

In the egg, American bullfrogs learn how to avoid becoming lunch

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American bullfrog at the E.E. Wilson Wildlife Management Area in the Willamette Valley. Credit: Lynn Ketchum, OSU

When exposed to potential predators as an embryo, the invasive

American bullfrog becomes harder to kill when it becomes a tadpole, according to a new study by Oregon State University researchers.

Tadpoles that hide more and develop faster when predators are present have better chances at survival, and the study sheds light on the frog's capacity to proliferate across the Pacific Northwest, said Tiffany Garcia, an aquatic ecologist in OSU's College of Agricultural Sciences and lead author of the study.

The findings were published this week in the journal *Oecologia*.

Bullfrogs are strong competitors for food and highly invasive in many environments. They are implicated in the decline in many native species, Garcia said.

"These embryos can learn about new predators while they are still in the egg, and they behave and develop differently after they hatch based on that learning," she said. "If these frogs can learn about predators before they are even vulnerable to them, it makes it that much harder to limit their spread."

In the study, the researchers collected [bullfrog](#) eggs from a seasonal, fish-less pond in Oregon's Willamette Valley. The researchers exposed one group of eggs to signals that predators were close by, in this case fish odor. They exposed another group to the smells of fish and injured tadpoles. The control group wasn't exposed to any smell.

The tadpoles that hatched from the [predator](#)-exposed eggs avoided predators more than the ones that hatched from the unexposed [eggs](#). They hid behind a small piece of black plastic, and they also grew into slightly longer [tadpoles](#).

"When that predator smell was around in the tadpole phase, they knew

what to do to be safe," she said. "They learn about the identity of predators that will pose a threat for them later in life."

It is the second known study of embryonic learning in amphibians, after the wood frog, and the only one that focused on an invasive species, Garcia said.

Mature bullfrogs can tip the scales at nearly two pounds and be as long as eight inches. They eat anything they can fit in their mouths, including other frogs, bugs, fish, birds and turtle hatchlings.

"They are what we call gape-limited predators," Garcia said. "That means their diet is only limited by their size. That's why they can have such a strong impact in invaded ponds and why we are looking for ways to control their spread. It turns out they have more weapons than we originally thought that make them very good invaders."

American bullfrogs are native to the eastern United States. Although some were observed in Oregon prior to 1900, most of the frogs were brought to the state in the early 20th century to be harvested as food - [frog](#) legs are sold at restaurants around the world. Most of those farms went belly up during the Great Depression, and the frogs were either released or they escaped.

More information: Tiffany S. Garcia et al, Embryonic learning and developmental carry-over effects in an invasive anuran, *Oecologia* (2017). [DOI: 10.1007/s00442-017-3905-5](https://doi.org/10.1007/s00442-017-3905-5)

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