An Ecosystem Services Assessment of Nitrogen Removal by Shellfish in Long Island Sound and the Great Bay/Piscataqua Region

INTRODUCTION

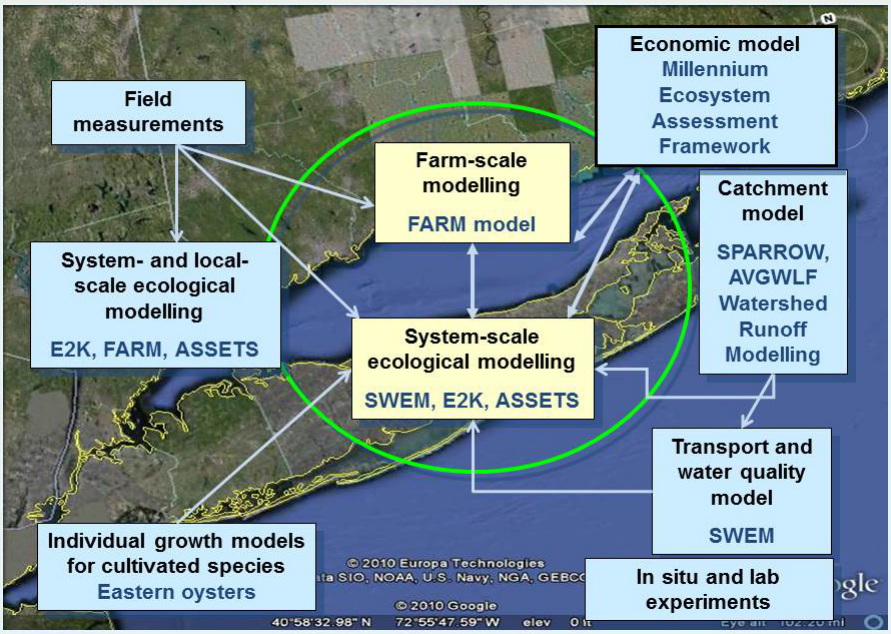
Increased nitrogen loading has impaired water quality in many coastal areas, including Long Island Sound and Great Bay/Piscataqua Region Estuaries. While nutrient management measures have focused on reductions of nutrient inputs, there is increasing recognition that changes in the waterbodies themselves, such as loss of shellfish, have reduced the capacity of coastal waters to assimilate nitrogen without loss of ecological services. Management measures that increase the assimilative capacity of coastal waters have the potential to cost-effectively complement nitrogen reduction efforts. Shellfish, for example, filter phytoplankton and detritus directly from the water, thereby removing nutrients by active uptake and reducing algal biomass available to cause hypoxia. Increased 'bioextraction' of nutrients by enhanced shellfish cultivation can complement source reductions as part of a comprehensive nutrient management program.

STUDY GOALS AND OBJECTIVES

Through a combined modeling approach, a multi-disciplinary project team evaluated the feasibility and potential importance of nutrient removal through bioextraction by oysters in Long Island Sound (LIS) and the Great Bay/Piscataqua Region Estuaries (GBP). These systems differ in size, nutrient loading, and susceptibility to eutrophication, and both are subject to active ecosystem restoration efforts. The study objectives were to:

i) Assess the level of eutrophication, ii) Determine the mass of nitrogen removed through oyster aquaculture at present and in scenarios of expanded production, iii) Assess how important the removal is in relation to total nitrogen loading, iv) Estimate the value of the 'ecosystem service,' or water cleaning, performed by the shellfish to help determine whether there is a role for shellfish growers in nutrient credit trading programs. Results are relevant to coastal eutrophication challenges and the need for seafood in the US and globally, and fulfill multi-agency missions for conservation, coastal planning, and pollution reduction.

Four different types of models were used.



Eutrophication Assessment

Application of the Assessment of Estuarine Trophic Status (ASSETS) model provides an aggregated image of current and expected eutrophication status. (www.eutro.org/register)

Individual Model for Eastern Oyster

An individual model of shellfish was developed for Eastern oyster with existing and new experimental data results. The model was integrated into the local and ecosystem scale models for full analysis of production and environmental effects.

Local Scale Modeling

The Farm Aquaculture Resource Management (FARM) determines shellfish production and nitrogen removal for Eastern oyster aquaculture at the farm scale. (www.farmscale.org)

Ecosystem Scale Modeling in Long Island Sound

The 2300 grid cell **System Wide Eutrophication Model** simulates water circulation and water quality for one year. Cells were merged into a 42 cell **EcoWin2000 model** (www.ecowin2000.org) simulating aquaculture and water quality on a decadal scale, the timeframe needed for economic analysis.

Economic Valuation of Ecosystem Service of Nitrogen Removal

An economic analysis was conducted using a "costs avoided" or "replacement costs" approach to estimate the value of the ecosystem service provided by oyster aquaculture.

CONCLUSIONS

- Removal efficiencies and costs of implementation of shellfish farms compare favorably with agricultural and urban BMPs.
- In LIS, the value of nitrogen removed is estimated at $8.5 - $230.3 million under current production, and is $17.4 - $469.3 million under expansion scenarios.
- In GBP, the value of removal at current production is estimated at $1.1 - $1.3 million and is $3.5 - $4.0 million under expansion scenarios.
- Values of nitrogen removal are likely underestimates because they only account for removal through aquaculture, not other benefits that improve ecosystem health and social well-being.
- Use of aquaculture as a complement to land-based nutrient management requires further verification of production and the value of removal. Nutrient trading programs would need to be modified to incorporate nitrogen bioextraction services from shellfish cultivation.

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