False spring: Climate change may erode frogs' ability to withstand salt pollution

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Wood frog (Lithobates sylvaticus) tadpole. Credit: Jessica Hua

Climate change may erode frogs' ability to withstand road salt pollution, according to researchers at Binghamton University, State University of New York.

Driven by climate change, spring in the northeastern United States is now earlier and more variable in temperature than it used to be, a shift that has rippled through ecosystems. Among the most severely affected are spring-breeding amphibians such as wood frogs, who may be lured out of the mud to mate too early.

When winter comes rushing back in, adult wood frogs will likely survive the chill—but their newly laid eggs may be at risk. But the impact doesn't end there, according to new research by Binghamton University's Department of Biological Sciences.

Later broods of hatchlings whose parents endure freezing temperatures associated with an additional winter storm are larger but less resilient to the effects of road salt, a common wetland pollutant, according to doctoral candidate Nicholas Buss, Assistant Research Professor Lindsey Swierk and Associate Professor Jessica Hua in "Amphibian breeding phenology influences offspring size and response to a common wetland contaminant," published recently in *Frontiers in Zoology*.

The research focuses on several populations of wood frogs located about a 4½ hour drive southwest from Binghamton, which typically enter breeding season anytime between mid-March and mid-April. It also addresses a common but sometimes overlooked environmental pollutant: salt.

Every winter, 10 million metric tons of road salt are applied to North American roadways, washing off in the melting snow and spring rain. This runoff can increase the salinity of nearby wetlands and prove toxic to freshwater species such as amphibians, Buss explained.

Amphibians are an essential component of wetland ecosystems. As tadpoles, amphibians feed on algae, increasing water clarity and quality of wetlands. Tadpoles additionally serve as prey to many species of

aquatic invertebrates, making them important contributors to the cycling of nutrients within wetland ecosystems.

Early spring and offspring

A combination of factors spur amphibians to mate, often hinging on both temperature and the timing of spring rain, Hua explained. For wood frogs in particular, researchers predict their breeding time by the absence of ice on the pond, a string of three to four days above freezing, and rain during those days.

While amphibians are cold-blooded, warmer weather isn't necessarily better. They evolved their breeding schedules over thousands of years in response to environmental cues, Swierk said. In comparison, climate changes over the last few decades have been rapid, testing the limits of these species' ability to cope.

"Our results suggest that the effects of climate change on wood frog breeding are complex, depending on the severity of freezing events from year to year, and are interactive with other human-introduced stressors like contaminants," she said.

Adult frogs that emerge during a false spring are often capable of surviving, thanks to unique adaptations that allow them to cope with freezing temperatures. The eggs themselves may be a different story.

"Though each wood frog female can lay over 500 eggs, many of these eggs may be vulnerable if the pond freezes over," Hua said.

The embryos, too, are hit hard by sudden cold. In a previous study, the researchers exposed frog embryos to cold conditions and found that they took longer to develop into tadpoles, weighed less after hatching and were less tolerant of road salt than embryos raised in warmer

environments, Buss said.

For the study published in *Frontiers in Zoology*, the researchers removed the eggs from the environment in which they were laid and raised them in the lab. They found that eggs laid later in the mating season by parents who were exposed to an additional winter storm were less likely to withstand salt pollution.

The researchers suspect that earlier-breeding frogs were exposed to less temperature-induced stress than those that bred later, which may have translated into less physiological stress and a better ability for those early breeders to acclimate to increased salt in the environment. While stress hormones can allow animals to survive when faced with temporary adverse conditions, prolonged or severe exposure to stressors can cause those same hormones to have ill effects, Swierk said.

"Chronically elevated stress hormones can have cascading impacts on other hormones, such as those related to homeostasis, growth or reproduction," she explained.

In the short-term and on the local scale, it's not possible for us to change these larger climate patterns. However, local management can be made aware of the exacerbating effects of pond contaminants on amphibians that breed too early, Swierk said.

"From an evolutionary perspective, it is fascinating to understand how animals can adapt, or fail to adapt, to rapid changes in their environment," she said.

More information: Nicholas Buss et al, Amphibian breeding phenology influences offspring size and response to a common wetland contaminant, *Frontiers in Zoology* (2021). DOI: 10.1186/s12983-021-00413-0

Provided by Binghamton University

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