Gaining a clearer understanding of ocean acidification in the Northeast

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Familiar organisms like lobsters could be affected by changing ocean conditions in the Northeast in the coming decades . Credit: Pixabay/CC0 Public Domain

By mid-century, the Northeast is expected to experience significant changes in climate, on land and in the region's waters. Leaders from

across New England and the Canadian Maritime Provinces teamed up with experts to compile a report containing the most complete and up-to-date information on the Gulf of Maine, that is also filled with actionable solutions to increase resiliency in the coming decades—all with hopes of inspiring quick action. Details can be found in the Gulf of Maine 2050 Climate Outlook and Action report.

UConn Assistant Professor in the Department of Marine Sciences Samantha Siedlecki is a co-author on the report, which presents a synthesis of research relevant to the region, including sea level rise, temperature change, and Siedlecki's focus—ocean acidification. The paper detailing Ocean Acidification projections featured in the report was published on May 12th in Elementa.

"For the report, the motivation was to include ocean acidification and focus on 2050, since 2100 feels so far away to most decision makers," Siedlecki says. "In the paper, we discuss three components of understanding OA in the region. First, we did a historical analysis where we review research done up to this point and we provide some new analysis as well. Then we review what we know about the health of the ecosystem and what we know about the biological sensitivity of the ecosystems that reside in the Gulf of Maine. Finally, we discuss future projected conditions and what that means for the ecosystem moving forward."

By 2050, the Gulf of Maine will experience many changes, including more heavy precipitation events, sea level rise, increasingly severe storms, and persistent sub-optimal water conditions.

The sub-optimal water conditions are predictable, says Siedlecki, because of our understanding of carbon chemistry. The ocean absorbs around 25% of atmospheric carbon, and as the concentration in the atmosphere increases, more carbon will be taken up by the ocean.

Exactly how much carbon is absorbed depends on variables like temperature and salinity of the water.

"My Ph.D. student, Kelly McGarry, developed an empirical model that relies on information like temperature, salinity, and oxygen. She developed a relationship between those variables to predict carbon variables from them using local high-quality carbon measurements. This relationship allowed us to extend some observational records in time and to extend some existing models in capability," says Siedlecki.

Building on previous work gives a clearer picture for understanding future carbon content in the ocean and the associated impacts on the ecosystem.

"Prior work has identified trends in one measure of ocean acidification—surface saturation state," Siedlecki says. "Saturation state represents an energetic threshold for organisms that make shells. When you see shells on the beach, an organism has generated that out of the same material we commonly know as antacids it's calcium carbonate. The ocean becomes more acidic as we add atmospheric CO_2 and that increase in acidity favors dissolution of calcium carbonate."

Siedlecki says despite the predictability, some trends in ocean acidification seen in the Gulf of Maine are unlike those seen elsewhere.

"We observed that, despite global ocean trends of increasing CO_2 in the atmosphere and in the ocean, the Northeast, and particularly the Gulf of Maine, has experienced a lack of a trend in saturation state, or even an increase in saturation state over the last decade or so, which is in complete opposition to what the rest of the world seems to be experiencing."

The reason, Siedlecki and her team describe, is due to the dynamics of

water movement and warming in the region.

"That has been tied to the warming and the processes responsible for that warming, including increased presence of Gulf Stream water in the area, since about 2005. Warming and ocean acidification are very much connected in terms of what's going on in the area."

One of the paper's main conclusions is that the influx of Gulf Stream water and possible decrease of Labrador seawater in the region is having a masking effect on the acidification process for now. However, by mid-century, the models project that the entire Gulf of Maine region will experience persistent sub-optimal conditions for most of the year, says Siedlecki.

Since organisms are sensitive to the saturation threshold, sub-optimal conditions will likely contribute to spatial shifts in some of the important habitats for the organisms familiar to humans in the Gulf of Maine, Siedlecki says. "Many important species like lobster and scallop will experience these sub-optimal conditions.

"Of course, warming is still going to continue to happen going forward and that warming will continue to mitigate the saturation state, as it has been. It won't be enough in order to completely negate the increasing trend in CO_2, at least under the emission scenario, representative concentration pathway (RCP) 8.5 that we explored, which is the most extreme—even more so than our current emission trends. There's obviously more work to do to better represent the choice that we face as a society."

More information: Gulf of Maine 2050 Climate Outlook and Action report: gmri-org-production.s3.amazona … Report_web_sized.pdf