issue in the Chesapeake, and potentially in other coastal waters, led to Congressional legislation that established the Oyster Disease Research Program (ODRP). Its major goal has been to develop research-based approaches for restoring the commercial and ecological viability of oysters that have been decimated by disease, says James McVey, who is with NOAA's National Sea Grant Program, which administers the program.

ODRP has underwritten a number of scientific and technological advances that are now being employed by state agencies and commercial operations. Among them are molecular tools for rapid diagnosis of Dermo infections, which are caused by the protozoan *Perkinsus marinus*. With our new technologies, we can detect just one cell of *Perkinsus*, says Gerardo Vasta of the Center of Marine Biotechnology, part of the University of Maryland Biotechnology Institute. Such tools as these, which are currently being field tested, can help aquaculturists and resource managers monitor oyster populations regularly and, if Dermo infections are found to be increasing, that may be a signal for precautionary measures such as growers moving cultured oysters to lower salinity waters or managers developing plans for harvests of reserves before disease becomes endemic.



This bar chart of annual dive surveys shows oyster recruitment and growth on three-dimensional reefs in Virginia. It tells a story seen over and over on the reefs that the Virginia Marine Resources Commission has constructed in Bay waters. A year following a large spat set (1998) a fairly high percentage grow to become "smalls," but by the next year those numbers have plummeted — hardly any survive to become market-sized.

oysters, there is so much we don't know, says Kennedy Paynter.

A strong advocate of reef reconstruction, Paynter has been working with the Oyster Recovery Partnership and the Maryland DNR on sanctuary reefs in the Patuxent, the Choptank and the Chester rivers and is carrying on long-term comparative studies of reefs planted with disease-free spat from the hatchery and spat that have been moved from public grounds. He is trying to develop sophisticated measures of the ecological value of reefs and has been studying oyster longevity in relation to disease and reef structures. He has found, for example, that the mean time to infection with hatchery seed planted on clean bottom may be several years, while for seed planted on top of infected oysters it could be months. The problem, though, is that while oysters may survive for more than four years in low salinity (under 12 ppt salt), spat settlement is typically infrequent. The salinities are at the low end of the oyster's spawning range. On the other hand, if salinities rise significantly, they are then subject to disease.

"Unfortunately, we've learned that we don't have a way to design restoration strategies to get around MSX," Paynter says. "The oysters we put in low salinity waters will be long-lived, create substantial habitat and filter significant amounts of water." However, though these oysters provide "ecological service," researchers don't know if they will contribute to annual recruitment and enhance sustainability of the population overall.

The Controversy: Is It Time for a Non-Native Oyster?

In limited field trials, *Crassostrea ariakensis*, a species native to China, has given strong evidence that it is much hardier than the Bay's Eastern oyster when it comes to battling disease. In comparative growth studies between the two in Virginia, and more recently in North Carolina, *C. ariakensis* was not only able to fend off MSX and Dermo but grew substantially faster and larger than the native would have if it wasn't being killed off by the diseases.

The Virginia studies were conducted in accordance with protocols of the International Council for the Exploration of the Seas (ICES) that require using second generation offspring of non-native broodstock — this minimizes the introduction of new pathogens and parasites. (Eugene Burreson of VIMS has pointed out, however, that ICES protocols cannot protect against exotic viruses.) Importantly, the young oysters were rendered infertile in the hatchery using a chemical technique that gives them three chromosomes. In August 2000, sixty thousand triploid seed oysters were distributed to Virginia growers who reared them under different salinity conditions in various confinements, including corrals, floating cages and sunken trays. Easy retrieval of all oysters was critical — studies by Allen and others have shown the capability for a small proportion of chemically-induced triploids to revert to diploids and therefore to become potentially reproductive.

It is the outcome of the Virginia trials that has created so much excitement about *C. ariakensis* as a complement, if not an alternative, to the Bay oyster. "None of us is against our native oyster," says Virginia waterman George Washington. "The Virginia Heritage program promised a tenfold increase [but] the oyster industry can't wait another ten years or even this year. I want to save the native oyster," he says, "but I want the industry to be around when we do."

Earlier in 2002, the Virginia Seafood Council proposed testing one million *C. ariakensis* at 39 locations in Virginia's por-

Non-native Oyters in the Chesapeake

- **1949** — Oyster disease Dermo found in Chesapeake Bay
- **1959** — Oyster disease MSX devastates populations in Virginia portion of Chesapeake
- **1985** — Dermo disease causes steep declines in oyster populations in Maryland portion of Bay
- **1991** — Virginia aquaculture industry requests introduction of non-native oysters
- **1993** — Chesapeake Bay oyster harvest reaches historic low; Chesapeake Bay Program (CBP) adopts non-native oyster policy (*Crassostrea gigas* and *C. ariakensis*); VIMS conducts first field tests of disease tolerance in *C. gigas*
- **1995** — VA legislature mandates VIMS to develop a strategic plan for shellfish
- **1996-97** — CBP forms ad-hoc panel to guide research on *C. gigas* and *C. ariakensis* (1996); CBP's Living Resources Subcommittee (LRSC) accepts ad-hoc panel's recommendations (1997)

tion of the Chesapeake between June 2002 and May 2003. An ad-hoc panel of the Chesapeake Bay Program's Living Resources Committee recommended not approving the request on a number of grounds. A major factor, though not the only one, was that the chemical method for inducing sterility may not be permanent; an alternative method that uses tetraploids, or animals given four chromosomes, has less risk, though that technique could not have furnished a million oysters for the trials.

While watermen and processors make a compelling case for growing *C. ariakensis* in the Chesapeake, there are a host of biological and ecological concerns about the impacts of a non-native oyster — and policy makers, sympathetic though they may be to the industry's plight, have been unwilling to give the green light until there is some assurance of just what those impacts might be. Will *C. ariakensis* survive throughout the Bay and how might it affect other species, especially the native oyster? Will it build reefs? Is it likely to be resistant to local predators, pests and diseases? If it grows so fast and so large, will it concentrate more pathogens than the native does?

In experiments conducted at VIMS, Mark Luckenbach found that juvenile Bay oysters were more competitive than *C. ariakensis*, as measured by increases in shell length and weight. Under these conditions, he says, *C. virginica* grew faster and had higher survival. When *C. virginica* were present, *C. ariakensis* had poorer survival and grew more slowly. These findings were conducted under laboratory conditions and carried only to the juvenile stage; nor do they account for the effects of MSX and Dermo, Luckenbach points out. This is to say that these and other findings cannot be extrapolated to field conditions.

Because of the ecological uncertainties on the one hand and the demands of the industries in Maryland and Virginia on the other, agencies and organizations in the Bay region have partnered in commissioning a study by the National Academy of Science (NAS) to assess the ecological and economic issues of introducing *C. ariakensis* into Chesapeake Bay. Under consideration are (1) the risks and benefits of aquaculture of triploids, (2) introduction of reproductive diploids, or (3) no introduction at all. The NAS recommendations are due by August 2003.

Maryland vs. Virginia — Differences of Opinion

While there is strong resistance by federal and state decision makers to importing non-native oysters capable of reproduction, there has been a strong policy, if not philosophical, divide between Maryland and Virginia. As Jack Travelsted of VMRC has observed, "Virginia is at

Summary of Field Trial
C. ariakensis vs. *C. virginica*

In a study of survival, growth and disease susceptibility of both oysters, VIMS scientists compared triploid (i.e., sterile) *C. ariakensis* with diploid (fertile) *C. virginica* at sites in three different salinity regimes: low (less than 15 ppt), medium (15-25 ppt) and high (greater than 25 ppt) in the Chesapeake Bay and on the Atlantic coast. The medium and high sites were conducive to MSX and Dermo disease. The results, shown below, demonstrate that *C. ariakensis* grew remarkably well. Researchers note, though, that *C. virginica* were at a disadvantage in that they were not only diploid animals, but were already infected with Dermo when tests were conducted.

Survivability

- *C. ariakensis:* Low salinity sites, 14% mortality; at medium and high salinity sites, 15%
- *C. virginica:* Low salinity sites, 81% mortality; at medium and high salinity sites, 100%

Growth after One Year at Low, Medium and High Salinity

- *C. ariakensis:* Mean length, 96 mm (low), 125 mm (medium), 140 mm (high)
- *C. virginica:* Mean length, 72 mm (low), 85 mm (medium), 75 mm (high)

Disease Prevalence during Second Summer

- *C. ariakensis:* 0-28% infected at three sites, mostly light infections
- *C. virginica:* 100% infected at all sites, heavy infections

Adapted from Calvo, G.W., M.W. Luckenbach, S.K. Allen, Jr., and E.M. Burreson. 2000. A Comparative Field Study of *Crassostrea ariakensis* and *Crassostrea virginica* in Relation to Salinity in Virginia. Special Report in Applied Marine Science and Ocean Engineering No. 360. Virginia Institute of Marine Science.

1999 — VIMS publishes research showing low commercial potential for *C. gigas;* Virginia Marine Resources Commission (VMRC) approves VIMS marketability proposal for *C. ariakensis*

2000 — CBP ad-hoc panel approves VIMS marketability proposal; Virginia Seafood Council (VSC) requests *C. ariakensis* introduction; Virginia Marine Resource Commission (VMRC) approves VSC request with VIMS monitoring

2001 Oct. — VIMS hosts symposium on Aquaculture of triploid *C. ariakensis*; for report, see www.mdsg.umd.edu/oysters/exotics/ariakensis/report/

Dec. — Agencies issue statements on the use of *C. ariakensis* for aquaculture in Chesapeake

2002 — Maryland legislature passes bill calling for research on *C. ariakensis*

National Academy of Sciences agrees to review *C. ariakensis* issue

Information adapted from the Virginia Institute of Marine Sciences

Just as Maryland and Virginia have been divided, historically, on the management of their oyster fisheries, they are divided on whether or not to introduce a new oyster species.

the more liberal end of the [introduction] spectrum."

In 1995, with the decline of the Virginia oyster industry impacting so many Bayshore communities, the General Assembly authorized VIMS to develop strategic plans for evaluating non-native species — those plans centered on the Pacific oyster *Crassostrea gigas* and the Suminoe *C. ariakensis*. *C. gigas*, which is native to Japan, is the dominant commercial species throughout the world — it was first imported to the U.S. northwest early in the twentieth century and is the basis of the industry there, as it is in France, England, Australia and much of New Zealand.

In contrast to Virginia, the state of Maryland until late this year has actively rejected consideration of importing a non-native oyster. While ecological uncertainty may be a key reason, there has also been a belief in Maryland that its lower salinity waters offer greater potential for restoration of *C. virginica*, though the last several years of low rainfall have increased Dermo and MSX and caused heavy oyster mortalities. With harvests once more on the downturn and the strong lobby for importing triploid *C. ariakensis* to Virginia, the Maryland General Assembly passed a bill that for the first time authorizes research on the Suminoe in order to judge its benefits for aquaculture.

As divided as Maryland and Virginia have been on the issue of pursuing the potential of a non-native oyster, they have also been divided, historically, on the management of their oyster fisheries. While watermen in both states have always harvested public grounds, much

SKIP BROWN

With harvests in Virginia *even more dismal than those in Maryland, packers in the state have depended on buying oysters from Maryland, where buyers are sent daily.*

of Virginia's production (until disease became so rampant) derived primarily from businesses and independent watermen who grew oysters on private leaseholds in the Bay and its tributaries. Maryland's production, however, derived primarily from wild harvests, with private leaseholds — though acre for acre considerably more productive than public grounds — contributing very little.

Early in the twentieth century, both states had their public oyster grounds surveyed — the Yates Survey in Maryland and the Baylor Survey in Virginia identified nearly 500,000 acres of grounds that supported or at one time supported natural oyster populations. These grounds were then legally closed to leasing for oyster cultivation. The only leasable grounds available in both states were those on which oysters had never grown naturally. While both states had laws that made leaseholds available, Virginia promoted leases and made it legal for businesses to obtain them. Though numbers of Maryland watermen held leaseholds, for the most part watermen in the state opposed them and were instrumental in legislation that prohibited businesses from obtaining leases. As a result, oyster farming in the state has always been negligible.

While many watermen in Virginia had small leaseholds, from one to ten acres, says Mike Oesterling of VIMS, the biggest lessors were packers. It is they who could afford to shell their bottom grounds so that seed oysters brought in from the James River, the Great Wicomico or other areas would not sink.

Shelling could be expensive. "Some packers had leases that got reliable strikes [of spat] regularly, after they put down shell," Oesterling says, "so they could even produce their own seed." If you harvest the same ground year after year, eventually it will soften up, so you'll have to shell the bottom to stabilize it again. "Packers had husbandry plans," he says. "They were farmers."

In both states, oystermen could only harvest public grounds during the open Virginia season (generally October to April) — leaseholders, however, could harvest their grounds all year round. In effect, Virginia packing houses and the small number of growers in Maryland had a 12-month industry, with oysters largely from the Chesapeake. The history of leaseholds and cultivation in Virginia is a primary reason that the Virginia Seafood Council, which represents packers and other leaseholders, requested authorization to grow one million triploid Suminoes. Though seafood processor Tommy Kellum would like to see reproducing *C. ariakensis* in the Bay, it is only the triploids that he is now concerned with getting authorization to raise. Because leaseholds and cultivation have a relatively small niche in Maryland, watermen in the state have opposed the use of triploids and have called for introducing diploids. "If Virginia is successful using triploids," more than one waterman has said, "*C. ariakensis* will be introduced in Maryland."

"I wouldn't have said this five years ago — we've lost our oyster," says Larry Simns. "Talking of disease-resistance is pie in the sky. And I don't even want to talk about triploids. Maryland and Virginia need to do this together," he argues, "we need to go to diploids." How harmful can they be, what is the risk, Virginia waterman George Washington asks rhetorically. "We don't have any oysters to have a risk."

To Release or Not to Release a Non-native?

If reproducing *C. ariakensis* were brought into the Bay, what are the worst-case concerns, even if they were introduced adhering strictly to ICES protocols? Would they introduce a new disease or new parasite? Would they displace *C. virginica* from some part of its range? If they grew really well, could they cause a fouling problem? Are there potential food web effects that cannot yet be predicted? What impact would boring sponges, cownose rays, crabs and other predators have? What is the disease tolerance under different conditions?

Scientists in China, for example, where the Suminoe has long been cultured, reported that since 1992 a series of mortalities, usually from February to May, occurred along the coast of the Pearl River valley, killing about 80 to 90 percent of affected oyster populations. Scientists found a "new intracellular microorganism in the tissues of diseased oysters" that has not yet been identified.

In France, where *C. gigas* is the basis of the entire industry, researchers are interested in other species such as *C. ariakensis* because of the potential for catastrophic mortalities of *C. gigas* from disease. The aim was to test the Suminoe's ability to adapt to local conditions. According to a scientific paper in *Diseases of Aquatic Organisms*, the oysters, which were maintained in laboratory quarantine, experienced some mortalities seven months after importation: nine of the dead oysters harbored a protozoan parasite that was never before reported to occur in the *Crassostrea* genus. As a result, the authors concluded, the Suminoe "is not considered to be a suitable substitute for *C. gigas* in France."

If large numbers of triploids are approved, could this lead to the introduction of an unknown parasite? Will an easing of restrictions lead to illegal introductions? On the other hand, could triploids spur the growth of a private aquaculture industry in Maryland so that watermen could both harvest native oysters that survive on public grounds and also farm triploid *C. ariakensis* on leased grounds? Farming oysters is more costly than harvesting public grounds and may not be economically feasible to produce for shucking houses, the traditional market for Bay oysters. The northwest may serve as a model where the half-shell market has been increasing dramatically: according to the Pacific Oyster Growers Association, 50 percent of the oysters produced in the northwest went for shucking a decade ago; today, 75 to 80 percent are destined for the unshucked market of bars and restaurants.

What is the potential for *C. ariakensis* to become established if it was brought into the Bay? "Given its rapid growth and resistance to disease, if a sufficient number of reproductively-capable animals are present, establishment does seem likely," says Luckenbach.

Since June, the National Academy of Science committee has heard from industry, scientists and state and federal agencies. In the months ahead, it will be sorting through all that is available — in reaching its recommendations, it will have to navigate the rocky waters between ecological uncertainty on the one side and socioeconomic demands on the other.

For More Information

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Virginia Institute of Marine Science (www.vims.edu)

Virginia Institute of Marine Science, *C. ariakensis* (www.vims.edu/abc/CA.html)

National Academy of Sciences (www.nationalacademies.org)

Don Meritt *picks up a clean oyster shell from a pile that fills a containerized steel cage. Meritt and his colleagues will fill these cages with Choptank River water and add millions of newly spawned oyster larvae. The larvae will feed in the tanks until they grow large enough to cement themselves to the shell, undergo metamorphosis and become spat that are ready for planting. Photograph by Skip Brown.*

PROFILE

DON MERITT: THE HATCHERY CONNECTION

BY MERRILL LEFFLER

Last year the Horn Point Laboratory hatchery produced more than 75 million disease-free oyster spat — these newly-set young, more than three times greater than the crop produced five years before, were placed in oyster sanctuaries and managed reserves, leased aquaculture grounds, community oyster gardens and used for a host of research and educational projects throughout the state. The hatchery at Horn Point — part of the University of Maryland Center for Environmental Science (UMCES) and located on the banks of the Choptank River just outside Cambridge on Maryland's Eastern Shore — has been responsible for nearly all of the hatchery-produced spat in Maryland.

The hatchery's increasing production, and its key role in oyster restoration in Maryland, is due in large measure to the efforts of Don Meritt (Mutt to everyone who knows him). Horn Point's wide-ranging cooperative arrangements, for example, with the Oyster Recovery Partnership (the non-profit organization that has expanded its coordination of restoration projects in Maryland over the last several years), the Maryland Department of Natural Resources (DNR), research labs, educational institutions, and community-based groups over the last decade, were not as inevitable as they may appear.

Meritt, a Horn Point faculty member and shellfish specialist for the Maryland Sea Grant Extension Program, began working for UMCES nearly 30 years ago at the Chesapeake Biological Laboratory, not long after finishing St. Mary's College. He was hired by Curt Rose to work at the hatchery that a group of faculty were developing — the initial goal was to test the potential for rehabilitating oyster stocks that had been devastated by

> *"Hatcheries can perhaps jump start restoration if oysters survive so that they can reproduce — then we can leave the rest to Mother Nature."*

Tropical Storm Agnes in 1972. The early plans were based largely on a commercial operation that John Dupuy developed at the Virginia Institute of Marine Science in conjunction with an oyster producer in Virginia. In the meantime, Rose left the university to work in private consulting. Meritt contacted George Krantz, then at the University of Miami but who had previously worked in Maryland where Meritt had met him, and told him about the job. Krantz applied and was hired to run the hatchery. During this time, UMCES moved the hatchery to the newly established Horn Point Lab and Meritt, with Krantz, went there as well.

When Krantz left in mid-eighties to work for DNR, Meritt took over — he has since moved the hatchery from a modest enterprise producing a million eyed larvae annually to one that last year produced three-and-a-half billion. While this number may seem mind-boggling, perhaps 10 to 20 percent survive the process of metamorphosis to become spat — thus last year's 75 million. What does that figure actually mean? Sanctuaries are generally planted with two million spat an acre, managed reserves and private leaseholds with one million. This means that last year's production could cover some 30 acres of sanctuaries and 60 acres of reserves. That is still a "drop in the bucket," Meritt says, at least in relation to the more than 200,000 acres of public oyster grounds in Maryland or even the 1000 acres of leaseholds that were once actively producing oysters until disease became so widespread.

And disease is *the* issue. How many of the hatchery oysters will survive MSX and Dermo? There is no easy generalization — it depends on a number of factors. For example, on water salinity: in salinities of 12 to 15 parts per thousand, oysters are especially vulnerable to Dermo (MSX operates more successfully above 15 ppt). And yet, if bottom grounds have been cleared of all oysters, then prepared with clean shell before planting the new spat, they have a better chance of surviving for years, says Kennedy Paynter of the University of Maryland College Park and the UMCES Chesapeake Biological Laboratory. That is because Dermo is transmitted from oyster to oyster — by clearing Dermo out of an area first, the hatchery-produced seed have a better chance of long-term survival. This is especially so in lower salinities —unfortunately, low salinities are not favorable to oyster recruitment.

Meritt has never advocated hatchery production being able to replace the reproduction of a healthy ecosystem. We might use it for restoring a small area, say 26,000 acres in the lower Choptank, he says, but you can't bring back 200,000 acres. "We can perhaps jump start it if the oysters survive so that they can reproduce — then we can leave the rest to Mother Nature."

By next year, Horn Point will have a much expanded hatchery as part of a new Aquaculture and Restoration Research facility. If all goes well, hatchery production could expand to 500 million spat, five times more than in 2001. What can be done with that increased output depends on where they are used. For argument's sake, Meritt says, assume they're all placed in sanctuaries: at one million spat an acre, that's 500 acres. Warming to this vision, he says, we might expect an average yield of 1000 bushels of three-inch oysters per acre — in this case, total production could reach 500,000 bushels, considerably more than public harvests have averaged over the last decade in Maryland. All this production from just one hatchery, he continues — imagine what many hatcheries or seed spat-producing facilities might contribute, especially if the oysters were able to survive disease and continually spawn new generations. The emphasis, however, is on "if" — native oysters in higher salinity waters are not generally surviving long enough to produce large numbers of larvae.

A Natural Biologist

As a youngster, Meritt did not imagine that he would one day be a scientist doing research in the waters he knew so well. A native of Maryland's Eastern Shore, he was raised in St. Michaels at a time "when all those little boutiques that now line main street were residences for people who worked on the water." On his mother's side, most of Meritt's uncles — and there were many — were farmers and watermen who tonged for oysters in the winter. Many of his friends from St. Michaels High School came from watermen families. "It was pretty natural to know what was going on in the water — all you needed was a license and a boat and you could go do it. You were your own boss." He had a rowing skiff early on and began making money from both soft and hard crabbing near shore as a kid. "I was probably in the 10th grade when I started trot lining [for crabs], and I did it all the way through college," he says. By high school, he was also shaft tonging for oysters as well, on the Miles River, Broad Creek and the Tred Avon.

Meritt was the first male in a large family on both sides to graduate from high school. Though he had thought about college he might well be a working waterman today, he says, if it wasn't for Dick Kleen, a teacher who had a great influence on his life. Kleen was an avid amateur ornithologist, dynamic and passionate, and his natural history club, which Meritt went into as a seventh grader, was his introduction to birding — "my first real passion in nature," he says. For a time, his goal was to go to Cornell and get a degree in ornithology.


SKIP BROWN

He didn't make it to Cornell but instead to St. Mary's College on the western shore via two-and-a-half years at Chesapeake College. "It took me a while to transition from high school to college," he says with some amusement. It took more time and a good deal of serendipity to bring out what has become a profession and personal passion, growing oysters in numbers that can make a difference not just for the fishery or for aquaculture but the Bay system itself.

After graduation, Meritt spent time in the Florida Keys working for a commercial fisherman for some months before returning to St. Michaels — he picked up different jobs, working for the Department of Natural Resources one summer to eradicate water chestnut on the Bird River, crabbing and tonging for oysters and working on skipjacks as well. While he was working with several former St. Mary's College students on a Power Plant Siting program on the Potomac River headed by CBL scientist Joe Mihursky, the job came open in the fledgling oyster hatchery at the lab. It seemed like the thing to apply for.

The hatchery's resources were meager. "Our larval tanks were buckets," Meritt says, "and we were dealing with tens of thousands of larvae." It was around this time that the State of Maryland established UMCES on the former DuPont estate where the Horn Point Laboratory was to be constructed. When UMCES moved the hatchery project there, Meritt was happy to return to the Eastern Shore.

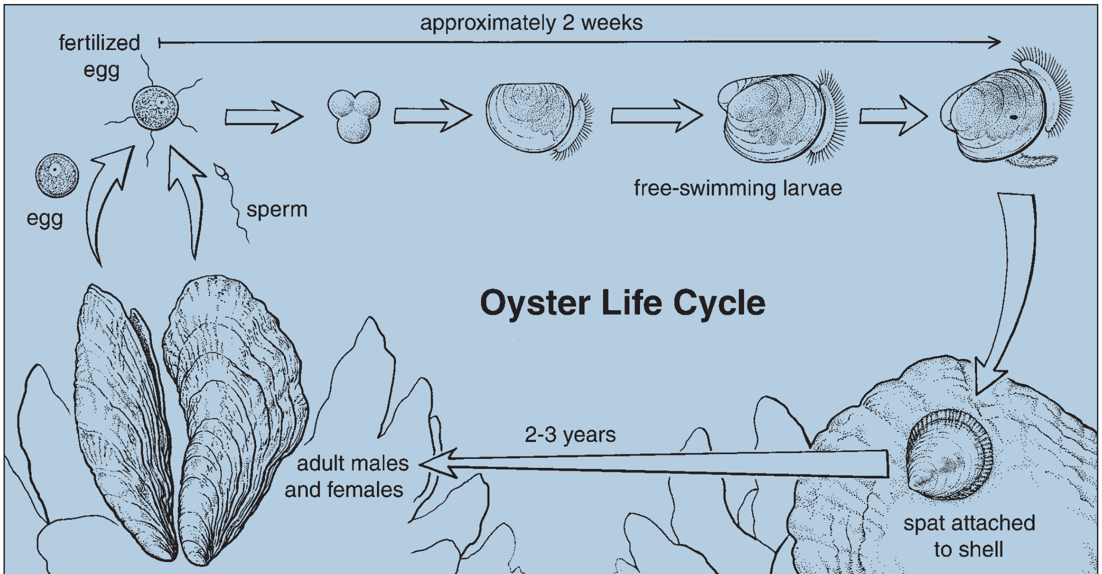
The hatchery was designed to produce "cultchless" oysters — oysters that set on a small chip and grow singly, not in clumps as they do in the wild and for current restoration programs in Maryland. Unprotected cultchless oysters are vulnerable to predation and need to be reared in confined systems such as floats in order to keep crabs, cownose rays and other predators from getting to them. This growing method is more expensive than growing "rocks" on the bottom, Meritt says. You then have to be able to sell them for enough to cover your costs — this usually means for the higher-priced half-shell market rather than the Chesapeake's traditional shucked meat market.

Initially, the hatchery was designed to do pilot-level testing that DNR would then apply for large-scale production at the state's Deal Island hatchery, which had been constructed from an old oyster shucking plant. While DNR still operates the hatchery, oyster production there has been limited.

In the years after Agnes, with average and lower rainfall, natural oyster production had come back to the Bay and commercial watermen were harvesting public grounds again. Given Krantz's strong background in aquaculture, he and Meritt began working with Maryland leaseholders to try to get private aquaculture on a par with other areas on the east coast. "We took a lot of criticism from public fisherman," Meritt says, "that we were wasting money with the hatchery when so many wild oysters were available."

Sea Grant Extension

A door opened for Meritt when Krantz left Horn Point — "I had already taken over "by default," he says with a certain self-deprecation. Then another



What Happens in the Hatchery?

In the Horn Point hatchery, eggs are first fertilized to produce larvae, which are fed an algae-rich diet and grown in tanks until they reach the "eyed" stage at two or three weeks of age. Physiologically, the process is punishing — even in a tank free of predators, only a small percent may survive to become spat. Tiny as they are, the older larvae (those ready to set) are distinguishable under a microscope. At this point they are separated from the other larvae and introduced into setting tanks containing clean, containerized oyster shells. The larvae then settle onto the surface of the shells, crawl around and when they find a suitable place, cement themselves to the shell. This transformation or metamorphosis from a free-swimming larva to a non-motile oyster is called settlement or setting and the oyster is now referred to as a spat. After a few days in the setting tanks that allow the newly-settled spat to grow and harden, the containerized shells are removed and placed in shallow water nurseries until final deployment to a planting site. Spat placed in the Bay take from one to several years, depending on environmental conditions, to grow to a harvestable size of three inches.

door opened when Tony Mazzaccaro, then head of Maryland Sea Grant Extension, proposed that he also work as an Extension shellfish specialist. Sea Grant Extension is a joint program with Maryland Cooperative Extension.

What does a specialist do, Meritt is asked. "He talks to people, sometimes large numbers of them," he replies. "Before Sea Grant, I was in the hatchery or in the field. When I started working with Extension, I began doing outreach programs. I was now in the position of training people." Speaking in front of audiences was not comfortable, he says. For those who know his outspokenness, it may be difficult to believe that it still isn't. "It changed me a lot, maybe for the better."

"Extension or outreach is like coaching. You have some knowledge that the people you're dealing with don't have and you're trying to convince them that what you have is reasonable. You want to show them how to do it so that they're successful and things don't backfire on them."

> *"Extension is like coaching: you have some knowledge that the people you're dealing with don't have and you're trying to convince them that what you have is reasonable."*

"To be a good Extension agent, you have to be able to have a coaching mentality. I coach baseball. Every kid can't pitch," Meritt says. "I have to be able to tell that kid you're not a pitcher in such a way that I don't crush them while keeping their enthusiasm up. That's the same for Extension. Sometimes the best lessons that an Extension agent can give are the ones that lead people to not do what they wanted to do when they first came to see you. We've probably saved people more money by preventing them from doing what would not have worked had they not listened to us."

Part of his own Extension training was learning what aquaculturists were doing elsewhere. In 1986, Meritt traveled to the Pacific Northwest because he had heard about the hatchery-based industry there. "Before I went out there, I thought I knew how to grow oysters," he says. "I learned that I knew very little."

"Until then, I had dealt with scientists and management people where the public fishery was driving the boat. Every time you mentioned aquaculture in the Chesapeake, there were a thousand reasons people gave why it wouldn't work here. In the Northwest," Meritt says, "everybody was doing it! One couple had an old shed and they were growing a few million spat for sale. Companies were vertically integrated. This was private industry."

To Meritt, a large larval tank for setting spat was 1000 liters. "In some of those hatcheries, they have 25,000 or 40,000 liter larval tanks. They don't have one tank but a row of them, 15 or 20. At the time, we were setting maybe a million spat a year; they were doing ten times that every day!"

That experience gave Meritt a sense of what he needed to do. "Those estuaries are tiny compared to the Chesapeake but they're outproducing what we're doing using just a few hatcheries. Two or three produce all the eyed larvae that growers throughout the Northwest are using to set their own oysters. That thought has never escaped me."

The critics naturally said that "what they're doing out there won't work here." But the concept will, Meritt replied. "Let's make what they're doing work here." He and Maryland Sea Grant Extension Agent Don Webster spent a good deal of time on the road showing growers how they could purchase eyed larvae produced in a hatchery, set the seed oysters themselves on bagged or containerized shell and then plant them on leased grounds or grow them in cages or floats.

While Meritt's vision was of what the hatchery could contribute to the aquaculture industry, he began to think of what he could contribute to research that the hatchery was increasingly getting involved in. To do that effectively, he needed an advanced degree. In the mid-eighties he entered a doctoral program in the Marine-Estuarine-Environmental Science Program at the University of Maryland College Park. He received his Ph.D. in 1993, writing his dissertation on the effects that several parasites — the boring sponge, the mud worm and Dermo — have on oyster shell growth, phsyiological condition and mortality. It took a while, he says, again in self-deprecation, but unlike most graduate students in science, he did it part-time while running the hatchery and doing Extension programs.

Disease and Restoration

As part of the Oyster Roundtable Agreements a decade ago among watermen, aquaculturists, legislators, scientists, environmentalists and state agency representatives, only certifiably disease-free oyster spat can be planted in upriver bottom grounds. In effect, this means that naturally-produced seed cannot be moved into these sites because most of it would likely come from areas in which oysters are already infected with Dermo.

Since lower salinities are less conducive to Dermo and MSX, the aim of the upriver plantings, says Kennedy Paynter, has been to give oysters the chance to grow without the intense pressure of disease. In the last two years of near-drought conditions, higher salinities have penetrated much farther upriver than in years of average rainfall and some of these oysters have been under stress. Still, the upriver plantings are working in that oysters survive.

"Oysters planted way up in the Choptank in 1994 don't have disease yet," Meritt says. On the other hand, those planted in the lower Choptank that have been there for two years have been wiped out, probably from MSX. Meanwhile, oysters planted two years ago in Tangier Sound, where salinities are high, two years ago are beginning to get disease. "We're having success and failure — that's what makes things so difficult," Meritt says.


DON MERITT

Seed oysters *in these stainless steel cages have hardened in near shore waters and are now ready to be transported for release onto restored reefs.*

The problem remains — how to keep oysters alive long enough so they can breed and produce survivors to produce the next generation and the next and the next. This requires a solution to the disease problem. Some people believe that we're harvesting survivors and that we should leave them there so that they and their broods can continue to reproduce. But how many generations will it take before they build sufficient numbers of survivors, he asks? It has been 50 years since MSX first decimated populations in Delaware Bay, but despite the promise of natural selection favoring MSX survivors, the situation is no better off. Will it take another fifty years, or a hundred?

"We may have an oyster that evolved for a Chesapeake Bay ecosystem that no longer exists," Meritt says. The Bay today has parasites it has never seen before; it has problems of nutrient enrichment and low oxygen — if not an absence of oxygen — on many bottom grounds during the summer. In addition, the sediment problems are much more severe than in the past. All these stresses may be contributing to this oyster not being able to handle *this* Bay.

To establish sustainable reefs, oysters have to grow bigger or more oysters have to accrue on the reef faster than the reef is collapsing or getting suffocated by sedimentation. In the past, Meritt says, this was easier, because there was less runoff; there were also buffers of underwater grasses in some areas that could settle out sediment that would otherwise smother reefs, preventing new oysters from setting. As it is today, oysters are not recruiting new young very well and diseased adult oysters are growing so much more slowly.

One approach to promoting sustainable reproduction has been to introduce disease-tolerant native oysters such as CROSBreeds and DEBYs that have been bred at the Virginia Institute of Marine Science and Rutgers' Haskins Shellfish Laboratory. These strains, originally developed for aquaculture where they are proving to be useful, are thought to offer some promise for revitalizing wild oyster stocks. The oysters are being tested at different sites in Chesapeake and Delaware bays and are also being grown by oyster gardeners in Maryland and Virginia.

The question remains, though, says

Standish Allen of VIMS, whether they can survive disease pressure over the long term and be used on the immense scale it would likely take to jump start reproducing populations. Can they help to genetically rehabilitate wild populations? "It's possible," says Meritt. "Have we been able to do it?" he asks rhetorically. "No." There are many unknowns, for example, about their maintaining disease resistance, about their inbreeding and the consequent susceptibility to new disease, and about the dilution of their genes in mating with local oysters.

As for bringing in a new oyster, *Crassostrea ariakensis*, Meritt says it could be a useful tool in the face of disease. "If it is introduced, it probably will be successful in some places and not successful in others," he says, "and where it is successful, and by that I mean reproducing and spreading itself, it may re-establish what we often refer to as 'healthy oyster reefs.' They may not be identical in structure (although I feel they would be similar), but they should provide much of the same function as our native oyster." There might even be two species of reefs in some places. Is that bad, Meritt asks? "Maybe, maybe not. I think that if *C. ariakensis* was successful, even in a few locations, that we might begin to see some of the ecological side benefits that we all want out of oyster restoration."

What the future holds remains to be seen — research proposals, which he is part of, are in the works to further investigate *C. ariakensis* and disease-tolerant *C. virginica* strains. The increasing capacity to produce oyster spat in the new expanded hatchery will make it possible to explore innovative approaches for both aquaculture and self-sustaining populations. If we're successful, he says, we could begin to see a revitalized oyster industry in the Bay, probably different from the one that we have had historically. "And, with good fortune," he adds, "parts of the Bay ecosystem will be a beneficiary as well." But Meritt doesn't kid himself — these are big "ifs."

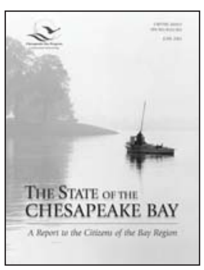
Et Cetera

Conferences

Restore America's Estuaries, April 13-16, 2003, Baltimore, Maryland. Restore America's Estuaries is a nonprofit organization established in 1995 to preserve the nation's network of estuaries by protecting and restoring the lands and waters essential to the richness and diversity of coastal life. The organization will convene its inaugural conference in Baltimore's Inner Harbor in April.

The conference will bring together those engaged in and interested in furthering the restoration of estuaries nationwide — this includes field practitioners, community leaders, consultants, scientists, regulators, program managers, educators and volunteers. For more information, visit the website at www.estuaries.org or call 703.524.0248.

Publications



The State of the Bay Report. This 58-page report, produced by the Chesapeake Bay Program, covers cooperative efforts to protect and restore the Chesapeake Bay, North America's largest estuary. It provides an in-depth look into current environmental conditions throughout the Bay region and includes information that residents of the Bay watershed can use to get involved in Bay restoration efforts. The report also describes the health of the Chesapeake, its tributaries, habitats and living organisms. Major sections include "Life in the Bay," "Sound Land Use" and "Water Quality."

The publication may be downloaded from the web at www.chesapeakebay.net/pubs/sob/ or ordered from the Bay Program, 410 Severn Avenue, Suite 109, Annapolis, Maryland 21403, phone 800.YOUR.BAY, fax 410.267.5777.

Web Resources

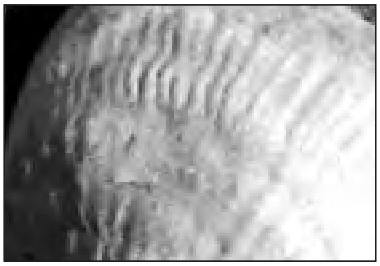
Water and Habitat Quality – www.eyesonthebay.net. The Maryland Department of Natural Resources recently launched this web site to make Chesapeake and Coastal Bays water and habitat quality monitoring data more publicly available. The site highlights new technologies that provide continuous data in near real-time as well as water quality mapping. Data from traditional long-term monitoring stations are also being updated to the web site within days of collection and links have been established to other timely sources of Bay monitoring information.

World Oceans Atlas – www.oceanatlas.org/index.jsp. To draw attention to the failing health of the world's marine ecosystems, the United Nations has launched an online atlas of the oceans. The site is an internet portal that provides information relevant to sustainable development of the oceans.

Designed for policy-makers, scientists, students and resource managers who need access to databases and approaches to sustainability, the atlas is comprised of fourteen global maps and four main entry points: "About the Oceans" contains maps and includes history, biology, statistical, climatological and ecological information; "Uses of the Oceans" covers the fisheries industry, shipping and mining, ocean dumping and marine biotechnology; "Issues of the Oceans" focuses on food security, climate change and human health; and "Geography of Oceans" contains information categorized by geographical area.

Oyster Research and Restoration Meeting

Oyster Research & Restoration: Developing Strategies for the Future, September 8-9, 2003, Annapolis, Maryland



For more than a decade NOAA Sea Grant has supported wide-ranging efforts to counter the impacts of oyster disease and to more effectively address many challenges facing the oyster industry nationwide. Among these efforts are developing new tools for disease diagnosis, breeding disease-resistant oyster strains, modeling, rapid detection of human pathogens in shellfish and new processing methods to insure public health.

In September, NOAA Sea Grant will join with the Maryland and Virginia Sea Grant programs to sponsor a two-day meeting that will bring together representatives of the scientific, management, industry and public outreach communities to build on those past accomplishments and to chart strategies and priorities for future directions. The meeting will offer both plenary sessions and facilitated workgroups. Plenary sessions will summarize the status of oyster fisheries in the U.S.; share recent developments at the leading edge of oyster disease research; and synthesize developments for management and restoration of oyster populations. Workgroups will develop recommendations and strategies on the following topics:

- Oyster fisheries management and restoration
- Genetics and oyster populations
- MSX and Dermo — Frontiers in disease and diagnostics research
- Public health and processing
- Aquaculture and hatchery issues

The meeting will provide a unique opportunity for participants to provide substantive input that will lead to the definition of new program priorities.

For registration, hotel reservations and other information on the meeting, which is limited to 150 individuals, visit the web:
www.mdsg.umd.edu/oysters/meeting

or contact one of the following Sea Grant representatives:
Jonathan Kramer, kramer@mdsg.umd.edu
William Rickards, wlr4z@virginia.edu
Jim McVey, Jim.Mcvey@noaa.gov

Chesapeake Quarterly is also available on the web at www.mdsg.umd.edu/CQ

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