How much is a clam worth to a coastal community?

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Collecting oysters in Greenwich, Connecticut. Credit: Steve Arnott

Researchers have developed a method to estimate the value of oyster and

clam aquaculture to nitrogen reduction in a coastal community. Nitrogen is a nutrient that comes from many different sources, including agriculture, fertilizers, septic systems, and treated wastewater. In excess it fuels algal growth, which can affect water quality and human health.

As a result, a growing number of communities are required to follow regulations to reduce the amount of nitrogen they release. Shellfish are an option that can be a valuable part of a community's nutrient management plan.

In a study in *Environmental Science & Technology*, shellfish biologists, economists, and modelers from NOAA Fisheries, NOAA National Centers for Coastal Ocean Science, and Stony Brook University used a transferable replacement cost methodology to estimate the value of oyster and clam aquaculture to nitrogen reduction in Greenwich, Connecticut.

Growing bivalve shellfish, including oysters and clams, provides direct economic benefits to a community by supporting jobs and making fresh local seafood available to consumers. It also provides ecosystem services—benefits that nature provides to people—including habitat for native species and improved water quality.

"When we started discussing this work, I had a long list of ecosystem services in mind—not just nitrogen remediation, but water clarity for swimming and seagrass colonization, habitat for recreational fish—all leading to improved quality of life in a coastal town," said Gary Wikfors, chief of the aquaculture sustainability branch at the Northeast Fisheries Science Center's Milford Laboratory in Milford, Connecticut, and a co-author of the study. "As a biologist, I learned from this study how complex a comprehensive economic valuation is! The economic benefit estimates in this report are just a small fraction of the total—the tip of the iceberg—but still appreciable at the municipal level."

Clams and oysters take up nutrients when they filter feed on algae. Some of those nutrients become part of their shells and tissue, and are taken out of the watershed when shellfish are harvested. This benefits the watershed, because excess nutrients can fuel overgrowth of algae, causing blooms, fish kills, and other negative outcomes that can affect ecosystems and human health.

Shellfish can be a valuable part of a community's nutrient management plan because they efficiently take up nitrogen. Estimating the dollar value of those water quality benefits requires a multidisciplinary approach.

What is the economic value of water quality improvements?

More than half of the local nitrogen input in Greenwich is nonpoint source, such as runoff from lawn fertilizer. The rest is point source input, such as treated wastewater. Nonpoint source input is often more challenging and expensive to reduce than point source input, requiring a multifaceted strategy.

Using a transferable replacement cost methodology, the researchers found that replacing the nutrient removal benefits of shellfish aquaculture in Greenwich with traditional engineered nutrient reduction strategies would cost between $2.8-5.8 million per year. The estimate assumes the use of a combination of wastewater treatment improvements, septic system upgrades, and stormwater best management practices in proportion to the local nitrogen sources.

Clam and oyster aquaculture removes approximately 9% of the total locally-deposited nitrogen from Greenwich Bay annually, or about 31,000 lbs of nitrogen per year. The percentage removed is even greater

when considering only nitrogen from nonpoint sources (16%), fertilizer (28%) or septic sources (51%). Per-acre nitrogen removal for oyster aquaculture was higher because oysters are grown more densely, but clams contributed more to nutrient reduction because more clams are harvested overall.

Shellfish are unique because they take up nitrogen across all sources, whether from lawn fertilizer, deposition from the atmosphere, or treated wastewater. Residents of the community benefit from shellfish aquaculture whether or not they eat oysters, as they enjoy improved water quality and taxpayers can save money.

Developing a transferable approach

The team developed two ways to estimate the value of shellfish. One is appropriate for a well-established shellfish aquaculture industry and estimates nitrogen removal from the annual harvest. The second allows ecosystem managers to project the nitrogen removal of a new or growing industry.

"We developed a method to estimate potential harvest in communities with limited or no current aquaculture, but with opportunities to expand or start aquaculture, to highlight possibilities," said project co-lead Suzanne Bricker from NOAA's National Centers for Coastal Ocean Science.

The approach detailed in this study can be applied to other communities wishing to reduce nutrients to improve water quality. Whether or not they have an existing shellfish aquaculture industry, local decision makers will find useful information about the environmental benefits of shellfish to their coastal waters. "There is growing interest in coastal communities around the United States in shellfish aquaculture, and our hope is that the approach we developed here can help inform local

discussions about aquaculture around the country," said project co-lead Julie Rose from the NOAA Northeast Fisheries Science Center's Milford Laboratory.

Greenwich as a case study

A coastal community with a thriving shellfish aquaculture industry, Greenwich served as an ideal case study for the nutrient reduction benefits of shellfish. Between aquaculture, recreational areas, and seed beds, approximately 60% of the seafloor in Greenwich is used for shellfish activities.

Partnerships with two local shellfish growers, Atlantic Clam Farms and Stella Mar Oyster Company, were crucial to this study. The companies provided data on their annual shellfish harvest and local aquaculture practices, which researchers used to model the amount of nitrogen removed.

The shellfish industry in Greenwich has been supported by an active municipal shellfish commission for more than 30 years. The Greenwich Shellfish Commission made local field logistics possible and plans to include these findings in their ongoing education and outreach efforts.

"Our commission assisted by providing access to field sites and pinpointing locations for sampling. When we're involved in a NOAA project, it's an educational experience," said Roger Bowgen, Greenwich Shellfish Commissioner, "The more we learn, the more we can explain to coastal homeowners and the general public when we engage them in conversations about shellfish aquaculture. It's a chain of discussion: everyone tells someone else."

More information: Anthony Dvarskas et al, Quantification and Valuation of Nitrogen Removal Services Provided by Commercial

Shellfish Aquaculture at the Subwatershed Scale, *Environmental Science & Technology* (2020). DOI: 10.1021/acs.est.0c03066