Summer heat waves and low oxygen prove deadly for bay scallops as a New York fishery collapses

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The heartbeat response of bay scallops to fluctuations in the bay's water temperature and dissolved oxygen were measured using optical infrared sensors, or "scallop Fitbits." Credit: Stephen Tomasetti

A new study by Stony Brook University researchers published in *Global Change Biology* demonstrates that warming waters and heat waves have contributed to the loss of an economically and culturally important fishery, the production of bay scallops. As climate change intensifies,

heat waves are becoming more and more common across the globe. In the face of such repeated events, animals will acclimate, migrate, or perish.

Since 2019, consecutive summer mass die-offs of bay scallops in the Peconic Estuary on Long Island, New York, have led to the collapse of the bay scallop fishery in New York and the declaration of a federal fishery disaster, with landings down more than 99 percent.

This study led by Stony Brook School of Marine and Atmospheric Sciences graduate Stephen Tomasetti, Ph.D., and Stony Brook University Endowed Chair of Coastal Ecology and Conservation Christopher Gobler, Ph.D., and a collaborative team of researchers reveals that extreme summer temperatures, becoming more frequent under climate change, exacerbate the vulnerability of bay scallops to environmental stress and has played a role in the recurrent population crashes.

The study reports the mass die-off of all scallops at a New York site in 2020, when an eight-day summer heat wave event coincided with repeated episodes of low oxygen. Yet, scallops at locales with higher oxygen or lower temperatures survived. Further investigation that year confirmed that the combination of high temperatures and low oxygen reduced feeding and energy reserves, causing mortality in ecosystem and laboratory scenarios.

"Global warming is happening at an uneven pace in space and time. It just so happens that summer water temperatures in the Northeast are increasing at a rate more than three times the global average, leaving organisms adapted to cooler temperatures endangered," says Gobler, the senior author on the paper.

By using a combination of satellite temperature and long-term

environmental records, field and laboratory experiments, and measurements of scallop heartbeat rates in an ecosystem setting because scallops' heartbeat rates vary with water temperatures, the researchers demonstrated that coastal waters from New York to Massachusetts—home to the nation's northern bay scallop fisheries—are rapidly warming and that bay scallops have become increasingly susceptible to the combination of high temperatures and impaired water quality.

The bay scallop fishery was formerly one of the largest shellfisheries on the East Coast and has progressively vanished from regions south of New York. With the New York fishery collapsed, the only remaining commercial U.S. fishery is in Massachusetts.

The study also revealed that although Massachusetts waters are still in the safe range for bay scallops, they have warmed at a rate even faster than New York waters and could be threatened in the future.

Tomasetti points to other examples of heat-induced mass mortality on the East Coast, like the loss of lobsters in Long Island Sound and blue mussels in coastal bays south of Delaware.

"Commercial shellfisheries are a vital part of our blue economy, and shellfish habitats are changing rapidly," said Tomasetti. "Mitigating further warming by transitioning to clean energy is critical. But while these global efforts are underway, committing to practices that will improve our local water quality like reducing nutrient pollution is also important."

Warmer waters physically hold less oxygen, so increasing the baseline oxygen levels in the estuary by improving water quality will help offset future oxygen loss from increased temperature.

The authors warn that warming in the Northeast US is projected to continue at a faster pace than the global average. The populations of mobile species like fish can respond by moving to waters with more tolerable temperatures. But for populations of bay scallops and other economically important shellfish species, movement is limited by their ability to disperse through spawning and the availability of suitable habitat. Populations forced to cope with temperature extremes may be more vulnerable to mass mortality events.

Public officials concur

"On eastern Long Island, our environment is our economy. The scallop crop industry can only thrive with resources like clean water and efforts to combat climate change," says New York State Assemblyman Fred Thiele. "With the climate crisis already at our doorstep, we have seen the devastating impact climate change has on our fishing industry. The repeated threat of scallop die-off in recent years due to rising temperatures in our Northeast waters has become crippling to the commercial fishing community and all related East End industries and businesses; this is yet another example of climate change's extreme and adverse impacts across our region.

"In addition to the Climate Leadership and Community Protection Act (CLCPA) that I helped pass in 2019, the 2022-23 state budget provides significant investments to help advance environmental conservation efforts to address climate change, measures that I believe are a step in the right direction," he adds, "and will also have a positive impact on thwarting the clear and present danger to the fishing industry on the East End."

"We have been watching with dismay the collapse of our unique Peconic Bay scallop population. This research is crucial to not only helping our community restore a vital part of our economy for local baymen and

consumers, but will help develop a critically important understanding of how we can address climate change impacts to our environment and marine life," says Suffolk County Legislator Bridget Fleming.

"I want to thank Dr. Chris Gobler, SoMAS, the Cornell Cooperative Extension, and all the other partners who are working to restore this most important species to the Peconic Estuary," says Suffolk County Legislator Al Krupski, whose district includes much of the Peconic Bay region. "Although the decline in scallop populations is dramatic, I am gratified that the marine science community, which includes so many dedicated individuals and institutions, has pulled together to try to reestablish a sustainable scallop population."

More information: Stephen J. Tomasetti et al, Warming and hypoxia reduce the performance and survival of northern bay scallops (Argopecten irradians irradians) amid a fishery collapse, *Global Change Biology* (2023). DOI: 10.1111/gcb.16575

Provided by Stony Brook University

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