

## APPENDIX


**RUTGERS**  
THE STATE UNIVERSITY  
OF NEW JERSEY

## Cultivating Shellfish Aquaculture in New Jersey

Dr. David Bushek, Director HSRL  
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Lisa M. Calvo, Rutgers/NJSG Aquaculture Specialist  
Brian Harman, Farm Manager, Cape May Salts  
Betsy Haskin, Proprietor, Betsy's Cape Shore Salts

**RUTGERS** Cultivating Shellfish Aquaculture in NJ

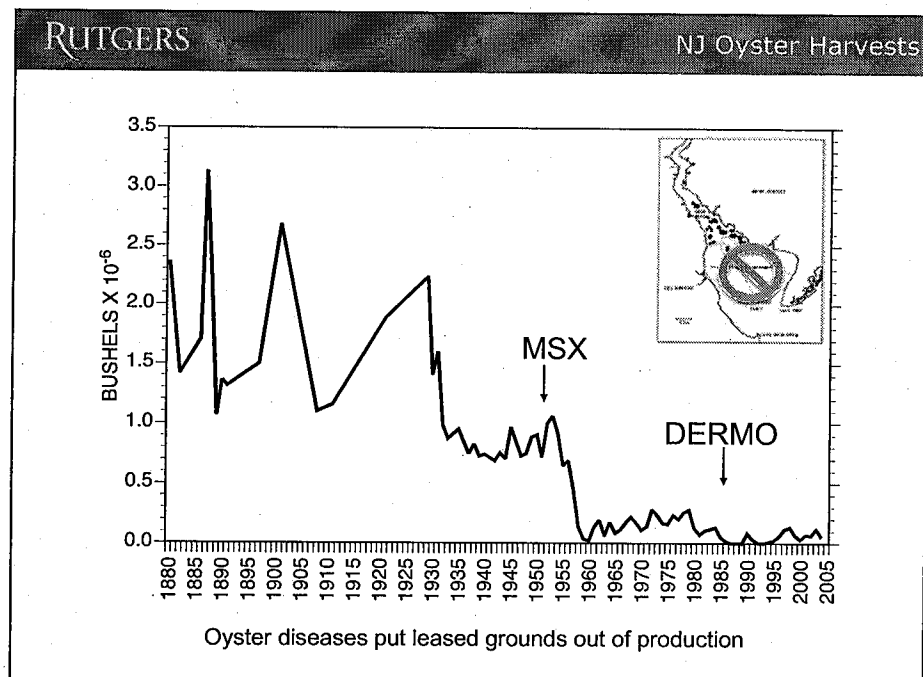
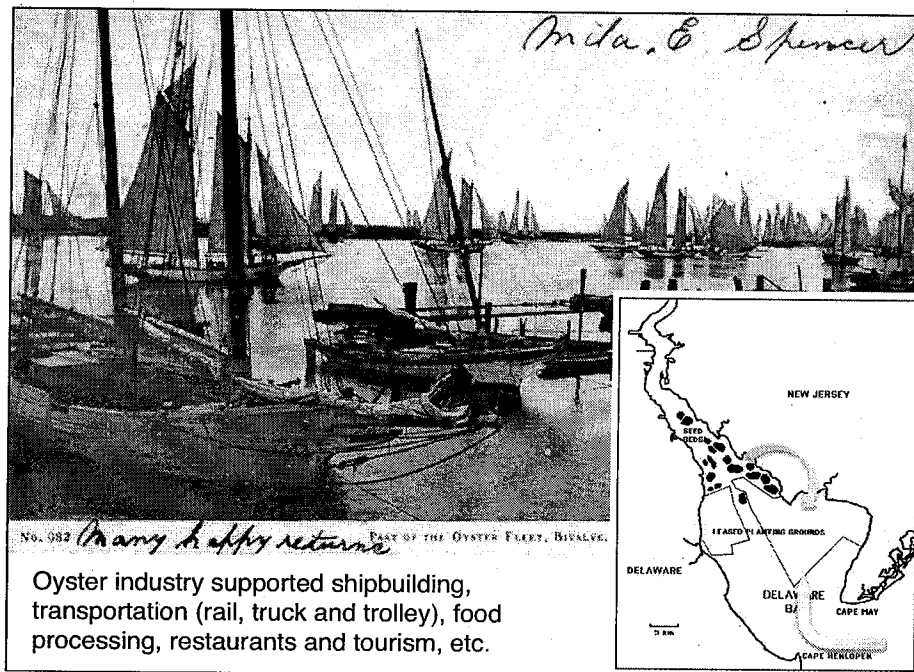
## Oyster Renaissance

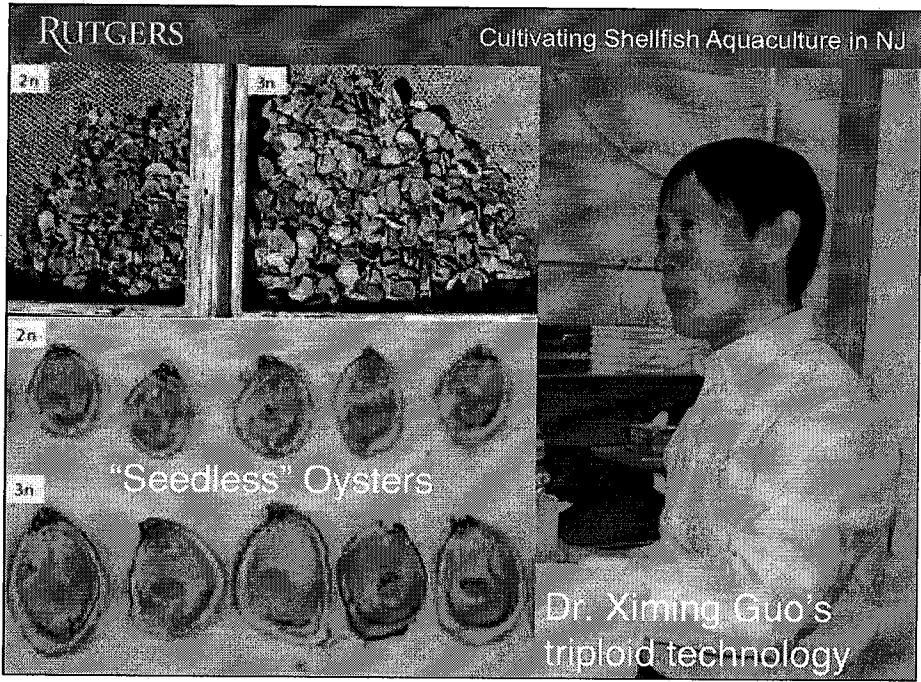
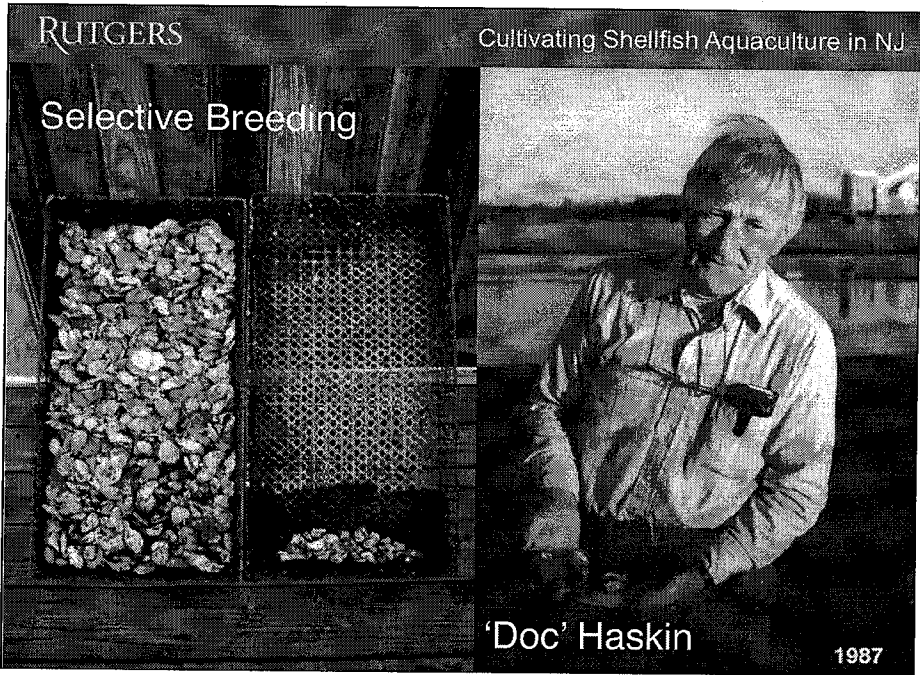


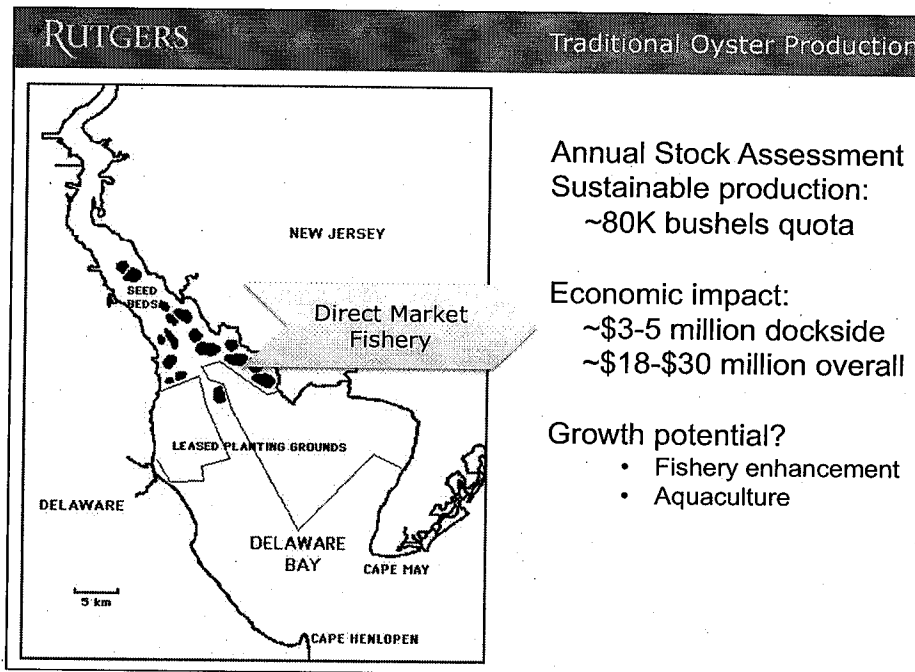
Fueled by—

- Increased availability of high quality oysters
- Clever branding, stories create intrigue
- New generation into food experimentation
- Oyster eating as experience
- Local food movement
- Growing emphasis on sustainability









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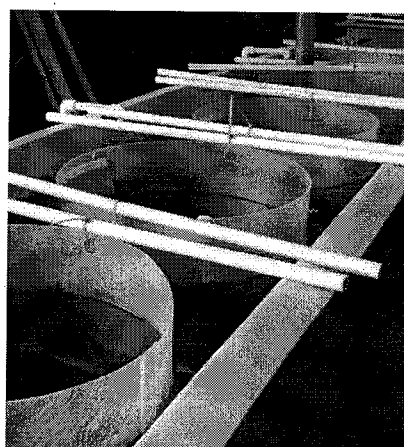
## Aquaculture = Agriculture

- Aquaculture is **farming** aquatic organisms
- Farming involves an **intervention in the rearing process**, such as seeding, stocking, feeding or protection from predators
- Farming implies **ownership of the stock**

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Cultivating Shellfish Aquaculture in NJ

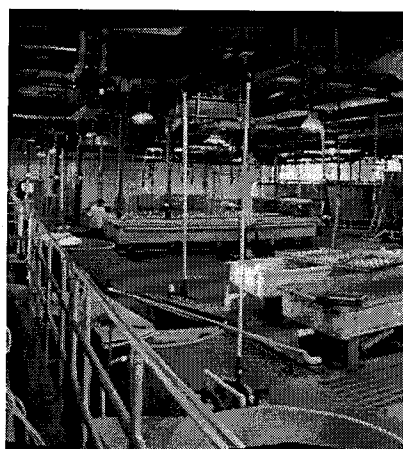
Production of hatchery reared disease resistant seed  
enables intensive oyster aquaculture in Delaware Bay



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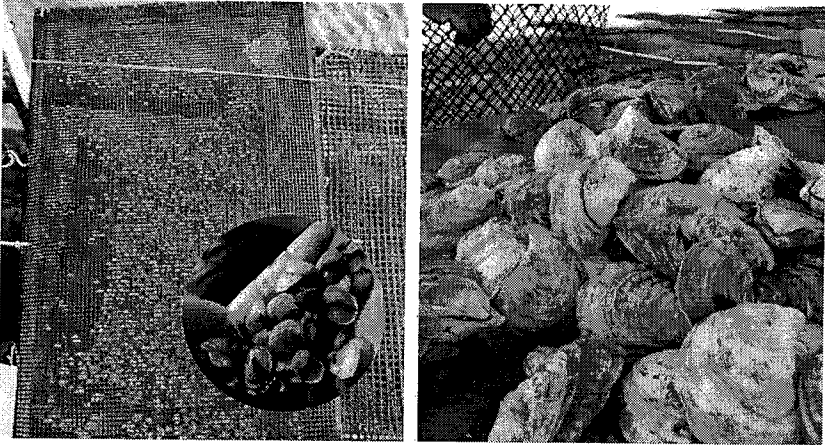
Cultivating Shellfish Aquaculture in NJ

NJ Aquaculture Innovation Center



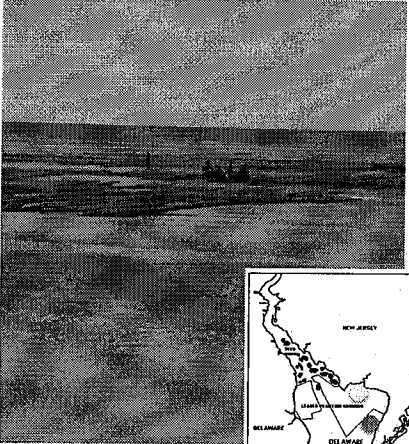
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**Intensive husbandry**  
1.5 – 3 year production cycle

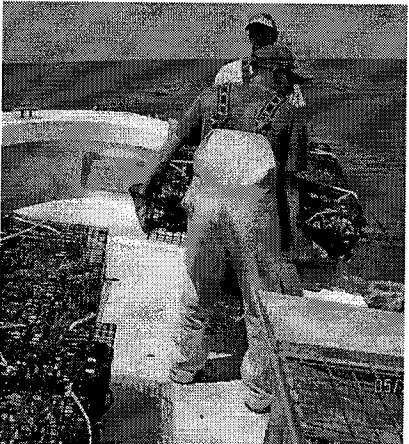


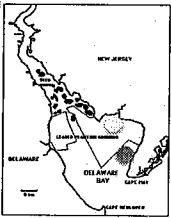
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**Intertidal**




**Subtidal**



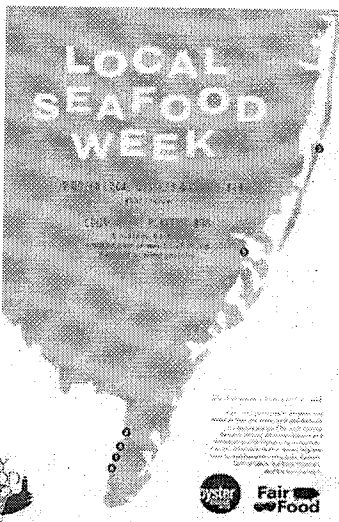


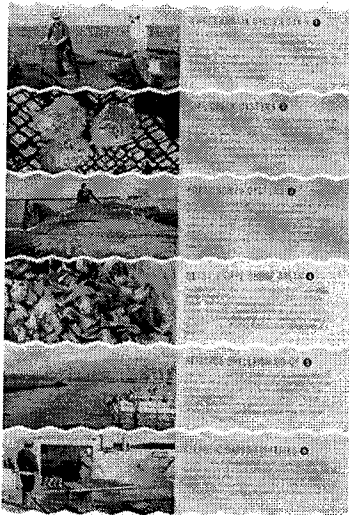
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## Distinctive High Quality Half-shell Oysters



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These two NJ platters alone sold over \$6,000 last week at the Oyster House in Philadelphia.

7x

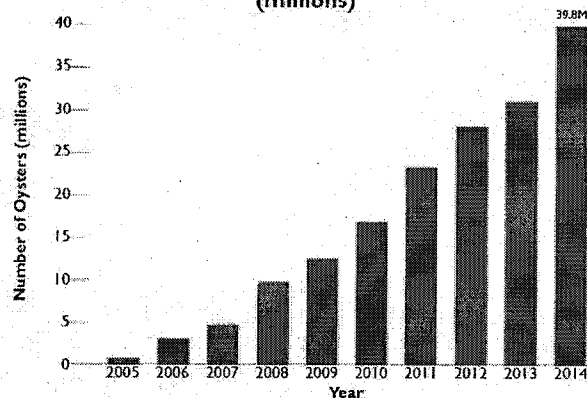
### Situation and Outlook Oyster Culture in New Jersey

- One public hatchery (NJAIC, Rutgers University)
- Seven farms sold oysters
- 1.57 million oysters sold
- Average farm-gate price \$0.55 per oyster
- Farm-gate value \$860,000, nearly \$6 million extended value
- 16.5 million oysters in production
- Anticipated harvest for 2014 was 3.1 million

Reporting year 2013 (Calvo et al, 2014). Reports available at <http://hsrl.rutgers.edu>

### Oyster Aquaculture Growth in Virginia

**Fig. 2 Number of Aquacultured Market Oysters Sold (millions)**



## Opportunities

- Close to regional markets = local food movement
- Excellent growing waters produce high quality oysters with exceptional flavor
- Thousands of acres of shellfish leases in Delaware Bay could serve as aquaculture sites
- NJ Aquaculture Innovation Center offers tremendous research and production capacity to support restoration & diversification efforts
- Cooperative community of environmentally responsible shellfish growers

## Benefits of a Green Industry

- An increasing body of science demonstrating environment benefits of oyster aquaculture
- Shellfish aquaculture can provide significant economic benefits to coastal communities while improving the water quality and enhancing the habitat of New Jersey's estuaries





## Challenges

- Lack of state mandate to promote shellfish aquaculture
- Lack of a stable management system
- User conflicts, limited available grow-out areas, particularly in nearshore
- Poor water quality in protected waters limits development of nursery areas
- Harsh seasonal weather conditions, extensive biofouling, disease loss
- Gear innovation and development



## Major Current Challenge

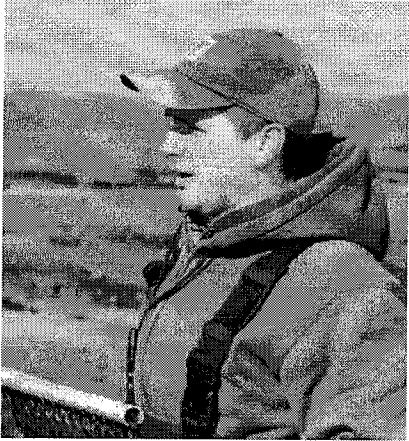


Photo: Kevin Edwards (an.umces.edu)


- Recent listing of red knot as threatened species under ESA
- Science-based information needed to inform recovery of red knots and management of shellfish farms

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## Oyster farmer perspective



Brian Harman, Manager  
Cape May Salt Oysters




Elizabeth Haskin, Owner  
Betsy's Cape Shore Salts

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## Challenges

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## Key Steps to Advance Shellfish Aquaculture in NJ

- Establish shellfish aquaculture as a state economic priority
- Design a management system tailored to the shellfish aquaculture industry
- Support research, technology development and innovation



## Establish shellfish aquaculture as a state economic priority

- Top down mandate
- Economic benefits
- Ecological benefits
- Growing demand for shellfish
- Other states competing in markets that are in close proximity to NJ
- Opportunity to create jobs and economic benefits in south Jersey

### Design a management system tailored to the shellfish aquaculture industry

- Establish state ombudsperson for shellfish aquaculture
  - One-stop shop for leases, permits, resolve inconsistencies in policy
- Design management system that enables shellfish aquaculture expansion
  - Consistent implementation of policies
  - Coordination among relevant agencies
  - Timely decisions in response to industry needs
- Support pathways for the growth of shellfish aquaculture
  - Identify suitable areas for industry expansion that reduce conflicts with other uses of the coastal zone
  - Restore water quality in shellfish closure areas
  - Provide land-based access to the Aquaculture Development Zones
  - Develop technology to advance subtidal shellfish aquaculture

### Support research, technology development and innovation

- Current sources of support are directed at priorities of federal funding agencies
- Small core staff
- Stronger state commitment needed to expand the industry

## Summary

- Research capacity, technical support and innovation framework in place
- Other states have developed shellfish aquaculture into a major economic activity
- Potential for growth of the shellfish aquaculture industry in New Jersey is substantial
- Near-term steps are well-defined and must be taken to promote industry innovation and growth
- Time to act is now

## Questions?





# Oyster Aquaculture

A new generation of economic development for NJ



*Oyster aquaculture provides significant economic benefits to coastal communities while improving the water quality and enhancing the habitat of New Jersey's estuaries*

Oyster aquaculture in New Jersey is poised for significant growth. A recent Rutgers University survey documented that 1.57 million farm-raised oysters were sold in 2013 with a farm-gate value of \$860,000. With many new farms coming on line and existing farms expanding, significant increases in production are anticipated over the next decade.

New Jersey's oyster farms are primarily located on extensive intertidal sand flats of the lower Delaware Bay known as the Cape Shore. The moderately high salinity and good food quality characteristic of this area supports rapid oyster growth and yields exceptional quality oysters. Here, hatchery-reared disease

resistant oysters are grown in rack and bag systems. The farms are accessed from the shore at low tide and the oysters are tended for a 2-3 year production cycle. In 2014, seven oyster farms had 16.5 million oysters in production.

In 2012, the State of New Jersey expanded shellfish aquaculture opportunities with the opening of Aquaculture Development Zones in the lower Delaware Bay. The ADZs comprise 1100 acres of offshore bottom and 51 acres of intertidal area. Demand for the pre-permitted inshore areas was high and all parcels were leased within months of the program's start. Ten of the 12 parcels are presently farmed and several of ADZ leases, are seeking to expand their farms to the maximum acreage allowable by the ADZ program.



## New Jersey's farmed oysters are distinctive high quality oysters, prime for the half shell trade



### *Key steps to advance shellfish aquaculture in NJ*

- Establish shellfish aquaculture as a state economic priority
- Design a management system tailored to the shellfish aquaculture industry
- Support research, technology development and innovation

In addition to the lower bay ADZs, there is a growing interest to expand aquaculture production to the traditional subtidal "oyster planting" grounds. Traditionally, these areas were used to grow out or finish wild oysters harvested from natural seedbeds. At the industry's prime, this extensive form of aquaculture occupied more than 30,000 acres of the lower bay. Unfortunately, following the onset of MSX disease in the late 1950s, and the intensification of Dermo disease in the 1990s, cultivation ceased on these once highly productive grounds due to high mortalities caused by the parasites. Today, 79 entities lease 32,226 acres of planting grounds; however, only a small percentage of available acreage is used for oyster production. Another 20,000 acres are available for expansion. The potential of the historically important leased grounds remains untapped. Aquaculture of hatchery-reared, disease resistant stocks presents new opportunities for invigorating oyster production on the leased grounds. Presently, two farms located in Cumberland County, NJ are demonstrating the viability and potential of aquaculture on these grounds.

New Jersey's farm-raised oysters are distinctive high

### *A look at the numbers*

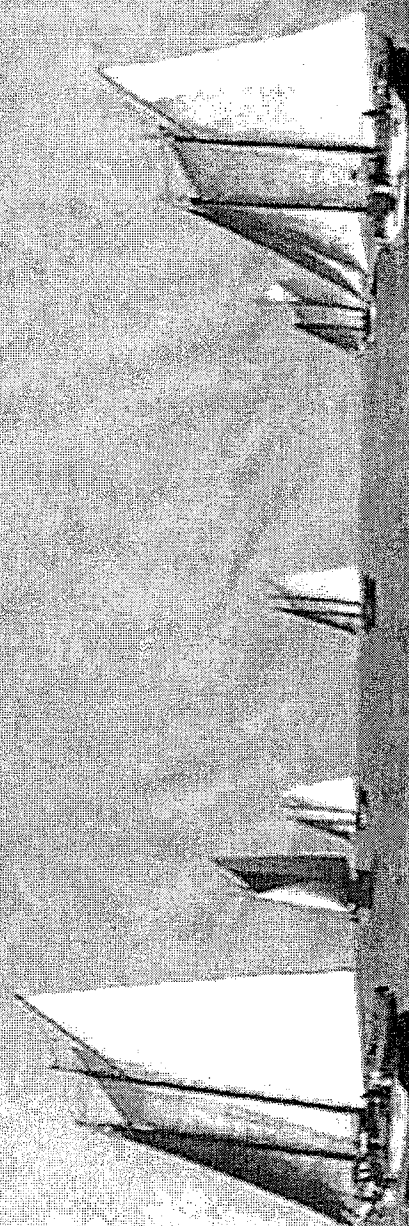
- 17 oyster farms
- 1.57 million oysters sold
- \$860,000 farm gate value
- \$5,200,000 extended economic value
- 16.5 million oysters in production

quality oysters that are sold for the half-shell market. This high-end market yielded wholesale prices averaging \$0.55 per oyster in 2013, greatly exceeding that of wild harvest product, which sold wholesale at \$0.25-0.35 per oyster. Direct market prices ranged from \$0.85 to \$1.25 per oyster. The year-round availability and consistent quality, shape, size, and appearance of farm-raised oysters drives a higher price and reflects the great care and husbandry required to produce this distinctive product.

High demand for cultured oysters from New Jersey, fueled by an oyster renaissance, presents tremendous opportunity for industry growth, however advancement will require state prioritization and enhanced management strategies.



# New Jersey's Delaware Bay Oyster Management & Restoration Programs



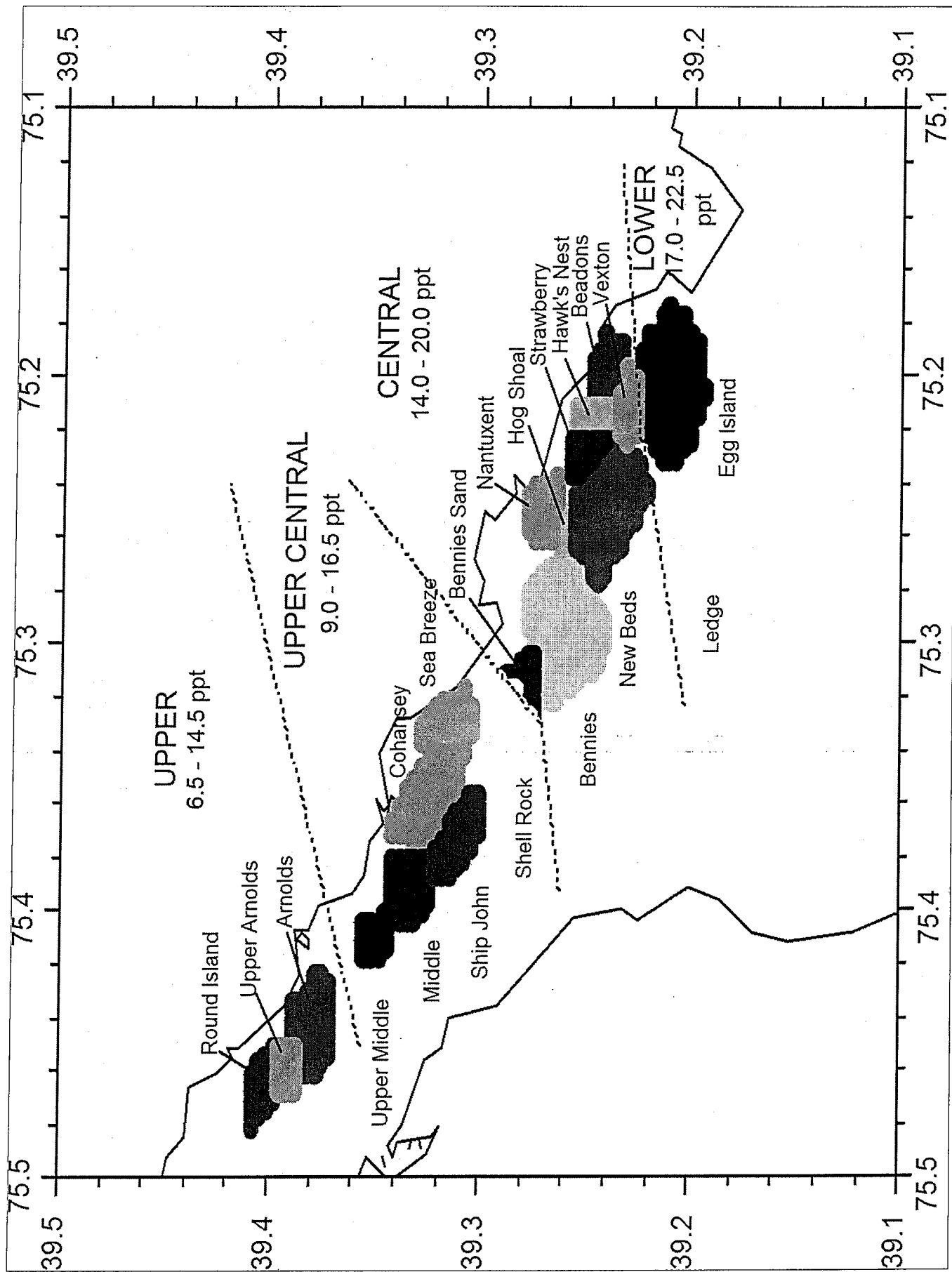
Jason Hearon, Senior Fisheries Biologist  
NJ Department of Environmental Protection  
Division of Fish and Wildlife



Marine Fisheries Administration, Bureau of Shellfisheries  
Bivalve, New Jersey

17x





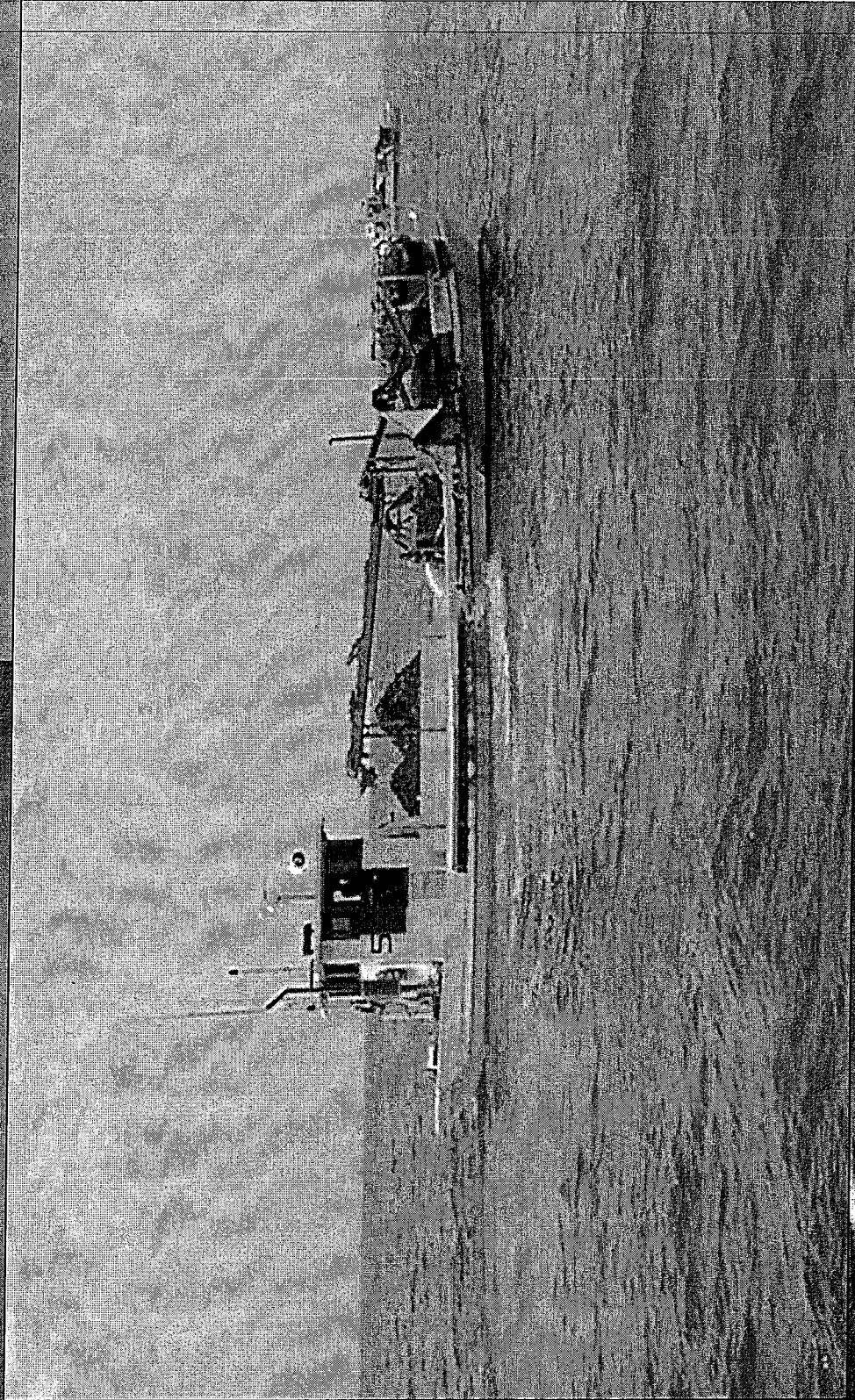
# Ecosystem Function



Oysters are a keystone species in the Delaware Bay, providing the basis for a vast community of benthic organisms.

Oysters and the reefs they create increase habitat and faunal diversity and through their high filtration capacity, they can even improve water quality.

# Oystering By Sail & Power

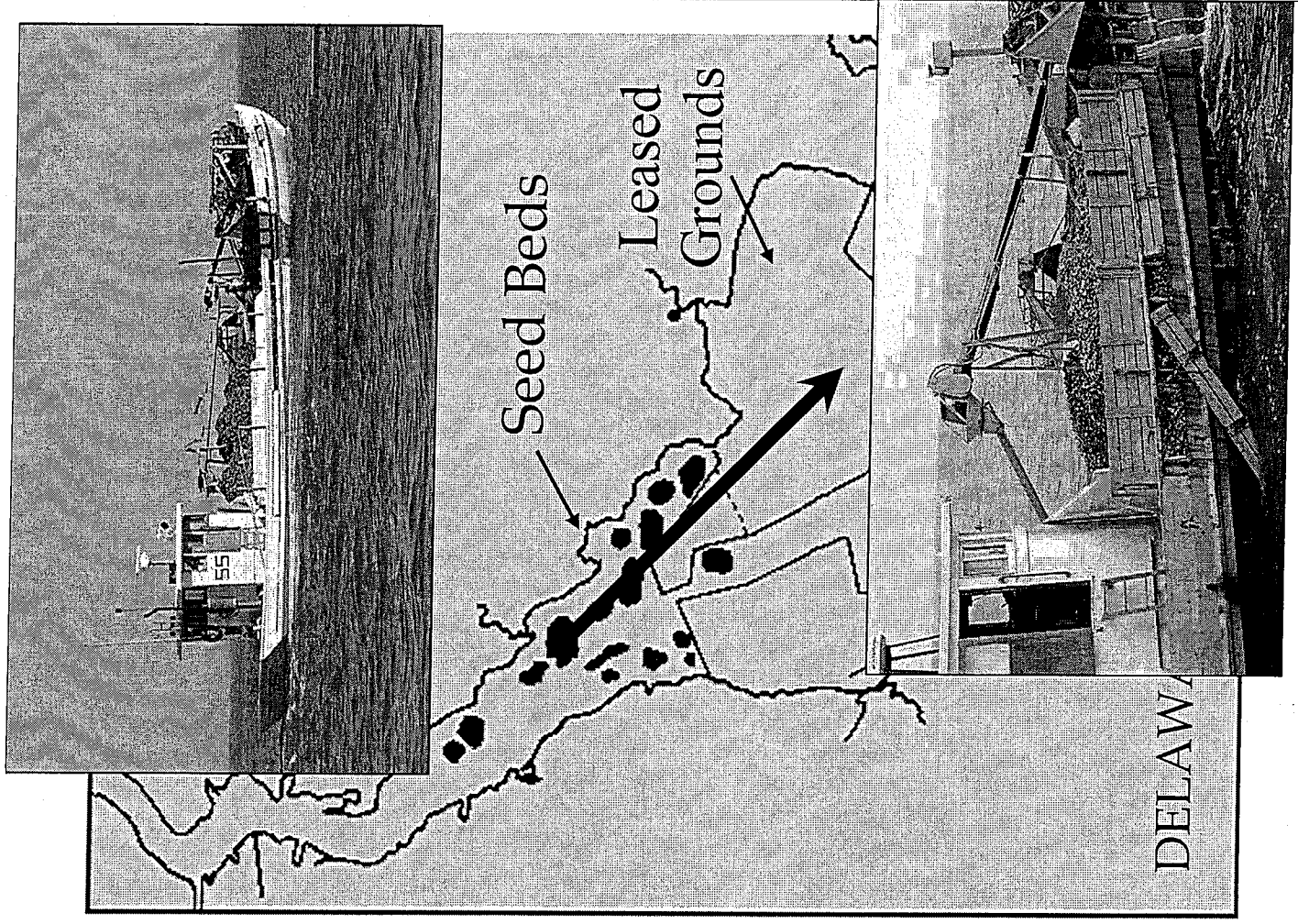


# Traditional Fishery

## Culture Intensive

- Wild oyster seed was harvested from natural beds in the upper bay (good survival, slower growth)
- Seed was transplanted to private grounds in lower bay (good growth and market-quality meats)

2/x

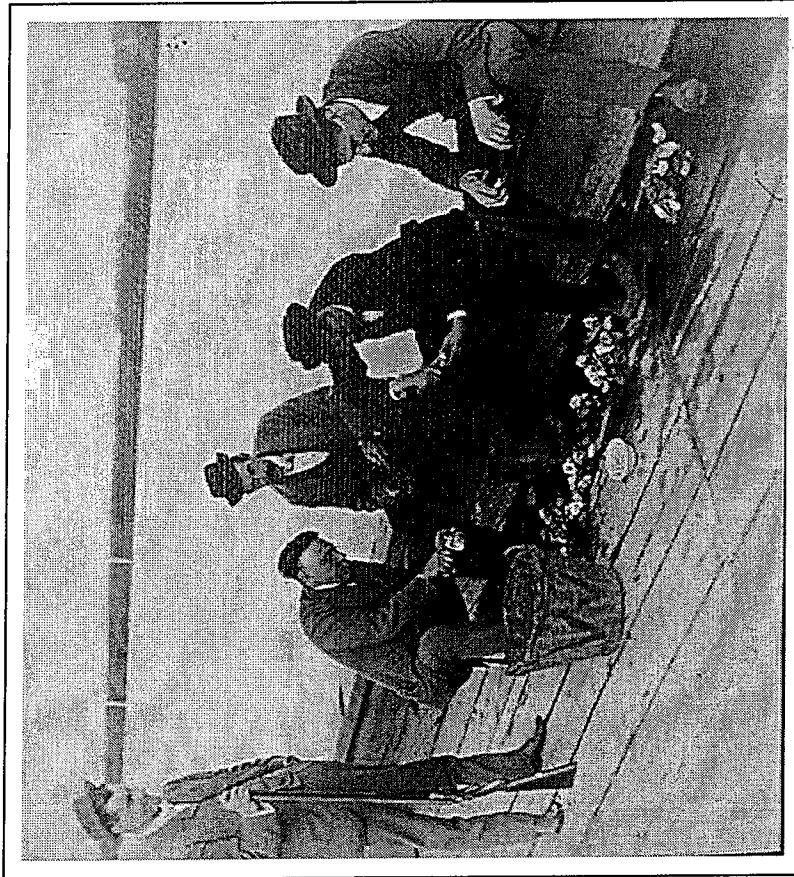




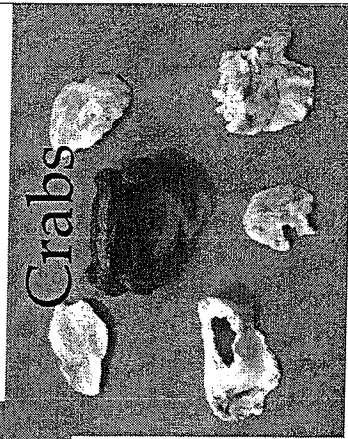
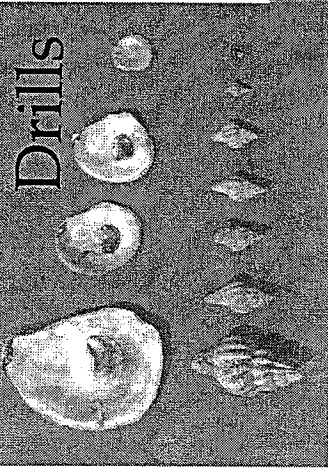
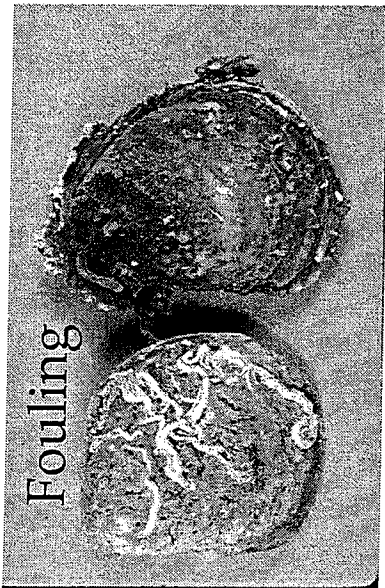
# Prosperity!

1880-1930

Annual harvests from  
1 to 2 million bu.



This harvest was augmented from oyster seed  
imported from southern states

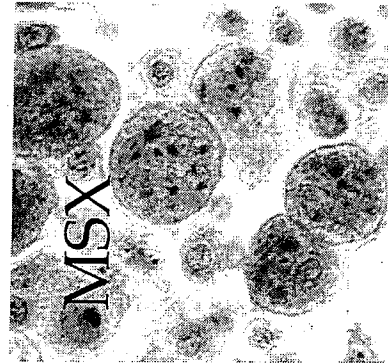


Competitors

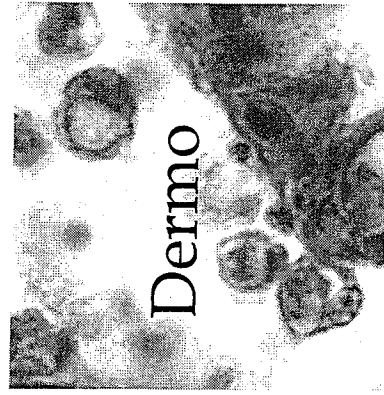
Predators

23x

The oyster has many enemies!



Parasites



# A Change In Management

1995: Direct Market Program commences, allowing oystermen to harvest oysters greater than 2.5 inches for direct sale.

1996-2006: 35 to 74 vessels participate annually

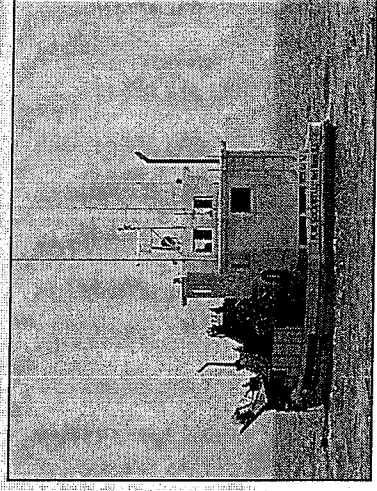
The State of Delaware followed suit in 2001 with amendments to their regulations that permitted the direct marketing of oysters from their seed beds.



# How Do We Assess the Stock?

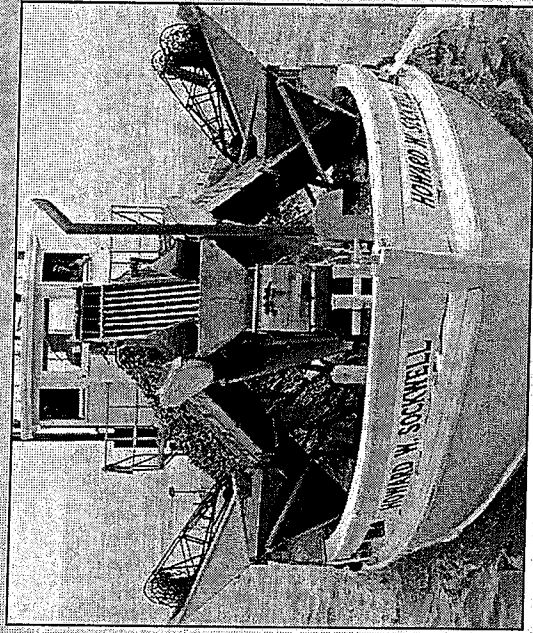
Formalized stock assessment includes:

- 1) a rigorous stock survey (performed by Rutgers University's Haskin Shellfish Research Lab),
- 2) an annual stock assessment workshop,
- 3) use of a coupled fisheries-disease model for projections of yearly harvest.



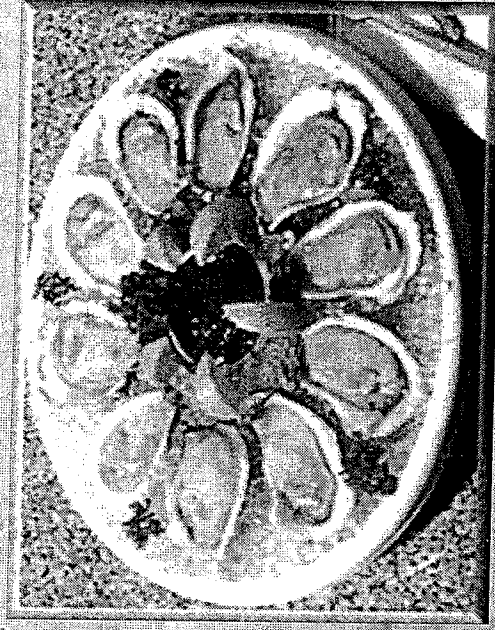


# Harvest Stabilization



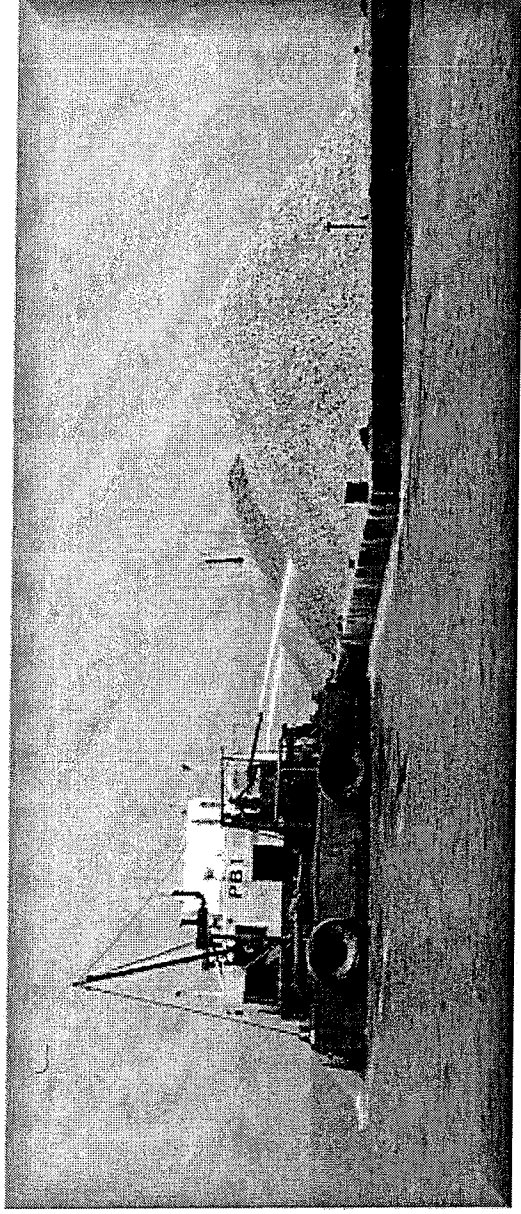
Significant progress has been made toward stabilizing oyster production.

Delaware Bay consistently produces a high value oyster



*B.C. Posadas*

# A Shellplanting Program



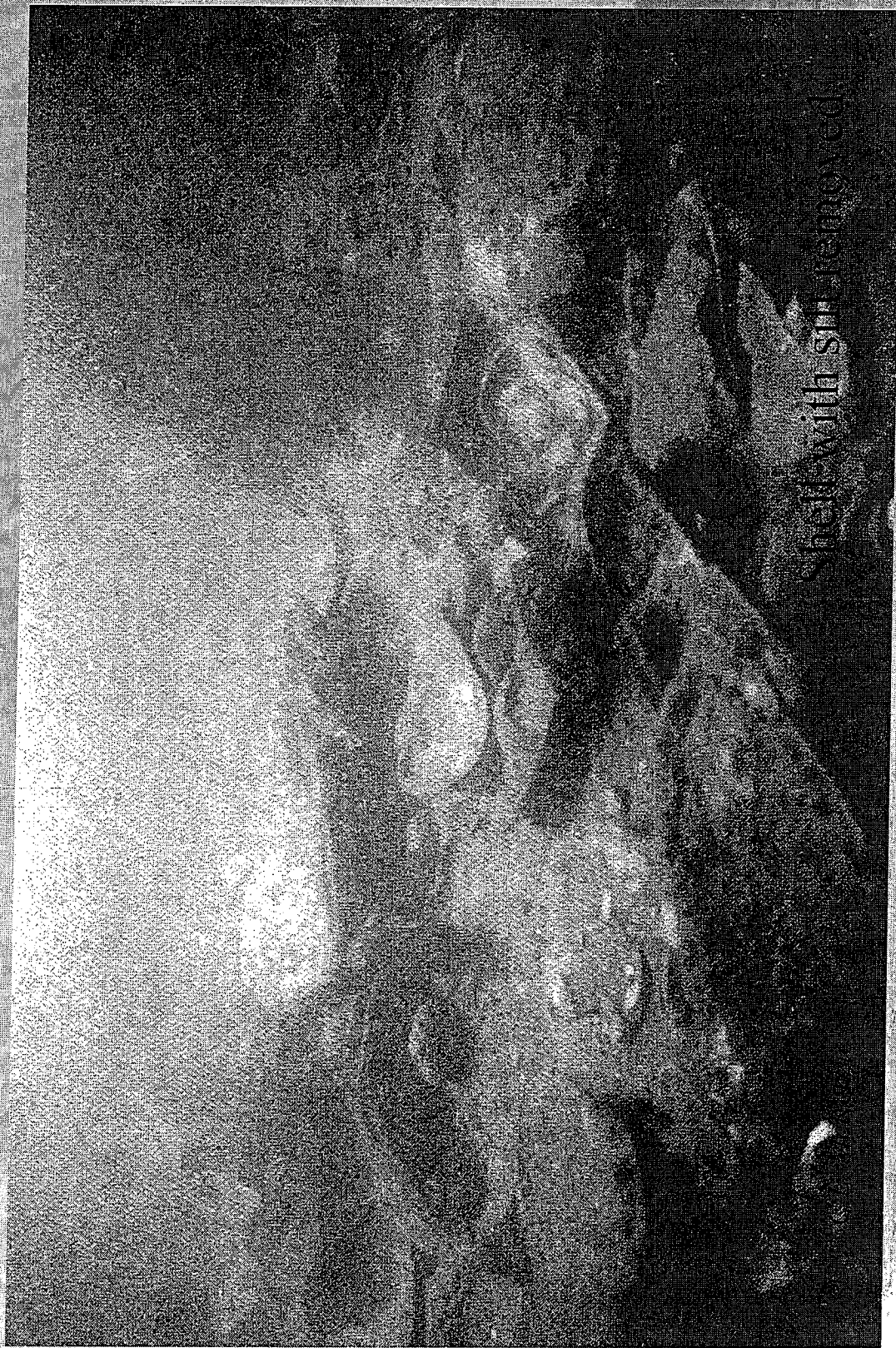
The most effective method to increase oyster production is to plant clean shell (also known as cultch) at the appropriate time to provide a clean surface for setting larvae.



# A Shellplanting Program



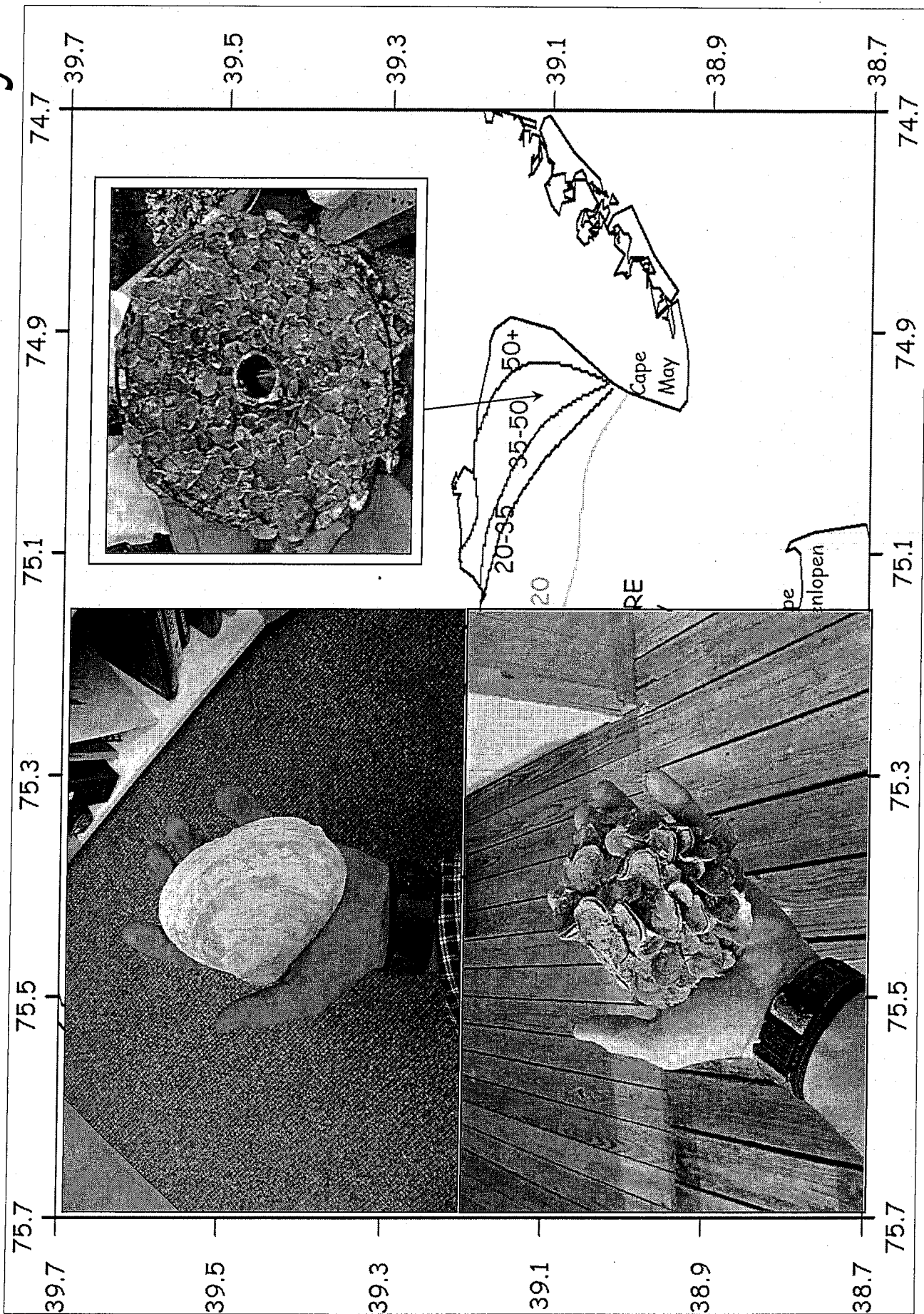
# A Shellplanting Program



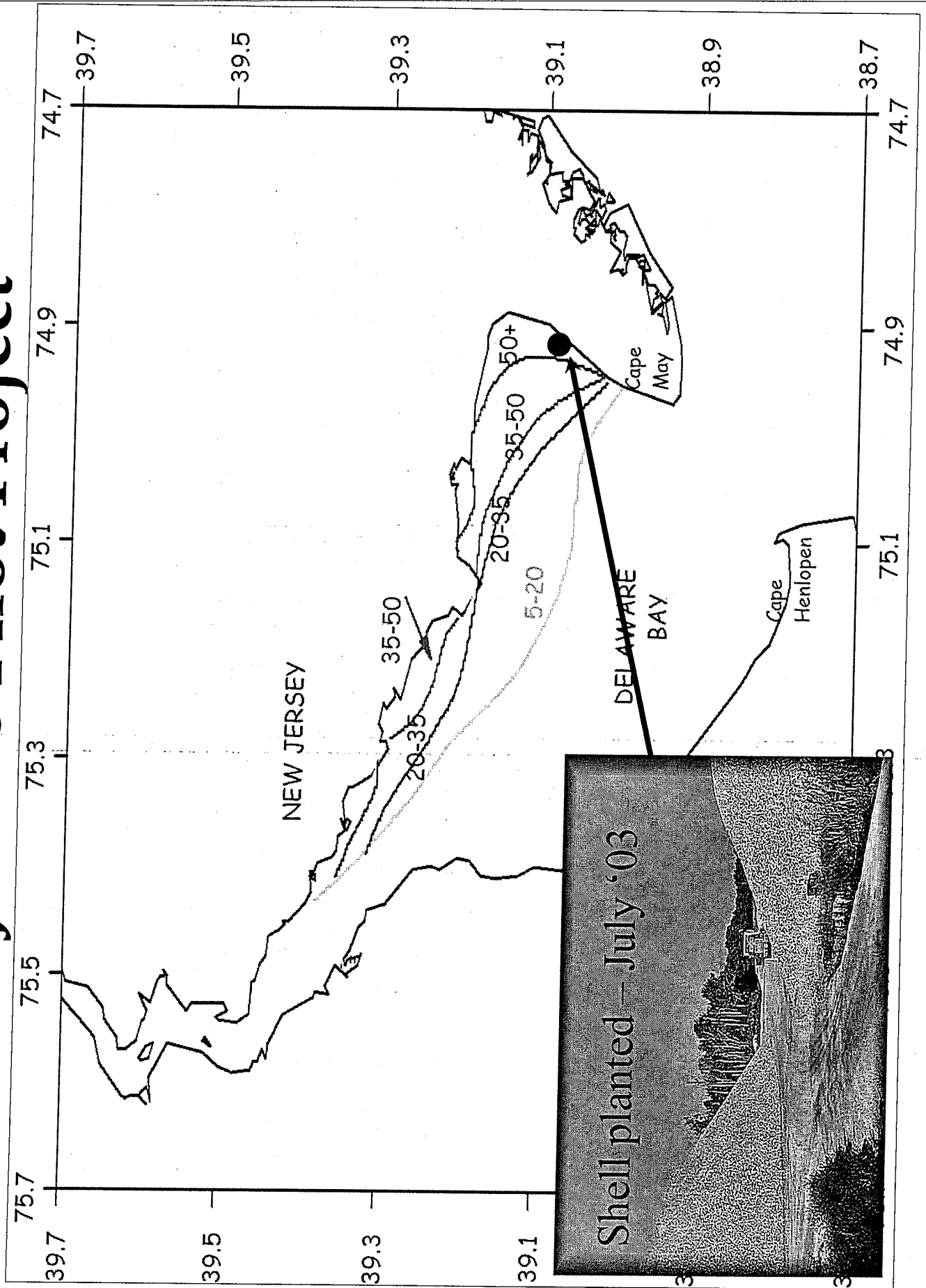
Shell with snail removed



# High Recruitment Zones of Lower Bay

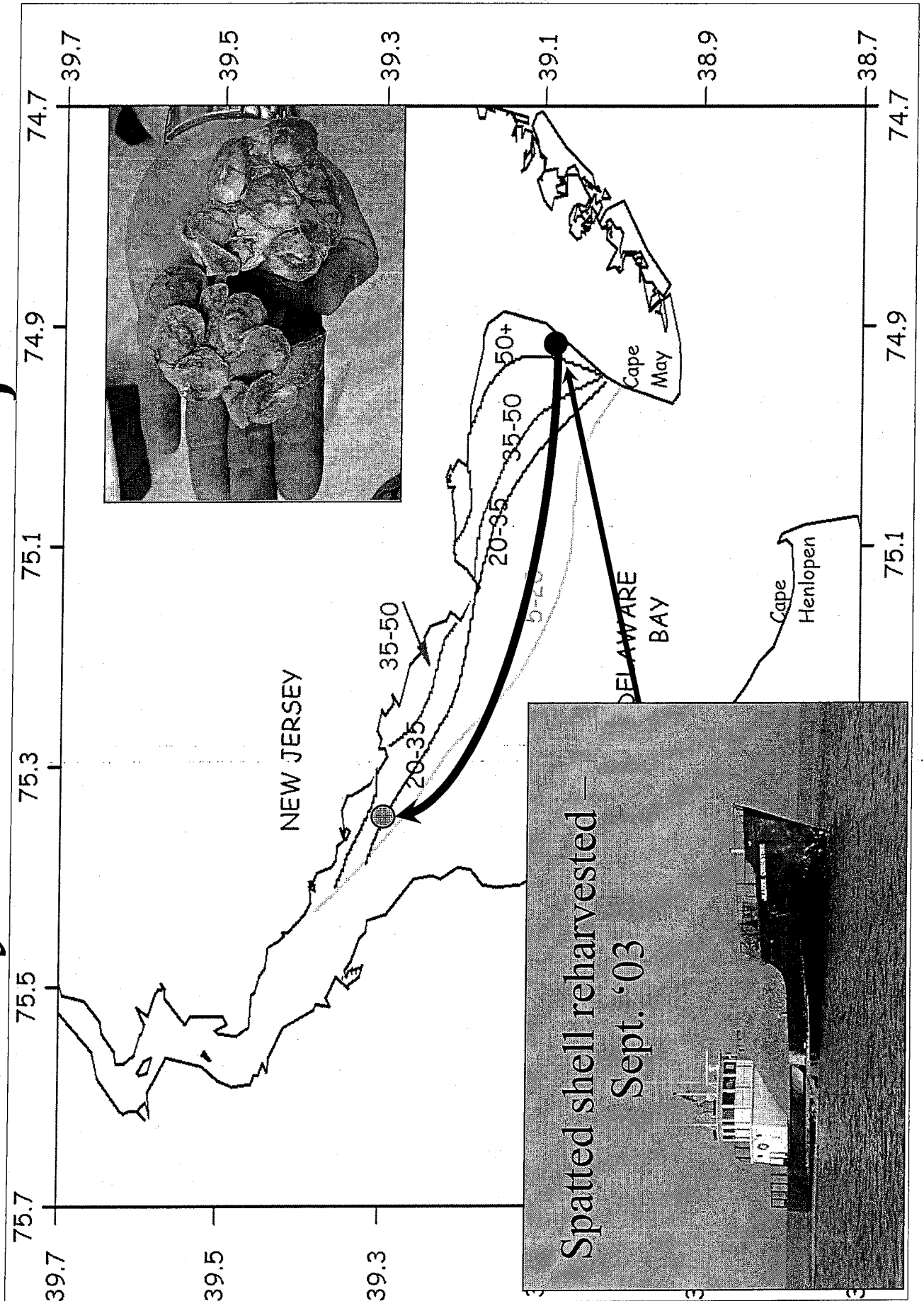


# NJDEP's Pilot Project



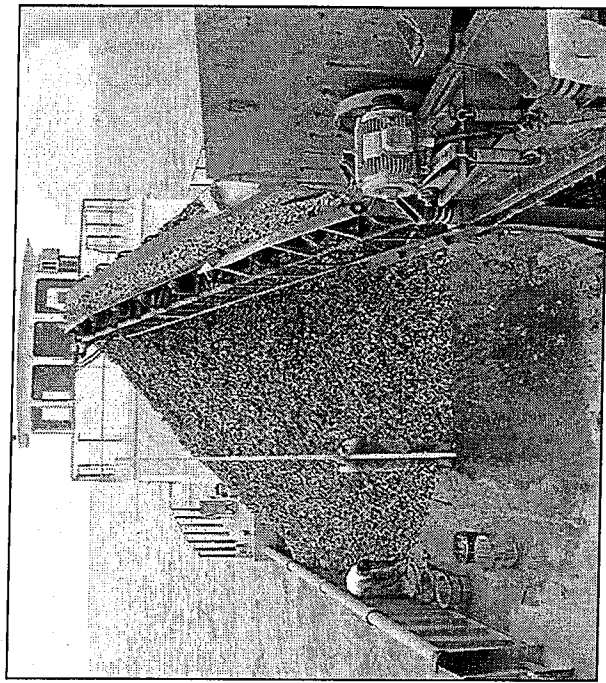
Shell planted - July '03

# NJDEP's Pilot Project



# What did we get out of this project?

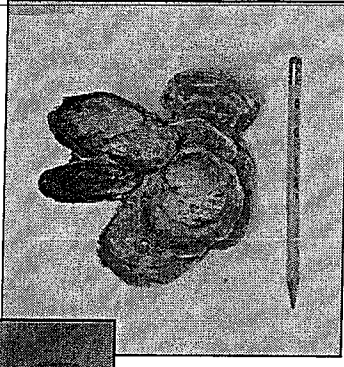
- 25,000 bu. clam shell planted
- ~16,500 bu. of spat and cultch recovered and transplanted
- ~1,800 spat per bushel  
(112 times the '03 Bay average (only 16 spat/bu.!))
- 30 million oysters were transplanted to the restoration site (Bennies Sand).



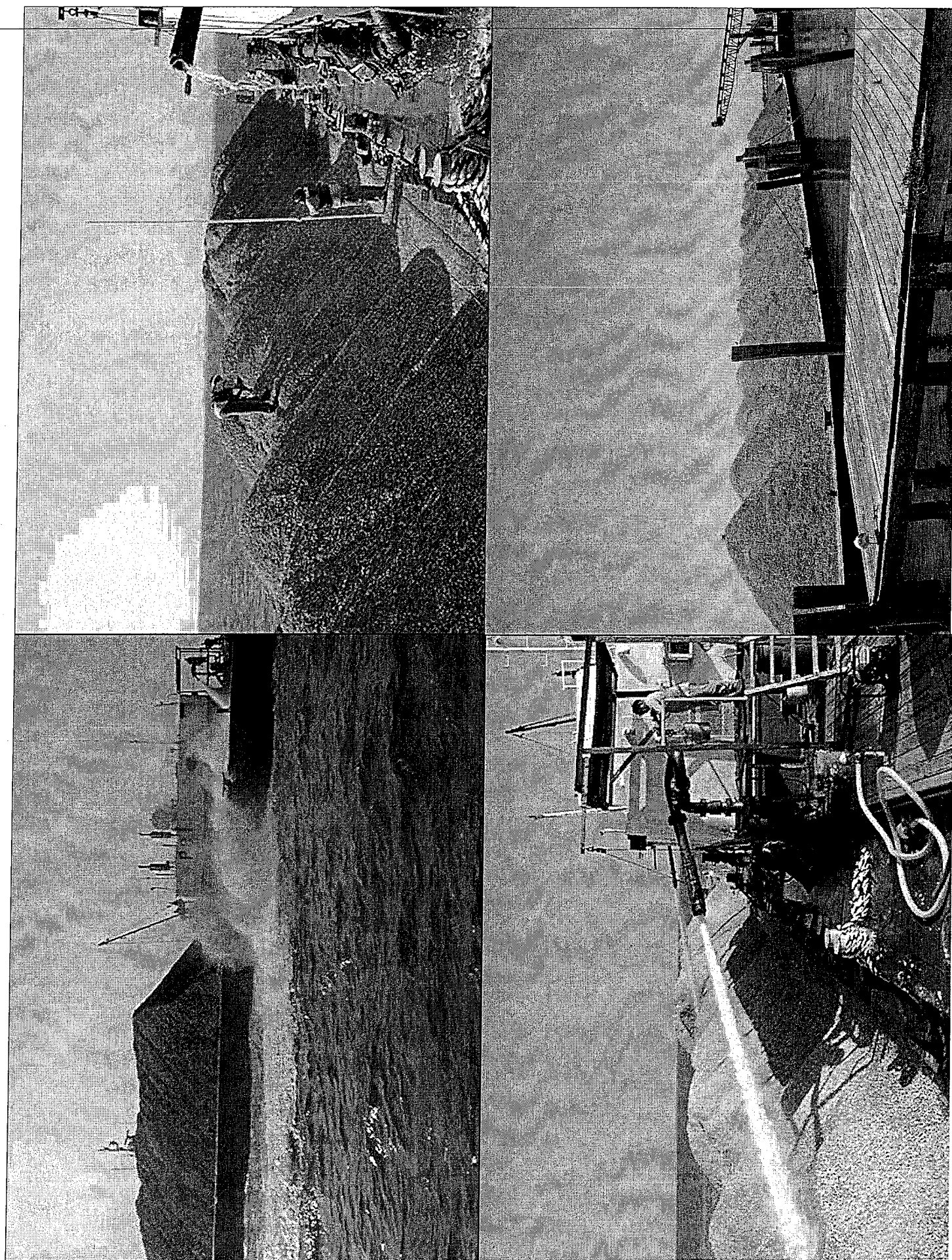
- The restoration site was monitored by DEP and HSRL staff for 2.5 years.
- Disease levels and mortality were generally low while growth was excellent.



# What did we get out of this project?



- 2006 SAW estimated the site would contribute 13,393 bushels to the 2006 harvest, a 26% increase.
- Ex-vessel value of nearly \$500,000 (project cost \$42,000)  
Total economic benefit of nearly \$3 million dollars.
- Six-acre project site (only 1% of Bennies Sand seedbed) had 58 percent of all of the marketable oysters on the bed.
- Total cost-benefit ratio > \$50 to every \$1 invested by the State.



# How Did We Do Last Year?

The '05, '06 and '07 programs involved the planting of approximately 1.5 million bushels of shell throughout the Bay (with 17 sites in the NJ waters)

## 2005 Metrics:

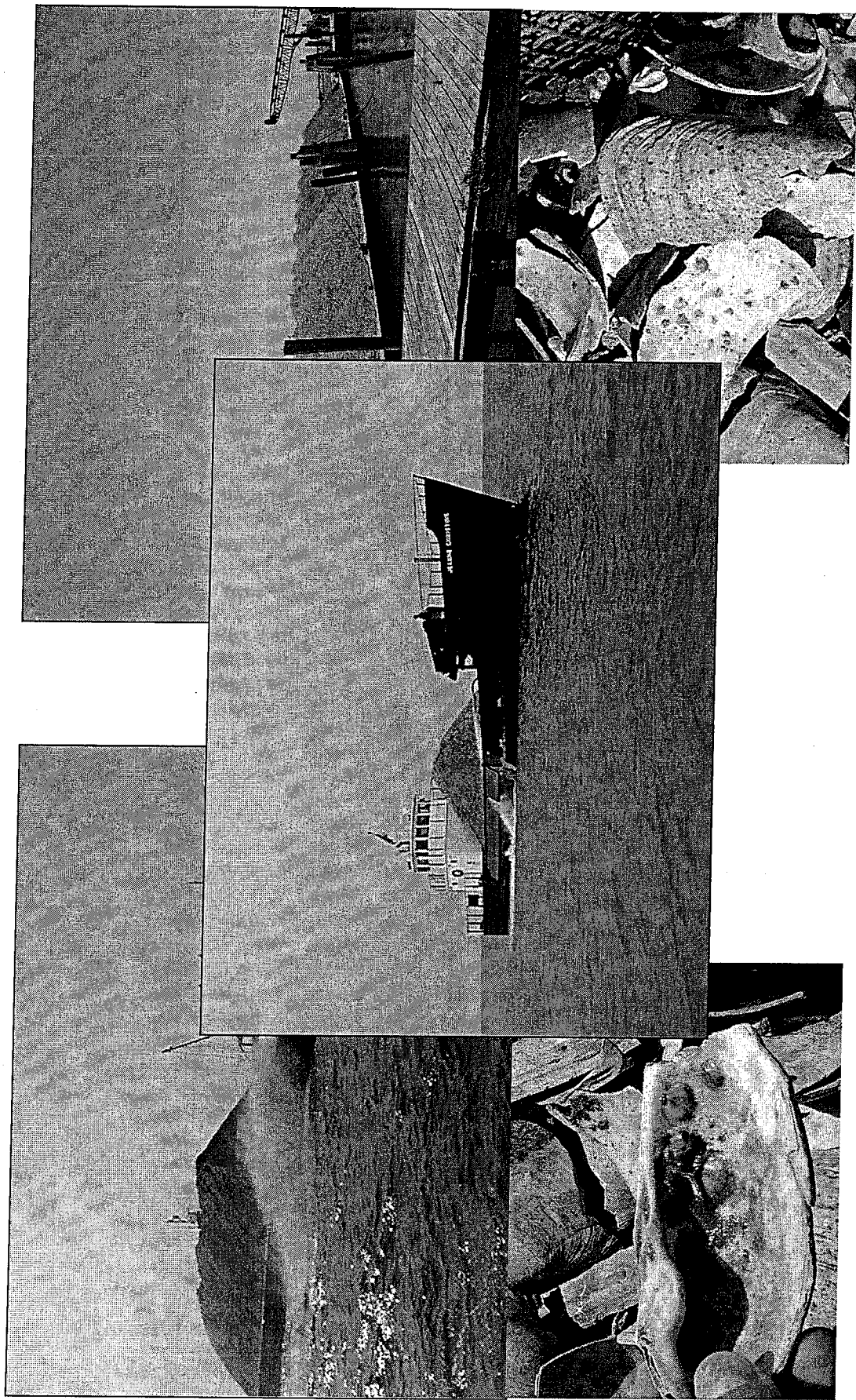
- Plantings had mean recruitment rates nearly 14 times the baywide mean.
- Plantings enhanced recruitment 'bay-wide' by 10 percent, despite planting only 100 acres.

## 2006 Metrics:

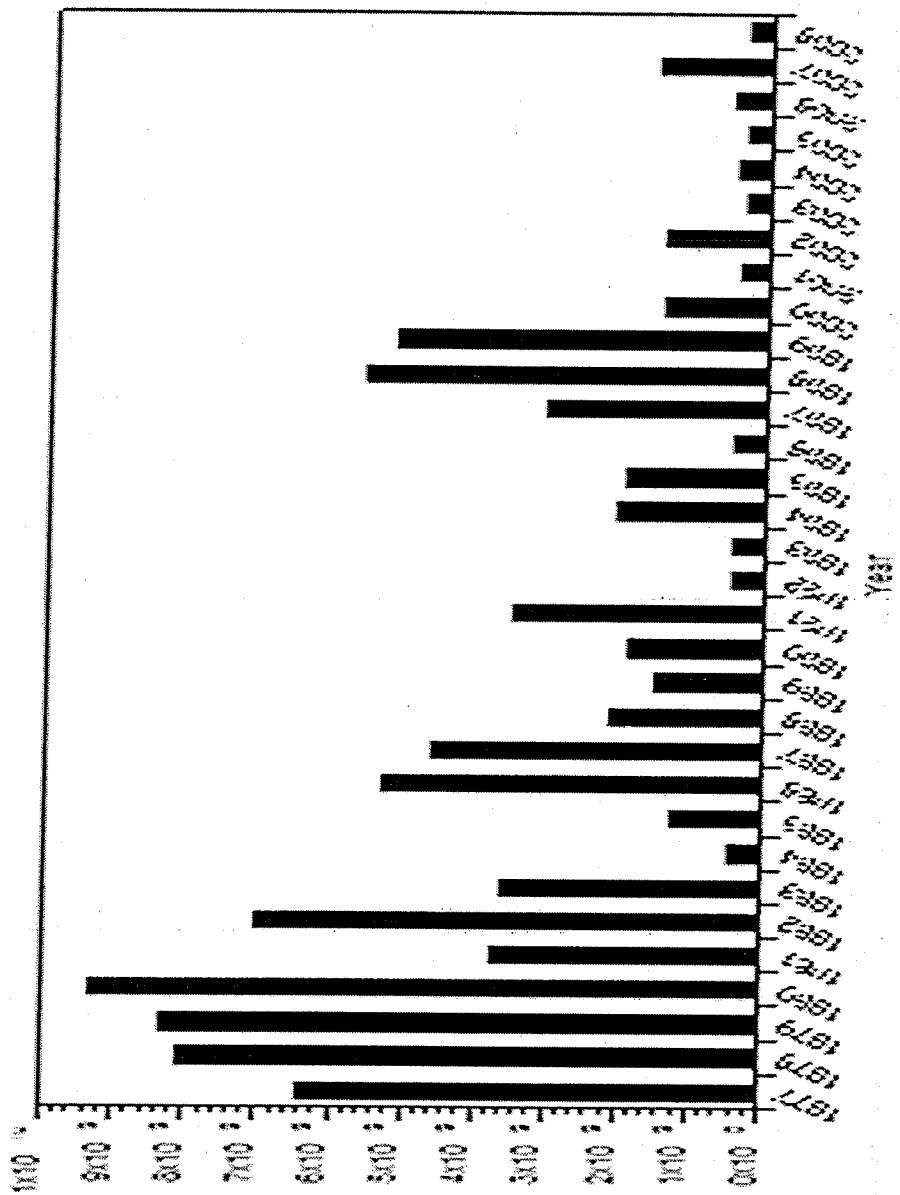
- Native shell in NJ naturally attracted only 21 spat per bushel, baywide. In contrast, shell planted in the lower bay high recruitment zones (similar to the NJDEP's '03 pilot program) attracted approximately 2,213 spat per bushel, over 105 times more spat than native shell.
- Specific restoration sites from 2005 could be opened for limited harvest as early as 2008.
- Multiple year harvest projections, while often tenuous due to the vagaries of nature, have the potential to significantly increase future commercial harvests.



# 2007 Shell Planting Program



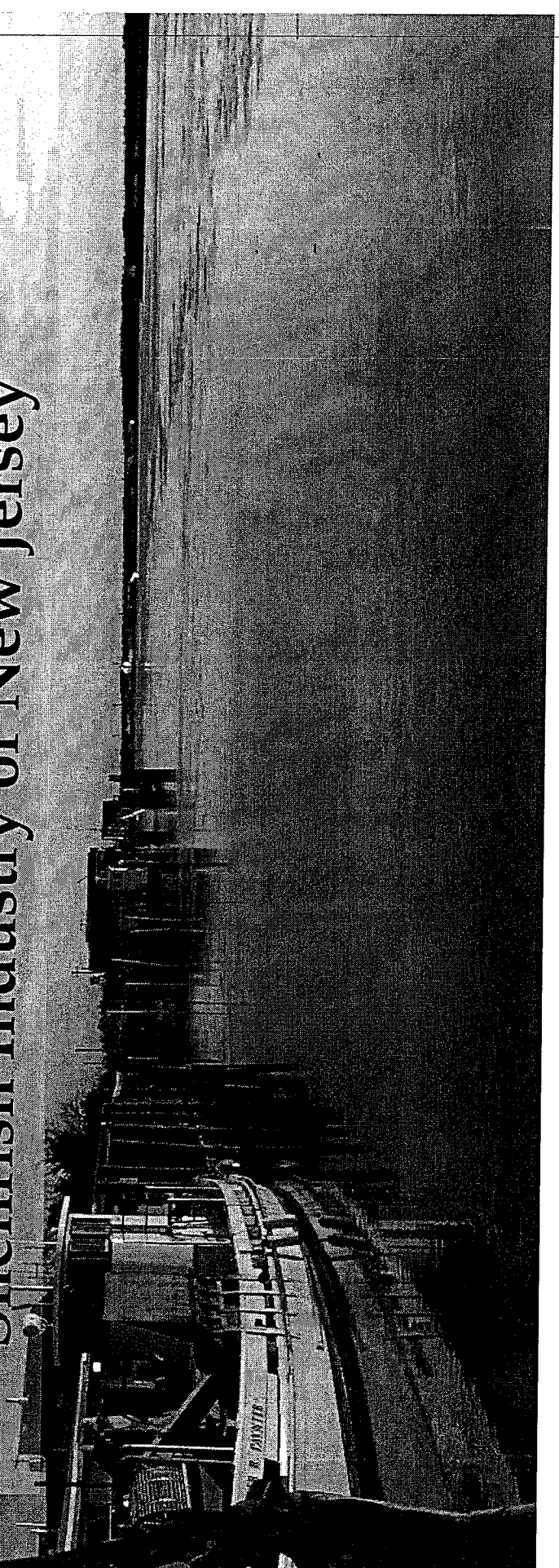
# Spat in New Jersey





## Partners:

- Rutgers University
- US Corps of Engineers
- New Jersey Dept. Environmental Protection
- South Jersey Economic Development
- Commercial Township, New Jersey
- Shellfish Council of New Jersey
- Shellfish Industry of New Jersey





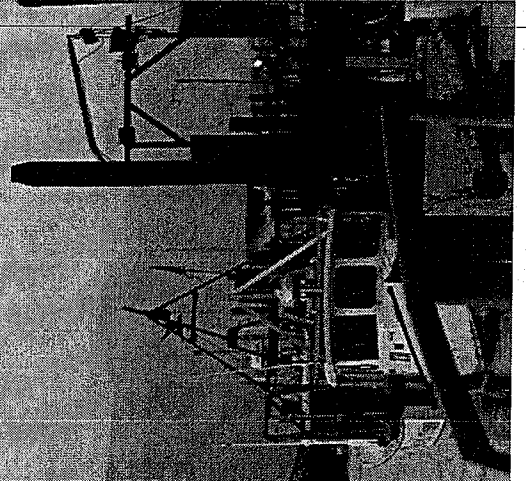
Hurricane Sandy was devastating to the mid-Atlantic. NJ had 9 coastal counties specifically targeted for disaster relief. Absent from those were Cumberland and Salem counties, where the Delaware Bay shore communities were hit hard;

however, the dollar value of these communities didn't get them the same attention as the more affluent vacation areas of NJ's Atlantic coast.

**Reports proclaim the millions of dollars being invested to rebuild vacation communities while little or nothing is being invested to rebuild and revitalize the blue-collar communities along NJ's Delaware Bay coastline.**



For example, in The Press of Atlantic City November 19<sup>th</sup>, 2014 edition, the top story described how a \$57.6 million dollar beach replenishment project for just 3 communities might get pushed to summer.

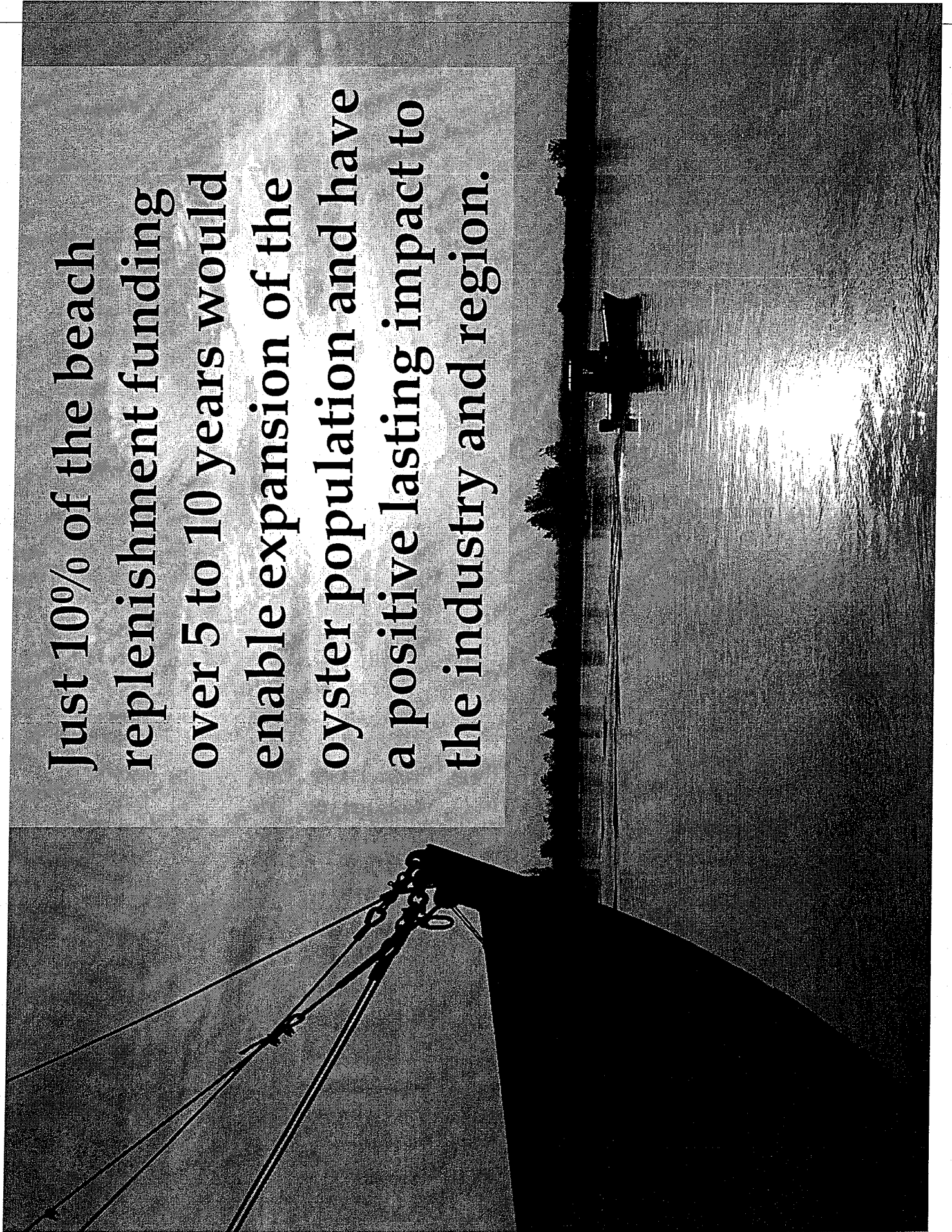




For just 1% of that cost used yearly, the NJ Delaware Bay oyster industry could return \$10 - \$40 per dollar invested using a proven shell planting method to rebuild the oyster population in Delaware Bay. Doing so would create jobs & provide desperately needed support to 2 of the most economically depressed counties in the state.



Just 10% of the beach  
replenishment funding  
over 5 to 10 years would  
enable expansion of the  
oyster population and have  
a positive lasting impact to  
the industry and region.



Our oyster industry has worked tirelessly to develop a sustainable fishery over the past two decades despite oyster losses to natural (not fishing) causes. We've achieved that by severely restricting our harvest and reinvesting in projects that increase the oyster population through a self-imposed harvest tax.



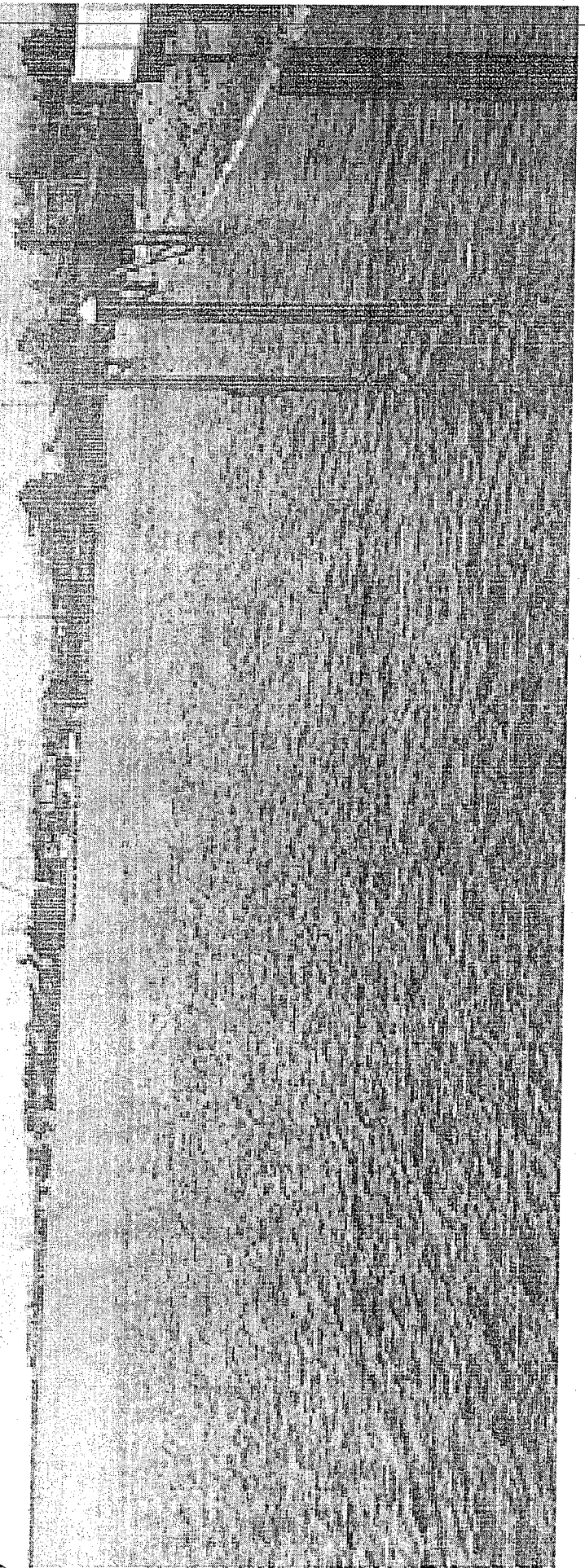
As the oyster population grows, the small fraction (less than 2%) harvested will not increase, but 2% of twice as many oysters doubles the harvest increasing the number of people (i.e. jobs) needed to process the harvest.



Unfortunately, natural causes such as the 2011 freshwater kills from Hurricane Irene and Tropical Storm Lee take out far more oysters than the fishery does. This reduces our harvest and the harvest tax income.

We are seeking \$1 million per year  
over a 10 year period to rebuild the  
oyster fishery with resilience, in the  
face of Mother Nature.

48x





**This investment is a fraction of that being invested elsewhere with Sandy recovery funds and, as demonstrated in our previous efforts, promises a potential return of about \$40 per dollar invested.**



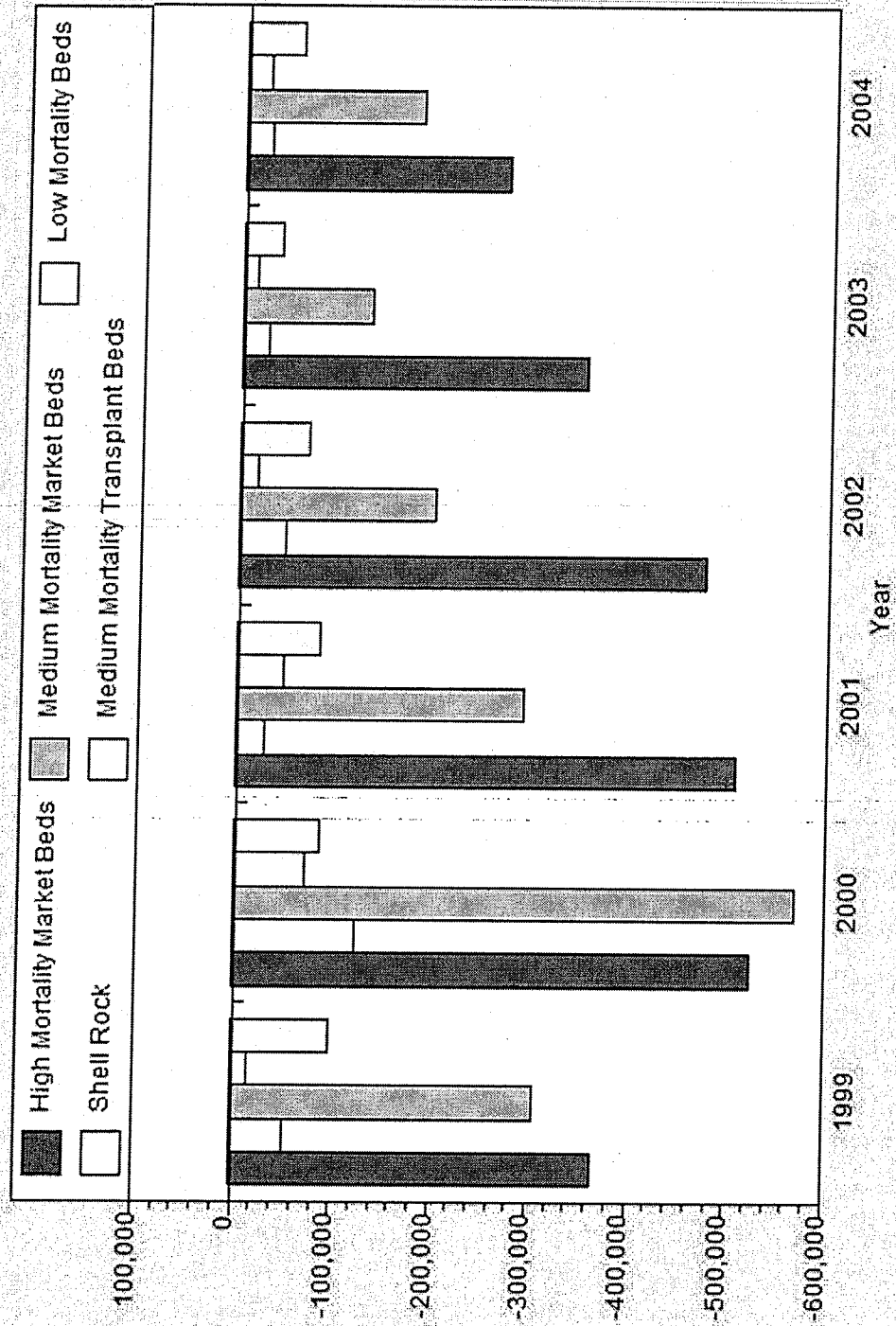
**Investing in our Delaware Bay oyster population accomplishes many goals. It revitalizes and grows the oyster industry – a major economic benefit in an economically depressed region. It increases the number of oyster that are filtering water and working for free to help improve water quality.**



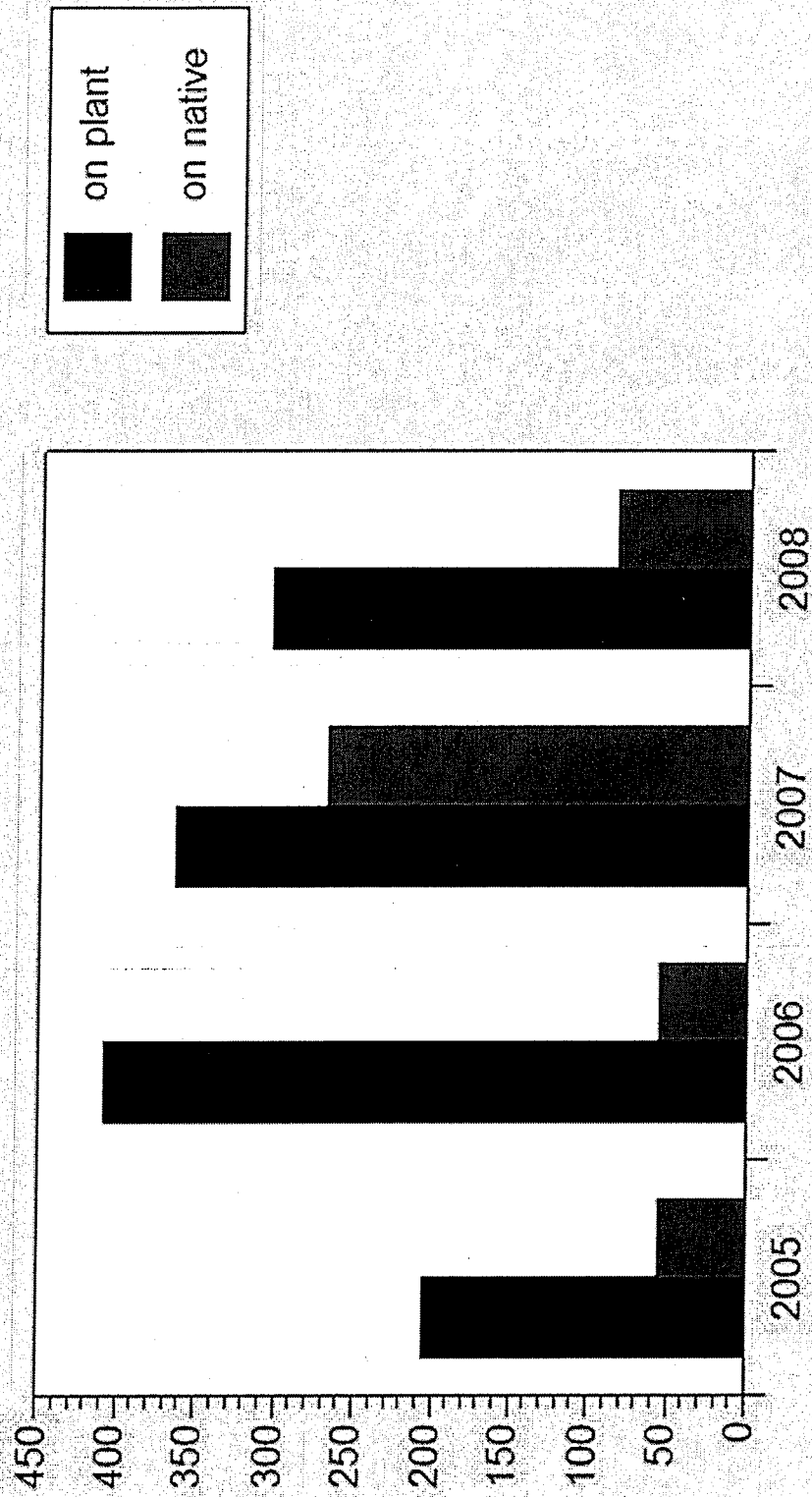
It accomplishes these fishery and ecosystem goals at a relatively minor cost compared to reparations occurring along the Atlantic Coast.

It seems a no-brainer but to the Delaware Bay shore communities of NJ, it appears the message is not being heard

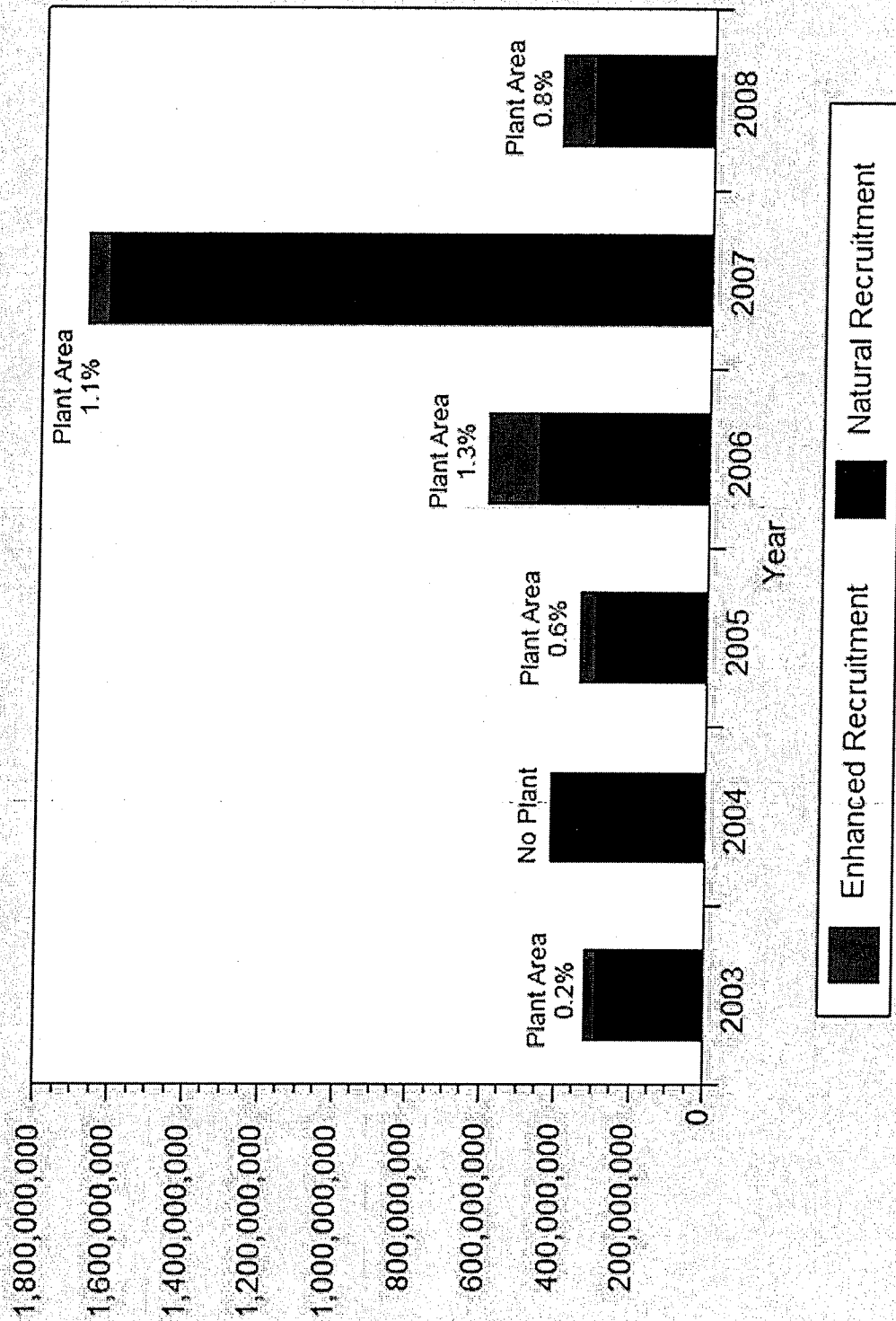
# Why sustain the beds?



Comparison of Spat per Bushel on Native Cultch or on Planted Cultch



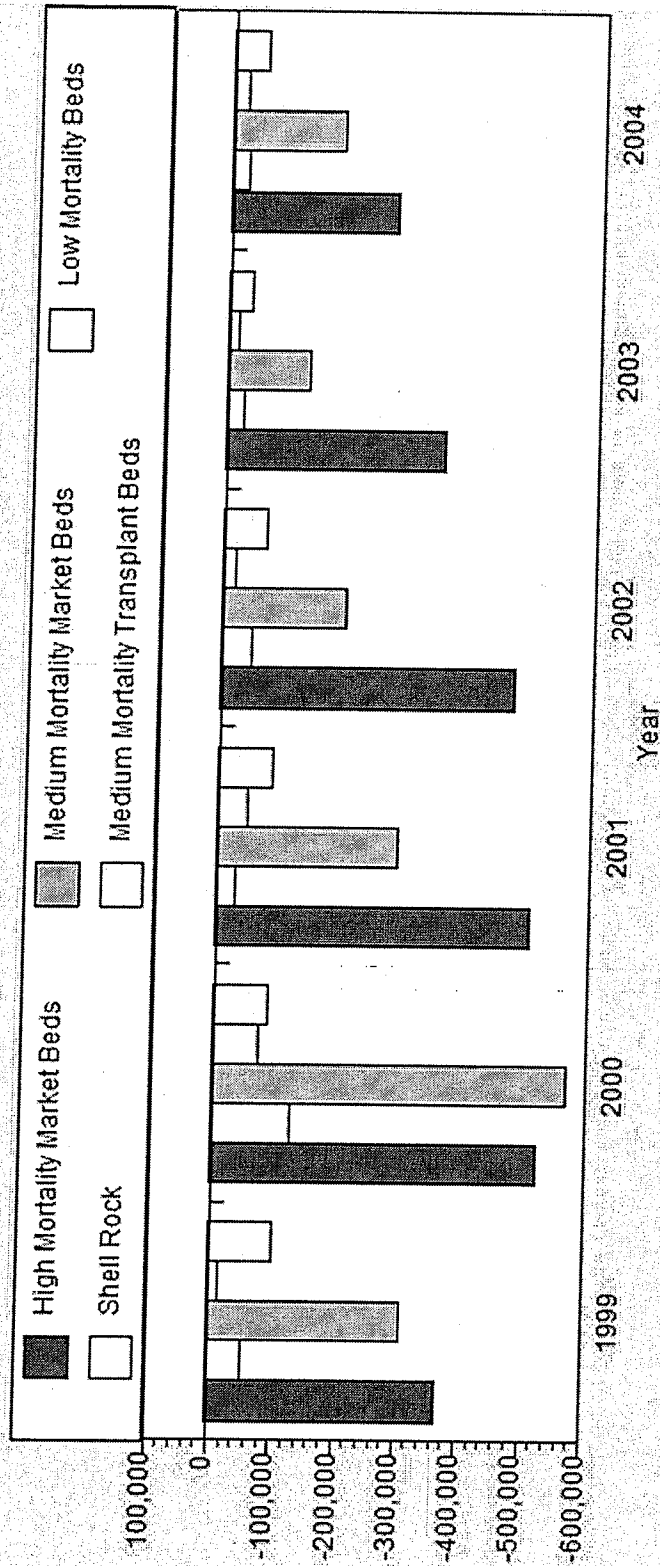
# Overall Recruitment Enhancement on NJ Beds



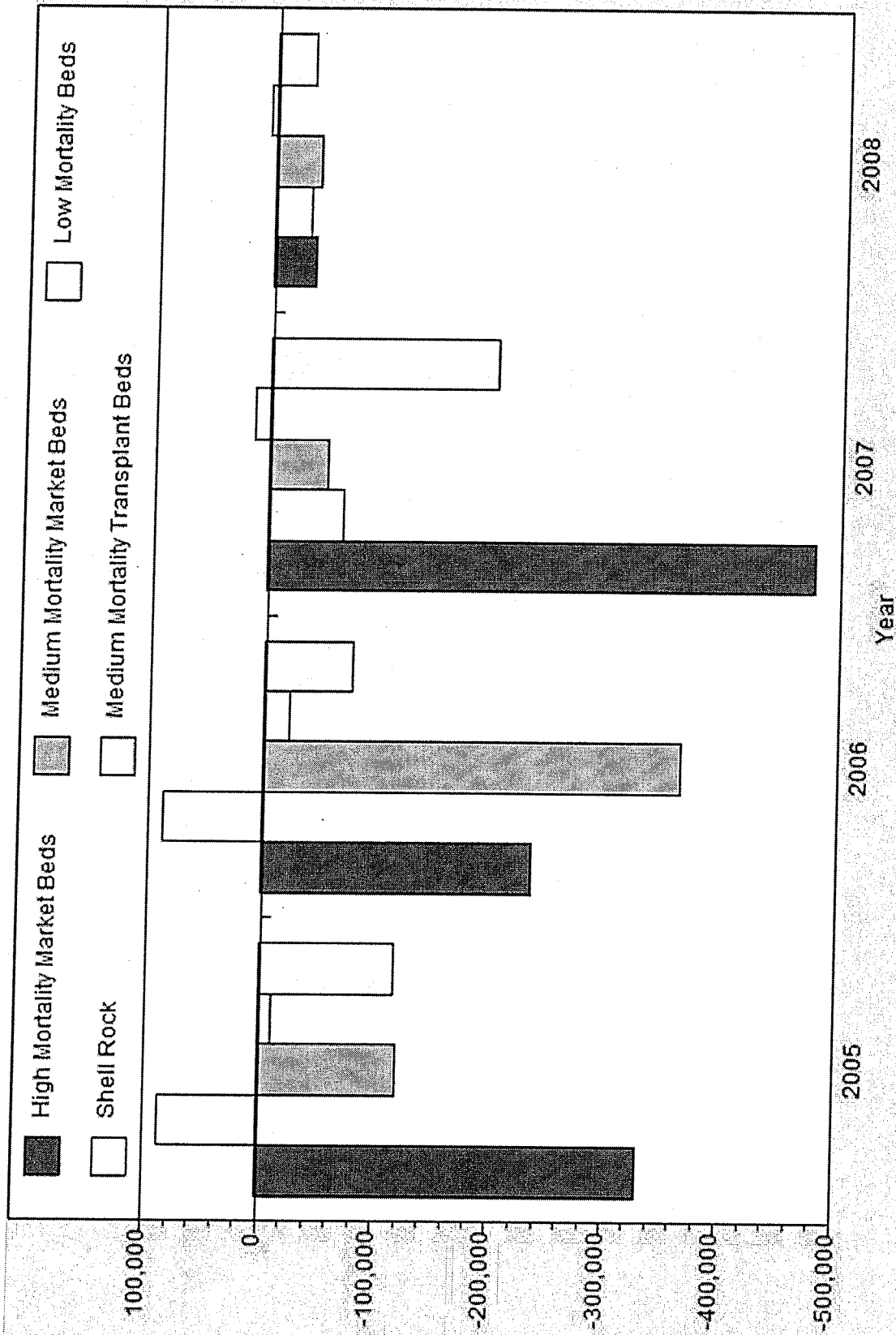


We know this program accomplishes Goal 1: Enhance Recruitment

What about Goal 2: Sustain the beds?



Loss of shell in years prior to shell planting

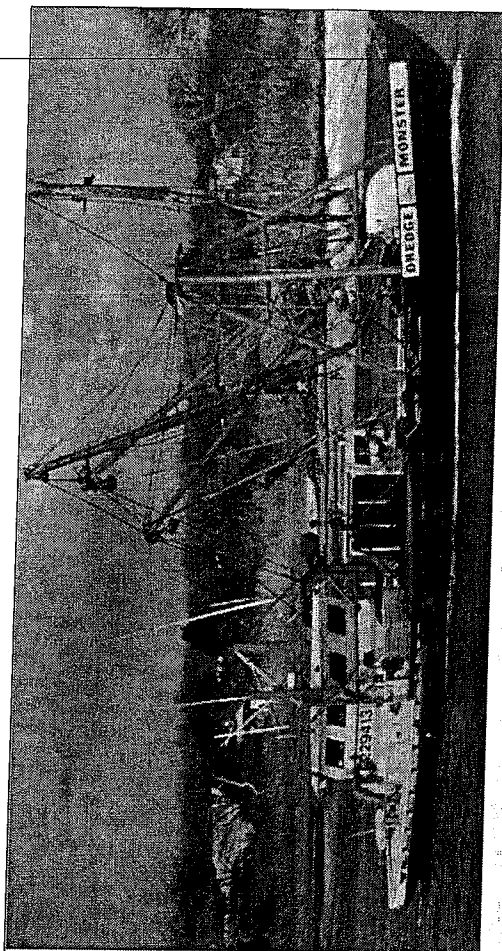


Shell in the years since shell planting began

# BONUS RESULTS!

## BENEFITS TO INDUSTRY = JOBS

Year	Bushels Planted	Projected Yield	NJ+DE Quotas
2005	220,400	87,379 bu	40,885 bu
2006	474,850	336,037 bu	73,293 bu
2007	646,520	198,510 bu	93,105 bu
2008	417,140	89,382 bu	101,822 bu
Total	1,758,910	711,308 bu	309,105 bu





**Just in case you have learned absolutely  
nothing from this presentation:**

Fact: Kangaroos cannot back up.

Fact: Americans consume 450 hot dogs every second.

Original Name of the Beach Boys: "Carl & the Passions".

95% of Americans put on the their left sock first.

***"Forty-two percent of all statistics are made up"***

**– Steven Wright, Fake Author, Comedian**

## *New Jersey Oyster Restoration Program - Delaware Bay*

Oysters are a keystone species in the Delaware Bay. They provide the basis for a vast community of benthic organisms. Oysters and the reefs they create increase habitat and faunal diversity and through their high filtration capacity, they can even improve water quality.

Through the late 1980s, the oyster fishery consistently provided steady employment along the Delaware Bay shores of both New Jersey and Delaware. Unfortunately, the oyster industry nearly disappeared during the early 1990s with the resurgence of a parasite that moved in from southern waters: *Perkinsus marinus* (commonly known as Dermo). This parasite is harmless to humans, but causes severe mortalities in oysters. From 1990 to 1995, the oyster industry provided little in jobs or revenue in New Jersey. Today, the Delaware bayshore areas are chronically afflicted by unemployment substantially above the State average.

In the mid 1990s, the Delaware Bay oyster industry faced an uncertain future. Transplanting oysters to one's leased grounds in the traditional fashion with Dermo lurking was a perilous gamble. In 1995, an old strategy was revisited for the first time in 150 years in New Jersey - direct marketing from the State's natural seed beds.

Despite the presence and effect of Dermo and through the coordinated efforts of both states and the industry, significant progress had been made toward stabilizing oyster production. By 2000, annual oyster production in New Jersey had stabilized at 50,000-75,000 bushels, contributing minimally \$8,000,000 in economic value to the coastal counties. Delaware Bay consistently produces a high value oyster. This increase in economic value per bushel of oysters harvested is higher here than most other oyster producing areas. In 2014, New Jersey fishermen averaged about \$50 per bushel in ex-vessel value, bringing the projected total economic benefit to \$24 million.

During the 1997-2002 period, through the combined efforts of the NJ Department of Environmental Protection's (NJDEP) Division of Fish and Wildlife, the Haskin Shellfish Research Laboratory and the New Jersey Shell Fisheries Council, a significant assessment infrastructure has been established that produced a sustainable fishery in Delaware Bay. In New Jersey, this process has been formalized through a rigorous stock survey, a stock assessment workshop and the development of a coupled fisheries-disease model to permit projections of yearly harvest.

Today, unfortunately, the resource (and industry) is showing the effects of years of below-average biological recruitment (i.e., the number of young oysters entering the population each year). This low biological recruitment is unprecedented since the commencement of an annual resource assessment program in 1953. The population size-frequency has shifted to larger, marketable oysters, but has left a paucity of small oysters. Over time, as these marketable oysters are removed through harvest or lost to disease, there are not enough small oysters to replace them. History has demonstrated that the oyster beds of Delaware Bay are capable of sustaining oyster populations much larger than those that are present today.

So, how does one address this recruitment problem? First, it is important to understand a little bit about oyster biology. When oysters spawn, they release eggs and sperm into the water column where fertilization takes place and free-swimming larvae develop. Larvae float passively until they sink to the bottom, where each larva seeks a clean surface upon which to attach. Once attached, it is called a spat. Perhaps the most effective method to increase oyster production is to take advantage of the oysters' larval stage with the timely planting of clean shell (also known as cultch) to provide a clean surface needed by setting larvae.

During the summer of 2003, the Division of Fish and Wildlife conducted an innovative multiphase shell-planting program with the objective of augmenting juvenile abundance on the state seed beds through the planting and recovery of newly set oysters in the lower portions of the Delaware Bay. Approximately 25,000 bushels of surf clam shell generated by local processing plants were planted in the lower Bay in areas known to have very high setting potential. Despite this potential, this region is rarely used for shell planting because oyster mortalities near 100 percent are not uncommon.

The 2003 shell planting had very high spat setting rates, at approximately 1,800+ per bushel. For perspective, the Bay average setting rate is approximately 50 spat per bushel (that is 36 times the natural recruitment rate). The newly recruited oysters (upwards of 30 million of them) were then transplanted upbay to a location on the State's seed beds. Harvest projections from this project were conducted that yield a *potential* harvest in 2006 of 30,000 to 40,000 bushels, which could have a dockside value from \$700,000 to \$1 million (since the project only cost \$40,000 to conduct, this would be quite a return on the dollar).

Since 2003 the program has continued with success by stabilizing the shell resource in the Delaware Bay that had been declining due to low oyster abundance. The Delaware Bay Oyster Restoration Project planted two million-two hundred thousand (2.2 million) bushels of shell on approximately one thousand-three hundred-fifty thousand (1,350) acres of existing oyster beds in the Delaware Bay. Post construction monitoring results from the program indicated extraordinary bay-wide recruitment rates. Shell plants have equaled or typically far exceeded the recruitment rates of native shell. Over the course of the last eleven (11) years of shell budget assessments, shell planting has resulted in a substantial reduction in shell loss (2003-2014) and has reduced the yearly deficit by a least two-thirds. The shell-planting program contributed incalculably to maintaining the ecological services provided by the bay's oyster beds. It is vital to reduce the amount of shell loss through shell planting in order to re-establish oyster beds of sufficient size and health to offset losses due to disease when low abundance limits the amount of shell added to the beds through natural mortality.

The work above was funded due in part to the success of the 2003 effort; NJDEP, Congressman Frank A. LoBiondo and the Federal Empowerment Zone Program were successful in collaboratively obtaining \$900,000 in funding to strengthen the oyster resource in Delaware Bay via a shell-planting program. A federal commitment of \$5 million (Congressional line item) was soon to follow in 2006 from money secured under the Omnibus Appropriations bill to the Second District of New Jersey through the US Army Corps of Engineers to continue with shell-planting efforts. This funding carried on shell-planting efforts in both New Jersey and Delaware until 2008, when the state and federal funding stopped.

The program that was designed to jump-start the revitalization process using state and federal resources while increasing complementary industry reinvestment as the harvest increased has all but gone away. The NJ fishing industry has a landing fee in place that is carrying the program through at only a fraction of the size needed to see the true revitalization potential of the past. Therefore, state and federal investment is needed to strengthen the oyster resource in Delaware Bay via a shell-planting program.

The lack of Federal investment in the Delaware Bay has been hard to watch over the past five years. New Jersey's industry has struggled to receive outside funding while Chesapeake Bay has continually received large infusions of federal investment (\$20 Million A Year).

The program's design is not revolutionary in the sense that similar approaches have been used successfully by other states and New Jersey in previous initiatives since 2003. The program will



build infrastructure and jobs in the Bay Shore community in some of the poorest counties of the state with an economic projection of \$50 dollars returned to every dollar invested; all while expanding oyster abundance and increasing harvest while revitalizing a keystone species. Management efforts by coastal states to bolster the oyster resource not only provide major economic benefits for harvesters and local communities, but also add to the overall ecology of estuaries.