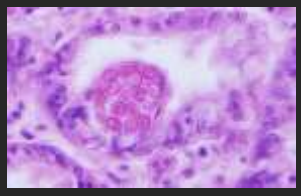
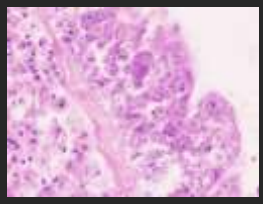
Coming to Terms with MSX and Dermo: The U.S. Experience with Oyster Diseases, and the Bright Future for Oysters in Eastern North America





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VIMS William & Mary Virginia Institute of Marine Science

OIE

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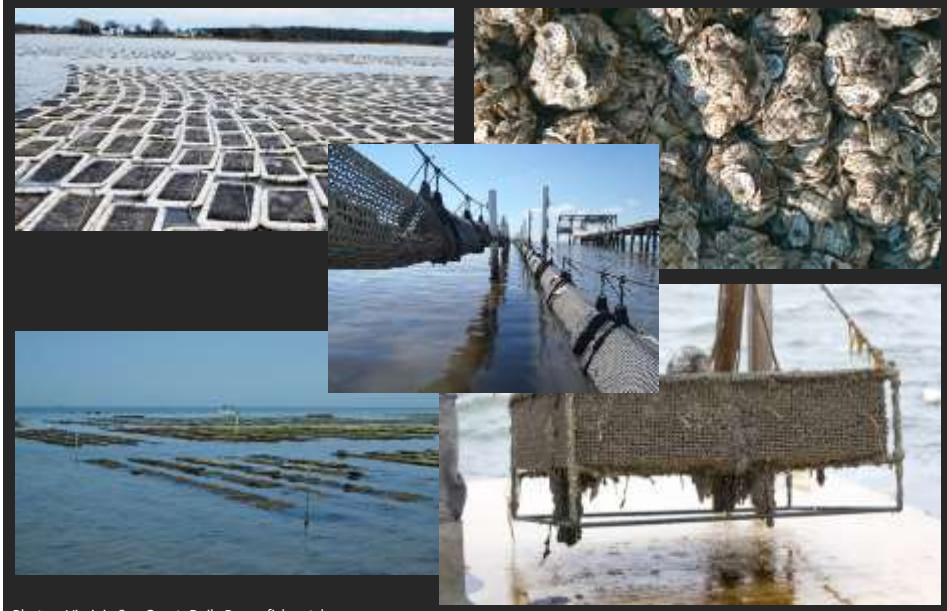
VIMS SHELLFISH PATHOLOGY LABORATORY

- Annual monitoring program for oyster diseases, components dating to the 1950s
- Major node in the regional network of pathology labs ensuring biosecurity in shellfish transfers
- OIE Reference Laboratory for Haplosporidiosis & Perkinsosis
- Research, education, advisory service in shellfish aquaculture health, pathology and parasitology

Expansion of Oyster Aquaculture



Photos: Virginia Sea Grant, Daily Press, fishwatch.org

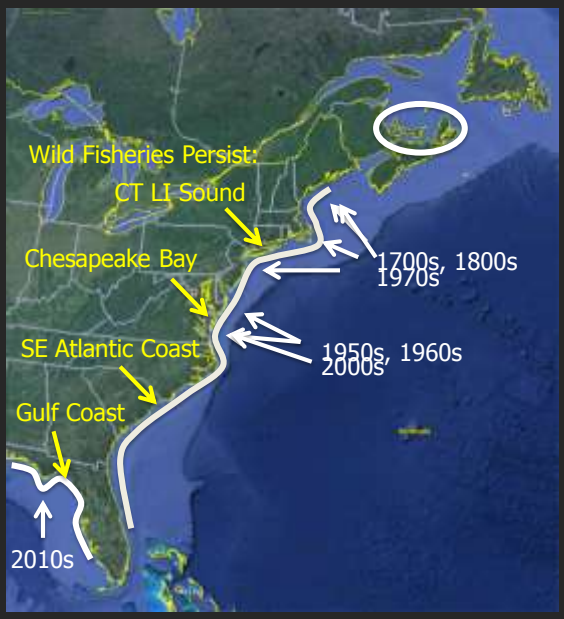
Structure of the Oyster Aquaculture Industry

- Oyster aquaculture sales by farms worth ~$50M USD
  - ✓ Total shellfish aquaculture $135M
- ~ 1100 farms (oysters and clams), 4000 direct jobs
- Dozens of small hatcheries, dispersed coastwide
- Nurseries integrated into hatcheries or farms, some independent

Information from Bob Rheault, East Coast Shellfish Growers Association

Lincoln County Magazine

Some Oyster History



A natural distribution coastwide

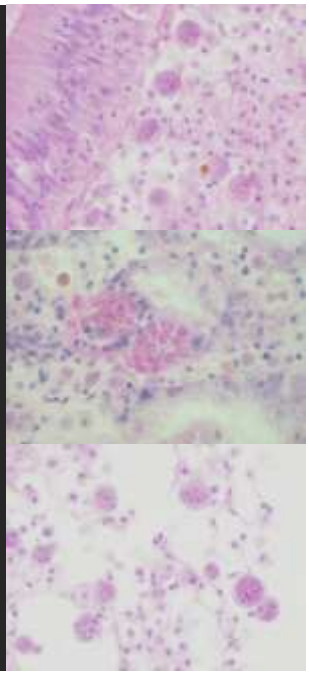
Wild populations diminished

Shift to intensive aquaculture

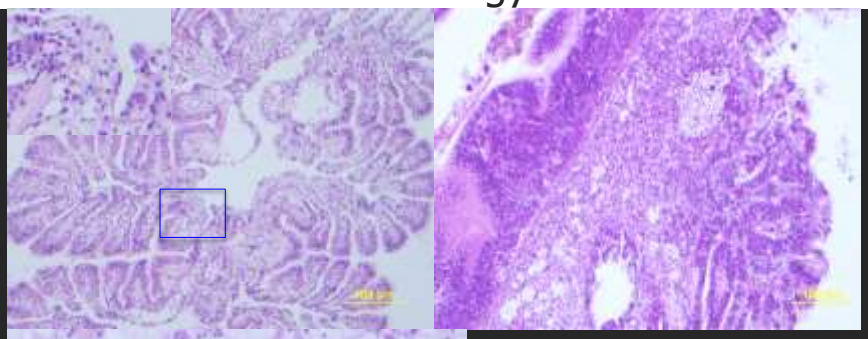
Learning to live with oyster diseases

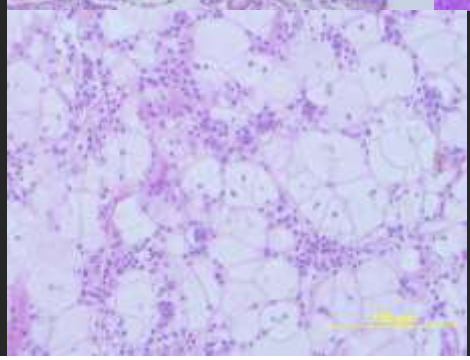
MSX, or *Haplosporidium nelsoni*

- "MSX" for "multinucleate sphere unknown", a protistan parasite
- Introduced from Asia, known along east coast of North America since 1957
- Active when temperatures are above 5°C, at salinities > 10 ppt
- Indirectly transmissible via as yet unidentified intermediate host(s)
- Agent of acute disease and mortality



Pathology





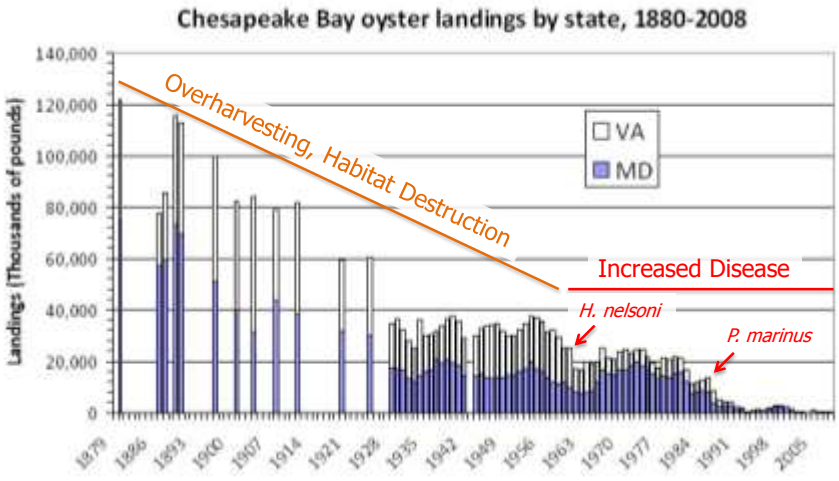
- Progression of disease and mortality can be very rapid (< 3 months)
- Very young seed oysters can be affected
  - ✓ Not just older individuals

Perkinsus marinus, or "Dermo"

- Also a protozoan parasite, but endemic
- Tolerates lower salinities than MSX, but effects greatest at salinities >10 ppt
- Prefers temperatures > 20-25°C
- Directly transmissible among oysters in a population
- Most significant effects in older oysters, >2 years of age

What Killed Your Oysters?

Oyster Landings



http://chesapeakebay.noaa.gov/fish-facts/oysters

Oyster Population, Industry in Virginia, Pre-MSX

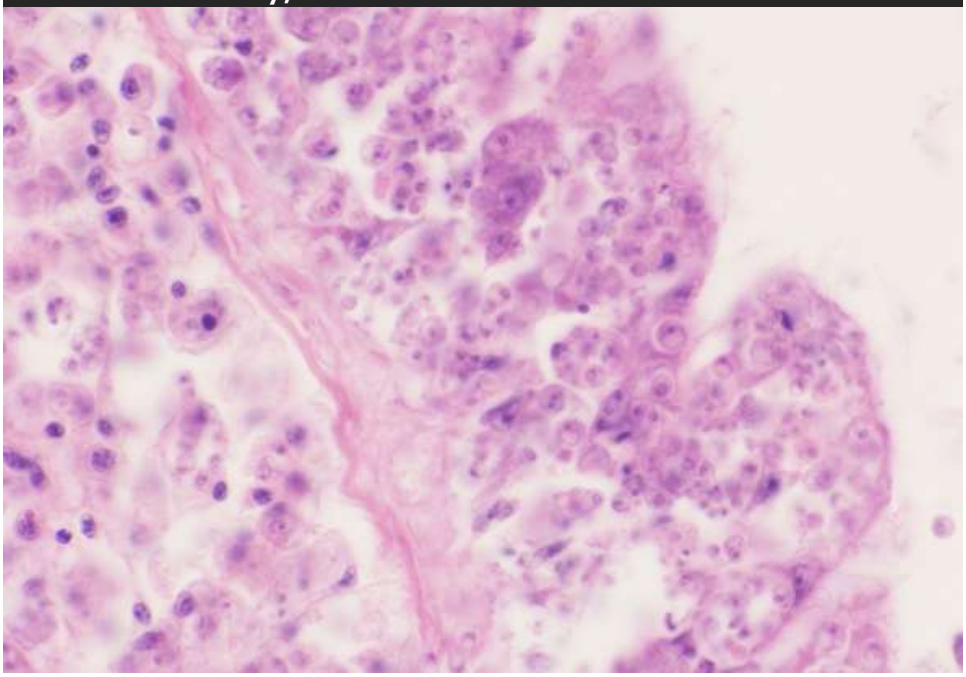
- Robust harvests from natural reefs
  - ✓ 1959-60: 700,000 bushels (Haven et al. 1978)
  - ✓ Recent annual: < 100,000 bushels (VMRC data)
- Large numbers of oysters transplanted from James River, planted over vast areas of lower Bay bottom
  - ✓ 1959-60: 2,533,275 bushels harvested from private leases (Haven et al. 1978)
- Oyster abundance in waters > 12-15 ppt much higher than today (Haven et al. 1978)

With MSX Emerging. . .

- Delaware Bay in 1957, Chesapeake Bay in 1959
- 95% mortality on reefs & planting grounds where salinity was > 15 ppt
- Planting industry abandoned in these waters

Economic devastation in Mid-Atlantic coastal communities arguably on a par with the Newfoundland cod collapse

Additionally, Dermo Intensified in the 1980s



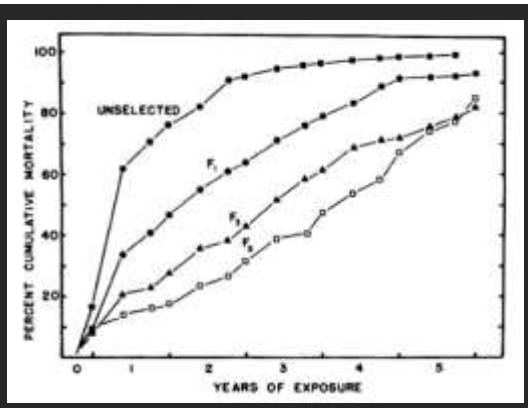
Might the Wild Oysters Recover?

- Not thought likely
- Oysters in disease areas too sick to reproduce
- Only oysters in disease-free upriver areas healthy enough to spawn
- No selective pressure on these upriver populations for evolution of resistance

Strategy: Selective Breeding to Beat MSX

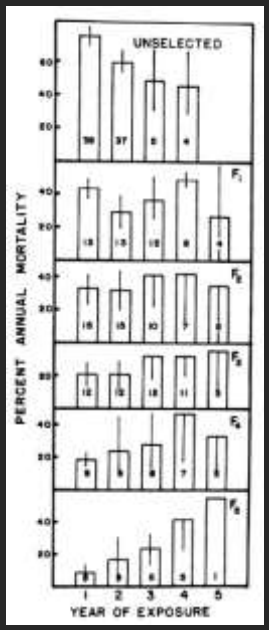
INFECTION AND MORTALITY PATTERNS IN STRAINS OF OYSTERS *CRASSOSTREA VIRGINICA* SELECTED FOR RESISTANCE TO THE PARASITE *HAPLOSPORIDIUM NELSONI* (MSX)

Susan E. Ford and Harold H. Haskin
Shellfish Research Laboratory, New Jersey Agricultural Experiment Station, Rutgers University, Port Norris, New Jersey 08349



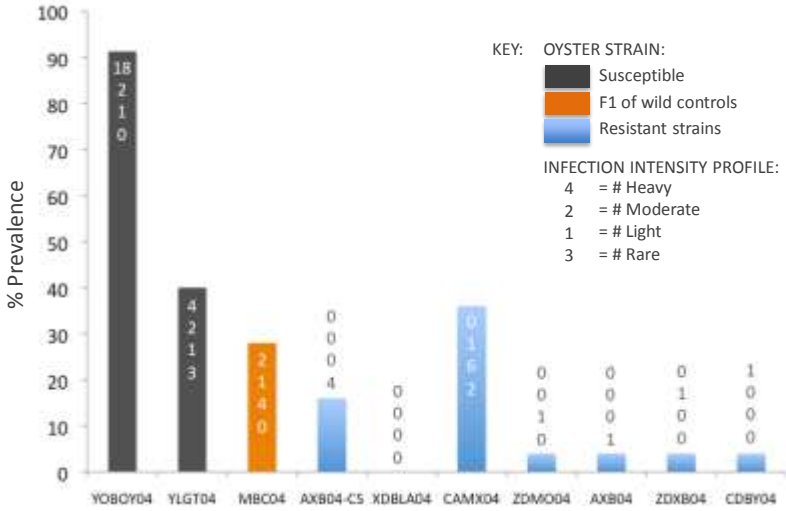
J. Parasitol. 73:368-376 (1987)

Selective Breeding to Beat MSX



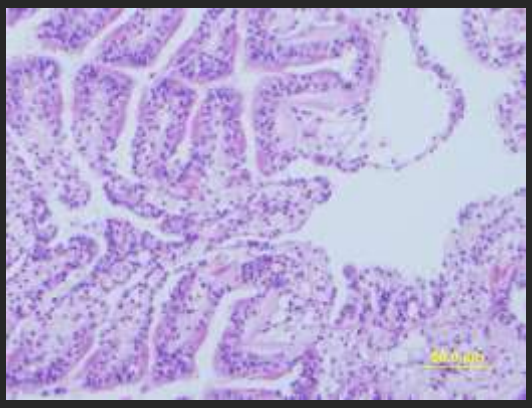
Contemporary Data from Chesapeake Bay

VIMS Aquaculture Genetics and Breeding Technology Center Deployments
Sub-market-sized oysters, York River, 2006



Insight into MSX Resistance

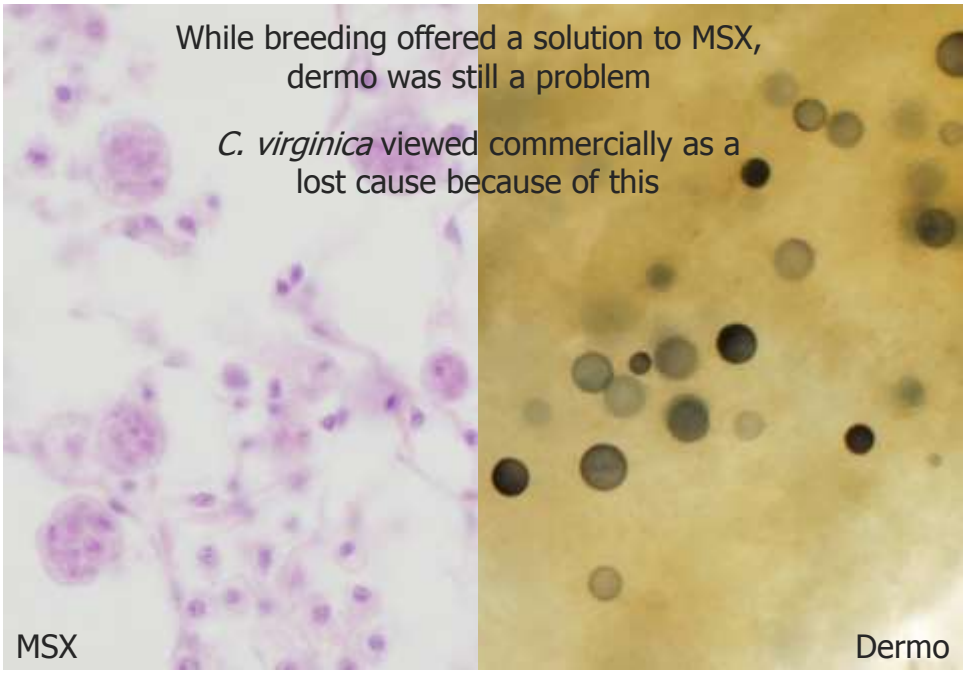
- How is resistance expressed?
- MSX-resistant oysters generally are not infected *at all*
- Where infections occur, they are generally light and epithelial



However…

While breeding offered a solution to MSX, dermo was still a problem

C. virginica viewed commercially as a lost cause because of this

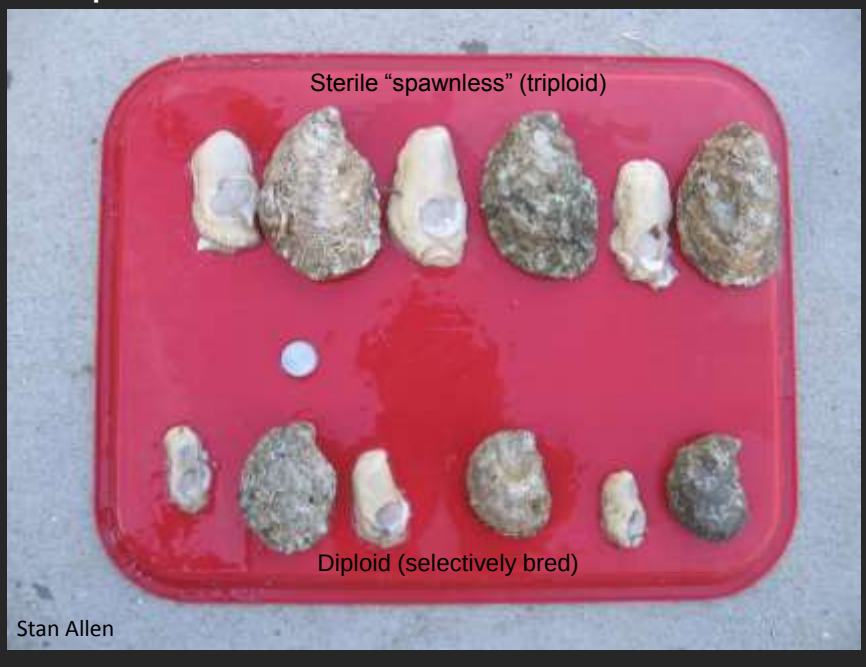


Proposed Solution: Introduce a Non-Native

- *Crassostrea gigas* and then *Crassostrea ariakensis* were considered for introduction into Chesapeake Bay

Mark Luckenbach

Unexpected Benefit: A New View of the Native



Stan Allen

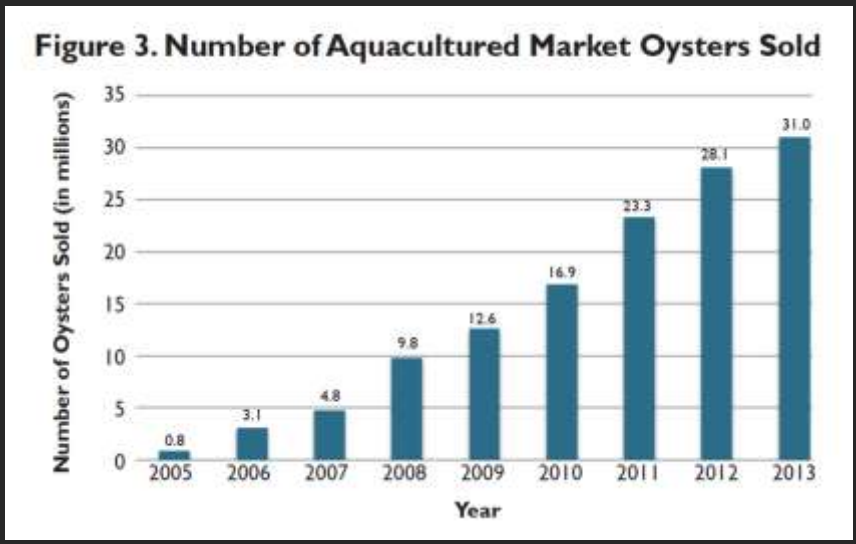
Grow out of half-shell

Stan Allen

Spat-on-shell

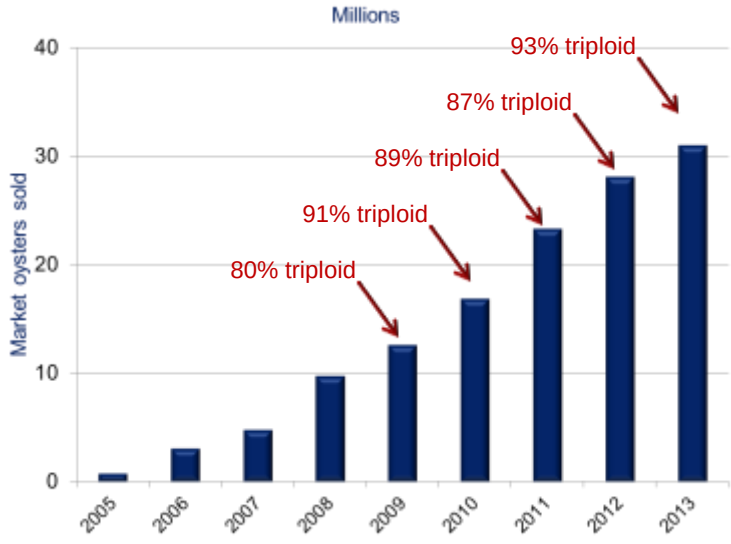
Stan Allen

Recent Virginia Oyster Production



From Hudson and Murray 2014

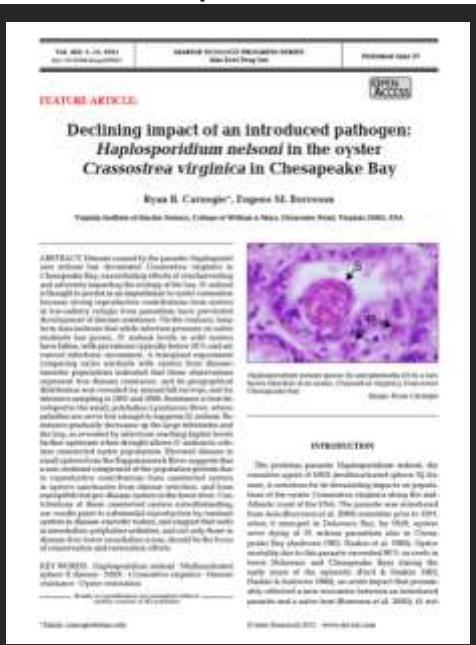
Recent Production Dominated by Triploids



Stan Allen

Hatchery-Based Breeding Embraced Coastwide

Developments in Wild Oyster Populations



FEATURE ARTICLE

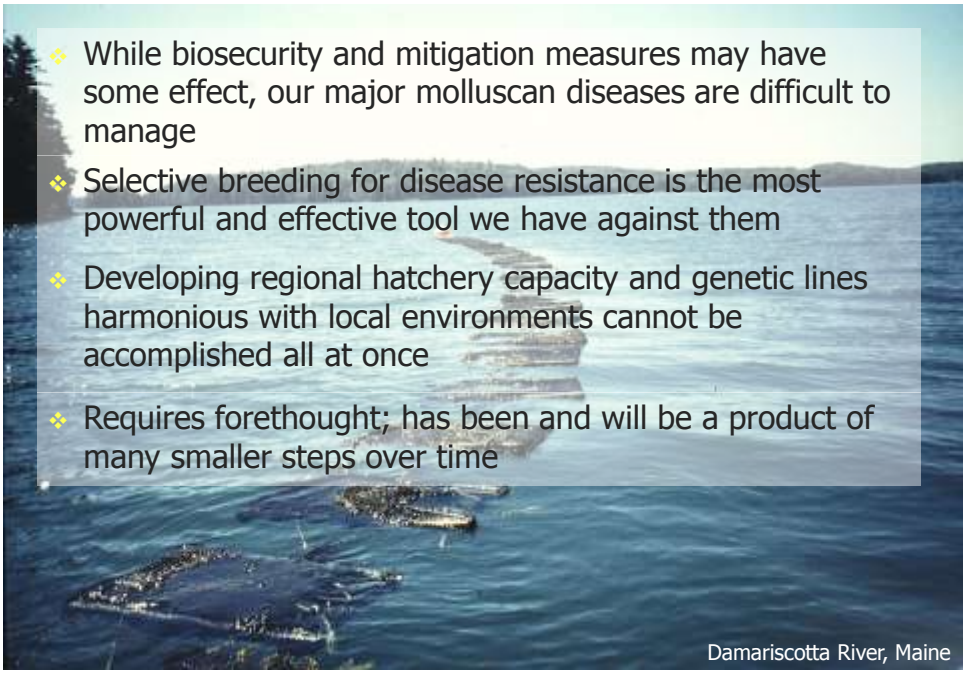
Declining impact of an introduced pathogen: *Haplosporidium nelsoni* in the oyster *Crassostrea virginica* in Chesapeake Bay

Ryan B. Carnegie*, Eugene M. Burreson

INTRODUCTION

- New evidence for resistance to MSX but also dermo
- Use of sanctuaries from harvest, rotational harvest plans to give resistant wild oysters more opportunities to pass on genes
- Natural oyster populations strongly rebounding, finally

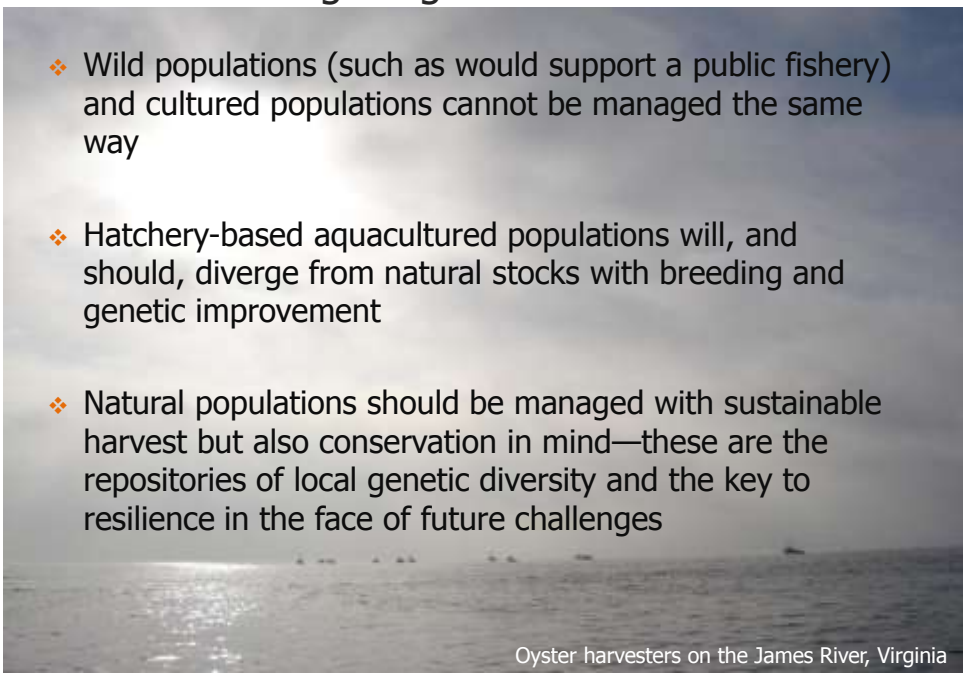
Lessons



- While biosecurity and mitigation measures may have some effect, our major molluscan diseases are difficult to manage
- Selective breeding for disease resistance is the most powerful and effective tool we have against them
- Developing regional hatchery capacity and genetic lines harmonious with local environments cannot be accomplished all at once
- Requires forethought; has been and will be a product of many smaller steps over time

Damariscotta River, Maine

If a Breeding Program is to be Pursued…



- Wild populations (such as would support a public fishery) and cultured populations cannot be managed the same way
- Hatchery-based aquacultured populations will, and should, diverge from natural stocks with breeding and genetic improvement
- Natural populations should be managed with sustainable harvest but also conservation in mind—these are the repositories of local genetic diversity and the key to resilience in the face of future challenges

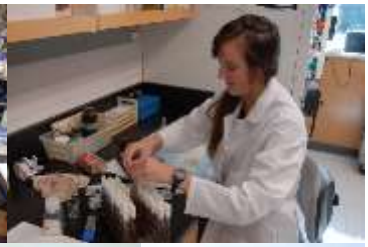
Oyster harvesters on the James River, Virginia

Acknowledgments

- UPEI and the Canada Excellence Research Chairs Program
- PEI Aquaculture Alliance
- PEI Shellfish Association
- PEI Dept. of Fisheries, Aquaculture and Rural Development
- Aquaculture Association of Nova Scotia
- Fisheries and Oceans Canada

York River at VIMS, looking down-estuary to Chesapeake Bay

Acknowledgments



- VIMS Molluscan Ecology Program
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- Virginia Sea Grant
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- Tidewater Oyster Gardeners Association (TOGA)

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