Shellfish Biosecurity: Risks, Management & Best Practices

Bivalve Shellfish Physiology, Pathogens, Diseases – 30 Nov 2016

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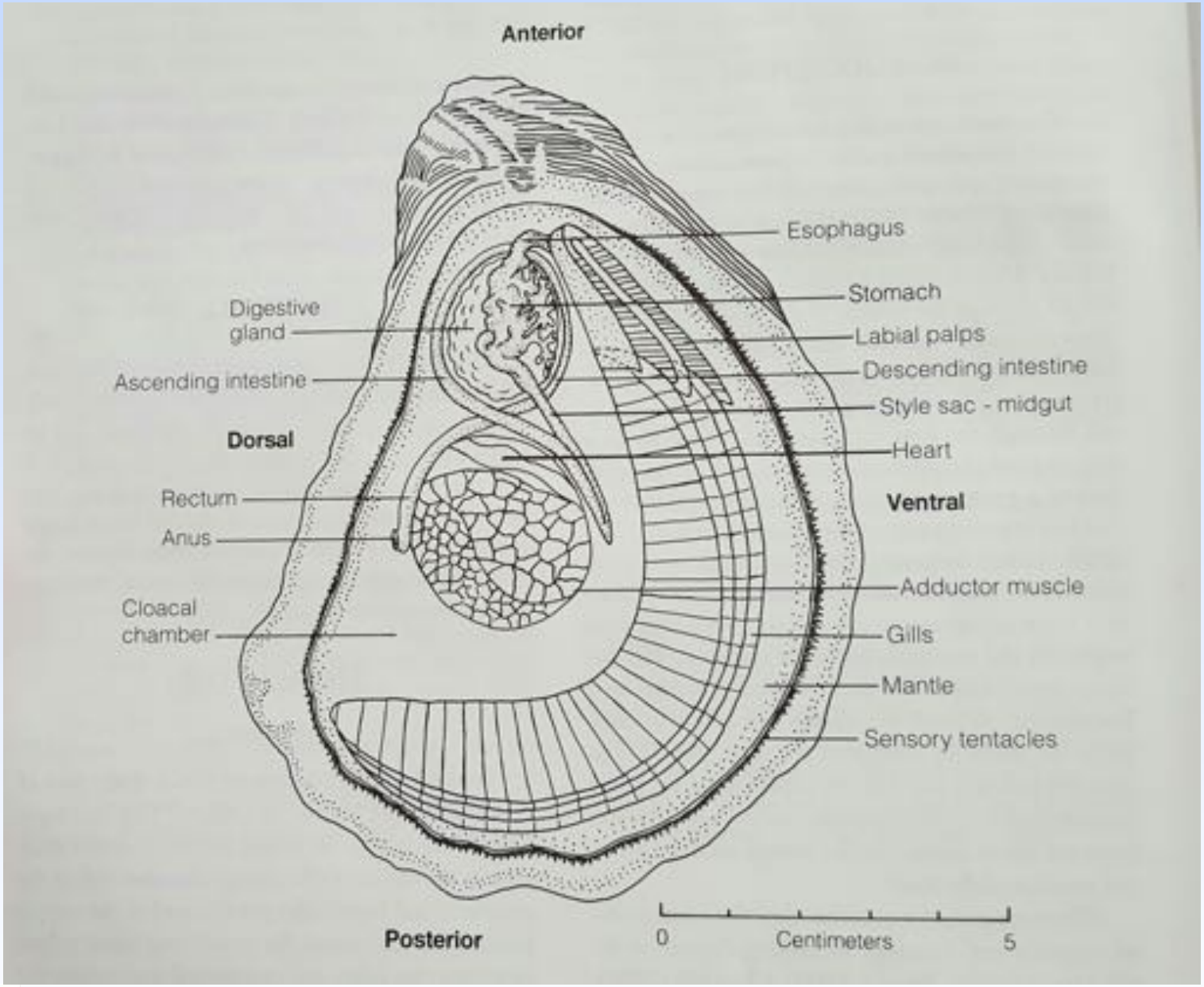
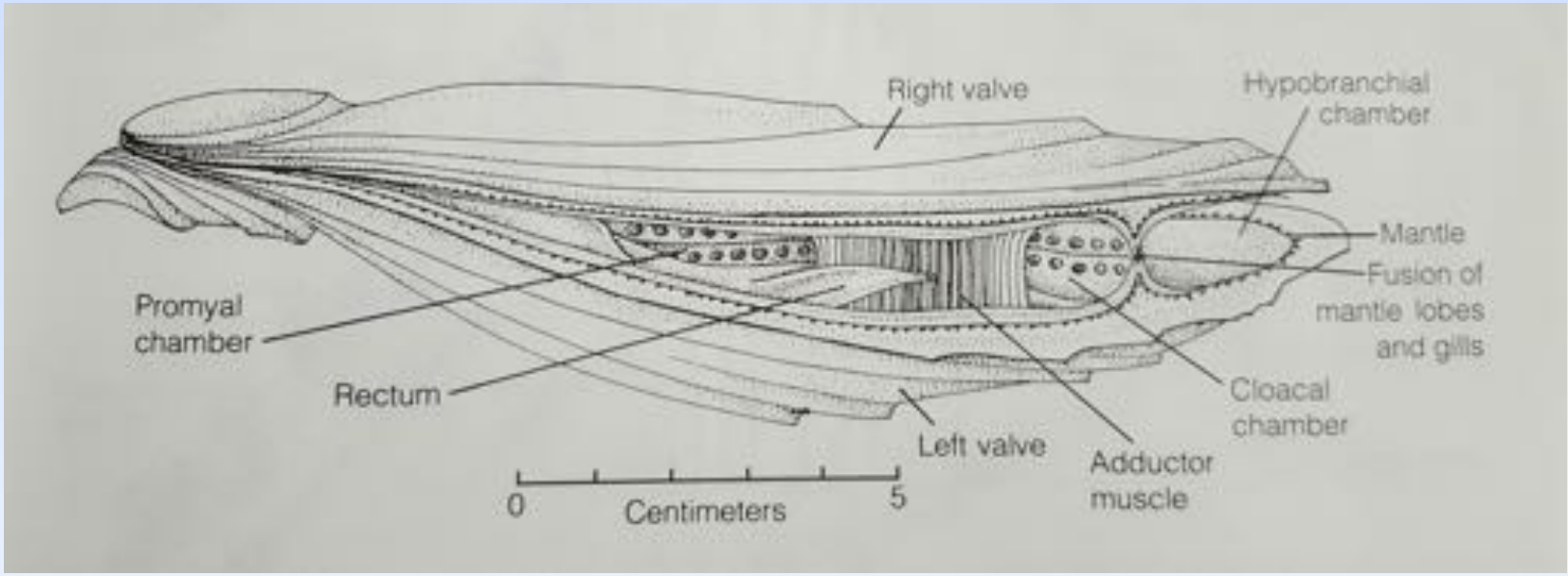
Photo by B. Mook



from Galtsoff 1964

Mantle



from Galtsoff 1964

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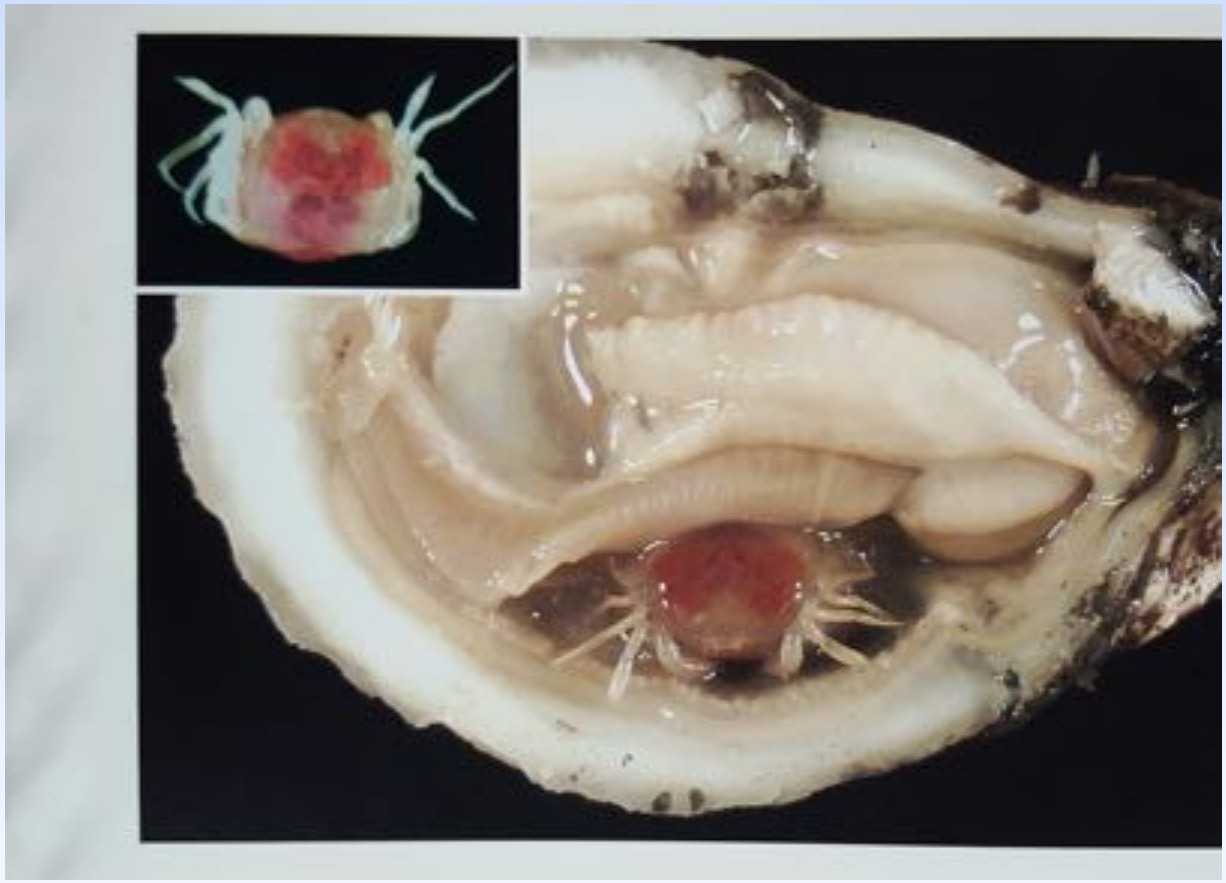
Gills & Palps



from Howard et al. 2004

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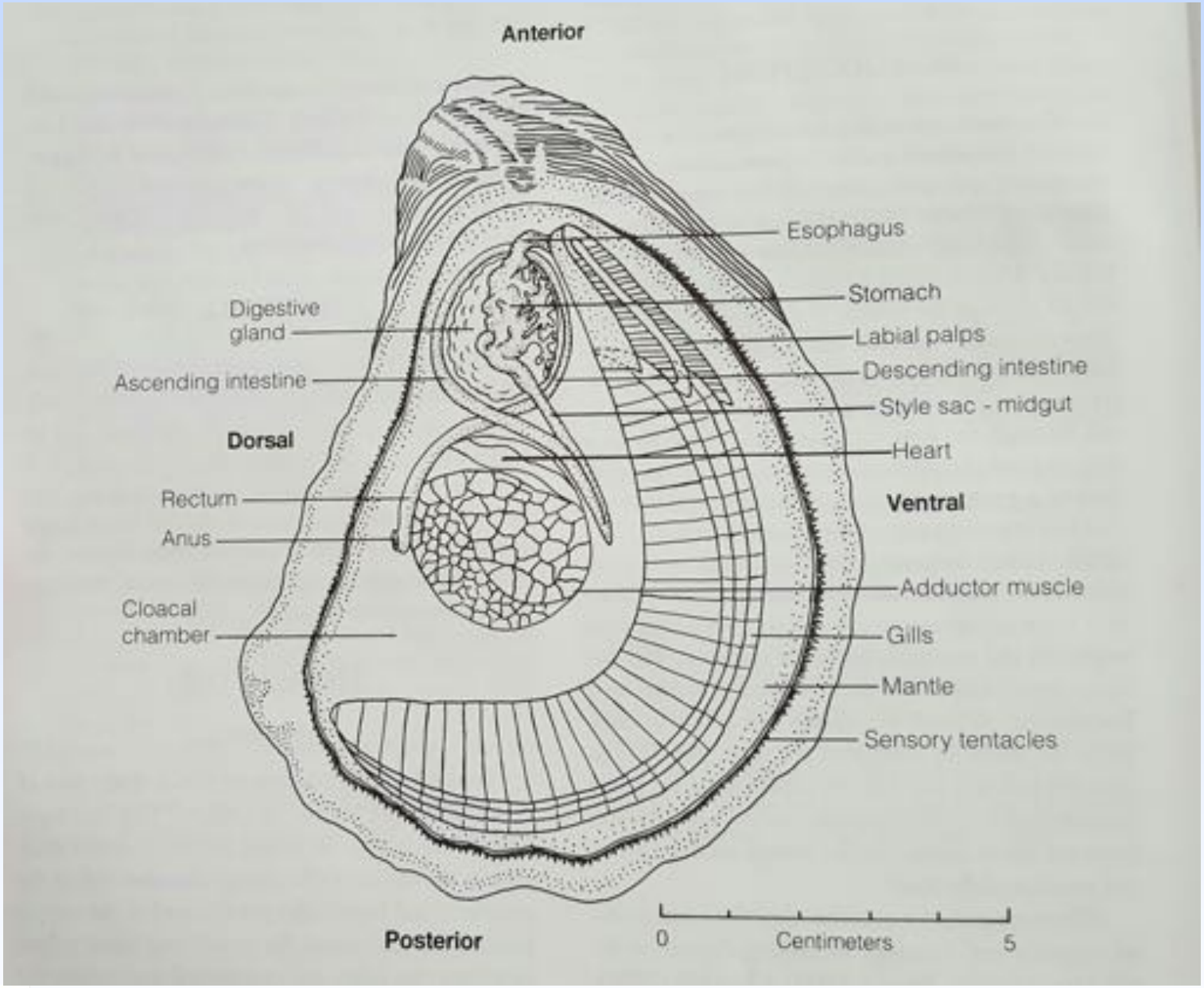

from Galtsoff 1964

Oyster Pathogens & Diseases

- Malpeque disease (1915)
- ***Perkinsus marinus*** **(init. *Dermocystidium*)**
- ***Perkinsus sp.***
- ***Haplosporidium nelsoni*** **(MSX, multinucl sphere X)**
- ***Haplosporidium costale*** **(SSO)**
- Gill necrosis virus (Portugal)
- *Marteilia refringens* (*Ostrea edulis*)
- ***Bonamia exitiosa***
- ***Bonamia ostreae* (*Ostrea edulis)***
- *Mikrocytos sp.* (Pacific)
- *Vibrio, Nocardia, Rickettsia*
- **Juvenile Oyster Disease (*Roseovarius crassostreae)***
- Ostreid Herpesvirus 1 (OsHV-1)

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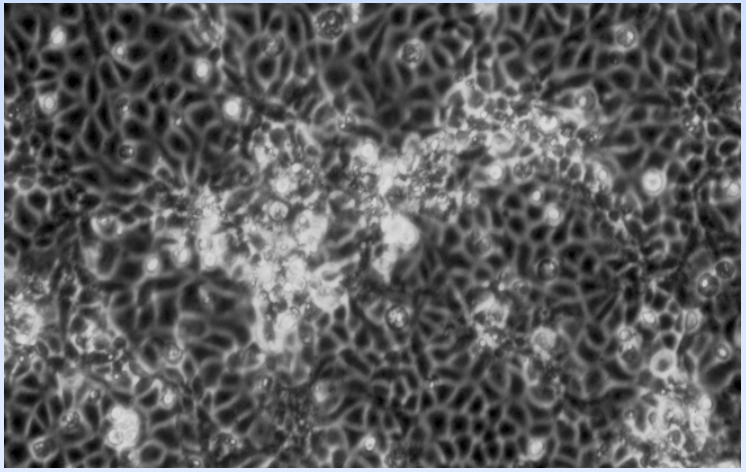
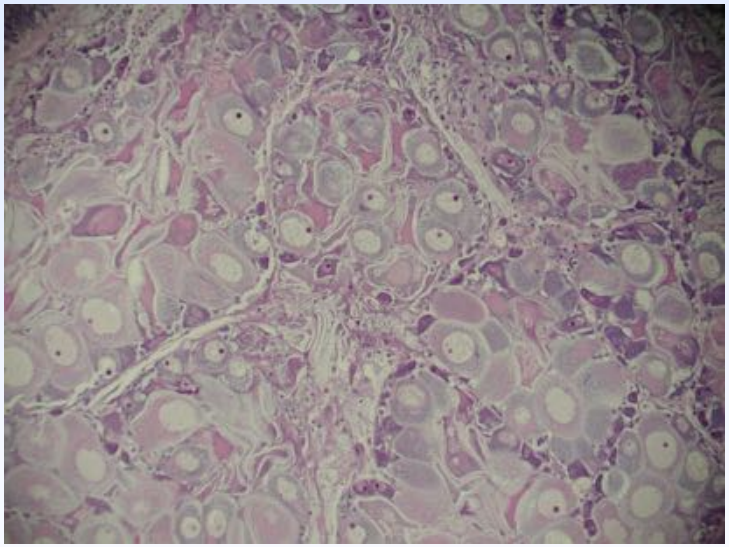
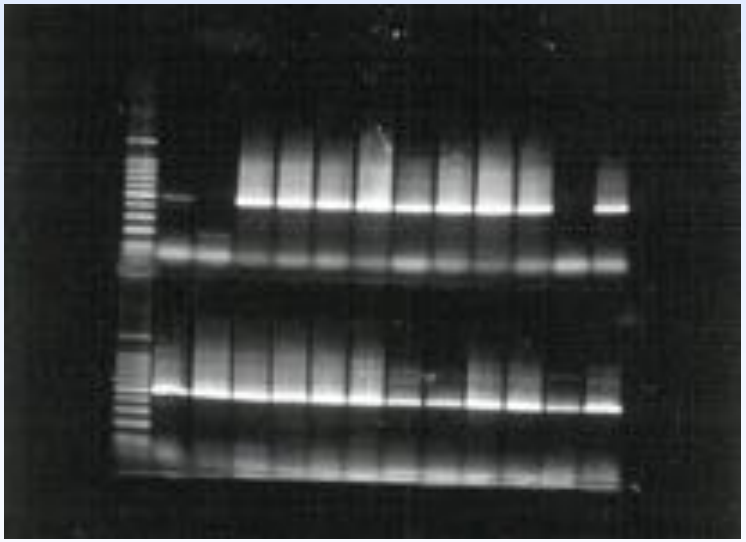
Testing Protocols

- Culture
- Microscopy
- Molecular biology
- Immunology
- Biochemistry
- Histology







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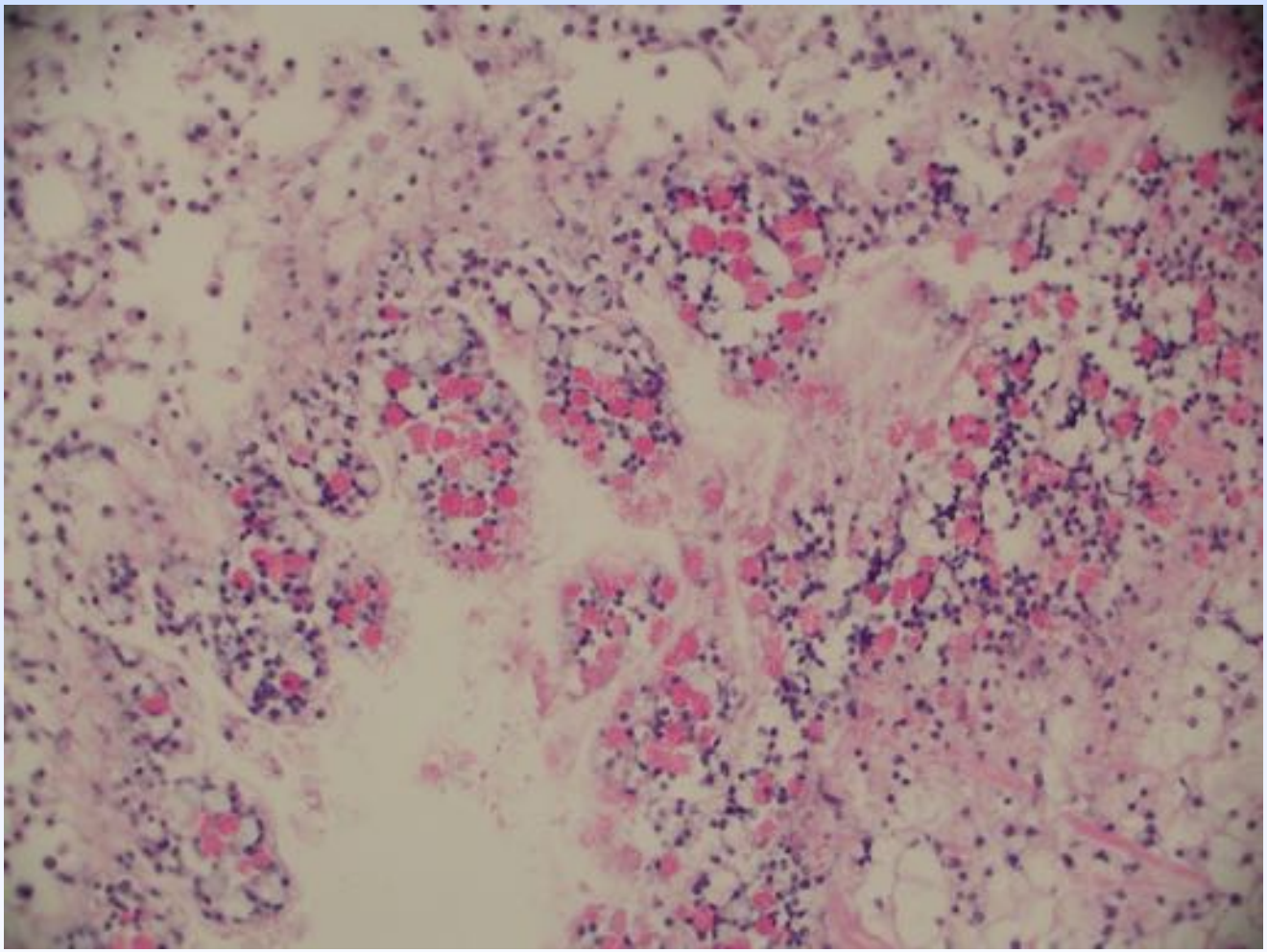
Haplosporidium nelsoni (MSX)



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Previous reports of *Haplosporidium sp*. in Maine *C. virginica*

Haplosporidium nelsoni (MSX)

- 1983 - Marsh River, Sheepscot, 2 oysters
- 1983 - Piscataqua River, 2 oysters (Sherburne & Bean, 1991)
- 1990 - Damariscotta River, 2.4%, limited mortality
- 1995 - Piscataqua River, low prevalence (Barber et. al., 1997)
- **2010 – Damariscotta River**

Haplosporidium costale (SSO)

- 1980s – (Andrews 1988; Ford & Tripp 1996)

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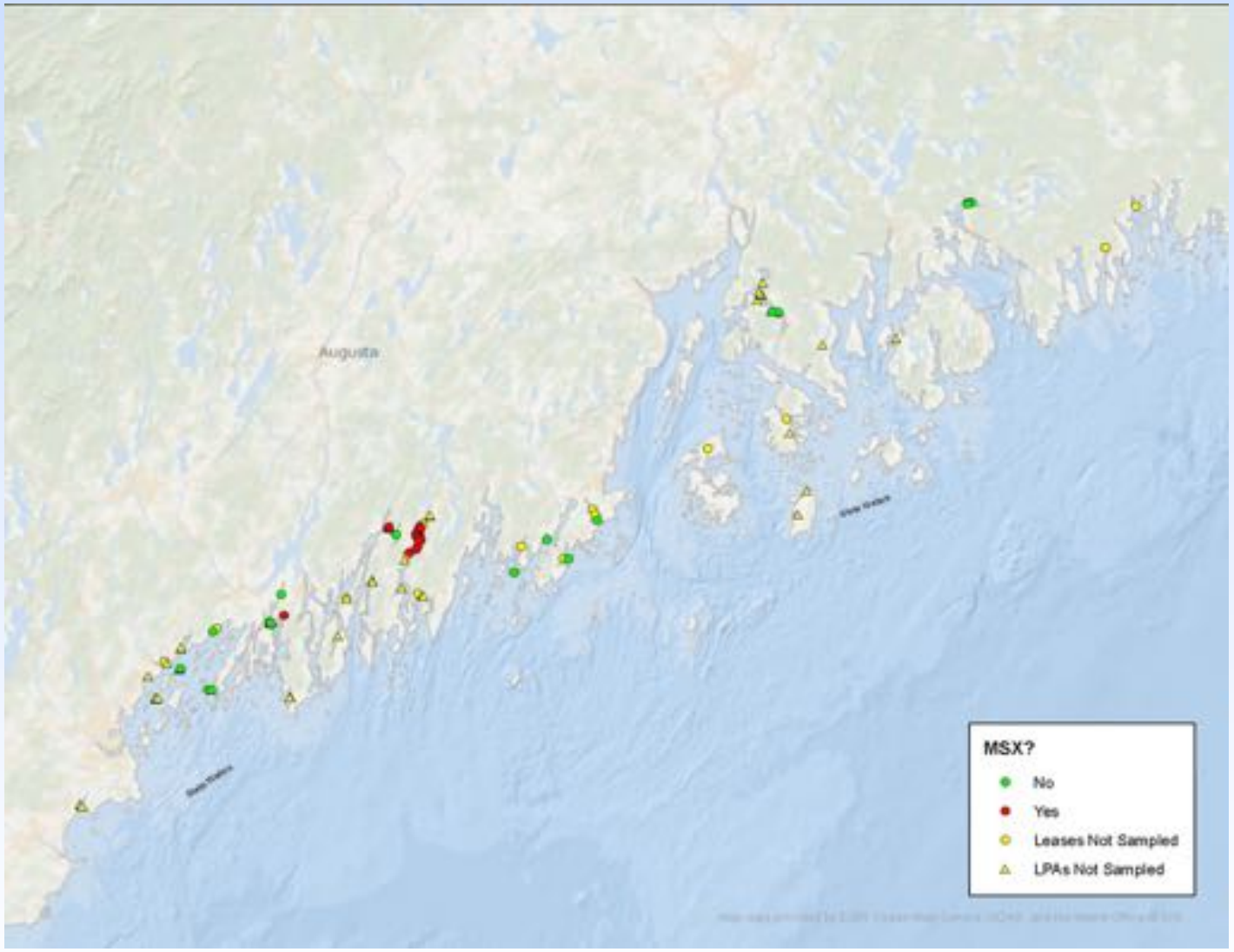
2010: Damariscotta River
Surveillance Strategy for MSX Infection Margins

- Mild winter followed by warm dry summer
- Increased mortality noted by growers
- MSX diagnosed
- Screened farms/natural beds outside
  - Populations defined by "bay"
- 62 oysters at each of 16 sites
  - >1" shell-length, if available
- KRB & MAHL
  - PCR general screen
  - Histology confirmation/intensity
- Expected a 95% confidence level of detecting MSX within a bay if ≥ 2-5% prevalence

2010-2011 Maine Dept. of Marine Resources MSX Survey

(M.L. Nelson, ME DMR; D.A. Bouchard, Univ. Maine; C. Giray, Kennebec River Bio.)



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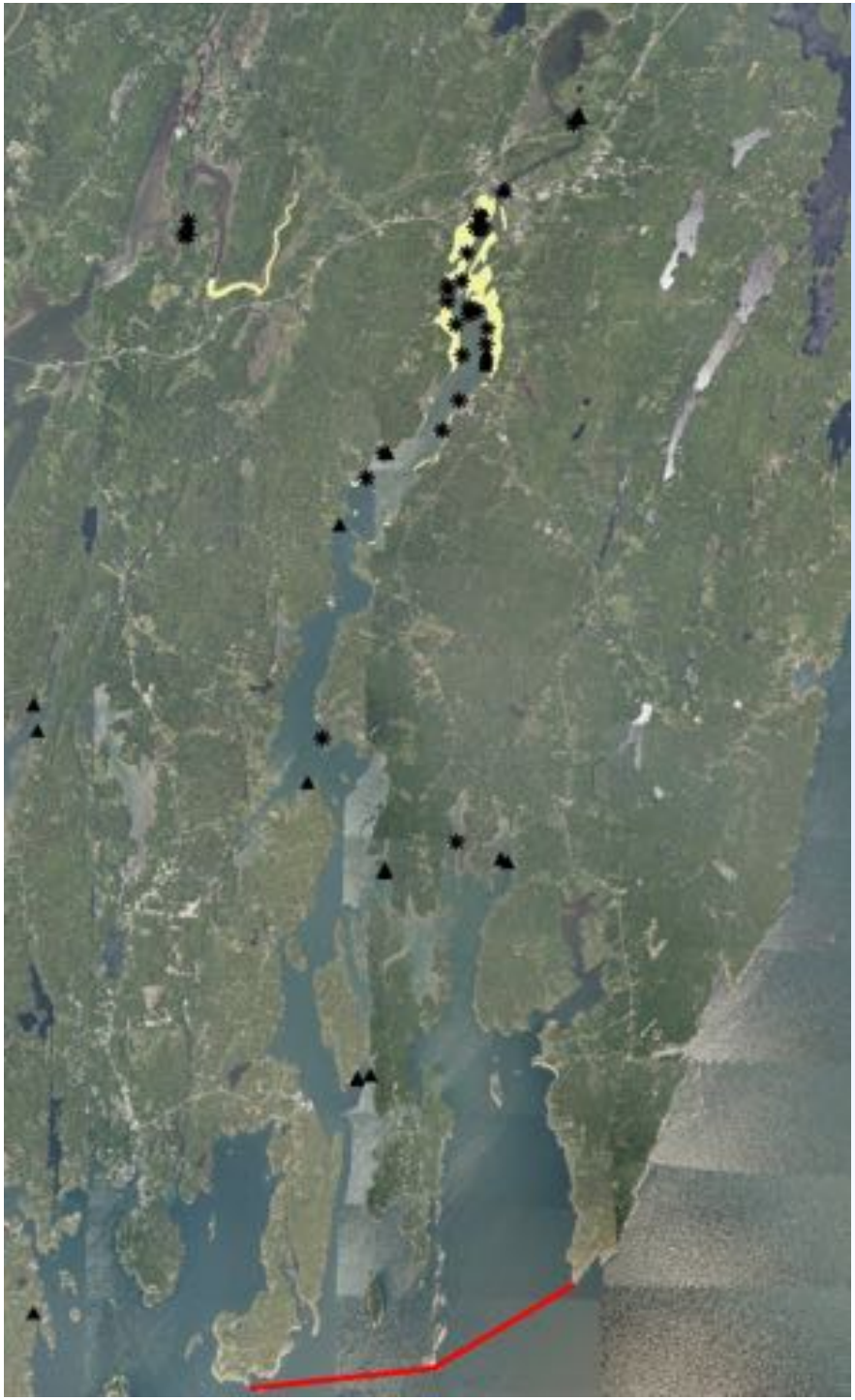
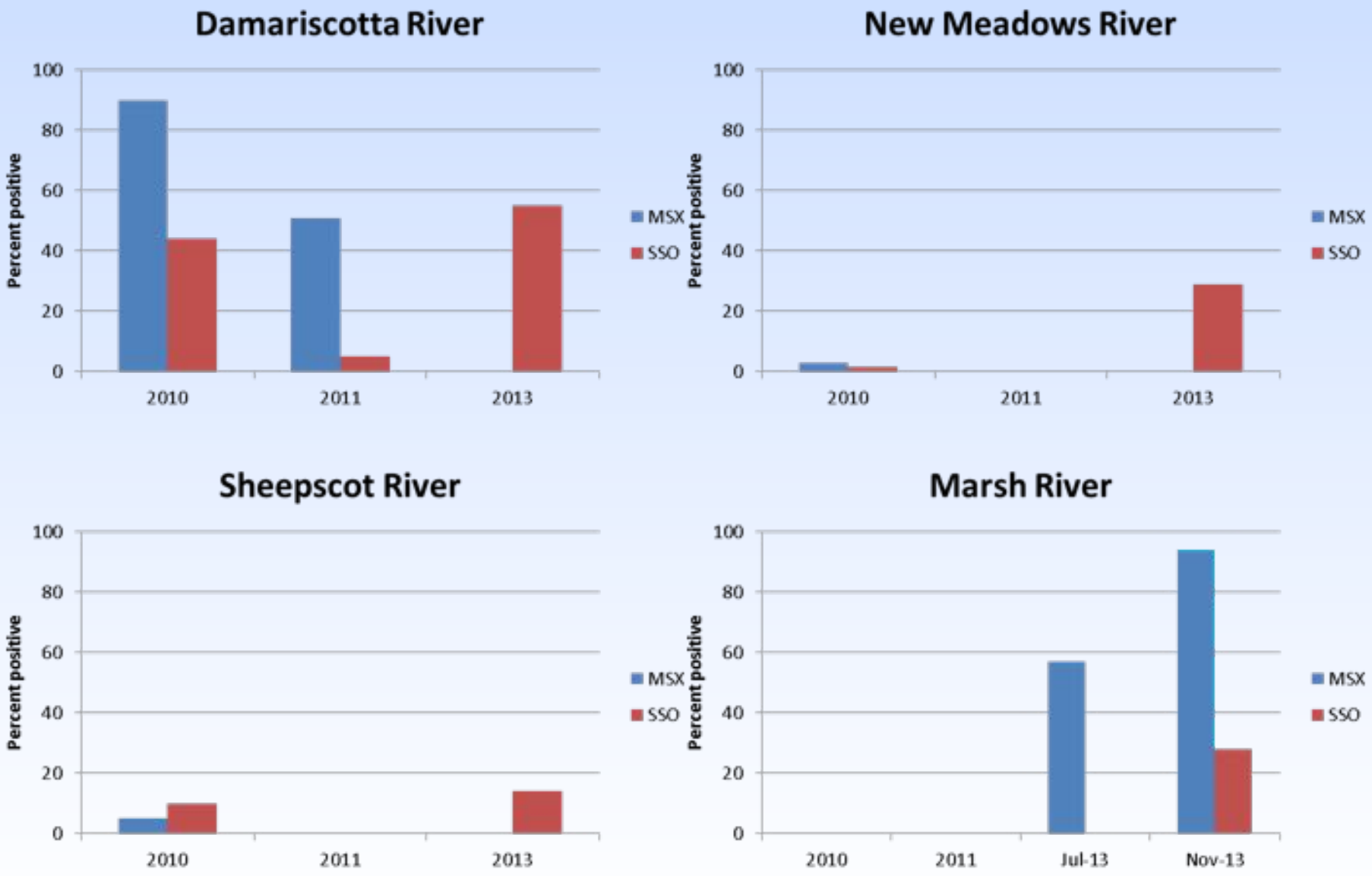
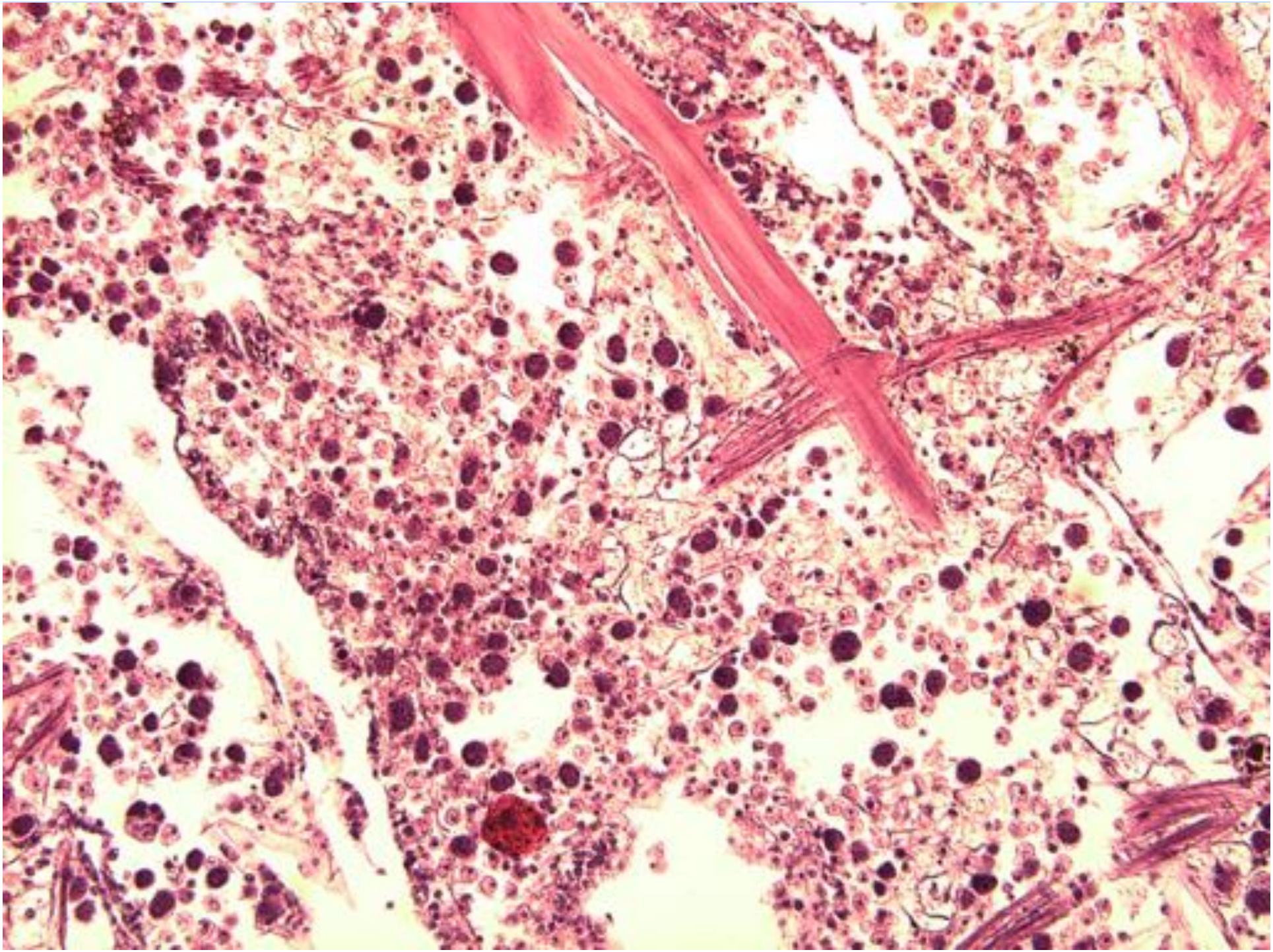


Long-term Management

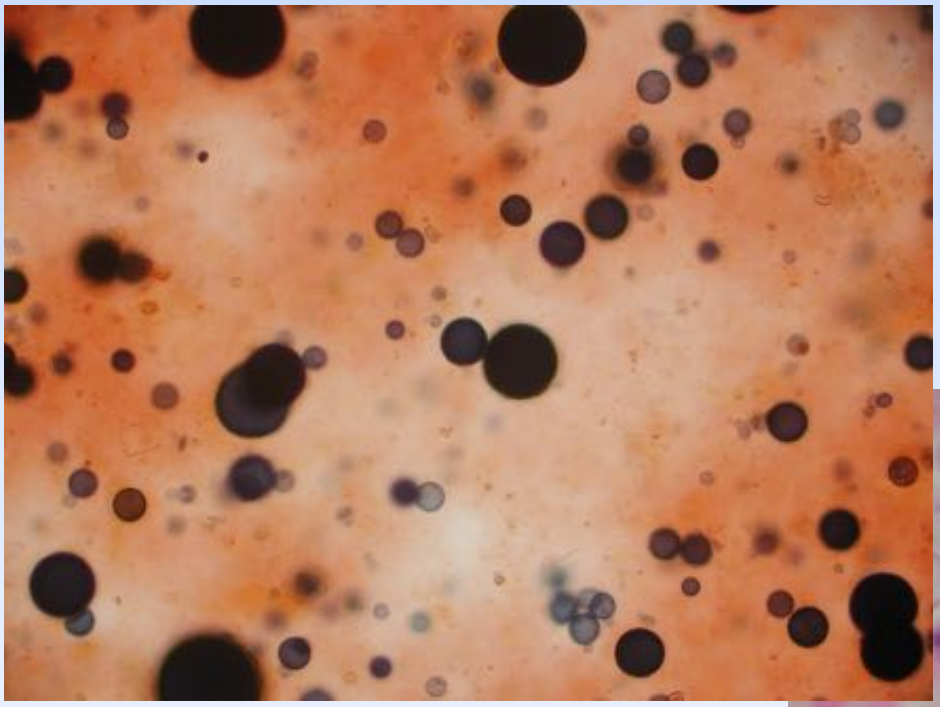
- **<u>Zonation</u>**
  - Damariscotta River Restricted Area
  - *C. virginica* may not be introduced to other Maine waters
  - “Do Not Resoak”
- Monitor farms and natural beds
  - Adjust “zones”
- MSX Forum (Sea Grant): information sharing
- MSX-resistant broodstock
- Revisit MDMR Chapter 24 regulations
  - Stakeholder Meeting March 2011
  - Importations…

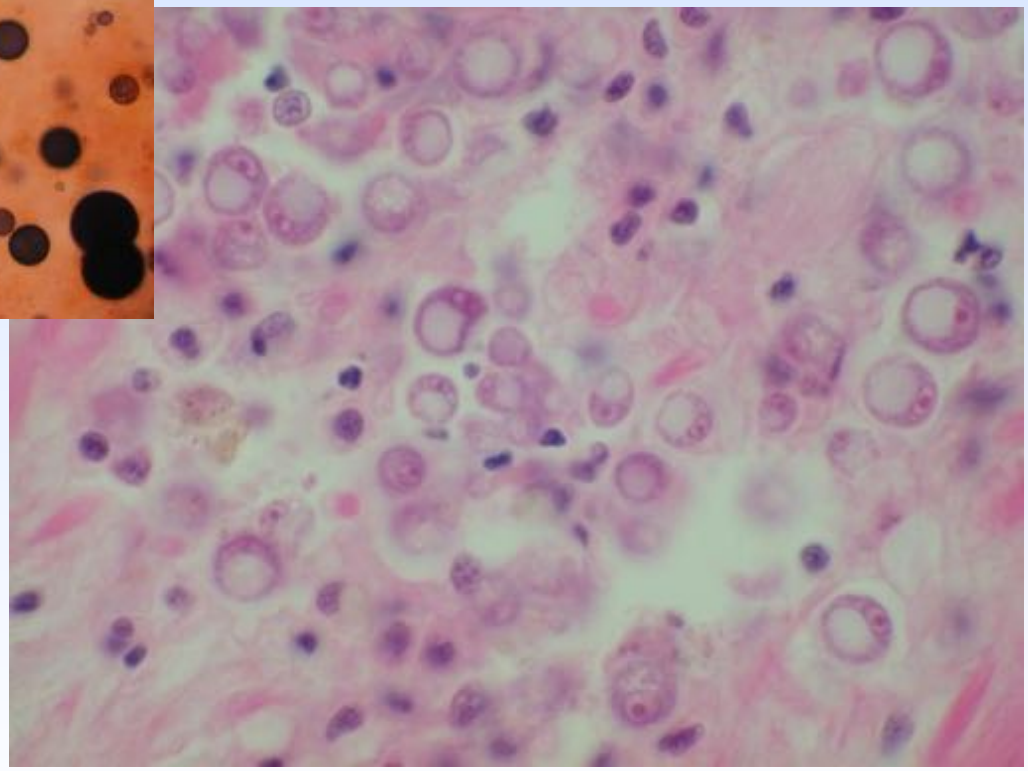
Prevalence of *H. nelsoni* and *H. costale* in Maine oysters





Perkinsus marinus (Dermo)





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Oyster Predators & Pests

- Oyster drills
- Crabs
- Flatworms
- Starfish
- Fish
- Pea crabs
- Trematode
- Boring sponges
- Polychaetes
- Parasitic gastropod *Boonea*

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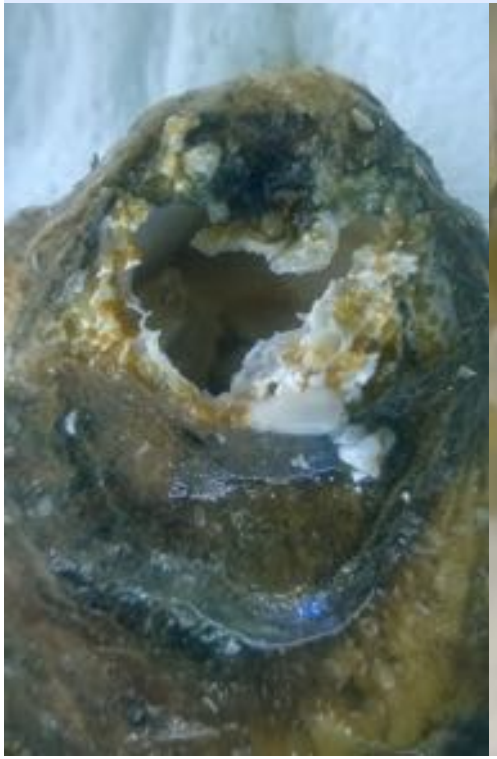

X Harbor oysters

Copper = 148 mg/kg dry wt (expected 13.2 mg/kg dry wt)
Zinc = 868 mg/kg dry wt (expected 87 – 189 mg/kg dry wt)

Safe intake for copper = 1.5 – 3.0 mg/d
>3-10 mg/d can cause toxicity
EPA Maximum Contaminant Level for copper in drinking water = 1.3 mg/L

3700 mg/kg dry wt reported from contaminated environments (Vaschenko et al. 2013)

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Infection vs. Disease

Infection

Presence of an infectious or foreign organism in host tissues

May or may not cause disease (host destroys invader, genetic adaptation, etc.)

Disease

Cell damage, host dysfunction due to:

- Genetic defects, abnormal cellular structure or function
- Nutritional imbalance, deprives cells of essential nutrients
- Extrinsic chemical / physical factors that injure tissues/cells
- Infectious agents, damage cells by physiologic action or physical presence
- Epizootic vs. enzootic

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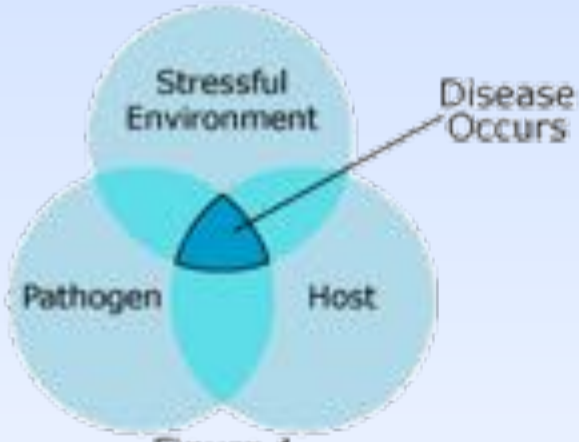

Figure 1

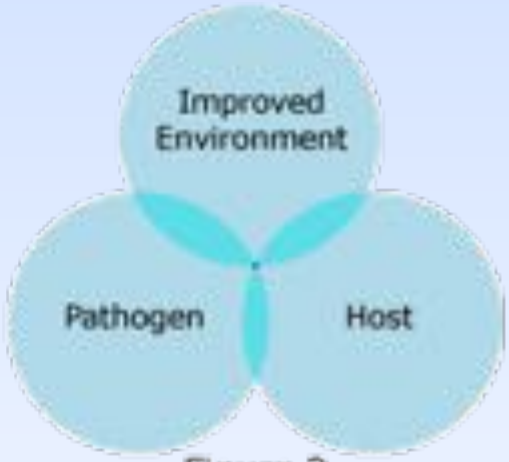

Figure 2

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Diagram from Anne R. Kapuscinski, Mark L. Gross and John Woiwode

Disease Prevention

- Avoidance
  - Specific pathogen free sources
  - Source history
- Variables
  - Density
  - Water circulation
  - Temperature
  - Salinity
  - Season
  - Bacterial load
  - Oxygen
  - Water quality
- Biosecurity Program
- Resistance: relative ability of organism to avoid infection or withstand effects of disease

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Biosecurity

“ Precautions taken to minimize the risk of introducing an infectious disease into an animal population. ”

- Specific pathogen free sources (Chapter 24 – Importation)
- Minimize movement onto & off farm
- Overall health program
- Disinfection protocols
- Pathogen surveillance
- Good farm practices (e.g. stocking density)
- Neighbor & Wildlife risk

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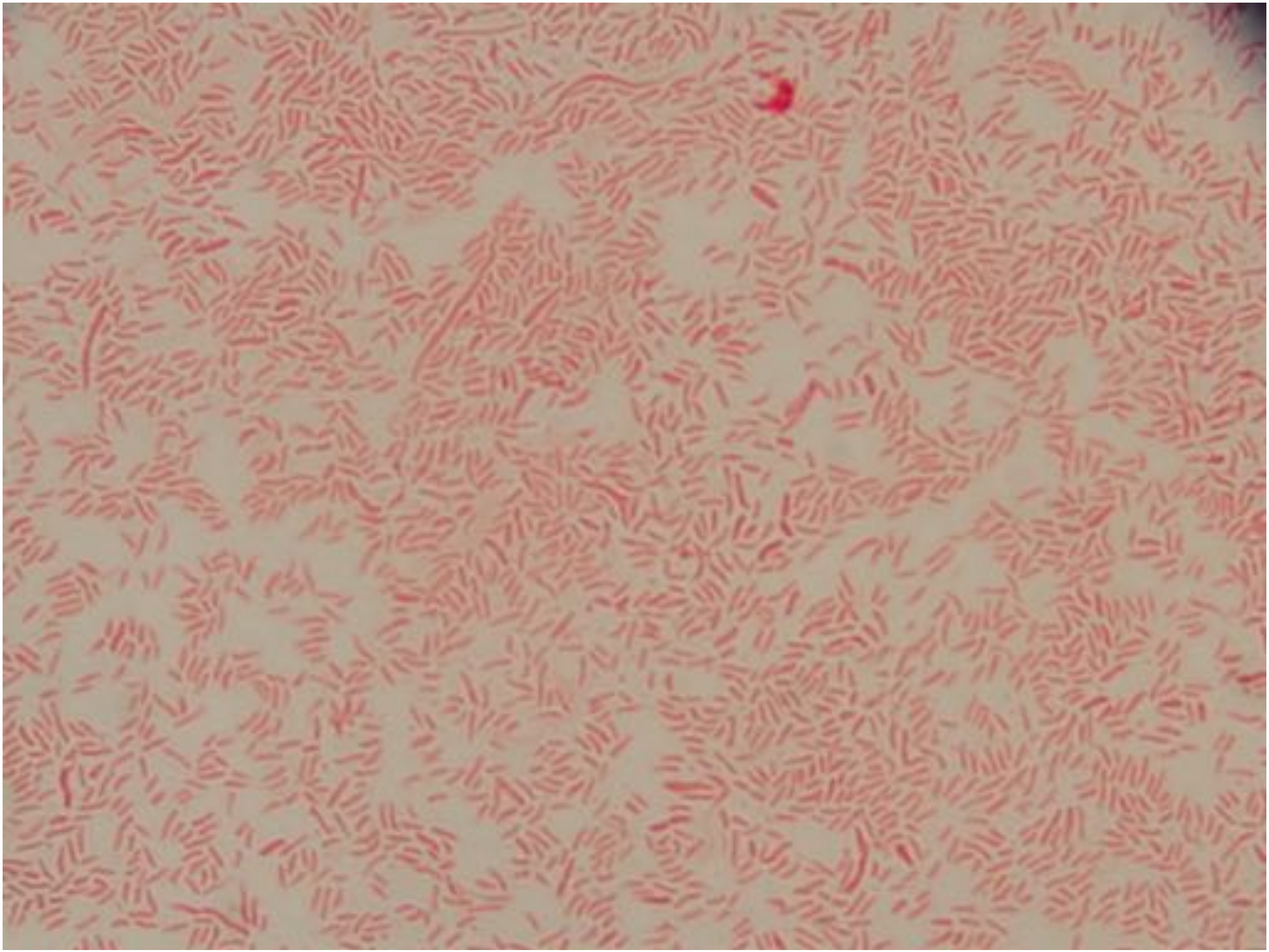
Risk Evaluation, Pathogen Surveillance, Zonation (USDA APHIS, Maine Aquaculture Association)

- Pathogen distribution
- Proximity of threat (neighboring area, common coast, distant)
- Commercial activity level
- Import control, cultivation (regulations, codes of practice)
- System flux (environmental, new species)
- Ports (activity & biosecurity)
- Processing (regulation of sourcing, waste & effluent)



Vibrio parahaemolyticus testing results – 2014

Bottom vs. surface prevalence 3 Sept

SITE	Vp REAL TIME PCR CT VALUES			BACTERIAL ID
EL3 SURFACE	18.5/18.4	32.9/32.9	23.8/23.8	*V. parahaemolyticus* *V. alginolyticus*
EL3 BOTTOM	35.4/35.6	neg/36.8	neg/36.2	*V. ichthyoenteri* *V. gallicus / xuii* *V. vulnificus* *Vibrio sp.* *Aliivibrio logei*
CC	neg/neg	neg/neg	neg/neg	*Vibrio alginolyticus* *Vibrio sp.*