Inland Bays Journal Special Report

Enhancing, Restoring Inland Bays Shellfish

CIB's Oyster Gardening Program is a key to increase populations in Delaware's Inland Bays

"Given the low level of natural oyster recruitment we have observed, the Inland Bays Oyster Gardening program is a key means for increasing oyster populations."

During the summer of 2003, the Center for the Inland Bays received a small grant from the National Fish and Wildlife Foundation to initiate a pilot-scale oyster gardening program. Now in its third season, the Oyster Gardening program is a cooperative effort of the CIB, Delaware Sea Grant Program and citizen volunteers. The purpose of the program is to raise juvenile oysters for stocking the demonstration oyster reef at the CIB's James Farm Ecological Preserve at Pasture Point on Indian River Bay, and for planned oyster restoration work in Little Assawoman Bay.

To accomplish this, volunteers who live on the Bays are enlisted and trained to care for nursery culture oyster spat in Taylor Floats at their own dock for annual stock.

Other shellfish restoration programs in the Chesapeake and elsewhere have demonstrated that raising oyster spat to a larger size in Taylor Floats, before putting it on the reef, can significantly reduce losses to crab predation. The oyster spat (on shell) used in the program is produced by the University of Maryland Hatchery at Horn Point in Cambridge, Maryland.

This year, oyster gardening activity has nearly doubled to 29 locations thanks to the volunteer efforts of 47 Inland Bays residents.

In addition to returning volunteers, new gardeners from Fenwick Island, South Bethany, the Bald Eagle Creek/Torquay Canal and Guinea Creek areas of Rehoboth Bay and the Indian River Marina have joined the oyster gardening program.

Volunteer gardeners have helped to produce more than 30 bushels of juvenile oysters on shell for reef development. The system-wide distribution of oyster gardening locations has also greatly facilitated the monitoring of Inland Bays water quality and the occurrence of shellfish pathogens. Oyster spat with an initial average size of 10 millimeters have been deployed in Taylor floats during the last two summers (2003 and 2004) at various locations in all three of the Inland Bays. Average increases in oyster growth - ranging from 23 to 45 millimeters depending on location - have been good to excellent.

Good oyster growth has been observed at all Inland Bays locations especially in the Oak Orchard area of Indian River Bay and the southern portion of Little Assawoman Bay. Oyster mortality in the Taylor Floats has been negligible at all locations. Growth rates observed during the initial deployment of oysters in Little Assawoman Bay contradict anecdotal estimates that bay water quality conditions there are generally unsuitable for bivalves. These results also demonstrate the high potential for oyster aquaculture in the bay using off-bottom gear, and the opportunity to take advantage of the relatively closed conditions of Little Assawoman for promoting natural recruitment by developing oyster spawning sanctuaries in the bay. Besides providing an optimum environment for nursery growth, the baskets of oysters and shell in the Taylor Floats create excellent habitat for grass shrimp, juvenile fish and other small invertebrates.

With the assistance of these Inland Bays resident volunteers, we were able to deploy oyster spat at more than 15 locations around all three bays during 2003 and 2004.

Through community involvement and participation, the program also sought to educate the public about the important ecological services provided by oysters and other bivalve shellfish in improving water quality.

For additional information about the Inland Bays Oyster Gardening Program, please contact John Ewart at ewart@udel.edu or E.J. Chalabala at wildlife@inlandbays.org.

Volunteer oyster gardeners receive their spat from CIB intern Mike Yost, right. The spat are kept in a Taylor float at the gardeners' dock.

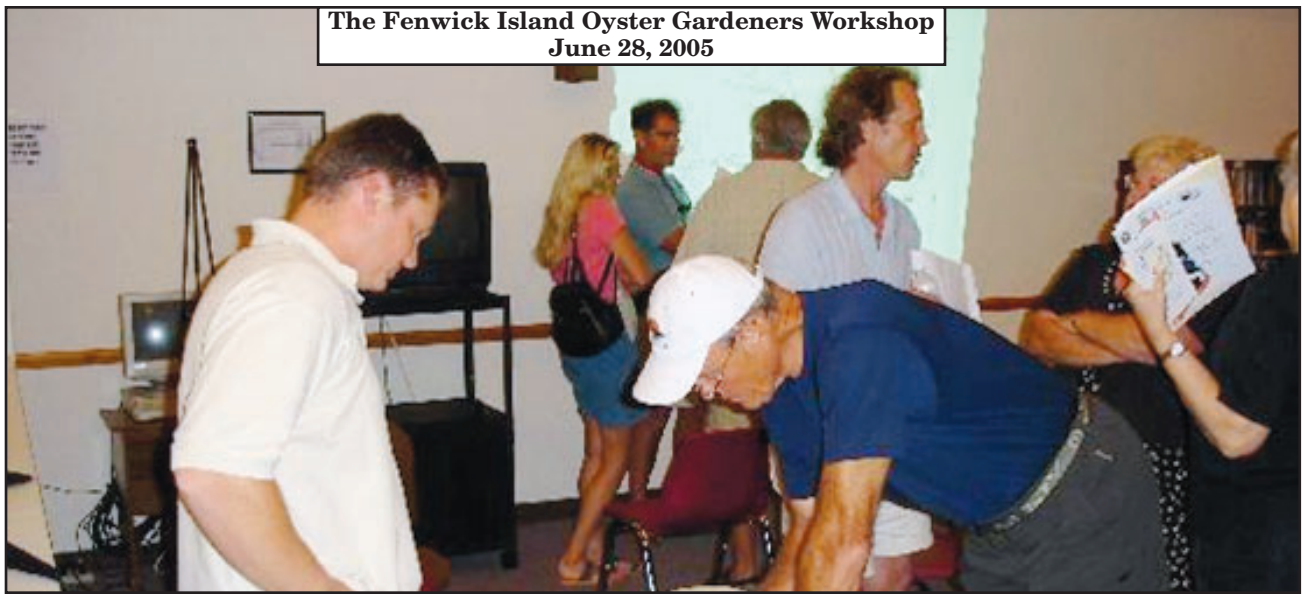
2005 Oyster Gardeners, Listed by Watershed

Our sincere thanks to all the volunteers working with us this season (47 individuals at 29 sites) They include the following:

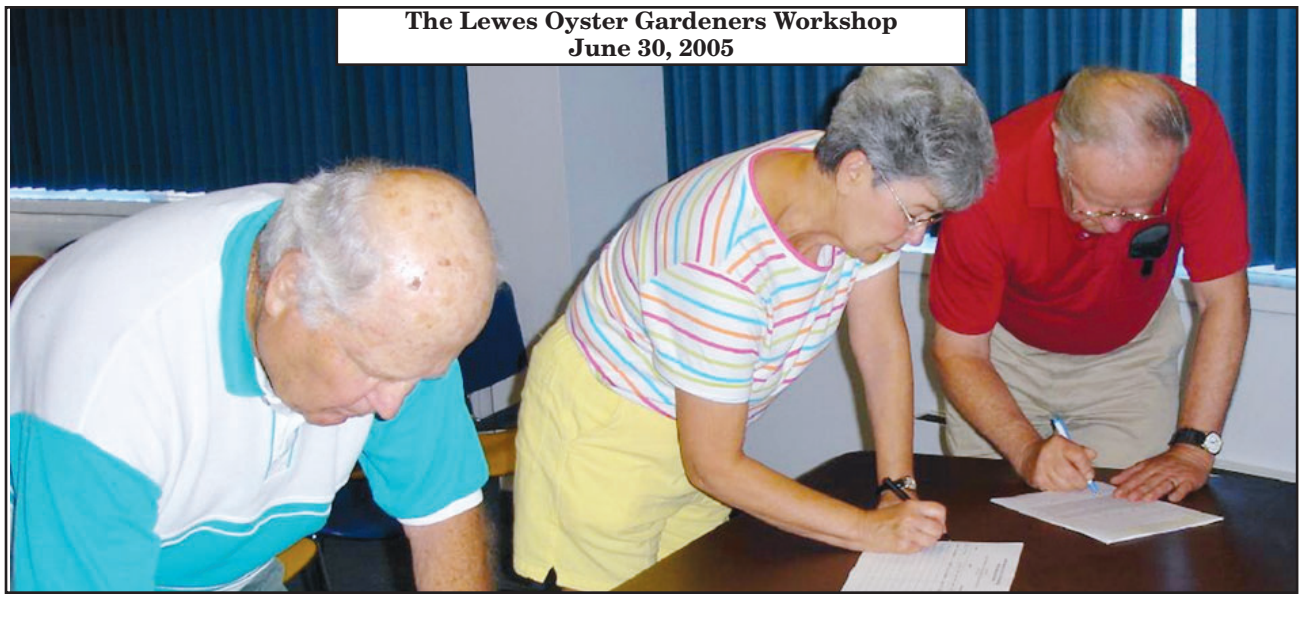
Little Assawoman Bay
Ken Arni
Vicki & Wayne Carmean
Troy & Cynthia Hardin
Buzz & Betsy Henefin
Lloyd Hughes
Martha Keller
Natalie & Steve Madeburger
David & Suzanne Tucker
Anna & Charles Welsh

Indian River Bay
Peter DeMarie
Nancy & Graham Purchase
Bruce Maurer
Gary King
Dave Wolzansky

Rehoboth Bay
Louis Allman
Steven & Dodee Black
John Cristea
Jeff & Deborah Dershem
Gil Ekdahl
Al Goldfarb
Blair & Missy Jones
Michael Kenjorski & Jane Nigg
Dave & Sandy Munchel
Bob & Winnie Oggenfuss
Ted Parker
Glenn & Molly Ruoff
Dom & Sue Scaglione
Justin Sikora
William Timmons
Nancy & Jerry Weinberg



The Fenwick Island Oyster Gardeners Workshop June 28, 2005



The Lewes Oyster Gardeners Workshop June 30, 2005

Inland Bays Applied Shellfish Research and Field Demonstration Projects Yield Valuable Information

By John W. Ewart
Delaware Aquaculture Resource Center
Delaware Sea Grant Marine Advisory Service
and
Jim Alderman and E.J. Chalabala
Delaware Center for the Inland Bays

Most of us living in eastern Sussex County know that Delaware's Inland Bays have been experiencing the impacts of chronic eutrophication and sediment erosion resultant from several decades of sustained nutrient input and development from within the surrounding watershed.

The cumulative impact of these inputs has degraded water quality and has altered the diversity and abundance of various species of fishes, invertebrates and submerged aquatic vegetation (SAV).

Other adverse environmental impacts include habitat loss, increased turbidity, episodic hypoxic and anoxic conditions and potentially hazardous phytoplankton and macroalgal blooms.

Within the last decade research has identified and quantified the key ecological role and contribution of bivalve shellfish (oysters, hard clams and other species) to estuarine water quality and clarity, nutrient cycling and sediment geochemistry.

Shellfish efficiently filter algae, sediments and other suspended microscopic material from the water column. This filtration process is the mechanism by which they capture and consume the particulate food necessary for growth and reproduction.

An equally important but lesser known benefit of shellfish filtration is that the solid waste products or bio-deposits resulting from feeding remove nitrogen taken up by phytoplankton. These nutrient rich biodeposits reduce the environmental availability of nitrogen in the water column and serve as a food source for small bottom dwelling (benthic) worms and crustaceans. These species in turn represent the food source for a diverse community of fish, crabs and other larger invertebrates.

The gaps or interstitial spaces created by the three dimensional profile of the living and dead shells making up the structure of oyster reefs (and commercial shellfish aquaculture gear as we are finding) offer a protective refuge and nursery habitat for juvenile fish and shellfish, stabilize the bottom and create a settlement substrate for a variety of seaweeds, barnacles, sponges, mussels and other species – including a new generation or year class of oysters.

The key role that oysters, hard clams and other filter feeding bivalves play in the function and health of coastal ecosystems and their important value as commercial and recreational fisheries is the main impetus for shellfish stock enhancement and restoration programs that are currently underway in stressed coastal estuaries around the United States and internationally.

These restoration programs are typically carried out at the local level through partnerships among community-based organizations, universities and state/federal government agencies.

In Delaware, the Center for the Inland Bays along with the University of Delaware College of Marine Studies, Delaware Department of Natural Resources and Environmental Control (DNREC), the regional office of the U.S. Environmental Protection Agency (EPA) in Philadelphia, Sussex County, local municipalities and numerous citizen volunteers are working cooperatively by supporting or participating in applied research and water quality monitoring to develop information directed toward improving shellfish management and the environmental quality of the Inland Bays watershed.

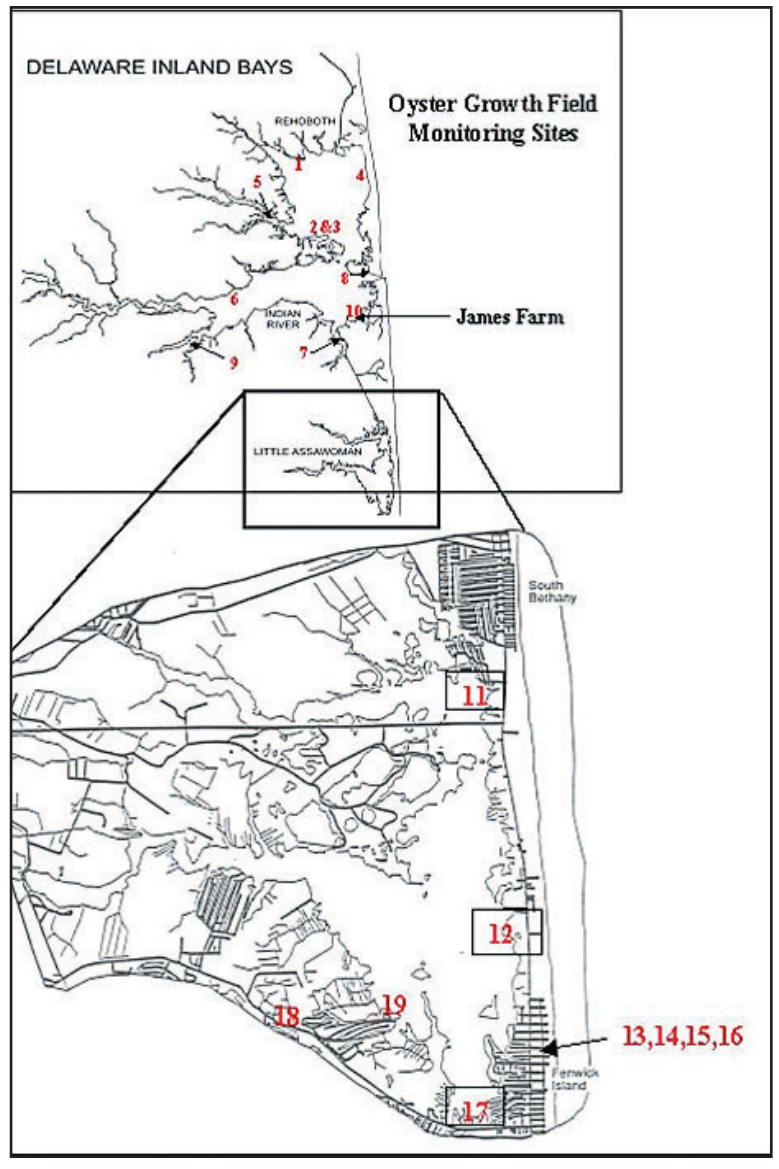
Inland Bays Shellfish Research

Maintaining healthy populations of bivalve shellfish for their ecological, recreational and commercial value to Delaware's coastal bays is an important priority of the Center's Comprehensive Conservation Management Plan (CCMP).

As part of the Center's mission for public education and to facilitate a long-term approach for the wise use and enhancement of the estuary, the James Farm Ecological Preserve, a 150-acre property with frontage on Indian River Bay was established in 1998. In addition to seasonal environmental education programs for middle school students and other groups, and a network of trails, observation platforms and other facilities, the James Farm also serves as a demonstration site for beneficial land use practices and similar watershed-based conservation activities.

The adjacent sub-tidal waters of Indian River Bay at the James Farm is one of several locations around the estuary where aquatic research and field demonstration activities are underway to determine how best to integrate shellfish conservation and aquaculture technologies into a management strategy for the Delaware Inland Bays.

Applied research to evaluate the use of in-bottom and off-bottom aquaculture methods for shellfish stock enhancement and replenishment was initiated at the James Farm during the summer of 1998. That first summer's activities involved small-scale deployment and assessment of field plantings of the hard clam *(Mercenaria mercenaria)* and the American oyster *(Crassostrea virginica).* Encouraging results of good growth and survival during that first field season prompted a series of additional, larger scale research and demonstration activities.



Findings: Environmental Conditions in All Three Inland Bays Support Shellfish Growth

Probably the most interesting observation to report is that environmental conditions in all three of the Inland Bays support good shellfish growth. Hard clams are the dominant bivalve species in Rehoboth and Indian River Bays.

Natural sets of oysters do occur, especially in Indian River Bay on rock outcroppings and other structure, but in very low abundance. Using Taylor Floats and off-bottom aquaculture gear as part of our oyster gardening program, we have observed good to excellent oyster growth in all the locations around the Inland Bays system where oysters were deployed.

Oyster Growth Monitoring Sites

Surprisingly, this includes the Little Assawoman Bay where natural shellfish populations are relatively insignificant, and other areas like dead end lagoon systems, previously considered unlikely to support shellfish due to poor water quality and water exchange. Also, different areas of the Inland Bays that do not typically receive natural sets of hard clams appear to support good to excellent growth when hatchery-produced hard clam seed is introduced.

A small-scale field demonstration trial developed initially to characterize and evaluate growth and survival of individual or "culchless" oysters using off-bottom aquaculture gear at the James Farm has consistently produced a small annual crop of market-sized oysters since the summer of 1998.

From June to November, it typically takes between one to two growing seasons to produce a 3-inch (75 millimeter) oyster from hatchery seed. Annual growth is very good to excellent and average mortality ranges between 5-10 percent.

We have also observed that the aquaculture gear (racks, cages, nets, ropes, trays & lines) also serve as nursery habitat by providing refuge and food for a variety of fish, crabs, grass shrimp and other small invertebrate species.

Pictured left, our native oyster, *Crassostrea virginica*, or American oyster.

Chronology of Inland Bays Applied Research and Demonstration Activities

Year
1998-2000 - Characterize seasonal oyster and hard clam growth

2000 - Eel grass (Zostera) bed at the James Farm (with hard clams)

2001 - Inland Bays shellfish pathogen monitoring (preliminary study)

2001-present - Establish and monitor a pilot scale oyster reef site at the James Farm

2002-03 - Assessment of native bivalve shellfish stocks in the Little Assawoman Bay; oyster and hard clam pathogen monitoring throughout the Inland Bays

2003-present - Citizens volunteer oyster gardening program

Off bottom aquaculture gear.

An aerial view of the James Farm.

The Native Versus Asian Oyster Debate

Some of you may be familiar with the current and sometimes contentious debate going on in the Chesapeake Bay about introducing the Asian oyster (Crassostrea ariakensis).

The conflict between the anticipated commercial benefits and largely unknown or poorly understood ecological implications makes this a very difficult issue that is virtually impossible to resolve in the desired short time frame.

The idea of a taking a similar approach for oyster restoration in the Inland Bays has been suggested.

Based on our experience working with the native American oyster (Crassostrea virginica), there is no indication that there would be any advantage to doing this and the list of unknowns and associated risks would be lengthy.

For additional information on the Asian oyster debate, visit the website mdsg.umd.edu/oysters /exotic/ariakensis.html or vims.edu/abc/CA.html.

What Lies Ahead for the Shellfish Program?

With the capable assistance of this year's CIB summer interns Sarah Beteljewski and Mike Yost, it has been a very busy summer. Fieldwork (unfortunately minus the summer interns) will continue into the fall season for as long as the weather allows.

Some ongoing and some new activities are planned for next season. We anticipate recruiting additional oyster gardeners especially in the Torquay Canal area of Rehoboth Bay and in Little Assawoman Bay and will continue stocking juvenile oysters on the James Farm reef.

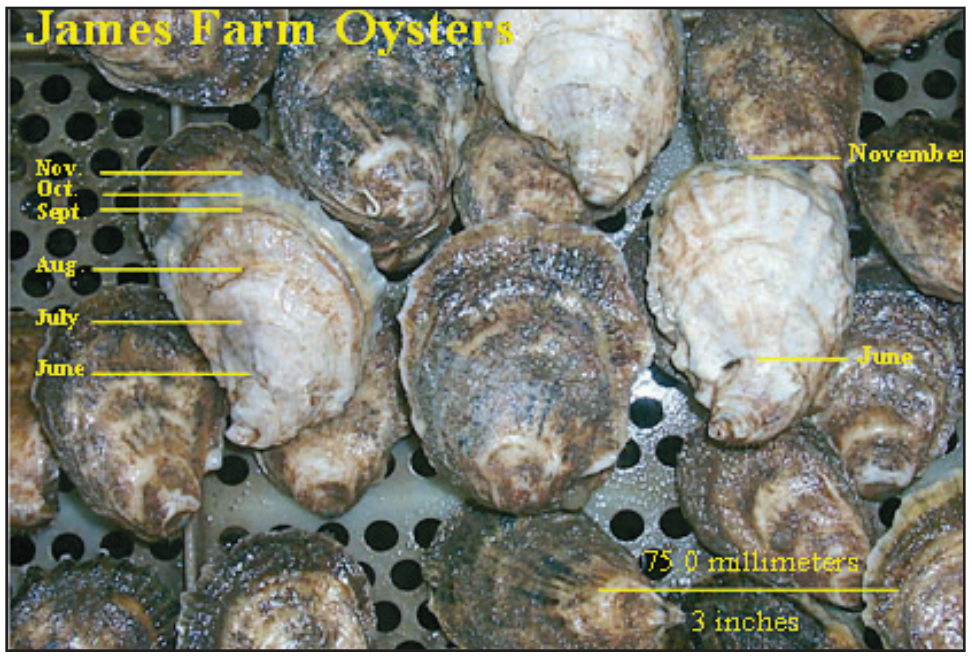
Patrick Erbland, a graduate student from the National Oceanic and Atmospheric Administration (NOAA) sponsored Living Marine Resources Cooperative Science Center program at Delaware State University, will continue a field study initiated this summer to evaluate the nursery habitat value of shellfish aquaculture gear for juvenile finfish and small invertebrates.

Also, we will plant additional hard clam seed and will begin working on developing a series of small fringing oyster reefs in Little Assawoman Bay this fall (and next summer) to develop adult populations that will hopefully serve as spawning sanctuaries.

Longer-term goals include the perpetual job of securing additional outside funding support for a long overdue inventory of Inland Bay shellfish resources and updating the shellfish management plan for the Inland Bays.

To stay informed on what we are doing, please visit the Center for the Inland Bays website inlandbays.org or the Delaware Aquaculture Resource Center's section on shellfish stock enhancement and oyster gardening at darc.cms.udel.edu/ #oyster.

The James Farm oyster reef.



James Farm seasonal oyster growth.

James Farm Oyster Reef Update

The pilot scale oyster reef, designed to create benthic habitat and serve as a spawning sanctuary, is located inside Pasture Point at the James Farm on Indian River Bay.

The reef consists of a quarter acre (100 foot by 100 foot) base or platform of surf clam shell covered with a layer of oyster spat on shell.

Funding to develop the reef was provided by a grant from the U.S. Environmental Protection Agency (EPA) in Philadelphia. Oyster spat used to stock the reef is produced at the University of Maryland hatchery at Horn Point in Cambridge, Maryland. The Horn Point hatchery produces millions of seed oysters annually for similar but larger scale restoration work in the Chesapeake Bay

Monitoring of oyster growth and survival on the reef during spring, summer and fall is providing useful comparative information on field performance among three applications:

1) Reef 1 - a section of the reef base stocked with oyster spat on shell during 2002

2) Reef 2 – a second area of the reef stocked in 2003 with juvenile oysters - nursery cultured spat on shell produced by volunteer oyster gardeners.

This section of the reef is supplemented annually with 10-15 bushels of a new year class of juvenile oysters from the gardening program; and

3) The off-bottom commercial aquaculture grow-out gear used for culchless oysters.

Both sections of the reef and the grow-out gear have produced reproductively viable (spawning) adult oysters. On the reef, some evidence of natural oyster recruitment, although light, has been observed.

In addition to anticipated losses from crabs, and oyster drills and other predators, two natural environmental events caused catastrophic oyster mortalities of up to 80% between 2003 and 2004.

A persistent smothering mat of "sea lettuce" *(Ulva lactuca)* covered the reef during most of the summer of 2003. The blanket of macro-algae severely reduced water flow across the reef and increased sediment accumulation leading to anoxic conditions.

A subsequent very hard winter with extreme low tides and single digit freezing temperatures, especially during January 2004, resulted in additional winter mortality. Ironically, a previous CIB newsletter article of ours published during Spring 2003 was a little too clairvoyant for comfort:

"Of course everything could change in a heartbeat with a hard winter, sustained freezing temperatures and icing of the Indian River Bay (like it did four years ago during February), the annual spring macro-algae bloom and the accompanying smothering mats of sea lettuce and hypoxia, increased predation, new disease outbreaks and so on and so on… Mother Nature has no shortage of obstacles she can throw at you when attempting projects of this sort."

While nothing has changed with regard to Mother Nature, annual supplements of juveniles from the oyster gardening program are helping the reef community to recover and the population will continue to improve as additional year classes of oysters are introduced.

Two oyster pathogens Dermo *(Perkinsus marinus)* and SSO aka Seaside Organism *(Minchinia costale)* have been detected in reef oysters but not at levels high enough to cause widespread mortality problems. Levels of Dermo on the reef are similar to that detected in natural set oysters on the opposite (northern) side of Indian River Bay.

Last winter was a relatively milder one and macro-algae accumulation on the reef this season was again a problem but not a major issue, so the reef is presently in a rebuilding mode.

Given the low level of natural oyster recruitment we have observed, the Inland Bays Oyster Gardening program is a key means for increasing oyster populations.

CIB staffers Jim Alderman, left, and E.J. Chalabala are pictured measuring James Farm reef oysters.

Little Assawoman Bay oysters.

Little Assawoman Bay experiments find success

The good to excellent oyster growth and survival that we have observed at different Inland Bay locations has included some unanticipated sites like residential "dead end" lagoon systems and the Little Assawoman Bay (LAB). Field surveys have confirmed that natural populations of oysters, hard clams and other bivalves in the Little Assawoman are virtually nonexistent. Episodic fluctuations in salinity, poor water exchange rates, zones of soft mucky sediments high in silts and clays and low broodstock biomass are believed to be limiting factors.

Oyster gardening growth results and excellent growth of hard clams planted in the LAB in October 2003, however, demonstrate the effectiveness and potential of using aquaculture methods for increasing shellfish populations.

Based on these results, the town of Fenwick Island has expressed interest in additional oyster gardening and related shellfish restoration efforts. The LAB is unique in comparison to the other Inland Bays because it's geography, low water exchange and relatively closed nature offers good potential for larval retention and gradual establishment of natural recruitment with the development of shellfish spawning sanctuaries.

Little Assawoman Bay hard clams.