ABC Helps Breeds a New Oyster Industry

Imagine bands of hunter-gatherers roaming the open spaces of Hampton Roads, stalking deer and collecting nuts to help feed the millions of people that call the area home.

Although this scenario might seem far-fetched, it is essentially how Chesapeake Bay's oyster fishery has traditionally worked, with watermen gathering wild stocks of the native oyster *Crassostrea virginica* to satisfy the palates of oyster lovers around the Bay, nation, and world.*

But if local and global trends are any guide, the traditional means of harvesting Chesapeake Bay's oysters will likely undergo a sea-change in the coming years, as the industry adds the techniques of aquaculture to its repertoire. That's according to Dr. Stan Allen, Director of VIMS' Aquaculture Genetics and Breeding Technology Center.

ABC, as the Center is known, is a leader in the development of the disease-tolerant strains and grow-out techniques now being adopted by a growing number of Chesapeake Bay watermen.

A recent survey of these watermen-farmers by Tom Murray and Mike Oesterling of the Sea Grant Marine Advisory Program at VIMS supports Allen's contention: the survey shows that sales of farmed oysters more than tripled between 2004 and 2005; it projects a doubling of sales between 2005 and 2006 (2006 sales figures will not be available until early 2007).

That projection would make 2006 a landmark year for oyster aquaculture in the Bay, marking the first time that production of farmed oysters surpasses that of traditional oyster landings. Aquaculture production is projected to exceed traditional landings again in 2007, by a factor of almost two.

"The lines representing aquaculture and fisheries production are starting to cross," says Allen. (See figures below.) He notes that traditional landings might occasionally exceed aquacultural production in the near-term due to the spikes inherent in a wild fishery. "But," he says, "aquaculture is only going to rise, making it more and more the reliable supply of oyster product in the Bay."

Waterman-farmer John Vigliotta of Ware Neck largely echoes these sentiments, saying that the major benefit of aquaculture is the consistency of production and the control it allows the grower. But he adds that he will continue to harvest wild oysters, particularly in years when environmental conditions produce an abundant set of natural oyster spat.

Lake Cowart of Cowart Seafood also continues with traditional harvesting, but has shifted his emphasis to aquaculture, with 50-60% of his recent production coming from farmed oysters.

A shift toward aquaculture-based oyster production in the Chesapeake is nothing new on the global stage. "This is a fact of life throughout the world," says Allen. "Oysters are cultured, not hunted, except in the Gulf Coast and a few artisanal fisheries."

The UN Food and Agriculture Organization reports that 93% of worldwide oyster production in 2000 originated from aquaculture. Chinese growers culture about 40 billion oysters per year; Japanese and Korean growers follow with about 2 billion oysters annually. France (1.5 billion) and the U.S. Pacific Northwest (500 million) round out the top five.

In contrast, Chesapeake Bay's fledging aquaculture industry cultured about 9 million oysters in 2005.

Allen says, "It's really kind of astounding that the highly developed East Coast of the U.S. is decades behind the technology of growing this bivalve. It's understandable in a way, first because the tradition of harvesting is so strong, and second because there has been a serious constraint to doing this in an economically feasible manner."

That constraint is the pair of diseases—MSX and Dermo—that kill most wild Bay oysters before they reach market size. Dermo first appeared in Chesapeake Bay in 1949, MSX arrived ten years later.

Vigliotta adds a third reason for the persistence of the traditional wild fishery: "The natural ones are free. There's little labor, you just go harvest them."

Aquaculture, on the other hand, entails a significant investment of time and money. Most oyster farmers in the Bay plant their seed in seafloor cages to protect against cownose rays. These wire cages must be periodically cleaned to allow water flow, and the oysters must be redistributed into new cages as they grow.

But ABC's selective breeding program for disease-tolerant varieties is now lowering the disease constraint to the point that the investment in native aquaculture is becoming profitable.

The program, run by transplanted Frenchman Lionel Dégremont, is proceeding along two fronts: a program of mass selection to produce disease-tolerant varieties for immediate industry use, and a program of family selection that is designed to identify correlations between disease-tolerance and other desirable traits.

"Mass selection," says Allen, "is the *modus operandi* that agriculture has used to domesticate wild species. When people first learned they could re-plant seeds and choose the best plants, they were performing mass selection—out of

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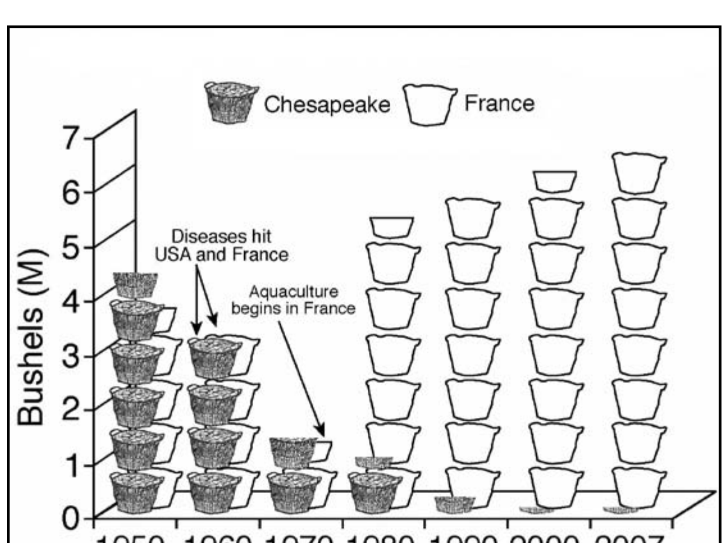
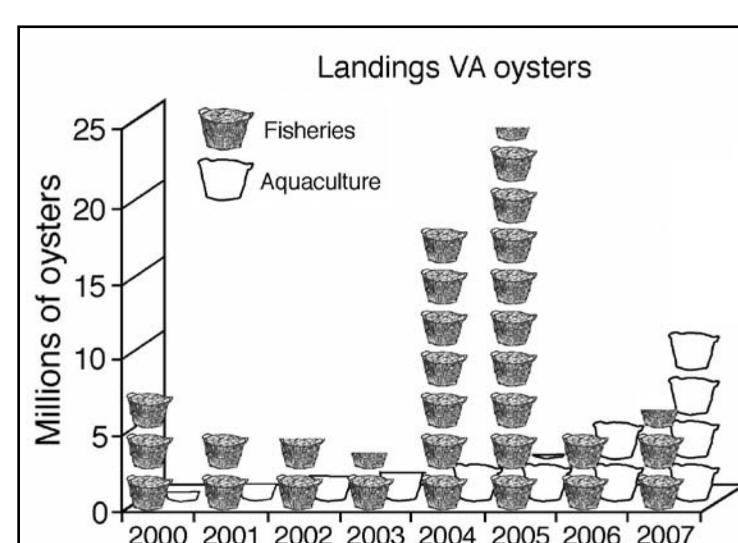
*Historically, Virginia oyster growers transplanted wild-harvested seed to leased growing grounds. Prior to the onslaught of diseases, growers paid little attention to the grounds between the planting of seed and the harvest of mature oysters 2 or 3 years later.



French growers have used aquaculture of a non-native oyster (C. gigas) *to greatly increase production.*



Recent trends indicate that aquaculture with disease-resistant native oysters will increasingly be a more reliable source of production than fisheries.

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the mass of individuals they bred the best ones to pass on desirable traits generation after generation."

To date, ABC has used mass selection to develop 12 lines of disease-tolerant oysters from East and Gulf coast stocks. "These lines vary from each other in slightly different characteristics," says Dégremont. "For example, the Louisiana line is good in lower salinity areas with little exposure to Dermo, but it's not particularly good in areas with MSX."

"The idea," Allen says, "is to give growers the aquatic equivalent of a seed catalog from which they can choose an appropriate variety to custom fit their particular farming operation."

In family selection, researchers breed for desired traits from among the competing progeny of particular male-female pairs. "This allows us to examine correlations among various genetic characters," says Allen. "We can find out if a fast-growing family is also disease-resistant, or whether it is dying quickly and the slow-growing families are resistant. That's an important distinction if you're going to start choosing for other traits later."

Right now, ABC researchers are focusing on developing disease-resistance, the most important character for enabling aquaculture. But, says Allen, "Once we achieve a modicum of resistance in the oyster, so that survival isn't the big issue, we want to start refining the domestication process to be responsive to other market traits like faster growth, greater yield, maybe shell shape, thickness, or color."

Use of disease-tolerant native oysters in aquaculture would set Chesapeake Bay growers apart from international competitors. In Asia, oyster aquaculture is based on the intensive culture of unimproved wild seed. In France, the Pacific Northwest, and Australia, it's based on hatchery rearing and intensive grow-out of an introduced species—*Crassostrea gigas*.

"Chesapeake growers could be unique in using hatchery-reared, native oysters in aquaculture," says Allen. "It's an intriguing alternative. Groups like the Fish and Wildlife Service and EPA that are concerned about a non-native introduction would like that scenario."

Although Allen is a proponent of the controlled introduction of sterile, non-native C. *ariakensis* oysters for use in Chesapeake Bay aquaculture, he also sees an important role for disease-tolerant natives.

"Our native oyster is a really good half-shell animal," says Allen. "It's being appreciated more and more for the half-shell market, even in the Pacific Northwest, where they're starting to ramp up production because it's such a nice product."

"The non-native," continues Allen, "might be a good product for the shucked trade, where they're just going to pop the thing open and take the meat. Its yield is high, it grows fast—you don't have as much of an investment as you do with the native."

The take-home message, he says, is that "we can probably minimize the need to make an introduction by changing our own species, but the non-native would add an additional strategy to the oyster farmer's toolbox."

"Careful consideration of non-native aquaculture could add a valuable component to the industry," says Allen. "I think it can be done in a way that is acceptable to society at large, and it would provide a huge extra resource in the panoply of choices available to the farmer."

Perhaps ironically, it is the recent large-scale trials with the non-native oyster C. *ariakensis* that opened the eyes of many watermen to the potential of aquaculture with the native oyster.

The trials grew out of work that began at VIMS in the mid-1990s, when the Virginia General Assembly charged the Institute with determining "whether species not native to Virginia waters could play a role in the shellfish industry." After noting the success of *ariakensis* in these early studies, industry asked for large-scale commercial trials of sterile *ariakensis* oysters to explore their economic potential for aquaculture in the Bay.

"In order for watermen to experiment with non-native oysters, they had to grow them, learn the aquaculture process," says Allen. "So they were exposed to a 'we can grow oysters' mentality. And each time that non-natives went out for trials, some natives went out for comparison, and the growers saw that these disease-tolerant natives survived quite well too. They then began to realize that they already had the gear, so why not just buy some native seed, the particular variety we tried."

"By giving watermen an opportunity to consider a non-native species," says Allen, "we've enabled them to consider the alternative of aquaculture."

In addition to being disease-tolerant, the native oysters in the large-scale commercial trials are also triploid—meaning they have an extra set of chromosomes that renders them sterile. Use of triploid natives ensures a fair comparison with the non-native trial oysters, which are also made triploid to keep them from breeding in the Bay.

Once again, trials of the non-native, triploid oysters provided an unexpected boost to aquaculture of the native species.

Says Allen, "Growers initially adopted triploid natives because it gave the oysters extra marketability during the spawning season—sterile triploids don't divert energy to reproduction or lose meat quality like spawners."

Cowart concurs with this assessment. "The triploid, disease-resistant oyster grows quickly in cages, and certainly has a better meat quality in August and September, much better than what the native oyster would have. So that's where we're putting our emphasis now."

But it turns out that the genetic process used to confer triploidy on native oysters confers additional benefits as well.

"There's some sort of additional effect," says Allen. "We call it heterosis or hybrid vigor. It imbues not only faster growth but higher survival to the triploid. It's just endeared it to the oyster-growing community in the Chesapeake."

Virginia Secretary of Natural Resources L. Preston Bryant, Jr. (Center) visited VIMS in June to learn more about current research, education, and advisory service activities at the Institute. Here, Bryant discusses non-native oyster issues with researchers in the VIMS oyster hatchery. From L: Dr. Eugene Burreson, Dr. Mark Luckenbach, Bryant, VIMS Dean and Director Dr. John Wells, and Dr. Stan Allen. Bryant also learned about on-going research projects at VIMS related to menhaden, biosolids, and shallow-water management. A tour of the seawater research laboratory currently under construction on the VIMS campus completed the visit.

VIMS graduate student Stephanie Wilson displays the microbes she designed for Giantmicrobes, Inc., a company that manufactures and distributes stuffed likenesses of common microorganisms. Wilson designed the firm's new aquatics line, which includes (from L) red tide (Alexandrium tamarense), *algae* (Anabaena), *sea sparkle* (Noctiluca), *pond scum* (Biddulphia), *and krill* (Euphausia superba). *Wilson, a fourth-year PhD student in Dr. Deborah Steinberg's Zooplankton Ecology lab, has had a lifelong interest in science and art. The aquatics line, along with several other Giantmicrobes products including fleas, dust mites, mad cow disease, and mosquitoes, are on sale in VIMS Watermen's Hall Gift Shop, which is open M, W, and F from 11-3 pm. Each 5-to 7 -inch doll is accompanied by an image of the real microbe it represents, as well as information about the microbe.*