Health Considerations for Oyster Restoration Programs

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Acknowledgments

- Roxanna Smolowitz
  - Synopsis of Infectious Diseases and Parasites of Commercially Exploited Shellfish.
    URL: http://www.pac.dfo-mpo.gc.ca/sci/shelldis/title_e.htm
Overview

- Major health goals
- Hatchery and nursery infectious diseases
- Infectious field diseases and diagnostics
- Health protocol and biosecurity considerations
  - General health
  - Potential pathogen risks
  - Mitigation approaches
Major Health Goals

1. “Release” healthy oysters
   ● Minimize infectious pathogens in culture
2. Avoid spread of pathogens and disease
   ● Significance of pathogen
   ● May be region specific
3. (**Choose/use appropriate habitat/environment for “release”**) 

1 and 2 require good husbandry and biosecurity
Pathogen significance

- Exotic (not local) vs. endemic (local)
- Regulated vs. unregulated
- Ubiquitous vs. rare or emerging
- Effect on health
  - Life stage differences
- Relative importance with regard to health assessment
Hatchery and Nursery Infectious Diseases
Potential Pathogen Sources in a Culture Facility

- Broodstock
- Algal stocks
- Seawater source
- Equipment
  - Gear
  - Cultch
  - Other animal vectors
- Miscellaneous sources
  - Air
  - Filters, surfaces, pipes, other system components
Juvenile and Larval Stages

- Diseases have only been identified in a captive setting
  - Nursery/hatchery
- Difficult to identify disease problems in wild stocks
- Greater susceptibility to more common opportunistic diseases
Hatchery/Nursery: Larval and Juvenile Diseases

- Fungi
- Bacteria
  - Opportunistic *Vibrio* spp.
  - *Cytophaga*-like bacterial infection of the hinge ligament
- Juvenile oyster disease (JOD)
  - *C. virginica* (MA, NY, ME)
  - Alpha-proteobacteria or protozoan
- Protozoa
  - *Isonema*-like flagellate
Hatchery/Nursery: Larval and Juvenile Diseases

- Viruses
  - Oyster velar virus disease (iridovirus-like)
    - Larval Pacific oysters (C. gigas)
  - Herpes-like virus infection
    - C. gigas, C. virginica (Maine)
  - Associated with high temps
Infectious Field Diseases and Diagnostics
Major Diseases of Concern

- Perkinsosis (Dermo)
- MSX
- Seaside Organism (SSO)
Perkinsosis (Dermo Disease)

- *C. virginicia, C. gigas*
- *Perkinsus marinus*
  - Apicomplexa, but more closely related to dinoflagellates
- Occurs from Maine to the Gulf of Mexico
  - Potential strain variation
- Direct transmission or via vectors such as drills
- Temp > 18°C
- Salinity ranging 15-30 ppt
- May take up to 2 years to cause mortality
Perkinsosis

- Diagnosed via:
  - Histopathology
  - Culture
    - Ray’s fluid thioglycollate media
      - hypnospores
  - PCR/RTPCR
- Management:
  - Require health screening before shipping seed
  - Develop resistant oysters
  - Allow infected leases/plots to lie fallow for 1-2 yrs
  - Monitor populations
- Listed in FDACS Division of Aquaculture BMPS
Other Species of *Perkinsus*

- *Perkinsus olseni*
  - *Mya arenaria*, *Tridacna* sp., others (*Tapes decussatus*), incidental finding in others such as *M. mercenaria*
  - Low mortality/prevalence
  - Maine to Gulf of Mexico, Portugal and Spain

- *Perkinsus chesapeakei*
  - *Mya arenaria* and *Macoma balthica*
Multinucleated Sphere Unknown (MSX)

- *C. virginica, C. gigas*
  - Oysters considered aberrant hosts
- *Haplosporidium nelsoni* (protist)
  - Doesn’t survive low salinities
- Florida to Maine
- Introduced to the East coast via *C. gigas*
- Listed in FDACS Division of Aquaculture BMPS
Multinucleated Sphere Unknown (MSX)

- Morts can reach 90-95%
- Diagnosis via:
  - Gross exam
  - Squash preps
    - Spores in digestive gland 7.5 x 5.4 µm
  - Histocytology
    - Plasmodia in blood cell suspensions
  - Histopath
    - Multinucleate plasmodia
  - DNA probes
Seaside Organism (SSO)

- Caused by the protist, *Haplosporidium costale*
- *C. virginica*
- Seasonal, complex life cycle ending in final sporulation killing the host
- Distribution on east coast of United States and Canada (from Virginia to Nova Scotia) in water with a salinity over 25 ppt
  - Outbreaks in Canada in 2003
Seaside Organism (SSO)

- **Diagnostics**
  - **Histopathology**
    - Multinucleate plasmodia and uninucleate spores containing bright red cytoplasm
      - Modified Ziehl-Neelsen carbol fuschsin technique
  - DNA probes
  - Difficult to differentiate MSX from SSO histologically in many cases
Other Diseases

- **Aber Disease (Digestive Gland Disease; Protist: *Marteilia refringens*)**
  - *Ostrea edulis, C. gigas*, (calico scallop has similar disease)
  - Europe, but considered an import risk in the US
  - Calico scallop
    - Mass mort prior to 1988
    - East coast of Florida

- **Bonamiasis (Microcell; Protist: *Bonamia ostrea*)**
  - Affects flat oysters, *O. edulis*
    - 2 new species affecting the Asian oyster (*Crassostrea ariakensis*) and flat oysters
  - Most infected oysters appear normal
  - Distribution
    - Europe and the United States (California, Maine and Washington)
    - Confirmed cases in Virginia and North Carolina in 2003 and 2004
Other Diseases

- Quahog Parasite X (QPX)
  - Net slime mold
  - *M. mercenaria*
  - Import risk; listed disease in the Florida Division of Aquaculture’s BMP document

- *Nematopsis* - gregarian
  - All bivalves

- Xenoma
  - Ciliates (Thigmotrix)

- Coccidiosis (*Klossia* and *Pseudoklossia*)
  - Various bivalves, but common in bay scallops
Other Diseases

- Rickettsiales/Chlamydiales
  - Most bivalves
  - Any epithelium
  - High morts in bay scallops
- Ovocystis
  - C. virginica, C. gigas
  - Papillomavirus-like papovirus
- Leukemia (hemic neoplasia)
  - Various bivalves
  - Unknown if infectious
- Others
Health Protocol and Biosecurity Considerations
Major Health Goals

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1 and 2 require good husbandry and biosecurity
Important Factors

- Life stage
- Population locale
- Endemic diseases
- Water body of origin or destination
- Water quality parameters (e.g., salinity)
- Source of materials used

*Different levels of importance based on type of restoration scheme*
Restoration Health Protocol

1. Agreement on what is “normal” and “acceptable” health
   - Including state and federal regulations
2. Current understanding of etiology, epidemiology, and relative importance of diseases
   - Cultured and wild stocks
3. “Normal” baseline for different populations
Restoration Health Protocol

3. Sound protocol for health assessment
4. Methods for mitigation of risk for diseases
   - Will vary depending on restoration method
5. Plan for follow-up after release
   - Evaluation can be simple or more rigorous
Acceptable Health

- Agreement on what is acceptable “normal” health for each life stage used for restoration
- Scenario dependent
  - Can be simple
    - Within “region” materials and/or animals
    - Observation/mortalities
  - Can be more complex
    - Externally derived materials and/or animals
    - Observation and sampling
Biosecurity Considerations

- Potential pathogens
  - Introduction into “cultured” population and/or “receiving” population/environment
  - Pathogen significance
    - Locally exotic vs. endemic
    - Dermo
      - (Arnold): Tampa Bay vs. Mosquito Lagoon vs. St. Lucie-Central
      - Strain variations?
    - MSX?
- Broodstock origin, hatchery location, or transplant origin
- Consider regions
  - East vs. west coast
  - Currents
  - Major water bodies (Tampa Bay vs. Sarasota Bay)
Scenarios

- Natural recruitment
  - Shell/Cultch addition
    - Oyster vs. non-oyster
  - Reef balls (synthetic)
- Hatchery
  - Wild broodstock
  - Algal cultures and seawater source
  - Shell substrate in tanks for larvae
    - Post larvae vs. older life stages
  - Release of setting size larvae into enclosure with shell
- General: site-to-site transfer/release of animals
  - Age/size/genetics
  - Geographic proximity
  - Currents/other features
Scenarios: Risk and Mitigation of Natural Recruitment

Potential pathogen sources

- Shell/Cultch substrate (1)
  - Oyster vs. non-oyster
  - Origin
  - Species
- Mitigation: shell/cultch
  - Limit use to within “region”
  - Consider pros and cons of species
  - Disinfection?
    - Effect on recruitment?

- Reef balls (synthetic) (2)
  - Mitigation: reef balls
    - New or disinfected
    - “Within region”
- Gear/boat/material vectors (3)
  - Mitigation: Gear et al
    - “Within region”
    - Cleaning/disinfection
Scenarios: Risk and Mitigation of Hatchery

Potential pathogen sources
- Wild broodstock (4)
  - Mitigation: broodstock
    - “Within region”
    - Statistical/random sampling
    - Separate conditioning broodstock into small tanks
    - Isolate and examine questionable broodstock
- Algal cultures (5)
  - Mitigation: algal cultures
    - Periodically evaluate for potential pathogens
      - Bacteria, fungi, protozoa
- Seawater source (6)
  - Mitigation: seawater source
    - “Within region”
    - Disinfection
- Shell substrate (1)
  - Mitigation (discussed earlier)
Scenarios: Risk and Mitigation of Release and Site-to-Site Transfer

Potential pathogen sources

- Live oysters
  - (“Inherent” risk while in culture if animals become diseased)
  - Potential source of pathogens for endemic population
  - Age/size/genetics
    - Real or potential difference in susceptibility to disease
    - Difference in likelihood of harboring specific pathogens

Mitigation: live oysters

- “Within region”
  - Geography
    - Location, currents
  - Statistical/random sampling (i.e., health inspection)
    - Diagnostic methods will vary with:
      - Life stage
      - Pathogen
Diagnostics

- Timing (collection, processing, and interpretation) and logistics
- Sample collection protocol to be developed
- Sample size
  - Numbers likely to be dependent upon
    - Pathogen of interest
    - “Relatedness” of sites of origin and release
    - Overall biosecurity of specific program
  - 30, 60, or 150
- Primary methods
  - Ray’s Fluid Thioglycollate Medium (Dermo)
  - Histopathology (others)
Other Considerations

- Other animals in/on culture materials, gear, or oysters
  - Vectors or carriers
- General vs. targeted surveillance
  - Loose or structured
  - Follow-up post-restoration event
  - Help determine etiology of morbidity/mortality or general health
  - Emerging or exotic pathogens and new information
Questions?