Study: Lake ice becoming unsafe, increasing drowning risk

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Ice block of black ice. Credit: Joshua Culpepper

Sports and recreational activities on frozen lakes across the Northern

Hemisphere are a popular pastime for millions, but according to new research out of York University, the safety of that ice is becoming more precarious and shorter in duration.

The paper, "Widespread loss of safe lake ice access in response to a warming climate," was published in the journal *PLOS ONE*.

As winter and early spring temperatures continue to rise with a warming world, the quality of lake ice is changing and that prompted the researchers to delve into available data to project how many fewer days of safe ice there could be in the future. That number could be upwards of 29 days depending on the condition of ice cover and whether the world reaches 1°C, 2°C or even 4°C of warming.

Although their previous work looked at ice thickness and duration, important indicators of ice safety, they are quick to point out that that is only part of the equation. Equally important and potentially as dangerous is the quality of the ice, which also helps determine whether it is safe, especially early and late in the season when the ice is either forming or melting.

"Quality and thickness need to be weighed together when deciding if the ice is safe to go out on. Our research found there will be fewer safe ice days and the formation of safe ice during the transition period in early winter will take longer, creating a higher risk for accidents and drownings," says Professor Sapna Sharma of York's Faculty of Science and senior author of the paper.

Led by York Postdoctoral Fellow Joshua Culpepper, the study tracked historical shifts in ice thickness and quality to determine how global temperature rises will affect the number of safe days on the ice.

"We used a lake ice model to examine changes in ice thickness of the

Northern Hemisphere between 1850 and 2100," says Culpepper. "We show that although many lakes are still forecast to freeze, as warmer temperatures become the norm, they will be unsafe to use for a longer time, especially if more white ice than black ice forms."

The quality of ice, how strong it is and how much weight it can hold, differs depending on whether it's predominantly white or black ice.

"White ice conditions increase the risk of falling through the ice as white ice has a lower load bearing capacity compared to black ice at the same thickness," says Culpepper, who cautions that as the climate heats, white ice conditions are expected to increase.

Shoulder seasons is when it is most unsafe

Lake ice formation in the Northern Hemisphere could be delayed anywhere from Nov. 15 to Jan. 18, dictated by how high average temperatures climb—1°C, 2°C or 4°C—and it is during this transition that white ice is most likely to form.

"We found lake ice will likely be unsafe longer at the beginning, than the end, of the ice season. Although the lakes will be frozen, they could be unsafe to use for three to four weeks at the beginning of winter and for an extra week at the end when ice is predicted to decay rapidly," says Sharma.

"This rapid break up of safe ice conditions suggests that the end of the ice season will offer some of the most dangerous conditions, but the beginning of the season is also highly risky. The greatest number of drownings through ice occur at the beginning and end of the ice season and this risk is expected to be higher with climate change."

How does white ice differ from black ice?

Even though the ice might measure the right thickness to venture out for a skate or snowmobile ride, if it is comprised mainly of white ice, it likely won't hold. This has already resulted in dozens of drownings, say the researchers.

White ice is more likely to form when temperatures are warmer than usual or there are warm rainy days following very cold days. It is usually opaque, like snow, and filled with more air bubbles, smaller ice crystals, and holds less weight than black ice. At temperatures close to 0°C, it could be more than 50% weaker.

Steady cold temperatures are needed for black ice formation, which is clear and dense, has few air pockets and larger ice crystals, making it able to hold heavier loads.

Guidelines on ice thickness for people, snowmobiles, cars and transport trucks on the ice are based on black ice. If people are measuring the ice thickness without accounting for the type of ice, that could lead to life-threatening plunges through the ice.

Lake ice is unsafe when it thins to less than 10 cm of black ice, less than 15 cm of equal parts black and white ice, or less than 20 cm of white ice. The formation of white ice is expected to increase as temperatures climb, increasing the unsafe transition period.

In Canada last December, six people, including a couple of teens in Ontario, died within a week by plunging through thin ice. Two more died in Ontario this February. In Finland, four people died from falling through weak ice in January and February alone, where the average is said to be 18 people annually. In Sweden, 16 people drowned from falling through the ice in 2014 and at least nine in 2021, for example.

The researchers hope to get the word out on the increasing precariousness of lake ice today and into the future, and hope people will take precautions before venturing onto the ice, even if it looks solid enough.

More information: Joshua Culpepper et al, Widespread loss of safe lake ice access in response to a warming climate, *PLOS ONE* (2024). DOI: 10.1371/journal.pone.0313994

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