

# UA 'Tsunami' Video Sheds Light on Struggling Pupfish

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Devils Hole pupfish in their natural habitat. (Photo by Olin Feuerbacher)

(PhysOrg.com) -- For the first time, an earthquake was recorded live in Devils Hole, home to the critically endangered pupfish species. The footage is educating scientists on how struggling species react to disturbance.

To most people in the southwestern U.S., the April 4 El Mayor-Cucapah earthquake felt like a rocking of the ground. But on a group of inch-long

[fish](#) that exist nowhere else on Earth outside of "Devils Hole," a crack in the ground in Nevada's Mojave Desert, it unleashed a veritable tsunami.

University of Arizona researchers were able to catch the event on cameras installed above and below the water's surface to monitor the fish's spawning behavior. It is the first time in decades of research at Devils Hole that an earthquake was captured on video.

The event provided the researchers with a rare opportunity to study how a critically endangered species copes when its confined habitat is shaken up in a dramatic way.

The Devils Hole pupfish spend their lives in what likely is the "smallest habitat of a vertebrate species," according to UA professor Scott Bonar, who runs a pupfish population recovery program at UA's School of Natural Resources and the Environment.

That habitat is the "spawning shelf" - a submerged rock surface covered by a mere two feet of water. It's here that the pupfish feed and go about their breeding activity. The shelf forms the only shallow part of a freshwater pool measuring 10 by 50 feet that marks the entrance to the Devils Hole cave.

The pool provides a window into the extensive carbonate aquifer within the Amargosa Valley groundwater basin. Despite explorations undertaken by cave divers, no one has been able to probe the depths of the Devils Hole cave system, although they are known to plunge beyond 500 feet.

## **Making waves**

On most days, Devils Hole looks like a glassy surface of crystal-clear water, shimmering with an unearthly, iridescent turquoise hue at the

bottom of a crack in the rocks 50 feet below ground level.

But on April 4, 16 minutes after the shockwaves arrived in the Mojave Desert 300 miles north of the epicenter near Mexicali in Baja California, serenity gave way to turmoil in the small world of the Devils Hole pupfish.

"The water was sloshing back and forth so hard it splashed against our cameras four feet above the waterline," said Ambre Chaudoin, a graduate student in fisheries conservation and management with the U.S. Geological Survey (USGS) Arizona Cooperative Fish and Wildlife Research Unit at the UA.

"The quake swept the shelf clean from algae, shuffling the silt and cobble around. Such disturbance can be important because the spawning shelf is less than 13 feet long and 7 feet wide, smaller than many walk-in closets. "

Chaudoin and fellow USGS researcher Olin Feuerbacher, a senior research specialist for the Cooperative, conduct the pupfish monitoring study as part of a joint effort to protect the Devils Hole pupfish population. Under its land grant mission, the UA is tasked with research aimed to learn how the fish might be propagated in captivity and what factors may threaten their survival as a species.

The study is being conducted by the USGS Arizona Fish and Wildlife Cooperative Research Unit and is funded by the U.S. Fish and Wildlife Service, in partnership with the National Park Service and the Nevada Department of Wildlife.

## **Struggling to survive**

Devils Hole pupfish numbered about 400-500 until the late 1960s, when

the water level in the pool dropped in response to pumping of nearby irrigation wells. Only a U.S. Supreme Court order prevented the shallow spawning shelf from falling dry, thus saving the species from extinction.

Since then, the Devils Hole pupfish have struggled to survive.

Chaudoin and Feuerbacher make the trip from Tucson to Devils Hole twice a month to check on the measuring equipment and download data. They happened to be on location conducting pupfish behavior surveys the day of the April 4 earthquake. Just 10 minutes before the quake struck, they had reconnected the video cameras to their recording position inside the pool.

"The fish begin to move out of the camera's view as the waves start getting bigger, and then, because of all the sediment being stirred up, you can't see the fish. As the waves grew stronger, the fish likely moved into deeper waters," Chaudoin said.

"Although we knew from water-level records that earthquakes influenced Devils Hole in the past, this is the first time we've caught one on video," said Paul Barrett, a Fish and Wildlife Service biologist who leads the Devils Hole Pupfish Recovery Team. "It may provide great insight into how the wave action cleans the fine silt off of the shelf."



Video cameras pointed at the spawning shelf to record pupfish behavior caught the earthquake in the act. (Photo by Olin Feuerbacher)

Although the violent sloshing during the quake washed away algae that are essential to the food web of the critically endangered fish, algae have already grown back substantially, according to biologists.

## **Spawning pupfish: Canaries in coal mine**

"We monitor when the fish spawn and when they don't, and the environmental factors present at the time," Chaudoin said. "We keep track of certain physical parameters in the water, such as oxygen and temperature. We also study the influence of day and night light cycles on the fish's behavior."

Disentangling the complex interactions between environmental factors and the pupfish's behavior is not a simple task. It appears a combination of several factors, such as oxygen concentration in the water,

temperature and length of daylight, all interact to trigger spawning behavior.

"Our goal is to monitor all these factors on an ongoing basis so we can obtain a continuous record," Feuerbacher said. "In the past, research at Devils Hole has focused on personal observations and measurements taken at certain times, which gives you only snapshots of what is happening at those times."

Chaudoin added: "The implications of the studies at Devils Hole reach far beyond protecting these little fish. In a sense, they are canaries in a coal mine. Because this habitat is so isolated and contained, we notice changes right away. In a sense, it's a living lab where we can study food webs and ecology, and the lessons we learn help us protect other habitats as well."

One of the questions the researchers are hoping to answer is whether natural disturbances, such as earthquakes, are a threat or a boon to the pupfish population.

## **Quakes with a purpose**

"Quakes can serve a useful purpose in shaking silt and other fine particles that have washed into Devils Hole off of the spawning shelf and into the deeper waters," said Barrett. "This frees important space between the substrate particles where the Devils Hole pupfish larvae seek refuge."

In fact, he added, after the April 4 Mexicali quake, the National Park Service recorded a slight increase in larval abundance as compared to a similar survey a few weeks before the earthquake occurred.

Federal and state surveys done within a week after the earthquakes

revealed about 118 fish in the pool, compared to about 70 the year before. Also, biologists saw newly hatched larval fish and evidence that the fish were spawning.

Despite increasing numbers, the population is still critically endangered, mostly because no fish exist outside of Devils Hole. In 2006, the population plummeted to a critical low of just 38 fish.

"Devils Hole was very important in the development of endangered species legislation in the U.S.," said Bonar. "Our part is to try and understand Devils Hole pupfish behavior, especially spawning and feeding, and the factors that influence those behaviors. Only with this knowledge can we successfully create a backup population and ensure the proper protection of this unique, endangered species."

Chaudoin observed that after previous disturbances, for example an earthquake in Chile and violent winter rain storms, the fish exhibited higher spawning activity than usual: "They were going crazy the next day."

Chaudoin and Feuerbacher do not like to speculate but they are intrigued by the idea that disturbance might play an important role in triggering or influencing the fish's spawning behavior. Chaudoin is investigating this question in a side project.

"There is a possibility they might like disturbance," she said. "Perhaps the video recordings will reveal something in the aftermath of the April 4 earthquake. I'm going to spend all my nightlife watching hours and hours of video and extracting data from it."

Provided by University of Arizona

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