Study reveals climate change impacts on Buzzards Bay

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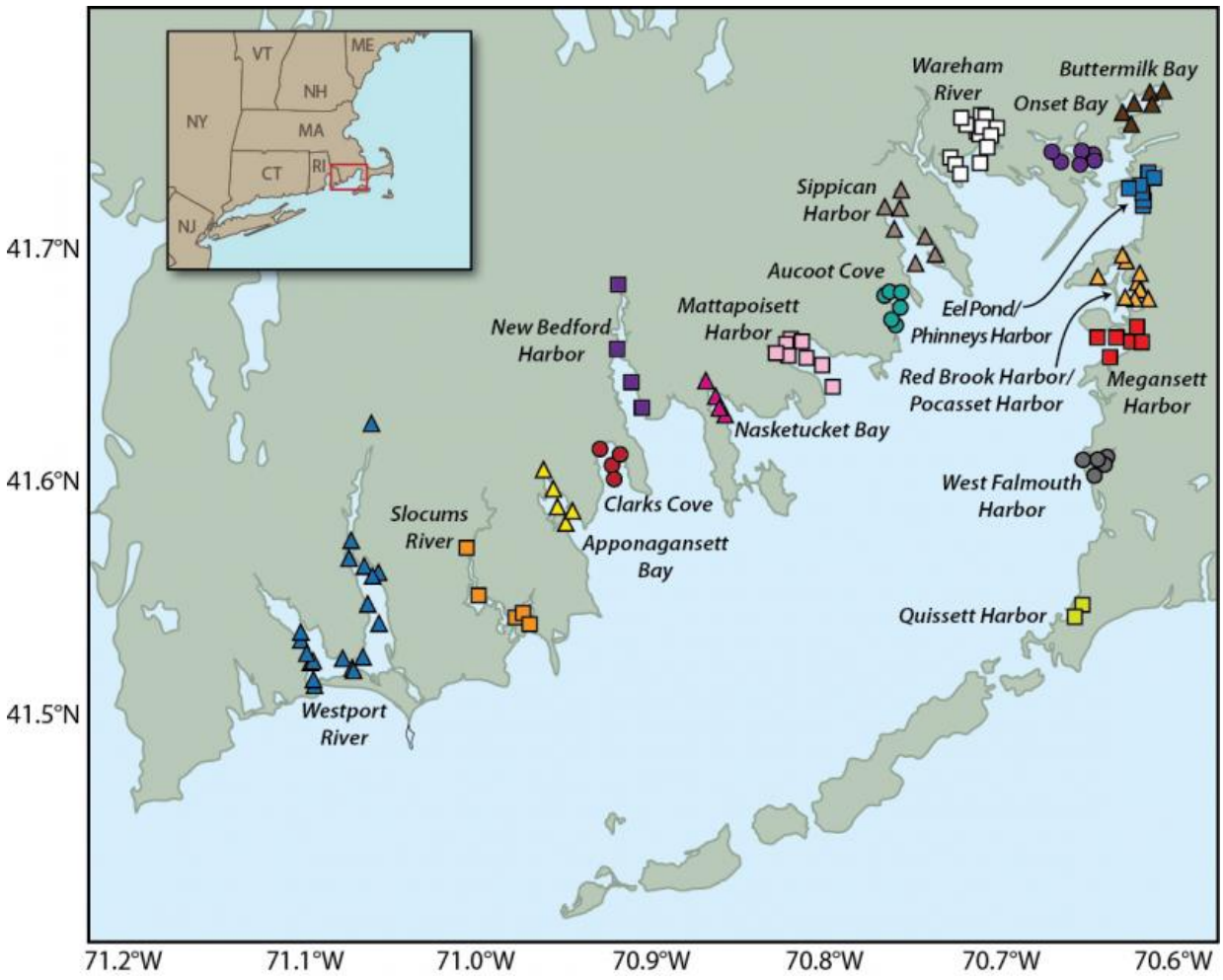

Researchers looked at which locations and sites had the most consistent data over the 22-year period (from 1992 to 2012), and then divided those into 17 distinct embayments. Above, each embayment is shown in a different color with the symbols representing collection sites within the embayments. Credit: Jack Cook, Woods Hole Oceanographic Institution

An analysis of long-term, water quality monitoring data reveals that climate change is already having an impact on ecosystems in the coastal waters of Buzzards Bay, Mass. The impacts relate to how nitrogen pollution affects coastal ecosystems.

Utilizing 22 years of data collected by a network of citizen scientists, researchers from the Woods Hole Oceanographic Institution (WHOI) and their colleagues at the Buzzards Bay National Estuary Program, the Buzzards Bay Coalition, and the Marine Biological Laboratory found that average summertime temperatures in embayments throughout Buzzards Bay warmed by almost 2 degrees Celsius—roughly 4 degrees Fahrenheit.

"That is a rapid temperature increase for marine life," said Jennie Rheuban, a research associate at WHOI and lead author of the paper published January 15, 2016, in the journal *Biogeosciences*. "For some species, a single degree Fahrenheit change can mean the difference between a comfortable environment and one where they can no longer thrive."

In addition, Rheuban added, the warmer water temperatures are fueling an increase in algae growth. While algae and other microscopic plants, which form the base of the marine food chain, are vital to a healthy ecosystem, too much can cause murky water, reduce sunlight and oxygen levels, and ultimately cause harm to marine life.

An analysis of long-term, water quality monitoring data reveals that climate change is already having an impact on ecosystems in the coastal waters of Buzzards Bay, Mass. The impacts relate to how nitrogen pollution affects coastal ecosystems. Credit: Tom Kleindinst, Woods Hole Oceanographic Institution

This means added challenges for improving water quality in some Cape Cod and southeastern Mass. watersheds that are already suffering from too much nitrogen, which is most commonly caused by releases from septic systems and wastewater treatment plants, atmospheric pollution, and fertilizer runoff. Excess nitrogen also boosts algae growth.

"What we're seeing in the long-term data is that the same levels of nitrogen in the system results in much more algae growth than it did two decades ago," Rheuban said.

This increase in algae growth and chlorophyll means that water quality is worse for the same amount of nitrogen, which has big implications for water quality targets and clean up plans.

Identifying and understanding how different ecosystems respond to climate change will aid in future monitoring and clean up efforts as coastal communities prepare to adapt. This research is part of multi-pronged project funded in 2014 by the John D. and Catherine T. MacArthur Foundation aimed at partnering with local organizations to develop science-based climate change solutions for coastal communities.

Summer Snapshots Over Time

Every summer since 1992, volunteers working with the Buzzards Bay Coalition have headed out to their local beaches and docks to help monitor the health of the bay. At sampling sites from Westport to the Elizabeth Islands, trained citizen scientists gather samples and test temperature, salinity, water clarity, and dissolved oxygen at the same locations, every five days from late May through September. In July and August, volunteers also collect water samples that are taken to the Marine Biological Laboratory where they are analyzed for nitrogen, phosphorus, and chlorophyll.

Every summer since 1992, volunteers working with the Buzzards Bay Coalition have headed out to their local beaches and docks to help monitor the health of the bay. Credit: Buzzards Bay Coalition

The Baywatchers program has amassed more than two decades of data that has been a valuable resource over the years not only to the Coalition's education and outreach efforts, but also to agencies that monitor water quality and draft clean up plans.

"The data has been used by every level of government to make decisions about the management of waterways from deciding which waters are impaired to determining how much nitrogen a specific estuary can handle," said Rachel Jakuba, PhD, science director for the Buzzards Bay Coalition and a coauthor of the paper.

This is the first time that over 20 years of the monitoring data has been analyzed for long-term trends and patterns, in particular with a focus on climate change. First, researchers looked at which locations and sites had the most consistent data over the 22-year period (from 1992 to 2012), and then divided those into 17 distinct embayments (see accompanying map for sites).

"We analyzed the data on an embayment by embayment scale," Rheuban said. "The degree of pollution in each embayment is very different and that has to do with a number of different factors —levels of development, whether there's agriculture or urbanization nearby."

For example, expanded sewering of larger towns on the west side of the bay has helped reduce excess nitrogen from reaching nearby waterways more than sites along the Cape Cod side of Buzzards Bay that do not have such infrastructure already in place.

"We don't see nitrogen increases across the board," Rheuban said. "But what we do see in the analysis of the data is an increase in temperatures and chlorophyll concentration across the bay and a changing relationship between nitrogen and chlorophyll—an indicator of algae growth and water quality—as those waters warm."

"This is potentially important because it suggests that in a future world with higher temperatures, towns around Buzzards Bay will have to remove more nitrogen from coastal watersheds to maintain the same water quality," added Christopher Neill, director of the Marine Biological Laboratory's Ecosystems Center and one of the study's co-authors.

These types of ecosystem responses to higher temperatures, researchers said, are crucial to include in updated management and clean up plans.

"Nutrient pollution plagues coastal waters up and down the east coast," said Scott Doney, a marine chemist at WHOI and a coauthor of the paper. "We hope the lessons learned from Buzzards Bay can help improve management efforts in many other locations."

Joe Costa, Executive Director of the Buzzards Bay National Estuary Program, who helped establish the Buzzards Bay monitoring program and a co-author of the paper, praised the WHOI team that initiated the study.

"This is a great example of the value citizen science data, and we appreciate the focus on the changing conditions in Buzzards Bay," he said. "The findings have clear implications on how we need to accommodate climate change in our strategies to reduce nitrogen pollution."

Provided by Woods Hole Oceanographic Institution