

Studies look at Pacific sea surface temperature to predict ice-out dates for Maine lakes

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Warming and cooling of tropical Pacific sea surface waters in the fall and winter can help predict the timing of spring ice-out dates in lakes across Maine and the North American region, according to recent studies by University of Maine researchers.

The ability to predict the timing of lake ice out at least a season ahead can inform a range of concerns, from lake ecosystem and water quality studies to community events, such as ice fishing derbies.

An unusually short ice-cover season has the potential to affect the stability, health and function of lake ecosystems, according to Mussie T. Beyene, who is completing doctoral studies in civil and environmental engineering at UMaine.

Since winter weather conditions affect the lake ice-cover period, Beyene aims to offer ways in which climate information may be used to assess changes in North American lakes at least a season ahead. The research is the focus of two recently published journal articles by Beyene and Shaleen Jain, an associate professor of civil and environmental engineering at UMaine.

Climate studies have shown the El Nino-Southern Oscillation (ENSO), a periodic see-saw in tropical Pacific sea surface temperature and pressure, affects North American winter weather, according to Beyene.

In previous research, Beyene and Jain determined the presence of seasonal winter temperature thresholds that engender unusually early and late ice-out dates—when winter ice completely disappears from the water's surface—in Maine lakes.

The researchers also looked at the role of regional North American atmospheric circulation patterns associated with El Nino, or the warm phase of ENSO, in promoting warmer winters, which produce early lake ice-out dates in Maine.

An important predictor for spring ice-out dates is the accumulated freezing and melting degree days—the sum of temperatures below and above the freezing of water, 32 degrees Fahrenheit.

In the pair's most recent paper published in *Water Resources Research*, they examined the role of winter accumulated freezing and melting degree days and other meteorological variables, such as snowfall, on ice-out dates in Maine lakes.

Working with Ramesh Gupta, the Trustee Professor of mathematics and statistics at UMaine, they developed a linear-circular regression framework to model the effects of the seasonal meteorological variables on lake ice phenology.

The researchers found the magnitude and variance of spring temperatures explain more than half of the total variability in spring ice-out dates for Maine lakes. The relationship between spring snowfall and the timing of spring ice-out dates is the strongest in northern interior Maine lakes and the effect of winter snowfall on ice-out dates is significant mostly in coastal Maine lakes.

However, the role of winter accumulated freezing and melting degree days in determining the ice-out dates in Maine lakes was found to be significant across all climate regions, according to the researchers.

Current research shows the effect of ENSO events on North American winter climate varies depending on the location and amplitude of tropical Pacific sea surface warming and cooling.

In a paper recently published in the *International Journal of Climatology*, Beyene and Jain examined the role of different El Nino conditions on eight North American lake ice-out dates and developed a risk analysis approach to assess the likelihood of early ice out. For some lakes, warming patterns in the eastern tropical Pacific were associated with almost twice the risk of early ice out.

"The National Oceanic and Atmospheric Administration provides an

outlook of the winter ENSO state, sometimes six months ahead," Beyene says. "By determining the winter accumulated freezing degree day thresholds that produce early ice-out dates in lakes, we can use our [winter](#) accumulated freezing degree day models that incorporate ENSO indices as predictors to estimate the likelihood of an early or late ice-out date a season ahead. We believe that numerous [lake](#)-related research and activities in Maine and elsewhere stand to benefit from these forecasts."

More information: Mussie T. Beyene et al. Linear-Circular Statistical Modeling of Lake Ice-Out Dates, *Water Resources Research* (2018). [DOI: 10.1029/2017WR021731](https://doi.org/10.1029/2017WR021731)

Mussie T. Beyene et al. Freezing degree-day thresholds and Lake ice-out dates: Understanding the role of El Niño conditions, *International Journal of Climatology* (2018). [DOI: 10.1002/joc.5671](https://doi.org/10.1002/joc.5671)

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