What is Nitrogen Retention Worth in New Hampshire's Great Bay Watershed?

June 2015 • Findings from C.Berg's Thesis Research • Co-Authors: S. Rogers (Adviser) and M. Mineau

SPECIAL POINTS OF INTEREST:

- Land Conservation efforts across the watershed could keep 3–28 metric tons of nitrogen out of Great Bay each year.
- Nitrogen retention may be worth between 10 and 50 million dollars over the next ten years.
- Community focus on wastewater treatment plants is necessary, even under a conservation-focused future.

New Hampshire's Great Bay Estuary is a valuable resource that provides a host of ecosystem services, the goods and services that nature provides humans. It is one of the 28 estuaries of National significance recognized in the Clean Water Act. Visitors and residents benefit from the healthy estuary socially, ecologically, and economically. Unfortunately, the health of the Great Bay Estuary is declining, and the publicly owned wastewater treatment plants in the watershed are facing the costs of upgrading facilities to the limits of technological innovation in order to reduce nitrogen loads into the estuary.

EXPERT STAKEHOLDER DRIVEN SCENARIOS:

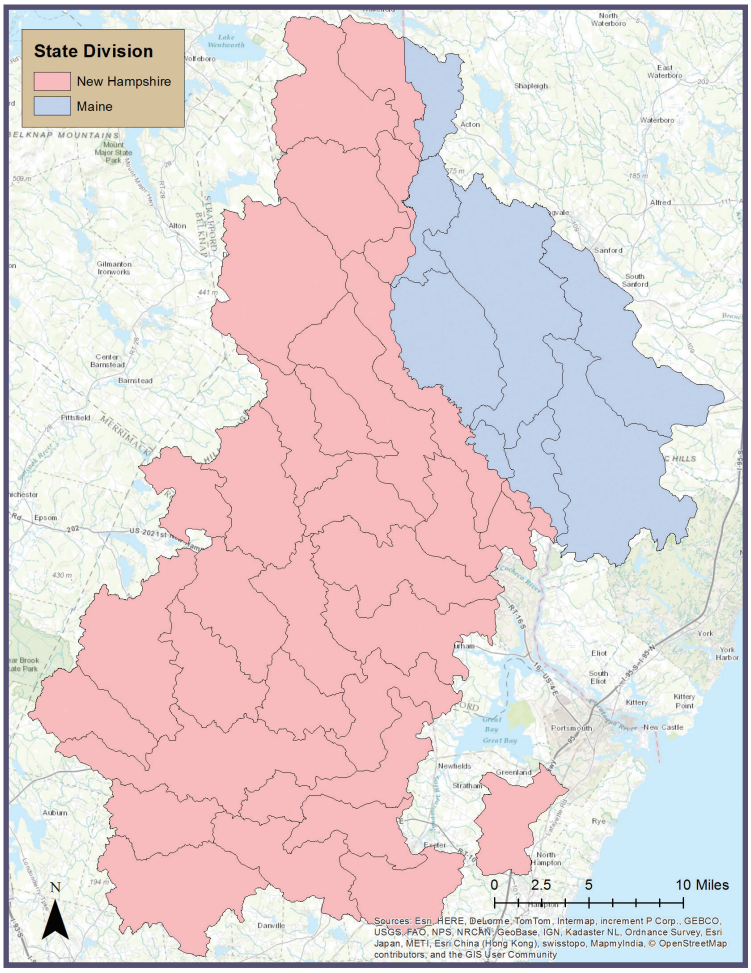
Sixteen experts representing various fields, organizations, and groups provided critical advice for what future land cover might look like in the Great Bay's watershed. They were asked to provide estimates for two different storylines: economic growth & conservation prioritization. They indicated that:

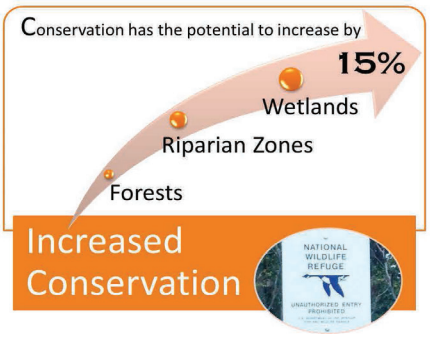
- Development would occur under both scenarios, but under a conservation-focused scenario, less development would occur and it would be focused around existing development instead of spread throughout the watershed
- Regulations regarding wetlands and shorelands will keep some areas from developing
- Conservation efforts will generally focus on existing forests and wetlands
- Under conservation, only a very small percent of forested land will be created from other land cover types

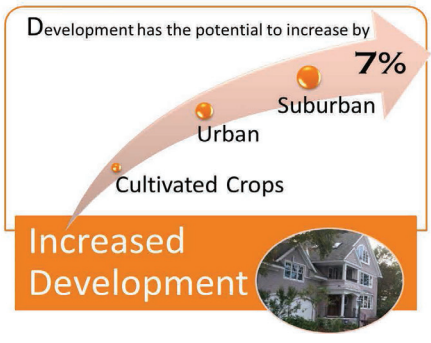
Based on expert input, we created two maps of potential land cover futures for 2025. These were checked against the 90 conservation focus areas designated in Maine and New Hampshire Land Conservation Plans, and approved by two local mapping experts:

[Increased Conservation 2025]

[Increased Development 2025]







OUR STUDY AREA:

As shown above, we looked at the non-tidal portion of the Piscataqua-Salmon Falls watershed which drains the coastal portions of Southern Maine and Eastern New Hampshire. The Great Bay Estuary is a cherished community resource that receives nitrogen loads from our study area and effluent from 18 wastewater treatment plants in the watershed.

What's Nitrogen Retention Worth in the Great Bay Watershed?

We utilized two models (InVEST & FrAMES) to run the scenario situations to determine what the non-tidal portion of the watershed would naturally remove. For more information about InVEST (Integrated Valuation of Ecosystem Services Tradeoffs) see **www.naturalcapitalproject.org/InVEST.html**; for FrAMES (Framework for Aquatic Modeling of the Earth System) see **www.wsag.unh.edu**.

CONSERVATION VS DEVELOPMENT:

Increased conservation efforts could prevent

3.1–28.1 tons of total nitrogen per year

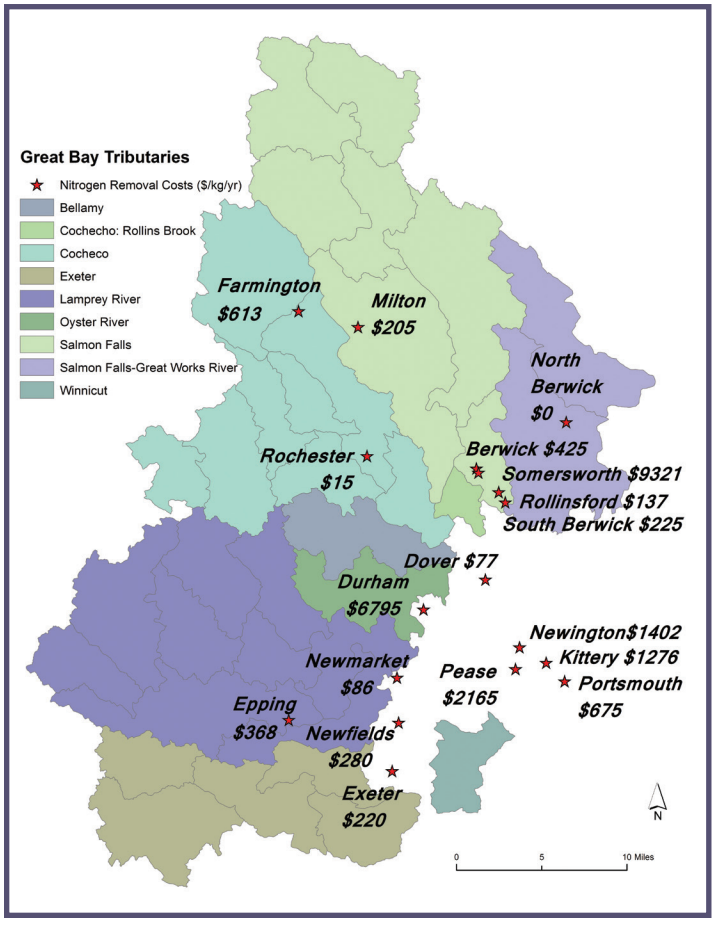
from entering the Great Bay Estuary. This is the equivalent of upgrading (at the lower estimate of nitrogen removal) **Epping's wastewater treatment plant** OR (at the higher estimate of nitrogen removal) **Newmarket's wastewater treatment plant**. These equivalencies were *based on the Draft Capital and Operation/Maintenance Costs Associated with Nitrogen Removal at 18 Municipal Wastewater Treatment Facilities Report* by New Hampshire Department of Environmental Services in 2010.

We relied upon the same source to derive location - specific values of nitrogen using the average, median, and subwatershed values of nitrogen, as shown in the tables over the lifetime of our 10 year scenarios. The range of values in the net present value calculation reflect different discount rates (1–5 percent). We based our calculations upon the avoided cost methodology which provides a conservative value for ecosystem services based on actual costs of treatment to remove nitrogen from wastewater. Ideally, investments in conservation could help reduce the costs of upgrades. Note that this method likely does not fully capture the entire value of nitrogen retention, but it provides one method to account for the retention of nitrogen in natural ecosystems.

	Value (Millions $)
Mean Marginal Value ($1538/kg)	40.1–46.4
Median Marginal Value ($396/kg)	10.3–11.9
Break-out by Subwatershed	16.1–18.6

Tributary Name	Value of N Retention ($/kg)
Winnicut	726
Great Works	242
Salmon Falls	339
Oyster	7314
Bellamy	82
Lamprey	244
Exeter	269
Cocheco	338

The watershed perspective provides insight into nitrogen loading into the Great Bay estuary, especially through the lens of ecosystem services. We recommend that towns consider the goods and services that natural ecosystems provide to their community.



(LEFT) Visual depiction of waste water treatment plant upgrade costs as calculated by weight of nitrogen removed per year by NH DES in 2010 dollars. Note that there is a vast range, and some plants either require more work to reach compliance or process less effluent than others.

(ABOVE, RIGHT) The subwatershed values were calculated by taking the median of nitrogen removal costs along each tributary or by using the town located within the subwatershed and converting them to 2015 dollars.

Like most studies that rely on models, there are layers of uncertainty in the data inputs, the model parameters, and the observational data used to calibrate the models. Similarly, the value of nitrogen is likely to fluctuate. Many final municipal upgrade plans were undecided at the time of this work. Note that we have provided a range of potential nitrogen removal under conservation and a range of values for the ecosystem service of nutrient retention using InVEST version 3.1.0, and these ranges would shift with more precise data or different models.

For GIS files of our scenarios, visit: **ddc.sr.unh.edu**

This report is based on a collaborative effort from Plymouth State University and the University of New Hampshire with insight from a variety of expert stakeholders. For a full report, please contact Chelsea Berg at ceb1012@plymouth.edu or Shannon Rogers at shrogers@plymouth.edu

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