Shellfish and Seaweed Biosecurity
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Hutchinson Center

Dr. Cem Giray - Kennebec River Biosciences
Review of basic bivalve anatomy, and how anatomy has bearing on how diseases function and spread. A few items:
- Oysters use about 17% of metabolic output to sort food off the gills.
- Gills help to separate egg masses from females, during ejection of eggs.
- When food is unavailable to oysters, the valves often remain closed, whereas where feed is available in the water, the oyster conserves energy and does not open the valves.
- The crystalline style is resorbed and grown, it rotates against the gastric wall and aids in digestion.
- For oysters, the circulatory system is open; hemolymph bathes the tissues and circulates back to the heart, which usually beats from 14 to 40 beats per minute, depending on temperature.
- In scallops, high activity such as swimming can increase heart rate up to about 160 beats/minute.
- In first year, oysters are typically male, and from there, sex can vary from one year to the next depending on several variables.

Pathogens of oysters are several, but the ones with biggest impact are Haplospordian species, and Perkinsus species. When testing for shellfish pathogens, the testing methods vary, but common tools include: cell culture, microscopy, molecular biology, immunology, biochemistry and histology.

MSX - *Haplosporidium nelsoni*
This organism first noticed in VA in 1959, has been seen in Maine, most notably in the Damariscotta beginning in 2010.
Haplosporidium costale, or SSO (aka Sea-Side Organism) was seen in the 1980's in Maine. Both MSX and SSO impact oysters by limiting the action of the gill and competing for nutritional resources within the oyster. MSX favors high salinities and warm temperatures; the Damariscotta event followed a warm winter and with low rainfall. MSX is still detected in wild oysters in the Damariscotta, but farmed oysters are now generally from disease-resistant stocks, and they have not detected the pathogen in farmed oysters recently. SSO has been measured occasionally in Damariscotta, New Meadows, Sheepscot, and Marsh Rivers (method??) but without mortalities observed.

Dermo disease - *Perkinsus marinus*
Seeing a rise in prevalence in the last couple of years in cultured oysters, though no reported mortalities observed thus far in Maine. Dermo can also cause high mortalities, though this disease kills oyster through tissue lysis - the tissues will become 'souplike' in the shell.

There are also a suite of predators and pests that can affect oysters; drills, starfish, flatworms, pea crabs, trematodes, boring sponge, polychaetes, Boonea (parasitic gastropod)

Compounds such as copper and zinc can also have an effect; coloring the tissues (green in the case of copper toxicity), and/or food safety

Some terminology is important to define:
<u>Infection vs. Disease</u>

Infection is the presence of an infectious agent or foreign organism, may or may not cause disease.
Disease is cell damage or dysfunction of the host, due to things like genetic defects, nutritional imbalance, chemical or physical factors that injure tissues or cells, infection agents that damage cells through physiologic functions of physical presence.

Epizootic vs. enzootic:
Epizootic: rapid increase in presence and may result in mortalities
Enzootic: a persistent background presence

Ways to prevent disease or to limit risk:
*Avoidance
pathogen-free seed sources
history of your source of organisms
(Variables here include: density, water circulation, temp, salinity, season, bacterial load, oxygen, water quality)

*Presence of a biosecurity program; a set of practices that producers take at the operational level, to limit risk. This can include seeking pathogen free sources of seedstock, minimizing and tracking movements of equipment, people and product on and off the farm, etc.

*Resistance: relative ability of the organism to avoid infection or to withstand effects of disease.

Presently, KRB is involved in a project on Risk Evaluation, Pathogen Surveillance, Zonation (working with USDA APHIS, MAA)
Goals include:
- knowledge of pathogen distribution
- proximity of threats
- commercial activity level
- import controls and cultivation (regulations, codes of practice)
- system influx: changes to the environmental system
- Ports; vessel traffic

One particular exposure example is processing and discharge of waste materials (eg oyster shells disposed in the water at an oyster bar)

Question: pH / acidity can have an impact? Yes, can induce stress and compound problems from pathogens

Marcy Nelson - ME DMR
Regulations that govern movements are through Chapter 24, "Importation of Marine Organisms."

(https://www1.maine.gov/dmr/laws-regulations/regulations/documents/24.pdf)

This covers both imports (into the state from outside the state) and introductions (includes movements from restricted areas, could be within the state). Damariscotta and Sheepscot Rivers

are restricted areas, by virtue of MSX presence. These restrictions also include wet storage, or putting the shellfish into flow-through systems.

Another relevant restriction from DMR has been on the books since 1992; the entire coast is restricted for flat/European oysters, *Ostrea edulis*. This is because of *Bonamia ostreae*, a disease of flat oysters, and permits are needed to move flat oysters within the state. A survey for Bonamia in 2012 came back mostly negative, expect for the Harpswell area, which also has a perhaps the largest population of flat oysters statewide.

DMR has worked with partners to review the regulations and to create a current set of regs: these are broad and provide latitude for the Commissioner to make specific requirements.
For seed:
- Regional pathogen status
- Filtration/uv on intakes
- Three year health history
- Biosecurity audits.
- Health screening
- Review by Aquatic Animal Health Technical Committee (in specific cases)

For broodstock:
- hatchery quarantine
- wash eggs and larvae
- screen seed prior to sale
- biosecurity audits

Anything being imported from outside of the state will require a permit.

LPA's (limited purpose aquaculture license) were created together with Health Zones, that govern the movements of organisms between different regions of the state. The Health Zones don't presently apply to Experimental or Standard Leases; DMR working to address that.

Seaweed must come from an in-state source (LPA's only, at present.

Denis-Marc Nault: ME DMR
Denis addressed neoplasia in clam, particularly Hemic Neoplasia (but Gonadal Neoplasia exists in the state as well). Hemic neoplasia in softshell clams are rated in 4 stages, with stage 4 regarded as 'imminent death'. Newly-planted and disease-free clams have been planted in areas with low presence of neoplasia, and then have subsequently been observed with high rates of neoplasia. This is important because of the long history of moving clams around the state, for reseeding efforts. Research indicates that neoplasia is at least partly a stress response; thinking that moving clams in the spring is not a good idea, because clams at that time are developing gonadal tissue, and are already stressed. Planting clams for re-seeding and/or farming is now recommended as a fall activitity over one for springtime.

Observing that the genotypes are nearly identical between sites in Maine, and other states throughout the northeast and to the south; little genetic variability within the region.

Note: QPX (Quahog Parasite Unknown):

When the New Meadows Lakes opened up, they tested the clams for QPX and didn't find any, but at the time they did move a large number of small clams around; a practice that they have since discontinued.

Neoplasias have been observed in blue mussels, in 2013 in Boothbay and Harpswell; had observed low reproductive capacity in some blue mussels.

Denis brought us to the DMR web page that cites the General Town Shellfish Information, (http://www.maine.gov/dmr/shellfish-sanitation-management/programs/municipal/ordinances/towninfo.html) and this page hosts links for transplant permits, and transplant permit maps. ME DMR is seeing a large increase in softshell clam seed purchases from municipalities, for transplanting. This also helps the DMR to understand the success of transplants and to track diseases that might have been partly stimulated by the stress of transplant.

Q: is there a record of when plantings happen, so that growers/diggers can learn from that? A: Used to think that spring planting made the most sense. Denis is working with some towns that are now moving to fall planting, so that they make it through the wintertime and take advantage of a less stressful environment. In some cases, spring/summer/fall harmful algal blooms (red tide) can result in a strong stress response in clams, so that's a consideration too.

Q: what kind of survival is seen with hatchery seed? A: that's hard to say - it's ongoing work; sometimes it works very well and other times, high mortalities are observed.

Sebastian Belle: Maine Aquaculture Association
What is biosecurity and why you should care??

Seems simple, but: our crops grow directly in the environment. This linkage is critical to all biosecurity conversations. Farmers only have control over the locations they choose to site their farms, and the management actions they undertake, but no control over the environment itself. The interactions of the environment with the individual farmed organism (fish, oysters, mussels, etc) are very close, because of the linkage by water. By the same token, growers within a common area are linked as well; what happens on one farm may easily have an effect upon another.

Energy can be used for maintenance, production and reproduction, as far as the farmed organism is concerned. Removing from any of those areas because of disease or dysfunction will slow the productivity/profitability of the aquaculture business.

Disease transmission can happen via many pathways:
- Direct contact (vertical or horizontal transmission)
- entry through gills, wounds, skin

Ingestion such as from infected feeds or prey items, or infected carriers/particles.

Sources are varied:
Water: inputs, transfers including aerosols, sprays or splashes
Fomites: inanimate objects, such as equipment (nets buckets, siphon hoses), footwear, clothing, vehicles.

Maintaining a visitor log for your farm can help you understand your risks, such as asking a visitor where they may have been earlier in the day or lately. If something happens on the farm, it can help the farmer document the source of the infection, and to understand what may have happened. Recordkeeping is really important for good management anyway, and especially for diseases.

Vectors vs. Zoonotics
Vectors are living organisms, that can carry a pathogen
Zoonotics: diseases from animals that can affect humans.

Current MAA loss control initiatives
- Biosecurity Plans and Audits (began in 1992, with salmon farmers in Cobscook)
- Pathogen-specific action plans: designed to deal with specific attributes of an individual pathogen or pest.
- Integrated pest management plans (such as for sea lice in salmon farming; based on understanding the life cycle of the pest/pathogen and selecting certain states at which to try to limit the problem)
- Codes of Practice (MAA first was in 2002)
- Area Management Agreements: transition mechanism guidelines, communication guidelines, health management and biosecurity protocols, integrated pest management guidelines, waste management guidelines, disinfection protocols.

Definition of biosecurity, from Subasinghe and Bondad-Reantaso, 2006
Biosecurity is: *'..concept of applying appropriate measures to reduce the probability of a biological organism or agent spreading to an individual population or ecosystem and to mitigate the adverse impact may result.'*

Uses of maintaining good biosecurity:
- reduce risk of disease introductions
- minimize spread of diseases/pests on farm
- promote health of the crop
- reputation and public perception
- all of these can have direct bearing on the bottom line

MAA has a generic biosecurity plan, they hand it to specific farmers who can tailor it to their operations.

Principles of Biosecurity:
1. Identify hazards
2. Assess Risks
3. Determine Biosecurity measures that are needed (must prioritize)

Biosecurity plans are often based on the approach from HACCP
1. Hazard analysis
2. Identify critical control points
3. Establish controls for CCP
4. Establish CCP monitoring requirements
5. Establish corrective actions
6. Establish HACCP system verification
7. Establish recordkeeping system

Why have a written plan?
Goal is to provide a complete and systematic risk analysis
Each facility/farm is unique
Processes, products, facilities and risks will change over time.

Note: We as a state need to know more about pathogens and pests of seaweeds. There appear to be relatively few professionals/researchers who study this topic presently, but some ground is being made in this area.

Respectfully submitted;
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Maine Sea Grant, and University of Maine Cooperative Extension