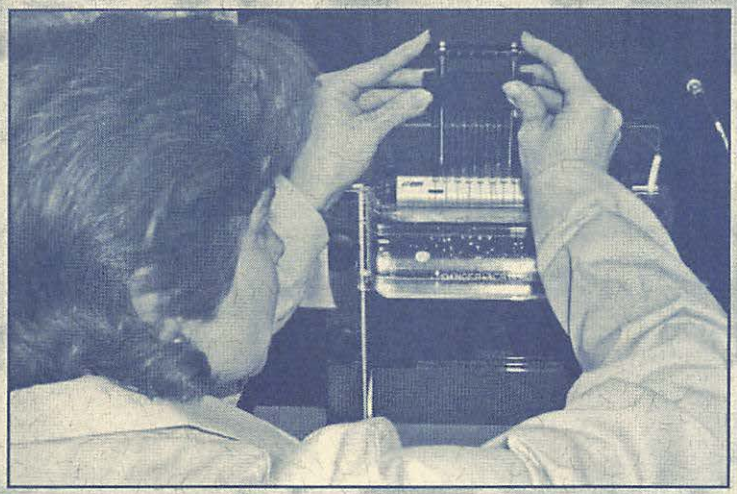
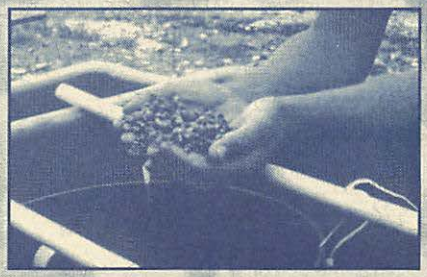
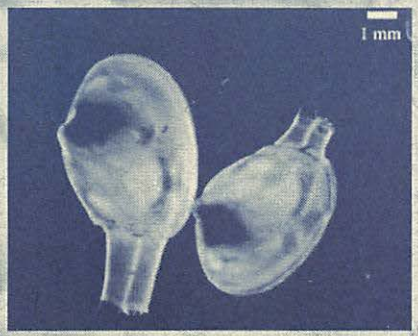
Aquaculture Genetics and Breeding Technology Center







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Aquaculture
genetics & breeding technology

Sea Grant
Virginia

William & Mary
VIMS
Virginia Institute of Marine Science
School of Marine Science

ABC at a glance . . . .

Aquaculture is the fastest growing segment of agriculture in the US. In essence, aquaculture can be viewed as the water-based equivalent of agriculture. Fisheries in the world's oceans are in decline or have reached their maximum capacity. Yet demand for seafood will continue to grow with population growth. Aquaculture represents our best hope for continued seafood harvests. With aquaculture comes the need for refined, improved, and domesticated species, like shellfish.

In 1997, Virginia legislators established the Aquaculture Genetics and Breeding Technology Center (ABC) at the Virginia Institute of Marine Science (VIMS), College of William and Mary in recognition of the role genetics and breeding play in aquaculture development. The Center is the first for which shellfish (clams, oysters, etc.) are a major effort, and one of the first dedicated centers for breeding marine species.

ABC is about the selective breeding and genetic engineering of shellfish - making them more uniform, like agricultural crops. ABC focuses on shellfish species because of their importance to Virginia and the region. As the Center's researchers improve the characteristics of shellfish, they also contribute to the economic development of Virginia's aquaculture industry.

ABC's research includes —

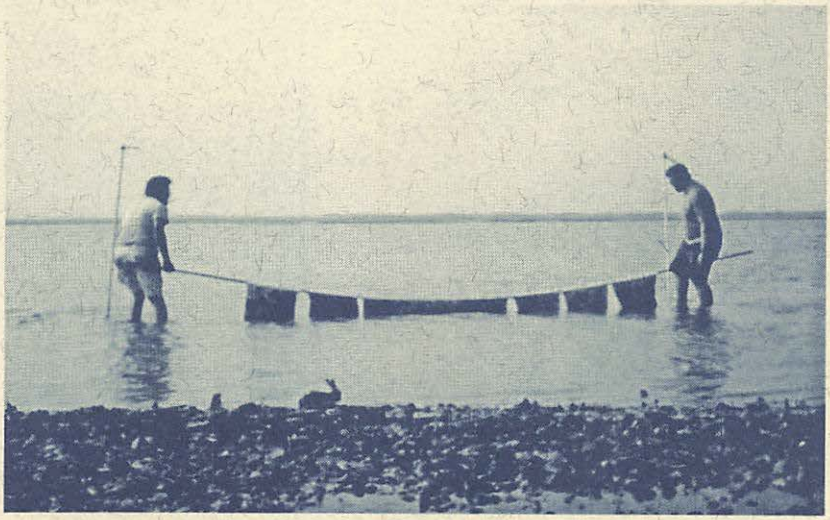
- *Developing shellfish brood stocks*
- *Improving genetic varieties through selective breeding (especially for disease resistance)*
- *Experimentally altering chromosome numbers*
- *Evaluating non-native species*
- *Developing molecular technology needed to exploit single genes.*

Simply put, ABC is in the business of adding value - biologically - to shellfish through selective breeding.

ABC's mission . . . .

ABC's mission is to develop, adopt, and maintain an array of innovative and applied technologies for genetics and breeding of aquaculture species.

The Center focuses on achieving premier status in shellfish genetics and breeding by bringing domestication and selection of species raised through *aquaculture* in line with those raised in *agriculture*.



ABC's impact on aquaculture in Virginia . . . .

ABC is contributing to Virginia's economic development in the aquaculture industry in a number of ways:

By developing shellfish breeding technologies and improving shellfish brood stock. ABC contributes to the economic viability of shellfish farming by providing the best strains for farmers to select from, improving Virginia's competitive edge through an improved and more uniform product.

By developing disease-resistant strains. ABC is taking a lead role in revitalizing natural shellfish populations and restoring oyster reefs with improved strains while at the same time fostering aquaculture growth in the state.

By providing cutting edge technologies for shellfish breeding. Certain new technologies may contribute to whole new industries in aquaculture, such as the culture of sterile non-native species. ABC's molecular technologies are providing new millennium tools for the genetic rehabilitation of oyster populations in Virginia.

By establishing a two-way communication with shellfish growers. ABC works closely with leaders in the seafood industry to determine the direction they feel aquaculture should take in Virginia and to assess their needs accordingly. Sharing information is critical to this process. ABC integrates industry recommendations in the process of developing select brood stock. The seafood industry works with ABC by providing grow-out grounds for stock testing.

Examples of ABC projects . . . .

Developing disease-resistant oysters. The Eastern oyster (*Crassostrea virginica*) populations have decreased dramatically because of two diseases, Dermo and MSX. ABC is developing varieties of oysters for disease resistance by selective breeding. The **C**ooperative **R**egional **O**yster **S**elective **Breed**ing (CROSBreed) is one such project – a collaboration among Rutgers University, University of Delaware, University of Maryland, and VIMS funded by the national Sea Grant Oyster Disease Research Program.

Breeding better clams. ABC's Clam Breeding Project supports a $15 million per year clam aquaculture industry. This project's goals are to improve brood stocks of hard clams – faster growing, more uniform, and disease tolerant – and to make these specialized brood stocks available to commercial hatcheries.

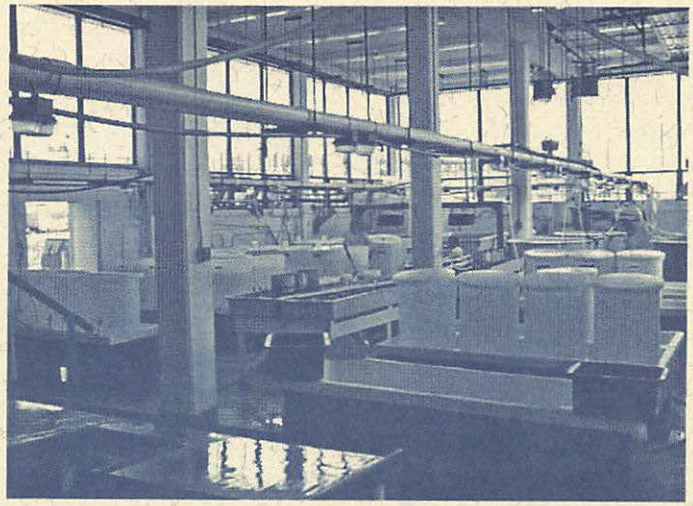
Developing unique markers for oyster species. In Virginia and throughout the mid-Atlantic, these molecular markers will be used to accelerate species selection for disease resistance and allow ABC to start identifying specific genes. At the international level, ABC is helping to define the range and extent of genetic resources in oyster species worldwide.

Evaluating and developing techniques for non-native aquaculture in the Chesapeake Bay. Non-native oysters are a valuable source of genetic material for breeding, for understanding comparative physiology, and for potentially providing alternative species for aquaculture. ABC is pioneering 21st-century technology to evaluate and develop techniques to reduce the risks associated with non-native aquaculture in the Chesapeake Bay. At the same time, ABC is constantly evaluating the economic potential of a variety of non-native genetic resources.

Partnering with oyster gardeners. The **G**ardener **RE**search **E**xtension **N**etwork (GREEN) project is a partnership between ABC and the many gardeners who grow oysters in the Chesapeake Bay. GREEN includes these gardeners in the design and operation of our projects. They assist us by providing access locations, materials, and even a portion of the required labor. The gardeners, in turn, benefit by learning first-hand about various oyster breeding research underway.

ABC's Hatcheries . . . .

Gloucester Point Hatchery. The VIMS campus hatchery is primarily devoted to genetics and oyster breeding. What sets this research hatchery apart from commercial ones is the large number of distinct spawns produced each season – an achievement requiring exceptional diligence from hatchery personnel. The hatchery also produces an array of unicellular algae species to feed larvae, young spat, and brood stock (parents for the spawnings).

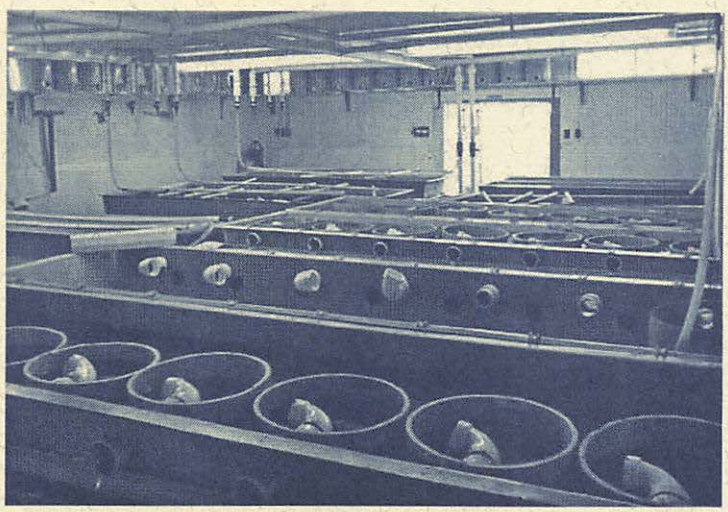


Gloucester Point Hatchery

The Center works with a handful of oyster species from around the world. To eliminate the risks of holding non-native brood stock, the hatchery has developed quarantine capabilities for brood stock, juveniles, and adult progeny.

Wachapreague Hatchery. The hatchery at VIMS' Eastern Shore Laboratory in Wachapreague is located on high salinity water. The hatchery spawns and rears clams and oysters, and to a lesser extent, scallops, soft-shelled clams, and surf clams.

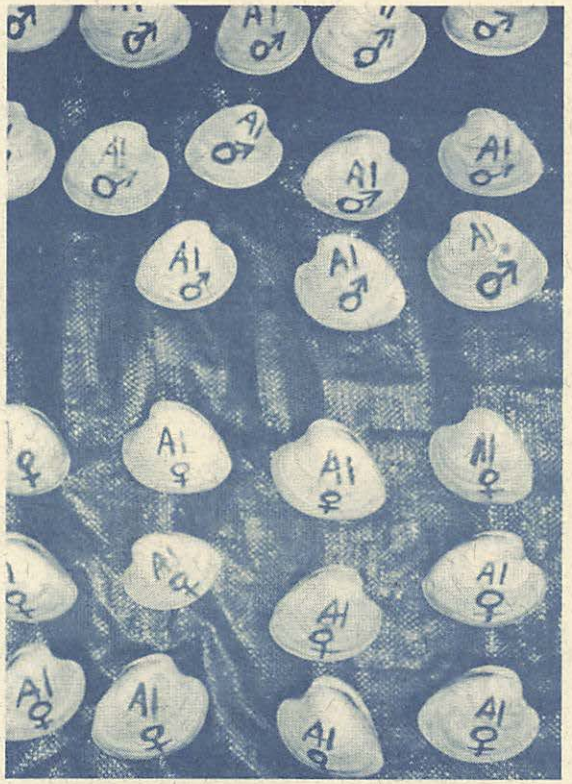
In Virginia, the hard clam aquaculture industry has many hatcheries and growers. To better serve these growers, the Center began the Clam Breeding Project in 1998 to "build a better clam." This project compares commercial strains of clams, defines the value of these strains, and refines them through selective breeding. The Wachapreague hatchery is our headquarters for hatchery- and nursery-rearing of such new strains.



Wachapreague Hatchery

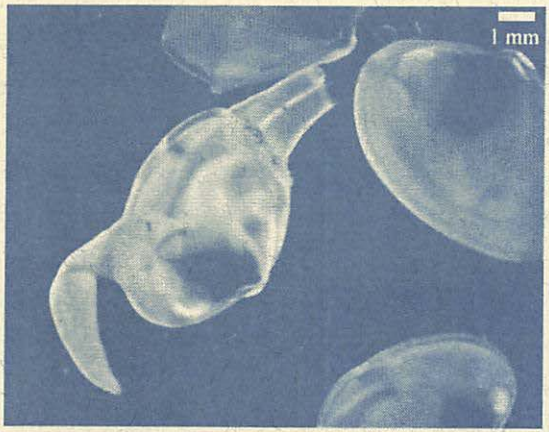
ABC's Breeding Lab . . . .

Some of ABC's principal breeding goals include selection for important traits in shellfish like growth in clams or disease resistance in the Eastern oyster, development of advanced breeding approaches for shellfish like polyploidy (containing extra chromosomes), and testing sterile non-native species. Polyploidy is widely used in agriculture crops to increase yield and enable special parental combinations to be mated together in sophisticated breeding schemes. The breeding lab also is headquarters for our selective breeding programs (clams and oysters) and for developing strategies to assist oyster restoration programs using selectively bred oysters. This latter activity is referred to as restoration genetics, and ABC is a pioneer in this field for shellfish.



ABC's Molecular Genetics Lab . . . .

Here ABC studies genomics, the organization of DNA, to obtain a genetic map of the oyster and to develop new tools for manipulating "disease resistance" genes. Studying DNA greatly accelerates selective breeding programs that should promote rapid development of a wide variety of strains and breeds. By using DNA markers as indicators of desirable traits, our researchers can select individuals for crosses on the basis of these markers, thereby shortening the effective generation time considerably and producing an improved brood stock more quickly. Markers also help us restore natural oyster populations by allowing us to "track" progeny from the brood stock planted on reefs.



Graduate Studies at ABC (VIMS) . . . .

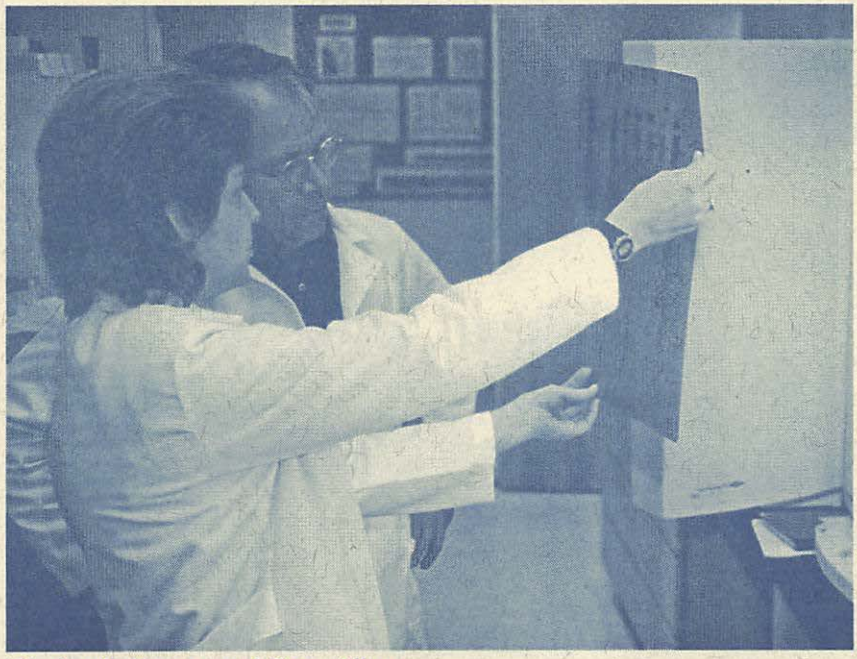
Because of the broad scope of our directed studies, there are many research opportunities for graduate students available in aquaculture genetics and breeding with ABC faculty. Ph.D.- level faculty members of ABC available for mentoring and their areas of interest follow:

Standish K. Allen, Jr., Professor - Cytogenetics and chromosome set manipulation of shellfish. Taking research breakthroughs in the lab and developing their commercial potential.

Kimberly S. Reece, Assistant Professor - Molecular genetics, marker development, systematics and phylogeny, genetic engineering.

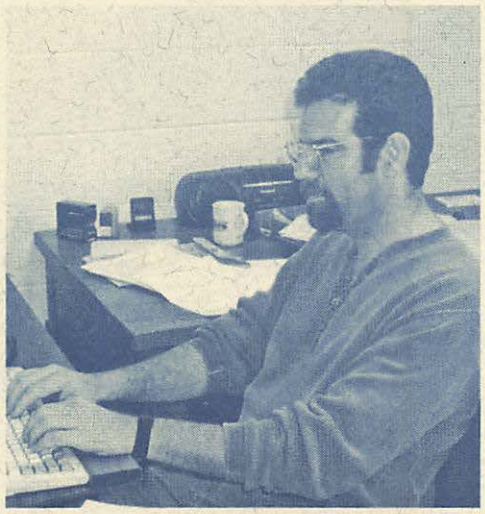
Mark D. Camara, Research Assistant Professor - Quantitative genetics, ecological and evolutionary genetics, restoration genetics.

Examples of recent student projects include systematics of Suminoe oyster (*Crassostrea ariakensis*), genetic stability of triploid oysters and the process of reversion, and evaluation of natural disease resistance in putative stocks of the Eastern oyster (*C. virginica*).



Kimberly Reece and Stan Allen

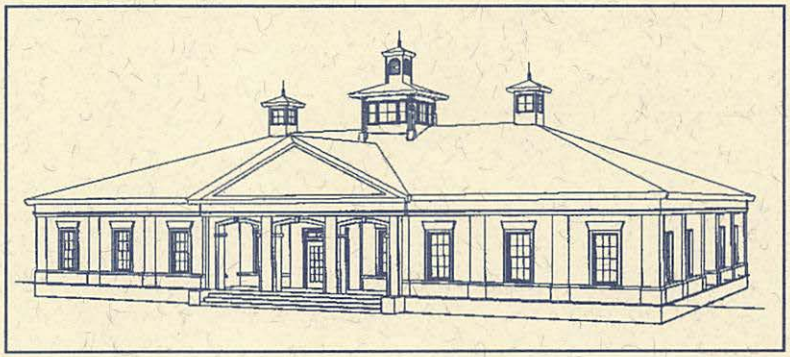
Mark Camara



ABC's growth plans and challenges . . . .

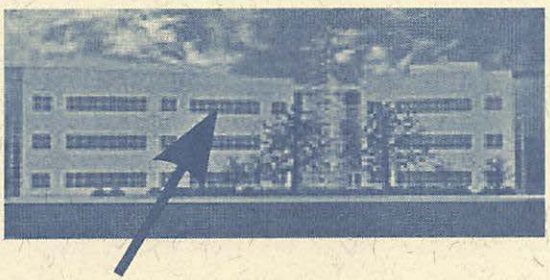
The Center is a new development at VIMS. Its potential is enormous and will require some expansion of current capabilities to assure its "world-class" status in shellfish breeding. Examples of several areas of planned development follow:

Kauffman Oyster Breeding Station (KOBS). ABC has completed plans for a unique field station and has issued a challenge grant for half of its capital cost. KOBS will provide capabilities to house special oyster stocks, both native and non-native in isolation (or quarantine). Examples of oyster stocks stationed there will include stocks of Eastern oyster from outside the region that are being evaluated, newly developed but not yet released strains, populations of oysters being held in isolation from endemic diseases, and special stocks of alternative species under evaluation.



Expansion of molecular genetics program. Currently constrained by research space, our molecular genetics program will soon move into newly renovated labs in Byrd Hall at the VIMS campus. At this time ABC will upgrade its instrumentation to aggressively expand our oyster genomics program to one of the most significant efforts in the world, and leader of oyster genomics for the Eastern oyster.

Plans for a bricks-and-mortar center for ABC. To take full advantage of ABC's unique position as a leading, world-class center in shellfish breeding, ABC needs the capability to leverage our program for additional support from state, federal, and international sources. ABC is in the planning stages of a 10,000-square-foot floor of a new building to realize this goal. Included will be space for conferencing, training, visiting scientists and affiliated researchers, as well as long-term storage of important germ plasm resources.



Proposed ABC floor