



Targeting Nitrogen Hotspots

The problem of nitrogen pollution in waterways is often treated as a high stakes blame game: wastewater treatment plants, agricultural runoff, stormwater, home septic systems, and even atmospheric deposition all contribute some amount of nitrogen to our waterways. It can be all too easy to point the finger at others as the main culprit responsible for harmful impacts we see from excess nitrogen. The reality is that we all share responsibility in finding a unified solution.

The effect of nitrogen as a powerful nutrient, especially in coastal waters, is highly dependent on where that nitrogen is from, and how its sources vary from place to place. On Cape Cod and other places with similar geology, the majority of nitrogen pollution is contributed from domestic wastewater, specifically wastewater from septic systems. Most domestic septic systems were designed to treat pathogens causing human illness, and they do it well; but they were never designed to treat nitrogen in wastewater. Given the Cape's porous geology, effluent from household septic systems is leaching too much nitrogen into groundwater, where it eventually empties into rivers and estuaries. The high nitrogen concentrations from septic systems can fertilize algae (microscopic aquatic plants that live in the water column) causing them to bloom. These "algal blooms" become pervasive and negatively impact aquatic life by blocking out the sun and starving aquatic plants below. As the algae decompose, the microbes that break them down deplete the oxygen dissolved in the water. This makes the area deadly for the remaining sea life and can result in "fish kills." The more nitrogen that enters the system, the more frequently these blooms can occur, especially as waters continue to warm due to the effects of climate change.

Addressing nitrogen pollution is vital not only to preserve aquatic ecosystems, but also to protect the local economies they support. In 2016 alone, ocean-related industries on Cape Cod contributed \$1.05 billion (in 2020 USD), 84% (\$893 million) of which was directly from tourism and recreation.¹ These sectors are an immensely critical source of revenue in Massachusetts, and they are directly dependent on the integrity of the Cape's coastline and the overall health of its watershed and coastal ecosystems.

There are 53 embayments throughout Cape Cod, the vast majority of which are impaired by nitrogen. According to the Cape Cod Commission's [2015 Cape Cod Area Wide Water Quality Management Plan Update](#), 78% of all controllable nitrogen pollution – nitrogen that is not due to natural processes – comes from septic systems. While the ultimate goal for many municipalities is to address the problem by installing sewer infrastructure, this endeavor will take time and significant funding to complete. Moreover, development patterns on the Cape are not dense enough in many places to affordably support the costs of conventional sewerage approaches. In those instances, effort is underway to develop innovative and/or alternative septic systems capable of treating household wastewater to low levels of nitrogen for use by homeowners at a cost they can afford. A number of innovative and alternative systems are showing great promise for this.²

Another approach being considered is to treat the groundwater itself to reduce its concentration of nitrogen. Permeable reactive barriers (PRBs), for example, intercept plumes of nutrient-rich

¹ National Ocean Economics Program, <https://www.oceaneconomics.org/Market/ocean/oceanEcon.asp>

² Some I/A septic systems are showing outputs of 5 mg-N/L, whereas current septic systems have outputs closer to 19 mg-N/L





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groundwater with wood chips or other media to convert active nitrogen in groundwater to its inactive form. Such systems have great potential but also require careful siting to determine where the greatest contributions of nitrogen are occurring. To know where to start, scientists with the U.S. Geological Survey (USGS) and EPA Region 1's Southeast New England Program (SNEP) are collaborating to pinpoint likely nitrogen "hotspots" – areas with high nitrogen content –at various locations in rivers throughout upper and mid-Cape Cod. Scientists hope to use their findings in conjunction with the geomorphology of the region to identify and prioritize sources of high-nitrogen pollution for immediate mitigation efforts. The work has been ongoing since 2019 and has shown promising results. "We have seen nitrate loads increase along rivers in patterns that imply focused, high concentrations of nitrate input in some cases," said Marcel Belaval, a hydrogeologist with EPA Region 1 working closely on the project. "The next steps will be connecting these nitrogen hotspots to contributing areas on the landscape – work that is underway right now." Identifying and treating these nitrogen hotspots will complement and enhance other work to improve the effectiveness of household septic systems.

For more information about this project, please contact Marcel Belaval at Belaval.Marcel@epa.gov or visit the Collaborative's website at <https://www.epa.gov/snep/epausgs-collaborative-snep-projects>

