Keep it from going Stinky: Oysters, Gear & Nitrogen
WEBINAR
Tuesday, March 23, 2021
10:30 am – 12:30 pm

Questions

The placement of the three different types of growing cages was not interspersed, and so results could be biased by systematic environmental differences across the grid. I am also curious whether dissolved oxygen was depleted below the cages, especially to the extent as to be detrimental to benthos.
Daniel Rogers: Water column dissolved oxygen was similar between all sites. It was most important to co-locate all experiments in the same hydrodynamic regime (same exposure, same depth, same distance from short, same sediment characteristics). In 2018 we also measured dissolved oxygen in the sediment cores collected. These sediments lose oxygen quickly, in the upper few 200 um even in the control site.

Did you determine whether the Oyster sizes are different given the variability?
Christina Lovely: The observed differences in oyster size among the different gear types is a true difference and is not a product of the natural variability among individual oysters. The confidence in this statement comes from the random sampling and replication in data collection. In collecting growth data, an oyster bag was never sampled more than once during a growing season, and a random number generator was used to select a minimum of three bags on every sampling date. Data points in the charts of shell growth and weight are also an average of all oysters sampled on a given date.

Was the seed all from the same hatchery/spawn?
Christina Lovely: The oyster seed used in the project was all from the same year class and same hatchery. For example, all first-year seed was from the same hatchery and the same year class and spawn, and all second-year seed (seed spawned the previous season) was from the same hatchery and the same original year class and spawn.

Did you see significant differences in mortality b/w gear types?
Christina Lovely: There was no significant difference in mortality among oysters within any of the three different gear types. Mortality was similar across all gear types.

You have done a nice job explaining the rationale for "building" your own farm. Was there consideration to work with industry partners to understand farm-scale effects? This would also engage growers in the process.
Daniel Rogers: For this project we did not consider working with an industrial partner. That could be a future project.

For Dan: Can you introduce/stimulate favorable microbial communities to accelerate/increase denitrification?
Daniel Rogers: Yes, each of the gear types resulted in an enhanced N2 release.

Did you determine how many oysters were needed in Waquoit Bay or sections of the bay to bring it into TMDLs?
Daniel Rogers: While you could extrapolate to a Bay-wide number there would be many assumptions in that calculation. The TMDL goal is about the input of N to the bay not the seasonal removal of N. It is important to note that oyster or other aquaculture may be a part of the solution but are not a complete solution by themselves. The advantage of shellfish is that they can improve impaired water bodies. This contrasts with engineering solutions like sewering that intercept and remediate the anthropogenic N before it enters the coastal waters. Both strategies have their place and can lead to better water quality.

Q. We have found that dissolved oxygen under cages varies dramatically with the tide. was this measured?
Daniel Rogers: We did not measure tidal scale processes. We focused on seasonal periods and gear influences. That said, the residence time of water in the bay is about 3 days. In other settings that may be important to monitor as well as sulfide

It looks like you may have some drift of organic matter from one treatment to another, given their proximity. could this have influenced carbon in substrate under the suspended gear?
Daniel Rogers: Yes, it is possible. If drift occurred, it would have originated from the bottom cages and would have increased organic input to the sediments at the edge of the floating bag site, which we avoided sampling. There was a shadow of macroalgae that built up between the bottom cages and the floating bag site late in the season at the time of the overhead photo. We spaced the farms to try and limit this and choose a site with "calm" and shallow water. We also sampled the interior of the farms not the edges to try and limit these edge effects.

How does the bag system compare with putting the oysters directly on the bottom after 1 year, then harvesting after the 2nd year?
Daniel Rogers: The oysters in the gear will likely have greater survivability than oysters on the bottom.

Q. Why the difference between 2018 & 2019 in N2 release rates? A temperature effect?
Daniel Rogers: The differences are not statistically significant, aside from a few that are weakly so. It's hard to constrain what drives these year-to-year differences. We have run many statistical analyses and conclude that variations in weather, wind, temperature, and other factors that were not directly monitored may account for these variations. We should point out that the trends however, and results (relative to control) for all test sites was consistent year to year for measurements of microbial activities of interest and release of N2.
Any indication of particle removal from the water column in/around the array?
Daniel Rogers: This was not directly measured. Mixing would prevent a visible detection of the effect of oysters with this scale of a farm (relatively small). One must assume oysters contribute significantly to improving water clarity just based on established filtering rates.

Isn't the sediment already negatively impacted?
Daniel Rogers: The sediments of Waquoit Bay are typical of relatively healthy coastal marine sediments below eutrophied waters. They are organic rich as a result of the high rates of primary production from excess nutrients, so in that respect, they are impacted. What we observed was change on top of that existing state.

Appears bottom cages have greatest impact on nitrogen removal. Would the removal be even greater if the oysters were not in cages, but rather just on the bottom without cages?
Daniel Rogers: It is unknown. Without the cages the survivability of the oysters may be drastically different. The oysters are need oxygen, the conditions in the sediment could result in slower metabolic processes. We did not have the data on sediment oysters as that was not the goal of the experiment, however, it could be addressed in a subsequent study.

Did anyone look at the benthic community (meio-, macrobenthos, and microbial primary producers) within the array and at the control site?
Daniel Rogers: No, we have not looked at primary production.

REEF COMMENTS

Artificial reefs are being constructed in RI with DEM and USDA NRCS assistance.
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ri/newsroom/features/?cid=nrcseprd1727828

Were you surprised to find that bottom cages, producing less oyster biomass compared to floating and oyster gro, had the most N removal from the sediments?

Daniel Rogers: We had hypothesized to start with that the proximity to the sediments would trend with N-removal rates. The efficiency of move carbon and nitrogen increases the closer you get to the sediments (less advection, reaction, consumption etc. can happen during transit).

In oyster reefs, microbes living among the oysters are also responsible for denitrification. Would denitrification happen among the oysters in the bags?

Daniel Rogers: We do not have data on the activity or composition of the microbes on or among the oysters in the aquaculture systems. It would be expected that there is some denitrification among that community. We do know that denitrification can occur on particles in the water column, the process requires a hypoxic to anoxic environment. In reefs, the oysters are part of the sedimentary community, they are near or indirect contact with anaerobic microbial communities.

Will these results be peer reviewed before formal release?

Daniel Rogers: Mara, P., et al. (2021) Comparison of Oyster Aquaculture Methods and Their Potential to Enhance Microbial Nitrogen Removal From Coastal Ecosystems. Front. Mar. Sci. 8:633314. doi:10.3389/fmars.2021.633314

How does the bag system compare with putting the oysters directly on the bottom after 1 year, then harvesting after the 2nd year?

From Christina Lovely: Mortality (from both predation and ice damage) is much greater when oysters are placed directed on the bottom after the first year.

Can you recap rdna for me and that process?

Daniel Rogers: DNRA: utilizing nitrate towards ammonium production rather than nitrogen release. It is a dissimilatory metabolic pathway where nitrate is used as an electron acceptor, however instead of producing N2 as seen in denitrification, the nitrate is reduced back to NH4+. This is an important ecological process because while N2 is mostly unreactive and will evade to the atmosphere, NH4+ is likely to remain in the sediments (at least temporarily) and may reflux out of the sediment to the water column at some later point. Even without movement of the ammonium to the water column the ammonium can stimulate further eutrophication of the ecosystem.