

Biologists try to dig endangered pupfish out of its hole

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Devils Hole pupfish in the Ash Meadows Fish Conservation Facility in Nevada's Amargosa Valley. These fish hatched from eggs removed from Devils Hole in Nov. 2013. Eggs are deposited on the yarn 'spawning mops.' Credit: Olin Feuerbacher, U.S. Fish and Wildlife Service

Scientists estimate that fewer than 100 Devils Hole pupfish remain in their Mojave Desert home, but a conservation biologist at the University

of California, Berkeley, is giving important guidance in the efforts to rescue them by establishing a captive breeding program.

Considered the world's rarest fish, with one of the smallest geographic ranges of any wild vertebrate, the tiny pupfish (*Cyprinodon diabolis*) – about one-inch long as an adult – neared extinction in spring 2013 when populations dropped to an all-time low of 35 observable pupfish. While more recent fish counts showed some recovery, the species is considered critically endangered.

The dire situation spurred the U.S. Fish and Wildlife Service to open the Ash Meadows Fish Conservation Facility, which is less than a mile from Devils Hole. Previous attempts to establish refuge populations of pupfish have not fared well, either because the transplanted fish did not survive or because they cross-bred with other species of pupfish. Biologists from the agencies managing the pupfish captive breeding program wanted a risk assessment to determine which methods have the highest chance of success.

A risk analysis by Steven Beissinger, UC Berkeley professor of environmental science, policy and management, found that when it came to reducing impact on the wild population, it was better to transfer pupfish eggs to a captive breeding facility rather than adults, and that it was preferable to transfer fish in the fall, when the population tends to be larger, rather than in the spring.

In addition, Beissinger found that moving more than six adults per year for three consecutive years rapidly increases the risk of extinction. The results, to be published online on Tuesday, Sept. 9, in the open-access journal PeerJ, showed that the wild pupfish faces a 28 to 32 percent risk of extinction over the next 20 years.

"The study really puts out more empirically the risk of extinction for this

fish," said Kevin Wilson, an aquatic ecologist at Death Valley National Park who is working on the recovery of the pupfish. "These findings are providing us with very good tools for our toolbox."



A view of the aquifer-fed pool in Devils Hole. The water surface is approximately 3 meters wide and 20 meters long. Credit: John Wullschleger, National Park Service

Tiny survivor in an extreme environment

The pupfish is found only in a limestone cavern in the Devils Hole

geothermal pool, about 60 miles east of Death Valley National Park. Geologists estimate that the cavern, which is at least 426 feet deep, was formed more than 500,000 years ago. The pupfish are believed to somehow have gained access to the site less than 50,000 years ago when a roof of the cavern collapsed, possibly due to an earthquake, exposing the cavern and its water to the ground surface. The oxygen-poor water in Devils Hole stays a toasty 92-93 degrees Fahrenheit, around the upper limits of temperature tolerated by most fish.

A study published last month found that climate change is contributing to the warming of the water in Devils Hole, negatively affecting the ability of eggs to hatch and larvae to survive. Pupfish populations also may have declined due to reductions in food supply and genetic diversity.

"Some species are critical to conserve because they serve important functions in their ecosystems, and others are important because they might be sources of new medicines, or they may have unique biological features that could inspire human innovation," said Beissinger. "We don't know if the Devils Hole pupfish has or ever will serve any of these important functions, which seems unlikely as long as the species remains restricted to its single cavernous refuge. We do know that the pupfish, like all species, has a fundamental right to exist that is independent of its value to humans."

The Devils Hole pupfish first was identified in 1930. In 1967, it was among the first species listed under the Endangered Species Preservation Act – which later became the Endangered Species Act – and thus became central in the arid Southwest water rights battles of the 1960s and '70s. The pumping of groundwater by agricultural interests and land developers in the region lowered the water levels needed by the pupfish to feed and breed. A landmark 1976 U.S. Supreme Court environmental rights ruling favored the fish and other species in Devils Hole by

requiring the maintenance of a minimum level of water, thereby curtailing groundwater pumping.



A view looking up at a scuba diver counting Devils Hole pupfish. The diver is approximately 8-10 meters below the water's surface. Credit: Photo courtesy of National Park Service

"The effort to save the pupfish resulted in the protection of aquatic ecosystems from the excessive pumping of groundwater throughout the Desert Southwest and inspired generations of conservationists," said Beissinger.

California condor moment?

Beissinger also calculated that if the wild Devils Hole pupfish numbers become small enough, it may be necessary to remove the entire population into a captive breeding program, an extreme measure he called a "California condor moment" because such a controversial action was used to rescue the condor from extinction in 1986.

He noted that, unlike the slow-reproducing condor that does not breed until 5 or 6 years of age, the Devils Hole pupfish has the potential for faster population growth because it matures quickly and can reproduce multiple times in its first year of life.

"Somehow, this handsome little fish has heroically persisted in the harsh desert environment through thousands of years of drastic climate warming and droughts," said Beissinger. "Should the human condition ever arrive at this point after another century of increasing carbon dioxide emissions and climate warming, we may need someone to help us out of our hole."

Provided by University of California - Berkeley

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