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Monitoring Shellfish Bed Restoration

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1. Background

Shellfish bed restoration involves setting aside and protecting and/or restoring natural shellfish habitat to promote growth and restoration of shellfish beds. Shellfish bed restoration provides several valuable ecosystem services which are monitored using the following measures of success (Bruchsbaum et al., 2006):

1) Recruitment and growth of the shellfish population undergoing restoration;
2) Providing habitat for other associated species;
3) Direct and indirect improvement in local water quality; and
4) Shoreline protection.

Shellfish bed restoration may be designed and undertaken with the intent that shellfish are not harvested, in order to provide a natural habitat and ecological functions that would otherwise be disrupted by harvesting. For example, in an un-harvested shellfish bed where older individuals are left in place, natural selection may foster survival of disease-resistant shellfish, growth of shellfish beds may promote enhanced nitrogen cycling, and so on.

Communities may wish to undertake shellfish bed restoration for some or all of the above ecosystem services, not just water quality improvement alone. For communities that are considering shellfish bed restoration for nitrogen management, the third measure of success is the most interesting; that is, improving water quality through enhanced uptake or removal of nitrogen by restored shellfish beds.

On Cape Cod, the Town of Wellfleet in collaboration with UMass Boston and the Center for Coastal Studies spearheaded an oyster reef restoration project in Wellfleet Harbor beginning in 2012. Two of the primary goals of this project were to improve water quality and habitat quality and increase commercial and recreational oyster industry and naturally disease resistant oyster spawning stock. In two years, the project has established approximately 4.5 million oysters in a two-acre zone (Frankic Report, 2012, 2013). Throughout this project, oyster growth and abundance, spat settlement, reef biodiversity, and water quality were monitored. The Wellfleet project is monitoring TN, chlorophyll, and turbidity and other water quality parameters in the source waters upstream of the reef and waters downstream of the reef. These differences are substantial enough to show a reduction in N, chlorophyll, and turbidity (due to a combination of all the above parameters) as a result of the establishment of the oyster reef. Other improvements noticed in this project (but unfortunately not quantified) are the decrease in *Ulva* and the decrease in silt.

When it comes to removal of nitrogen removal from the ocean, there is a key difference between shellfish aquaculture and shellfish bed restoration. Shellfish aquaculture involves harvesting of shellfish which directly removes some nitrogen from the ocean. In contrast, shellfish bed restoration often involves leaving shellfish in place to provide habitat, increase biodiversity, serve as a spawning sanctuary, protect against erosion, and so on. If harvesting of restored shellfish is not done, then direct removal of nitrogen via removal of shellfish does not occur. Furthermore, if shellfish are left in place, when they die their tissues rapidly decompose and return nitrogen back to the marine environment. Even if shellfish temporarily clear the water column due to their feeding activities, when they die their nitrogen will re-enter the environment. Thus shellfish bed restoration without harvesting cannot be credited for the direct uptake and removal of nitrogen that can be credited to shellfish aquaculture nitrogen.

However, shellfish beds may enhance denitrification, as described in the section on Shellfish Aquaculture. Credit for nitrogen removed via denitrification would be established using the methods described in the Shellfish Aquaculture section. More research is needed to understand how shellfish beds promote nitrogen cycling and the significance of denitrification in natural and restored shellfish beds. Also, there is some experimental evidence that if shell is used as a substrate for shellfish bed restoration, new growth of shellfish on shell material increases N removal, but shells release N as well (Bricker et al., 2014).

2. Monitoring water quality improvements in restored shellfish beds

Monitoring long-term water quality improvements in and above restored shellfish beds may be the most direct way to demonstrate their role in reducing nitrogen concentration. This section describes monitoring to measure effects of shellfish bed restoration on water quality, based on Bruchsbaum et al (2006) as well as monitoring recommendations for shellfish aquaculture. For monitoring other ecosystem services, see Bruchsbaum et al. (2006). In addition, the Massachusetts Audubon Society, Wellfleet Bay Sanctuary has established and monitored an experimental oyster reef for the purpose of enhancing biodiversity (Faherty, 2011). Their monitoring protocols and quality assurance project plan are available at the Massachusetts Bays National Estuary Program website at http://www.mass.gov/eea/agencies/mass-bays-program/grants/oyster-reef-wellfleet-2011.html .

Recommended monitoring parameters are the same as for shellfish aquaculture: water quality monitoring to demonstrate improvement in water quality, whether it is due to shellfish uptake and/or denitrification or other processes.

Recommended water quality parameters:

- Water clarity (Secchi disc, total suspended solids, turbidity);
- Total nitrogen;
- Particulate nitrogen;
- Dissolved oxygen, at several depths in the water column (at a minimum, in the surface layer, mid-water-column, and near-bottom);

- Chlorophyll a;
- If more than one shellfish species are being tested, monitor for species-specific differences in the above parameters.
- Frequency of monitoring water quality; Initially water quality should be monitored every two weeks for all parameters except dissolved oxygen. For dissolved oxygen, continuous monitoring of near-bottom water would be best as dissolved oxygen can vary a great deal on a daily basis.

Research needs

More research is needed to measure the effects of shellfish bed restoration projects on nitrogen cycling and nitrogen removal or reduction at scales and timeframes that are useful for environmental remediation (Brumbaugh et al., 2006).

References

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