

Scientists see long-term hope for Maine's lobster fishery despite warming waters

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The lobster boats 32 Below, 32 Below II and Miss Jayne are lit up by the sun shortly after sunrise in Cape Porpoise harbor in January. New oceanographic research at the University of Maine paints a rosier picture of the Maine lobster fishery's future in the face of climate change, but there is still a great deal of uncertainty. *Gregory Rec/Staff Photographer*

Dire predictions about the effects of global warming on Maine's lobster population may be exaggerated and underestimate the potential that conservation measures have to preserve the fishery into the future.

Rapid warming in the Gulf of Maine and the collapse of lobster fisheries in southern New England have fueled predictions that lobsters will likely move north out of Maine waters in the coming decades. But ongoing research at the University of Maine is revealing a more optimistic long-term view of the Maine lobster fishery.

The UMaine scientists are now projecting that temperatures in Gulf of Maine will likely remain within lobsters' comfort zone because of the gulf's unique oceanographic features, though changing ocean currents are harder to predict. The researchers cautioned that the dynamics of global warming are complex and make it difficult to project far into the future with certainty.

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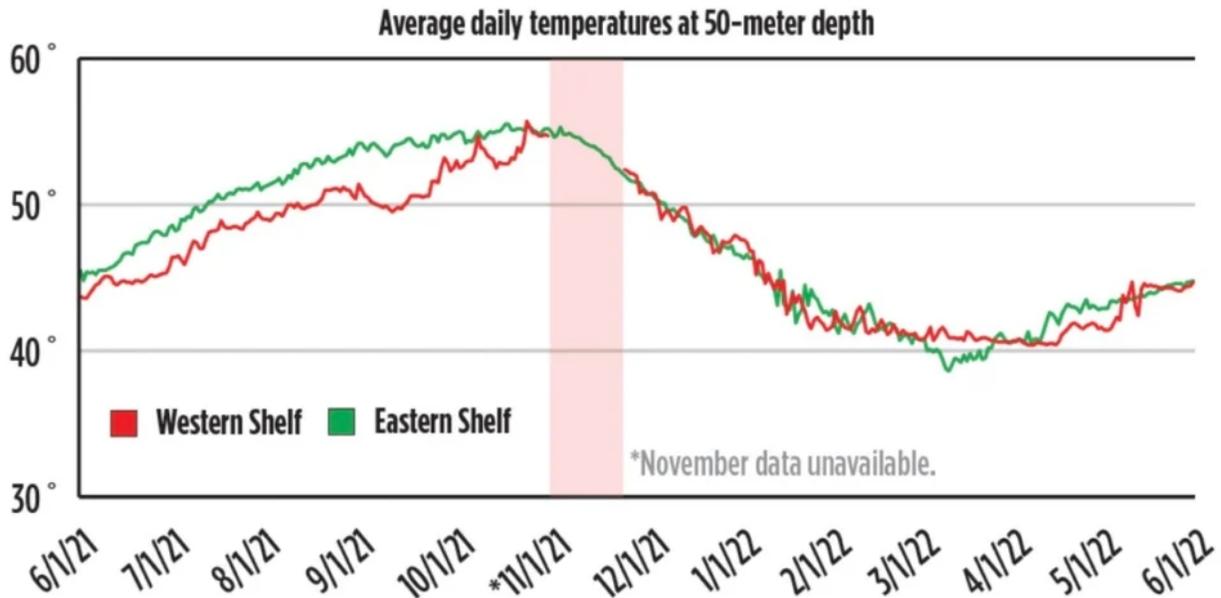
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Ocean stratification – where water of different densities separates into distinct layers – is keeping the bottom temperatures colder on the Gulf of Maine’s western side, the scientists say, while strong tidal mixing in the eastern gulf and the Bay of Fundy helps moderate the water temperature there during the summer. Because Maine waters have historically been so cold, they say, even a couple of degrees of warming should keep Maine’s bottom waters below 68 degrees, the temperature at which lobsters begin to show signs of stress, according to the Atlantic States Fisheries Management Council.

Though average sea surface temperature in the Gulf of Maine broke the 2012 record last year, bottom temperatures remained much cooler. Data from the Northeast Regional Association of Coastal Ocean Observing Systems shows when sea surface temperature peaked at 72.7 degrees Fahrenheit in August at the western Maine shelf observation buoy, the water 50 meters below the surface was just 51.5 degrees there, and would peak at only 55.6 degrees later that year.

Maine ocean bottom on the cool side for lobsters

Ocean floor temperature data for both eastern and western ends of Maine waters show temperatures ranging from about 40 degrees to 55 degrees throughout the year. American lobsters prefer temperatures in the high 50s to mid-60s but tend to become stressed above 68 degrees.



SOURCE: Northeastern Regional Association of Coastal Ocean Observing Systems; University of Maine
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Kathleen Reardon, senior lobster scientist for the Maine Department of Marine Resources, mentioned projections that Maine water temperatures should stay within lobsters’ comfort zones at the latest Lobster Zone Council meeting in East Machias. A lobsterman in

attendance interrupted, saying “One minute it’s on TV: ‘Gulf of Maine waters warming faster than any body of water in the world,’ and now you’re telling me it’s not going to?”

“No, it is warming faster,” Reardon responded, but she said even when taking warming into account, “hitting 70 degrees on bottom? That’s a really long ways away. In Maine, we still have a very, very different water temperature regime range than in southern New England, so yes, things are changing, but we are not, hopefully, likely to approach those really stressful temperatures in at least the next 50 years.”

In fact, the warming has brought Maine waters into the bottom range for lobster settlement, she said. Lobsters spend the larval phase of their lives suspended in the water column, feeding on zooplankton, and will only settle to the bottom in water between 12 and 20 degrees Celsius, or around 53 to 68 degrees Fahrenheit.

At the eastern Maine shelf observation buoy, temperatures ranged from 45.2 degrees to 55.3 degrees at 50 meters’ depth from June through November 2021, according to NERACOOS.

“Because water temperature has actually increased, this is actually a case where warming ocean has had a positive impact,” Reardon continued. “We have had more optimal conditions, and especially in eastern Maine, I think that’s what’s driven the increases (in lobster landings).”

NUANCES OF GEOGRAPHY

Richard Wahle, a marine biologist and director of UMaine’s Lobster Institute, agrees. He leads lobster settlement surveys of the ocean bottom to determine how many lobsters are settling in different areas and publishes the results yearly in the American Lobster Settlement Index.

Wahle said that in the past couple of decades, the waters in eastern Maine have entered the low end of the thermal range for lobster recruitment, which led to a boom in lobster settlement from 2005 to 2008.

“We’ve sort of crossed a threshold that has just opened the floodgates for settlement in eastern Maine,” Wahle said. “And that, in turn, has really turned on the spigot for lobster production.”

The surveys are mostly conducted by divers, but the Lobster Institute, in partnership with lobster processing company Ready Seafood and the Department of Marine Resources, has been deploying deep-water collectors at various sites to get a sense of how settlement is occurring in deeper water.

They found that since the deep water is colder in western Maine than in eastern Maine, lobster settlement has still been concentrated in shallow, warmer waters there, while in the eastern portion of the state, newly settled lobsters were spread relatively evenly over the full

range of depths. In western Maine, more warming could open up deeper waters to lobster settlement.

One often-cited Rutgers University study predicted that lobsters could shift 200 miles north into Canadian waters this century. The researchers modeled future thermal habitats using data from trawl surveys and ocean circulation models based on high and low future greenhouse gas emission scenarios.



A lobster walks over the top of a lobster trap off the coast of Biddeford in 2018. *AP Photo/Robert F. Bukaty*

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But that report, published in the scientific journal PLOS ONE in 2018, did not take into account the nuances of Maine's oceanographic features, Wahle said. Those nuances are the result of the basin's unique geography and how it amplifies the tidal heights, which is independent of climate change.

One of Wahle's former postdoctoral students, Arnault Le Bris, now a faculty member at Memorial University of Newfoundland, was lead author on another 2018 paper, published in the Proceedings of the National Academy of Sciences, that made projections through 2050 about the status of the fishery based on climate projections.

Le Bris' forecasts predicted that southwestern parts of the Gulf of Maine, such as Massachusetts and Cape Cod Bay, may be seeing some shallower parts entering that less-hospitable range of temperatures during the summer, but that the eastern portion will fare much better.

"The degree-and-a-half of projected warming in the (eastern) part of the Gulf of Maine would still be well within the comfort zone of lobster," Wahle said. "So what Kathleen (Reardon) said mirrors a lot of what we've been saying all along."

Still, projections are never perfect, he points out. While the projections Le Bris used captured the differences in tidal mixing, they are based on standard atmospheric effects on ocean temperature and do not reflect changing ocean current patterns in the Gulf of Maine, which Wahle said are harder to model.

Recent reports have shown that deep, warm, salty, nutrient-poor Gulf Stream current is pushing north into the Gulf of Maine and blocking the cold, nutrient-rich Labrador Current, which is weakening and becoming less dense from dilution by meltwater.

“I’m not sure the oceanographic forecasting is at a place yet that can project what those conditions are going to look like with respect to the relative strength of the Labrador Current and the Gulf Stream, but to the extent those trends continue, we may be seeing a worsening effect,” he said.

CONSERVATION EFFORTS CAN HELP

While water temperatures themselves might not directly stress Maine lobsters in the near future, there are a number of other climate-related factors that will likely impact their survival.

The shifting deep ocean current patterns have been impacting primary production in the Gulf of Maine, and leading to declines in *Calanus finmarchicus* and other plankton, which in turn affect the whole food web.

Le Bris’ projections did anticipate declines in lobster abundance in the coming decades due to climate-related stressors such as more predators as other fish species move northward, changes in plankton abundance, and increases in shell disease.

But his paper was optimistic that the conservation measures Maine has in place to maximize the reproductive potential of the stock and simple adjustments to them could help stave off major declines or the type of fishery collapse that occurred in southern New England, where conservation measures were not enacted until it was too late.

“Even though global climate change is severely impacting marine ecosystems, widely adopted, proactive conservation measures can increase the resilience of commercial fisheries to climate change,” the authors wrote.

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Maine’s conservation measures include maximum harvestable size limits that protect the breeding stock, minimum size limits that allow young lobsters time to breed, and protections against harvesting egg-bearing females through a mandatory V-notching program, in which a V-shaped cut is made into the tail of a female bearing eggs. It is illegal to keep females with this mark even if they are caught when they’re not bearing eggs.

“All those measures ... put our fishery in a really good position to not only stave off a collapse from potential future warming, but to capitalize on great conditions for reproduction potential to build the population,” Wahle said.

The Le Bris paper estimated how much less of the southern New England stock might have been lost if it had had conservation measures in place, and how much less of an increase in lobster abundance Maine might have seen without them.

If Maine didn't have its protections for large and small lobsters and reproductive females, the authors estimate lobster abundance would have increased by 242 percent rather than 515 percent since 1985. If conservation measures had been implemented earlier in southern New England, it estimates the stock abundance would have decreased by only 57 percent instead of 78 percent over that time.

Wahle said these measures helped Maine take advantage of favorable conditions – the increase in temperature and a decrease in groundfish that prey on young lobsters – that made the coast more suitable as lobster nursery grounds and played a role in the explosion in lobster landings. These could continue to help the fishery stay resilient against future threats.

LESS SETTLEMENT, FEWER LANDINGS

In addition to the American Lobster Settlement Index, the marine resources department conducts surveys to get a sense of the abundance of slightly older lobsters that are still below legally harvestable size, through trawl surveys, sea sampling (accompanying commercial lobstermen and measuring lobsters in their traps) and with ventless trap surveys. Commercial lobster traps must have vents that allow lobsters below legal harvest size to escape. These surveys are used to predict future landings.

All of the surveys have been showing declines in young lobsters for several years, with some exceptions. The settlement survey reported a significant increase in settlement in the Gulf of Maine from Penobscot Bay to New Brunswick, and a lesser increase from Casco Bay to New Hampshire in 2019. The settlement and ventless trap surveys showed lobster settlement in the western part of the state has not been declining, but it has been declining for five years in the area from Friendship to Steuben, and for two years from Steuben to Cutler.

The Atlantic States Marine Fisheries Commission Board is considering whether to enact new management measures that would be triggered if these young lobster surveys show declines past a certain point, with the goal of keeping the Maine fishery around 100 million pounds landed annually. The board may increase the minimum size of harvestable lobsters, because doing so would allow lobsters more time to reproduce before being caught. Hearings on these measures have not been scheduled yet but are expected to be held this summer.

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When Reardon, the state lobster scientist, brought up the proposed increased minimum size limits at the lobster council meetings, lobstermen suggested that instead, other states should adopt Maine's maximum size limits to protect large breeders, because now a Maine lobsterman can throw back an oversized lobster only to have it caught by Massachusetts or Rhode Island fishermen. But Reardon explained that increasing the minimum size limit by even an eighth of an inch would have far greater impact because of the sheer numbers of lobsters that would be left to reproduce for a longer period.

Reardon told the lobstermen that the declines in sublegal-sized lobsters could be caused by a number of factors.

"Maybe we're just coming off of a (settlement) bubble, ... maybe they are starting to eat each other, or maybe the fish (predators) are coming back," she said. "I don't know what's driving the declines."

One of the lobsterman in attendance said he has been seeing a lot more codfish, which prey on juvenile lobsters.

Lobstermen also questioned the survey methods, arguing that they have been seeing an increase in lobster abundance in deeper waters than the ventless surveys capture and suggesting that the trawls are not being done in the right areas.

Most survey data do come from shallower waters, and the marine resources department's lobster monitoring report of 2021 notes that the observed declines may be the result of a shift in distribution of lobsters across different depths. Reardon also acknowledged that the ventless trap survey does not capture deep water settlement, but noted that multiple survey methods, including trawls conducted at 75 fathoms, are producing similar results.

The expansion of the deep-water collector deployments in the American Lobster Settlement Index surveys are helping scientists develop a better picture of how lobster habitat use is changing. Wahle has adjusted landings projections to reflect depth data, resulting in projections with lesser declines, and the 2020 landings did match the new projection model. Still, Wahle acknowledges that any forecasting model oversimplifies reality.

"Try as we might, we can never capture all the mechanisms at work," he wrote in the latest survey report. "They are always a work in progress. Still, prediction remains a worthy aspiration because it equips us to consider informed choices as we confront an uncertain future."

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