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Study: Alaska wood frogs are champion deep-freeze hibernators

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North America's northernmost amphibians can stay frozen solid most of the year before they thaw and emerge to hop, breed, sing and conduct other summertime business, according to a [newly published study](#) led by scientists at the University of Alaska Fairbanks.

The [wood frog](#), found in a broad geographic area ranging from the southeastern United States to the Brooks Range of Alaska and the Mackenzie River Delta of Arctic Canada, is famous for [surviving frigid conditions](#).

New research shows that its period of deep-freeze can extend to seven months a year, longer than previously believed. The study was published in the *Journal of Experimental Biology*. That means wood frogs, at least in their farthest north range, may be able to stay frozen longer than any other animal besides insects, according to the study.

Only the [Siberian salamander](#) -- the only salamander species found above the Arctic Circle -- comes close, with a frozen hibernation period of four to five months, and body temperatures measured as low as minus 31 degrees Fahrenheit, according to the UAF-led study.

The researchers tracked down 18 frogs in their natural habitat starting in September 2010, glued tiny sensors to them and monitored their temperatures over the winter. Research continued in 2011 and 2012, with a total of 30 frogs placed outdoors in the woods surrounding the UAF campus.

Freezing imperils most animals because it dries out their cells, and ultimately their bodies. But wood frogs and other freeze-tolerant animals have methods of protecting their cells, sometimes with a natural antifreeze material. "In the case of wood frogs, it's sugar -- blood sugar, glucose," said study co-author Brian Barnes,

*Ned Rozell photo*

director of [UAFs Institute of Arctic Biology](#). This [UAF video](#) helps explain.

What appears to give northern Alaska frogs their special powers to survive winter conditions is a buildup of glucose during several freeze-thaw cycles in the fall, Barnes said. "Frogs in nature are freezing multiple times," he said. Those cycles -- about a dozen times per fall for the frogs monitored in the study -- appear to trigger repeated doses of adrenaline that causes the glycogen in the frogs' livers to break down into glucose, he said.

Frogs out in natural conditions had glucose levels much higher than what had been detected in prior laboratory tests, where frogs were generally frozen only once, he said. And frogs in the study were able to survive even after their bodies had cooled to minus 0.4 degrees F, though Barnes said he and his colleague believe the animals' bodies can chill to much colder temperatures.

Would a wood frog from a more southern part of its range, like Southcentral Alaska, or possibly the Lower 48 states, freeze for as long and survive temps as cold as the Fairbanks frogs? That is unclear, Barnes said. There might be genetic distinctions between population segments, or all frogs may have the capability of loading up on freeze-protecting glucose, he said. He and his colleagues are hoping to do further research to see how wood frogs from different geographic areas fare in Fairbanks winters.

Understanding the frogs' deep-freeze capabilities, scientists say, could help address a range of needs.

[Past research](#) that identified the process that enabled frogs' frozen hibernation -- a period when heartbeats and breathing are stopped -- suggested potential benefits to people needing organ transplants and other medical treatment.

The new information about northern frogs' freezing capabilities may shed light on an environmental problem worrying biologists -- the proliferation of abnormalities, such as missing or misshapen limbs, afflicting southern populations of various frog species.

Don Larson, the UAF doctoral student who helped lead the latest wood frog study, is investigating that question. Many of the deformities found in frogs are blamed on a parasite that enters the habitat through snails, Larson said.

The parasite has slammed frog populations in the Lower 48 -- at one Minnesota pond he studied, half of the leopard frogs had parasite-caused deformities -- but so far the deformities have not been documented farther north than British Columbia, he said. "It turns out the parasite is harmed by freezing," said Larson, who has been doing laboratory experiments on the subject. But freezing, though it reduces parasite numbers, does not kill them all, he said.

Alaska wood frogs have not escaped the pattern of abnormalities that is afflicting frogs and toads elsewhere, and the problems inspired a [research project at the U.S. Fish and Wildlife Service](#).

One [study](#), published in 2008, found abnormalities within frog populations in Alaska national wildlife refuges occurred at higher rates for animals living closer to roads.

Preliminary information suggests that frogs in the Kenai National Wildlife Refuge -- one of the sites with higher rates of abnormalities -- are suffering from a combination of predation, pollution and higher water temperatures, according to the Fish and Wildlife Service. Frog tadpoles appear to be having limbs amputated by dragonfly larvae, which are possibly proliferating in warmer waters, the service said. Meanwhile, levels of contaminants like PCBs and heavy metals are relatively high in the waters used by wood frogs, contributing to other problems, the service said.

Now that winter is over, Barnes said, **Alaskans should be seeing newly thawed frogs** in and around ponds and hearing the **mating calls** they use to launch their frenzied summer. "They sound like ducks quacking," he said. The frogs' emergence is likely to be early this year, thanks to the warm and early spring, he said.

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