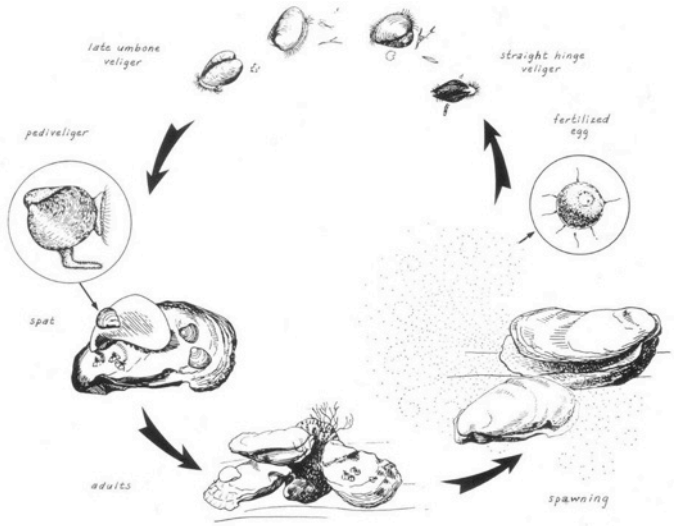
Disease Management Strategies for Shellfish Aquaculture: The important role of hatcheries

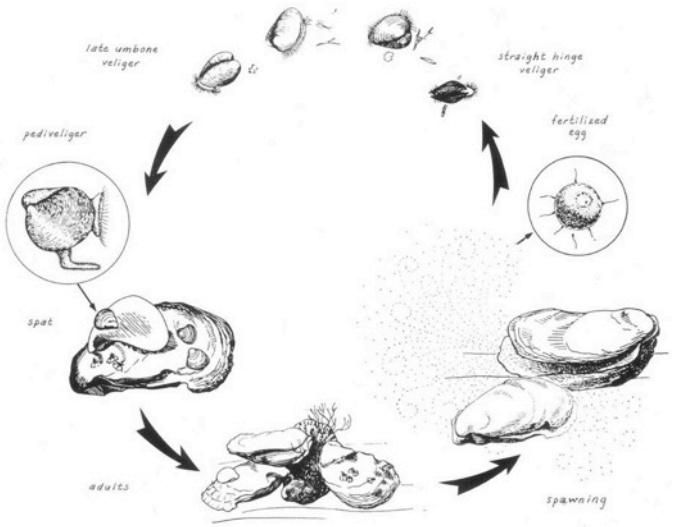


Marta Gomez-Chiarri (gomezchi@uri.edu), David Rowley, David Nelson (URI), Dina Proestou (ARS), Anu Frank-Lawale and Standish K. Allen Jr (VIMS), Ximing Guo (HSRL - RU), Paul Rawson (Umaine)

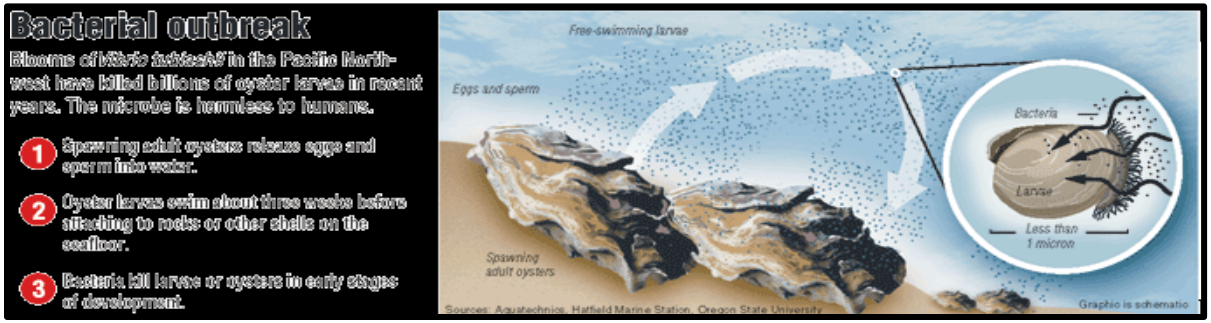
Milford Aquaculture Seminar 2014

Disease Management in Shellfish Hatcheries: Goals of this talk

- Point out to some recent research relevant to hatchery management
- Start a conversation regarding research needs (ECSGA survey will follow)

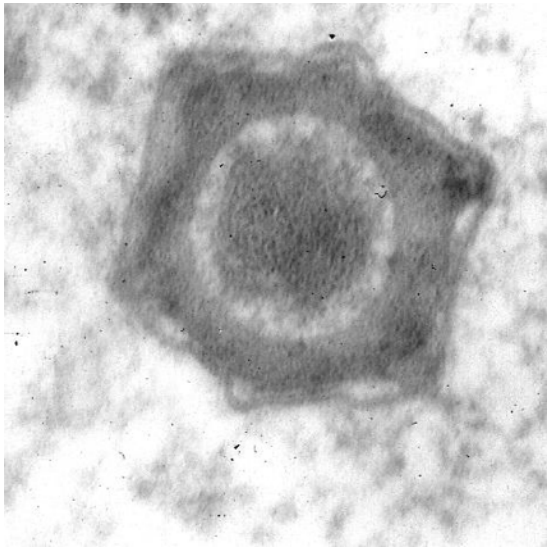


Diseases affecting larval shellfish



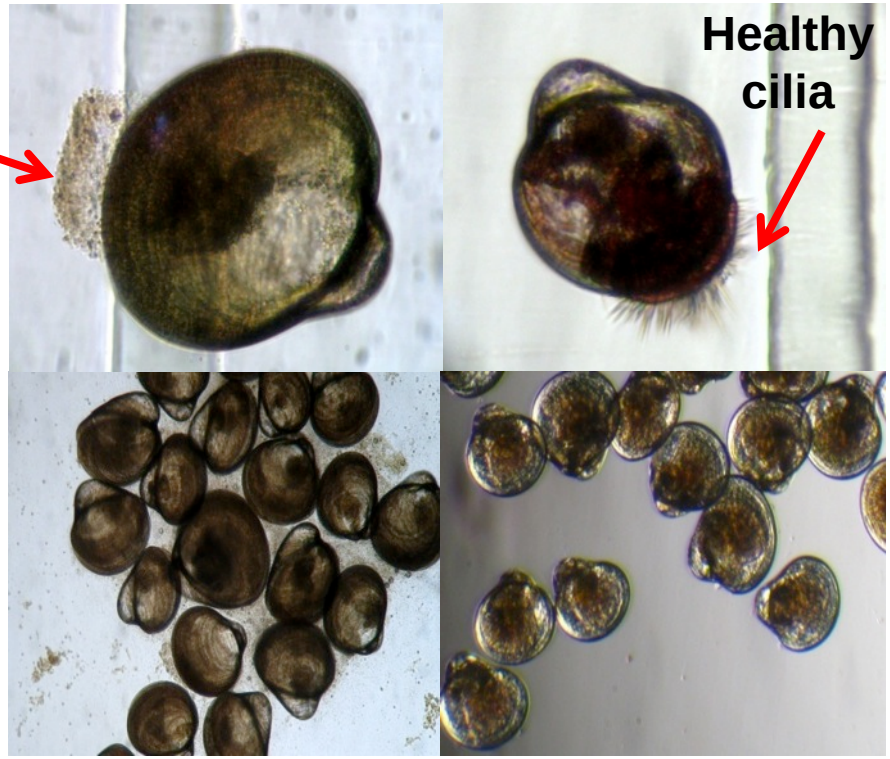
Source : Los Angeles Times

Vibriosis:
Vibrio tubiashii



Iridо-like virus (Oyster velar virus disease of Pacific oysters) (Tristan Renault)

Clumped cilia



Infected larvae

Healthy larvae

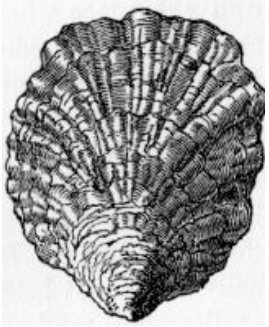
SHELLFISH HATCHERY

Water

Air (moisture)

Algae

Broodstock



Tanks, screens, and other equipment
Thiosulphate

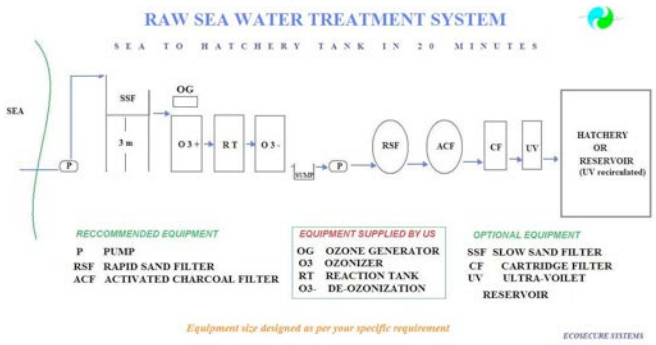
Culch

Some sources of vibrios in Shellfish Hatcheries

Sample type	Concentration of vibrios (colonies)
Microalgal stocks	**500,000 per ml**
Microalgal carboys (static)	300,000 per ml
Microalgal continuous flow	20,000 per ml
Microalgal static (20 – 25,000 L)	7,000 per ml
Larval tank water	1,000 per ml
Broodstock tank water	240 per ml
Algae stock transfer room air	<0.3 per minute
Air conditioner air flow tank room	36 per minute
Tank room carboy air system	234 per minute
Tank room tank air system	**>2,000 per minute**
Larval air line	1,500 per minute

Elston et al. 2008, Dis Aquat Org 82: 119–134

Water



Issues: Water Quality Problems
- Pollutants and toxins
- Ocean Acidification
- Pathogens

Effects on larvae (from chronic stress to acute mortality)
- Decreased growth
- Developmental anomalies
- Decreased settlement
- **Susceptibility to infections**
- Certification for interstate transport of seed

Avoidance and Prevention:
- Siting of hatchery
- Source of water (well)
- Water quality monitoring
- Monitoring for pathogens (need for easy to use diagnostic tools)
- Water treatment systems (physical, chemical, **biological**)

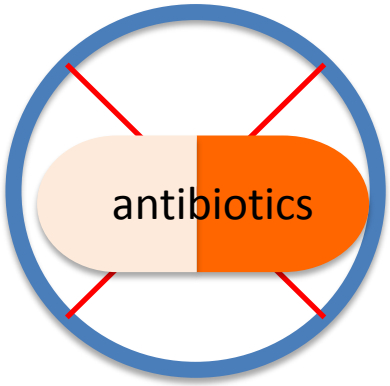
Algae (food) Aeration

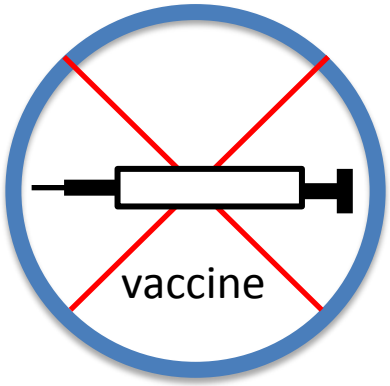
Issues:
- Cost, technology
- Nutritional requirements of larvae
- Feeding rates and frequency
- Aeration rates, mixing
- Potential routes of introduction for pathogens

Effects on larvae (from chronic stress to acute mortality)
- Decreased growth
- **Pathogen outbreaks**

Avoidance and Prevention:
- Source of water (well)
- Source of algae
- Monitoring for pathogens
- Pathogen control: physical, chemical, **biological**

Controlling disease outbreaks in shellfish hatcheries





Alternative management methods are needed

PROBIOTICS

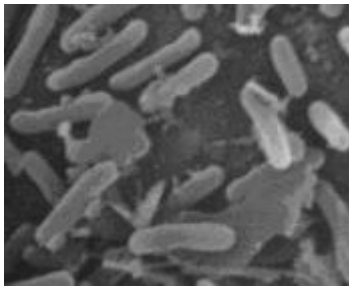
Probiotics as disease management tools

Live microbes which have a beneficial effect on the host

"Green" alternative to the use of antibiotics

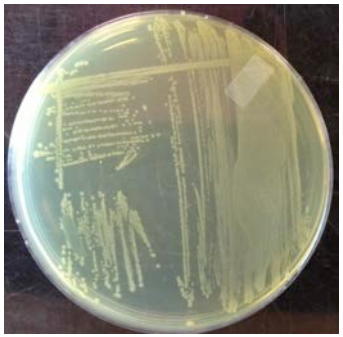
Proposed modes of action:

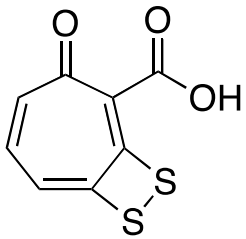
- ✓ Production of an antimicrobial compound
- ✓ Competition for adhesion sites and nutrients
- ✓ Enhanced host immune system
- ✓ Enhanced nutrition
- ✓ Enhanced water quality



Probiotic bacteria discovered at URI

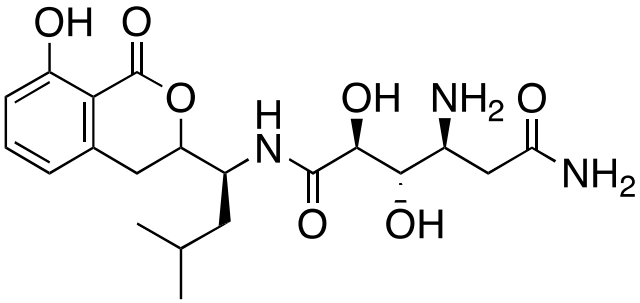
1. *Phaeobacter* sp. S4 was isolated from the inner shell of a healthy adult oyster





TDA

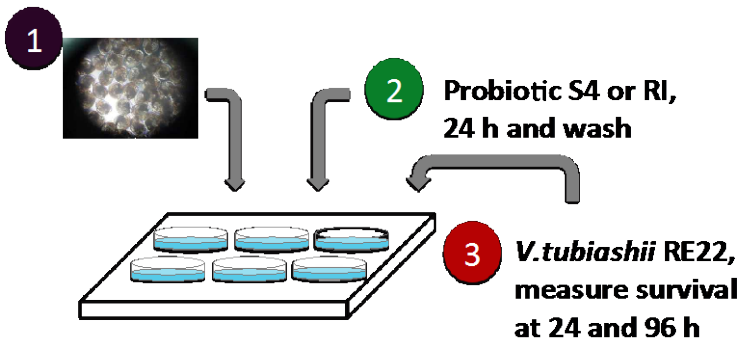
1. *Bacillus pumilus RI0695* was isolated from a marine invertebrate from the Narrow River (Narragansett, RI)



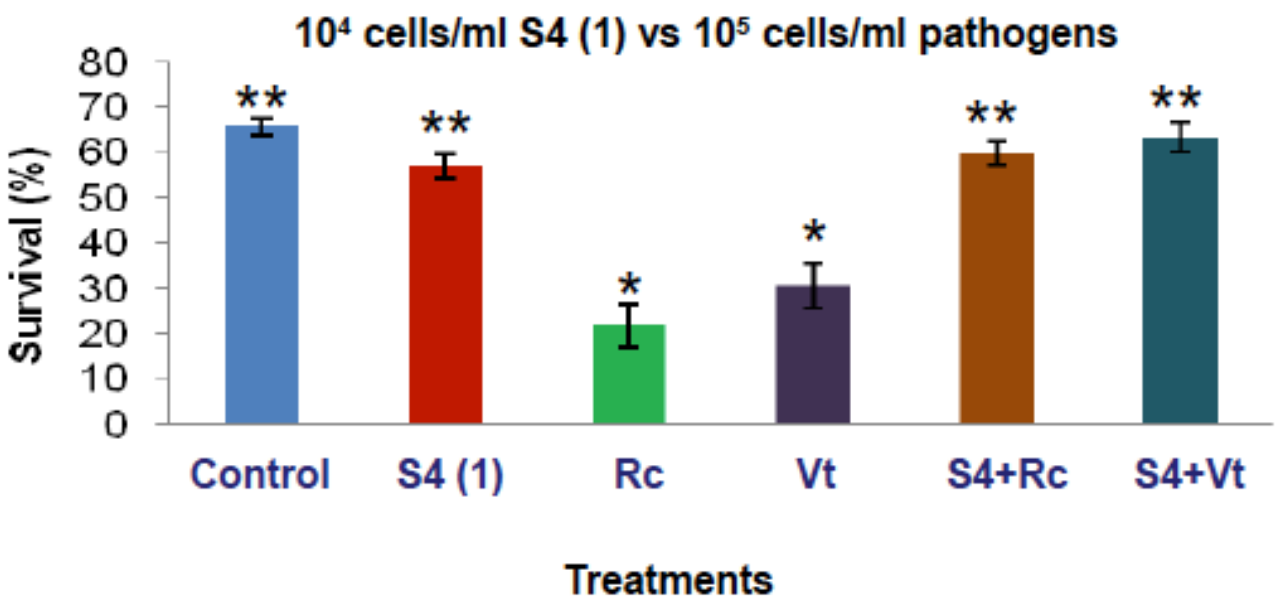
amicoumacin

Probiotic activity of *Phaeobacter* sp. S4

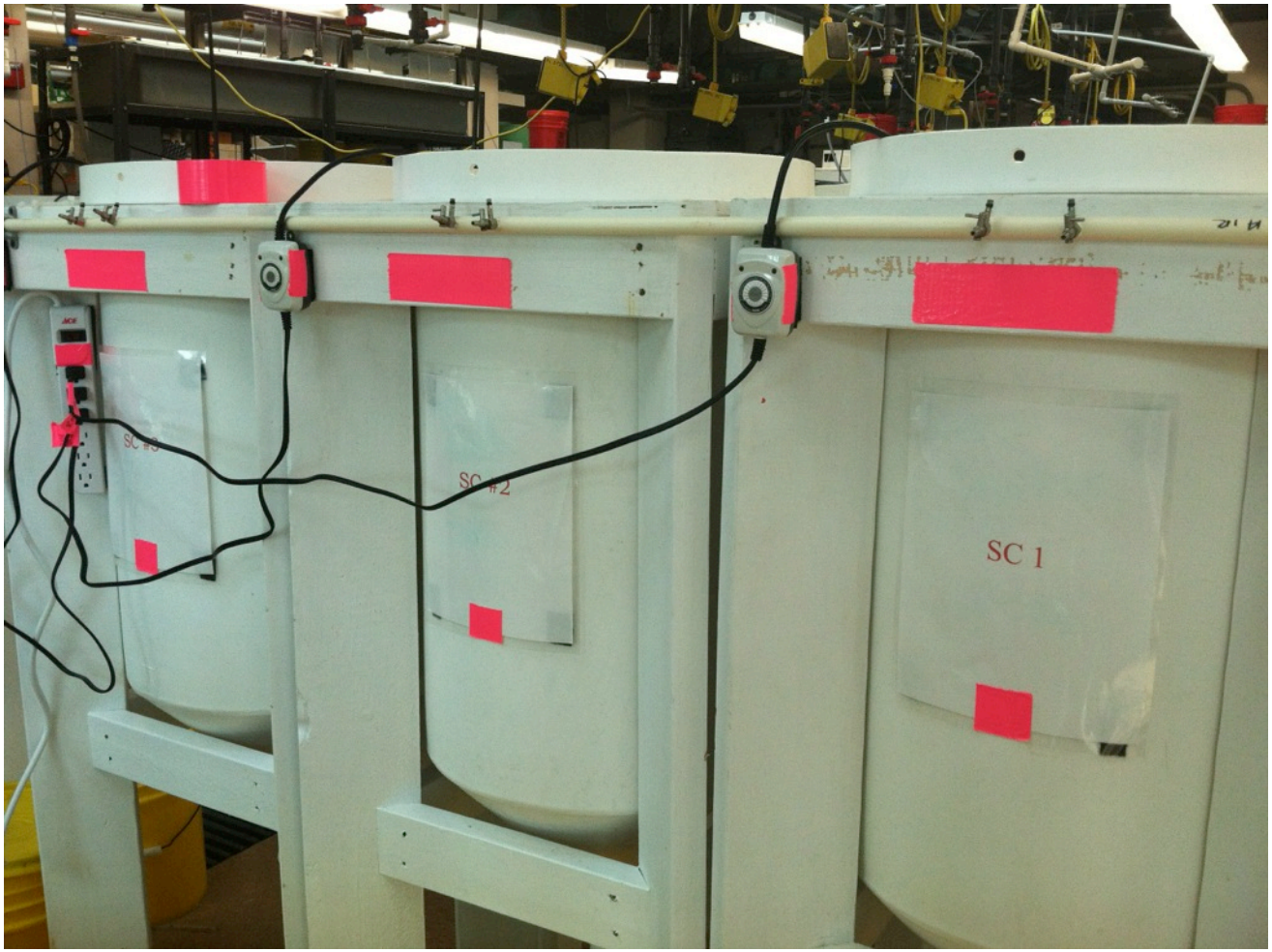
Challenge



Pretreatment with S4 protected larvae against challenge with the bacterial pathogens *Vibrio tubiashii* (Vt) and *Roseovarius crassostreae* (Rc) (Karim et al. 2013 – JSR)



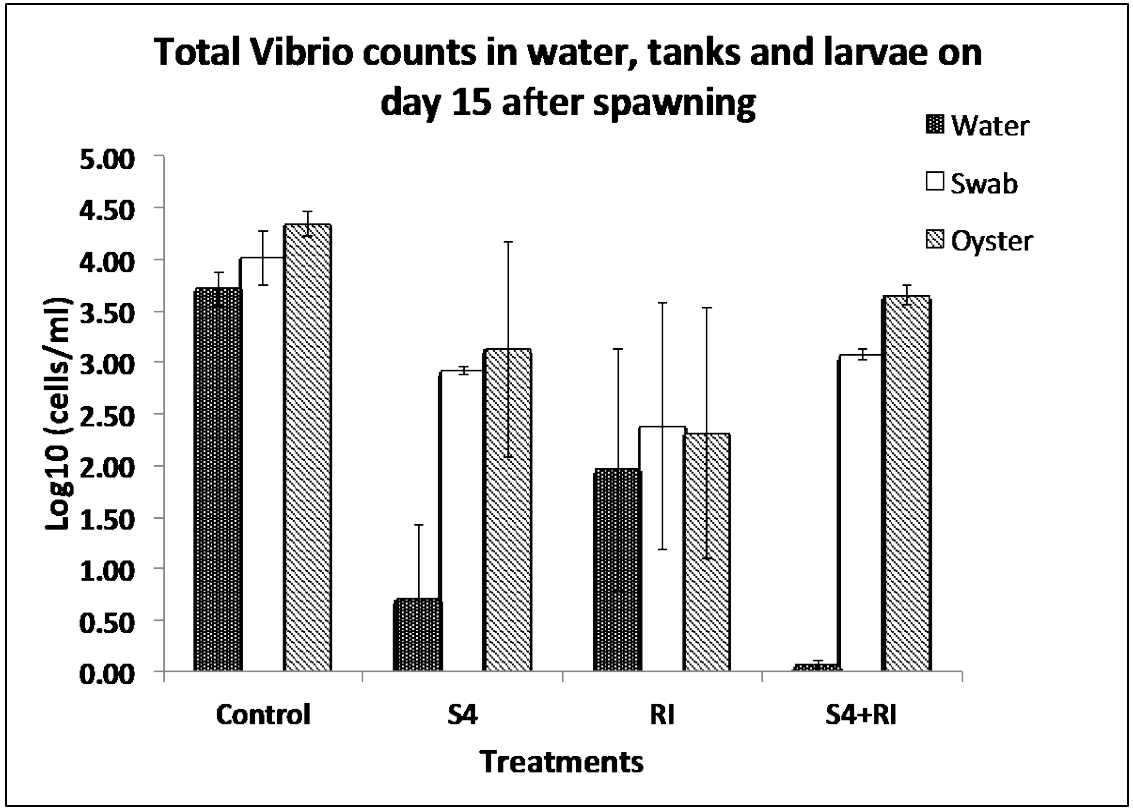
Hatchery Trials

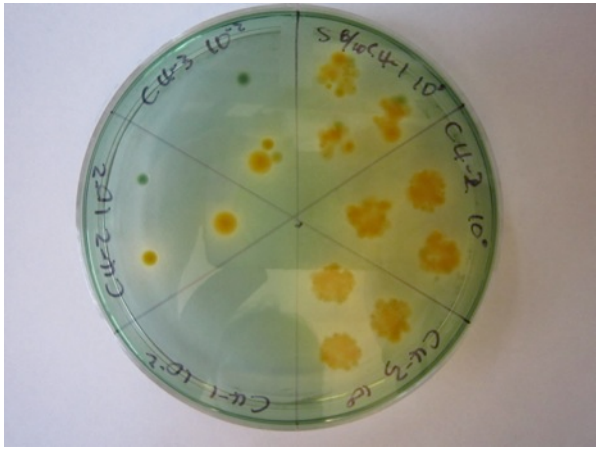


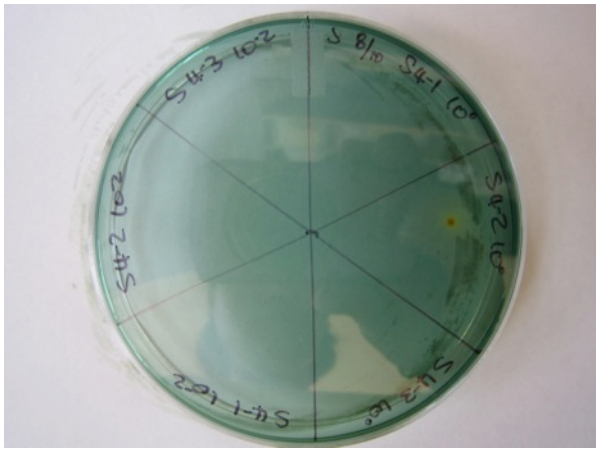
Location: Blount Shellfish Hatchery at Roger Williams University

Karin Tammi, Kate Markey, Roxanna Smolowitz

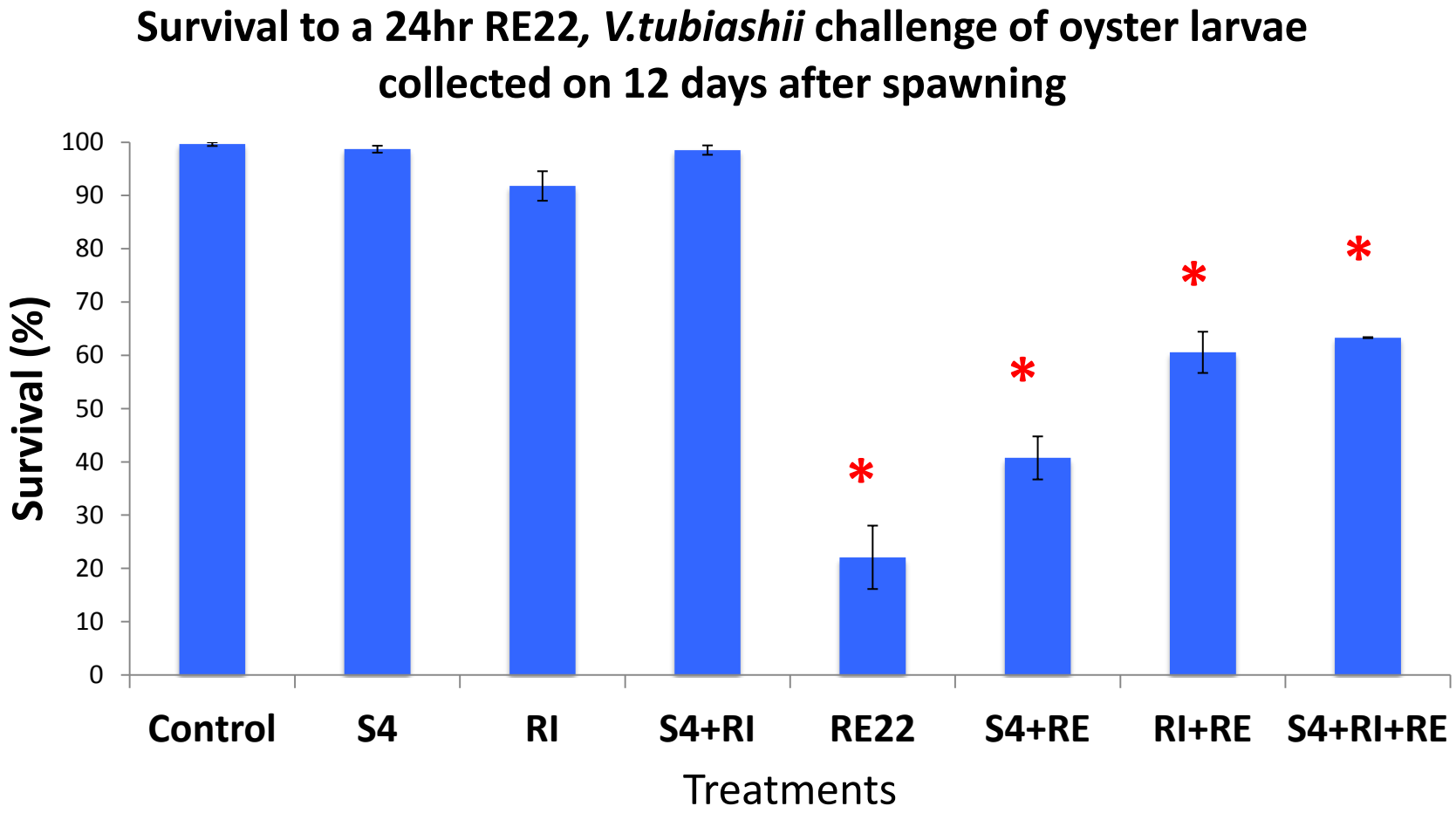
Probiotic treatment reduces vibrios in hatchery tanks





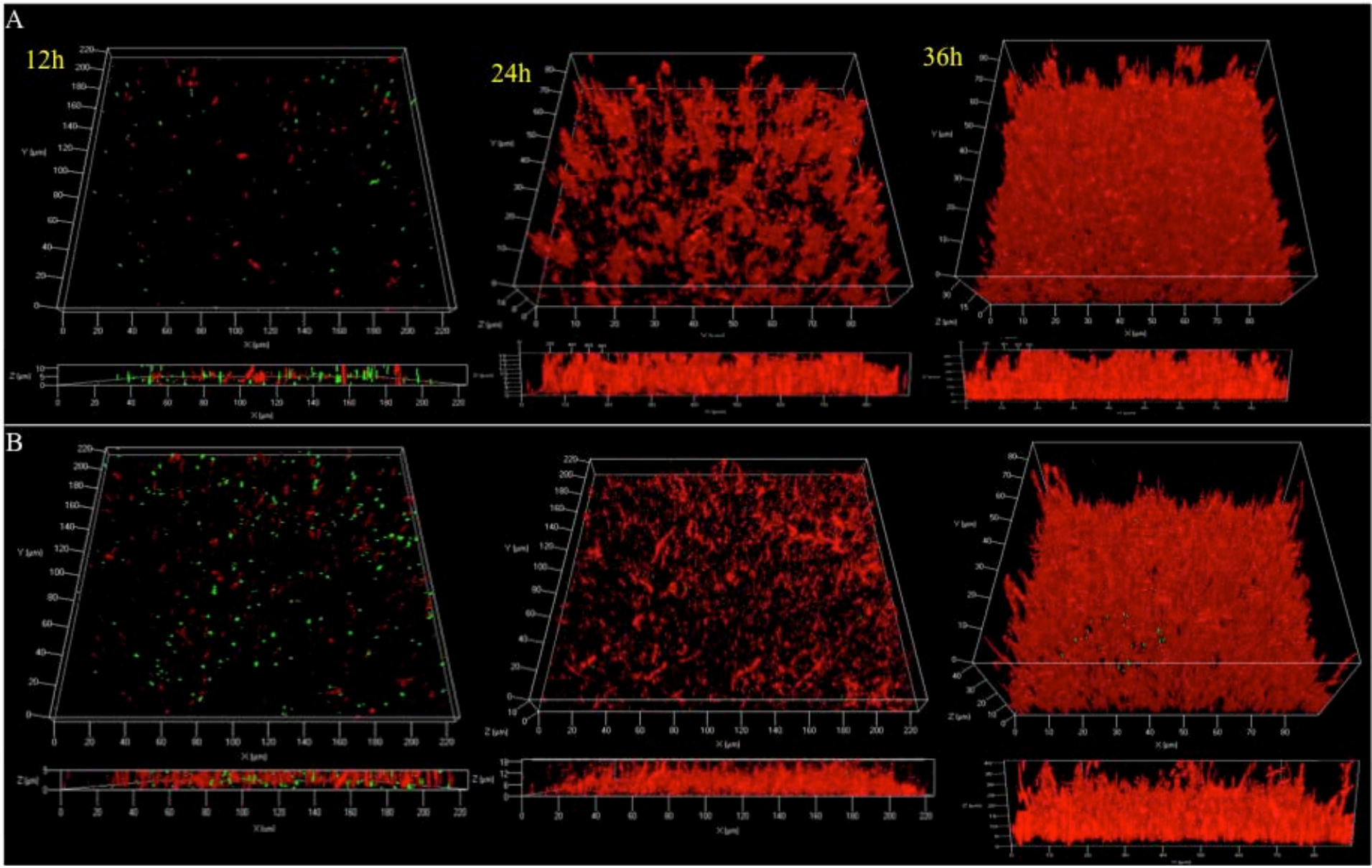


Probiotic treatment protects oyster larvae against bacterial challenge



Probiotics provided on days 0, 2, 6, and then daily until day 12.

The ability to produce antibiotics and to form biofilms contribute to the probiotic activity of S4 against shellfish bacterial pathogens



Summary for Hatchery Trials

1. Probiotic Strains *Phaeobacter* S4 and *B. pumilus* RI0695 are <u>safe</u> for use in oyster larviculture.
2. Total <u>vibrios are reduced</u> in the water and tank surfaces.
3. Larva exposed daily to fresh *Phaeobacter* S4 and *B. pumilus* RI0695 in hatchery showed increased survival after bacterial challenge in laboratory.

Broodstock

Issues: *variability in quality between batches*

- Source of broodstock
- Health of broodstock (dermo, MSX, SSO)
- Conditioning and spawning
- Genetics
    - Disease resistant strains
    - Triploids
    - Inbreeding

Effects on larvae: *will affect future performance*

- Spawning success (and easiness)
- Growth and survival
- Settlement rates

Avoidance and Prevention:

- Disease monitoring
- Effective size of spawning population
- Breeding programs
- Research on strain performance – the **importance of using disease resistant strains well adapted to local conditions**

Culch

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East Coast Shellfish Growers Association

Roger Williams University

Breeding for Disease Resistance in Eastern Oysters: An Initiative from the East Coast Shellfish Breeding Consortium

Shellfish Genetics Laboratory

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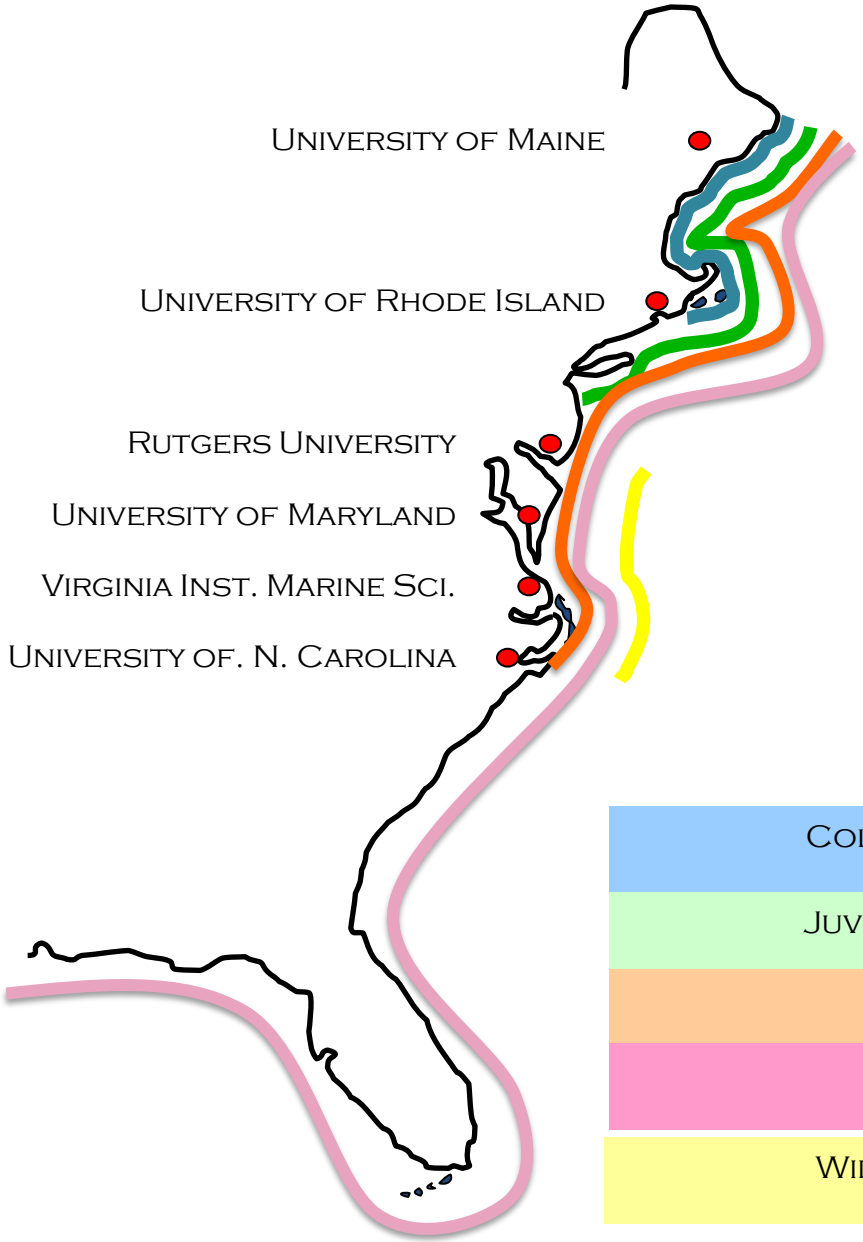
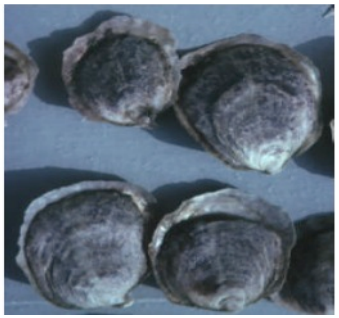


RECENT EXPANSION RANGE

JUVENILE OYSTER DISEASE – 1980s

DERMO DISEASE – 1990s

MSX DISEASE – 1980s (CT, RI, MA), 2000s (ME)



Cold Water Physiology

Juvenile Oyster Disease

MSX Disease

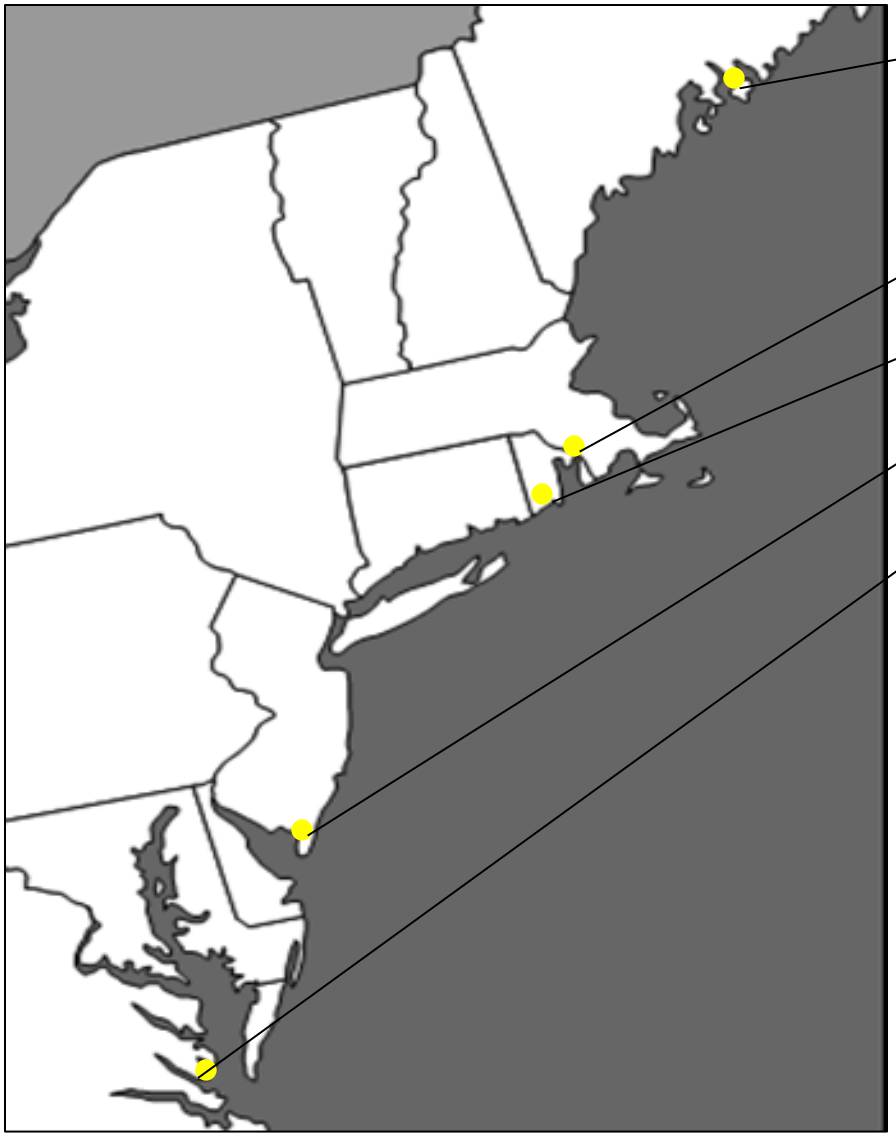
Dermo Disease

Wide salinity variation

Regional Challenges to Oyster aquaculture

Currently Addressed by the shellfish breeding consortium

Testing line performance at different sites



- Maine: Damariscotta Bay (did not grow DEBY & hANA lines)
- Narragansett Bay, RI
- Ninigret Pond, RI
- Delaware Bay, NJ
- York River, VA

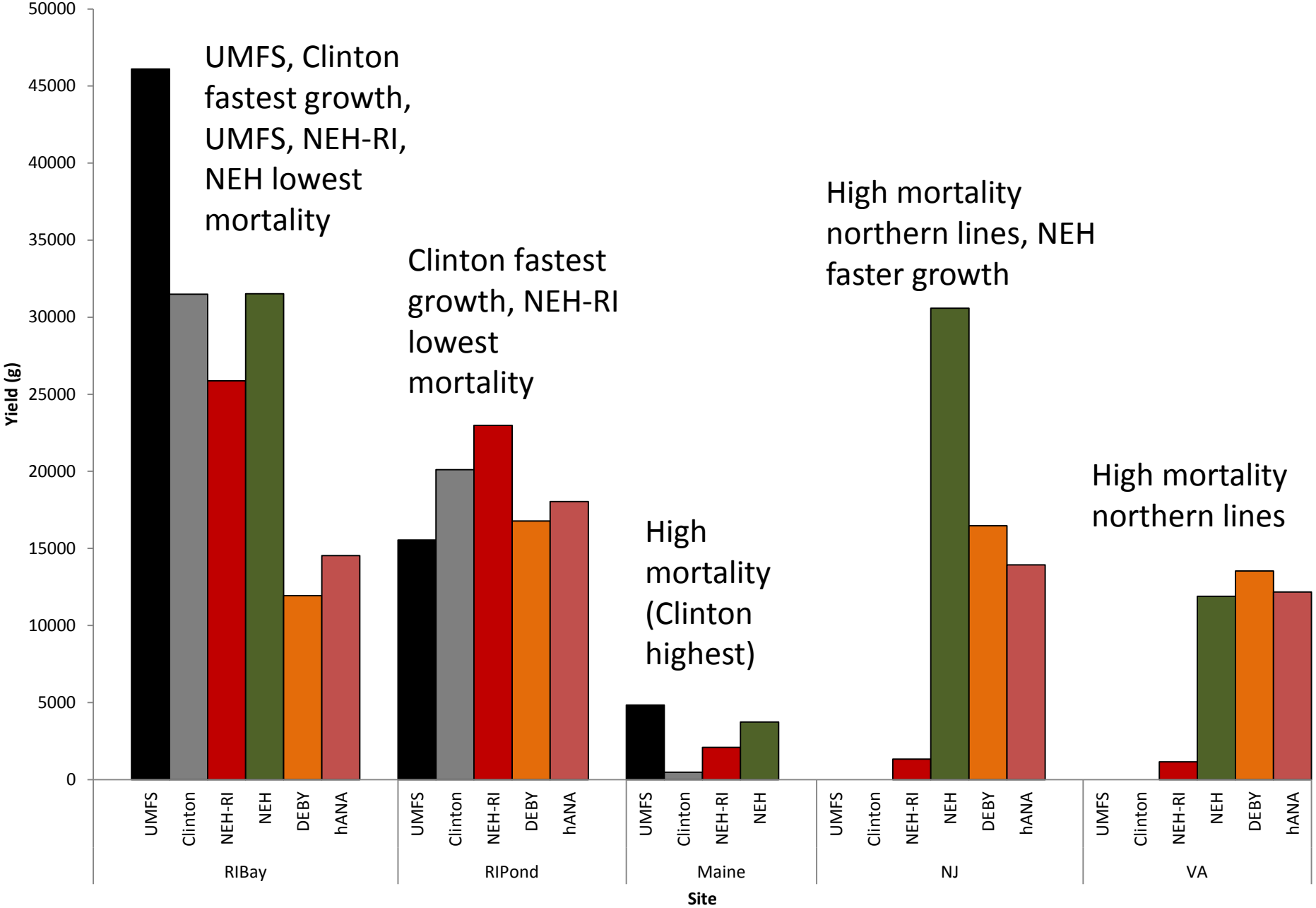
"Northern" Lines:

- NEH (Dermo, MSX)
- NEH – RI (Dermo, MSX, SSO)
- UMFS (ROD)

"Southern" Lines:

- Hana (Dermo, MSX)
- Deby (Dermo, MSX)

Total Yield (g) by Site and Line



The importance of adaptation to local conditions

- In general, lines perform best at the locations in which they were developed and maintained
- Disease resistance is important
  - High mortality of northern lines in NJ and VA sites can be attributed to disease (dermo and MSX)
  - High mortality in ME due to ROD – *UMFS* performed best
- *Need for regional breeding programs*
- *Hatchery participation?*

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