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The Georgia blind salamander could be an indicator species for the health of the Floridan aquifer, but scientists don't know if it's thriving or declining

BY BETSY L. HOWELL – NOVEMBER 29, 2016

Photo by Jake Scott - The Georgia blind salamander's subterranean habitat makes it difficult to study. As a result, very little is known about the species.

"Every biologist thinks his or her species of interest is the canary in the coal mine," says John Jensen, state herpetologist for the Georgia Department of Natural Resources. "But the Georgia blind salamander, in my opinion, really fits this analogy better than most." Jensen, who has worked with the species for two decades, explains his reasoning by pointing out the salamander's habitat: aquifers. "It lives in the groundwater — groundwater that we rely on for drinking. If we are seeing declines or disappearances of blind salamanders, then we should be very alarmed."

Yet to know if these salamanders are declining or disappearing, it's first critical to know where they are, or are not, living in the aquifer. Georgia blind salamanders, along with other "stygobitic" species — that is, species that live in groundwater systems or aquifers, — are some of the most difficult species on earth to find. Scientists know they inhabit the Floridan aquifer, a vast, subterranean network of limestone passageways that underlies much of the southeastern United States, yet information on specific locations of salamanders is hard to obtain. Some parts of this network permit erect walking by humans, while many areas can only be accessed by crawling through "worm holes" — tight passages barely large enough for an adult body. Water-filled rooms and tunnels can only be navigated by scuba diving. The underworld hazards to surveyors are many and varied.

There is the potential for getting lost or stuck, running out of air or encountering bad air (generally a result of carbon dioxide buildup from the decomposition of organic matter), or breathing air flecked with the fungal spores that cause histoplasmosis, an infection that can cause fever, coughing, and fatigue.

"Very little is known about this species," Jensen admits, "beyond their general habitat and morphology. I have only seen blind salamanders in Climax Caverns [in southwest Georgia] and those pools took hours of caving to reach. The animals were in water directly below a southeastern myotis bat roost. The bats had contributed guano to the bottom of the pool, and this dark substrate really helped make the translucent salamanders visible."

Georgia blind salamanders first became known to science in May 1939. That spring, one individual was brought up in a water sample from a 200-foot well in Albany, Georgia. This female salamander had eggs visible in her sheer belly, measured just three inches long, and did not have eyes. With transparent limbs and body, tiny dark spots speckled throughout, and long, delicate, blood-red gills, the animal might have crawled out of the pages of a fairy tale. Or come from another planet. Living in a world of darkness makes sight and coloration unimportant, while the feathery gills help to capture oxygen in slow-moving water. Such characteristics make this species unlike almost all other salamanders.

The blind salamander remained alive in captivity for one week. Unmotivated to eat any food offered, she stayed motionless most of the time on the bottom of the aquarium where she was housed.

When she did move, it was by using her limbs, but also by fishlike movements from her body and tail. Vibrations in the room from sounds or activity sent the animal dashing wildly about the aquarium.

One week after the salamander had been collected, a fall from the x-ray table killed her before more could be learned and observed and before her young were born. From this discovery, however, came the Latin name for the genus of the Georgia blind salamander, "Haideotriton," or "salamander of the lower regions."

In April 2010, the Center for Biological Diversity (CBD) petitioned the US Fish & Wildlife Service (USFWS) to list Haideotriton wallacei under the Endangered Species Act. The Center cited two primary threats to the species: Habitat loss from water pollution and water level fluctuation as a result of drawdown of the aquifer for human uses. In 2011, the USFWS published a finding that CBD's petition presented "substantial scientific or commercial information indicating that listing [of the Georgia blind salamander] may be warranted." This finding meant that the federal agency would begin a status review to determine if the species should be listed. That review is still being assembled.

The lack of understanding of the blind salamander's distribution is a concern when trying to determine the level of threat to the species. As Jensen points out, "Although these salamanders may occur in aquifers well away from accessible caves, their densities may not be as great due to the lack of organic matter." However, no one knows for sure, a fact that makes effective conservation extremely difficult.

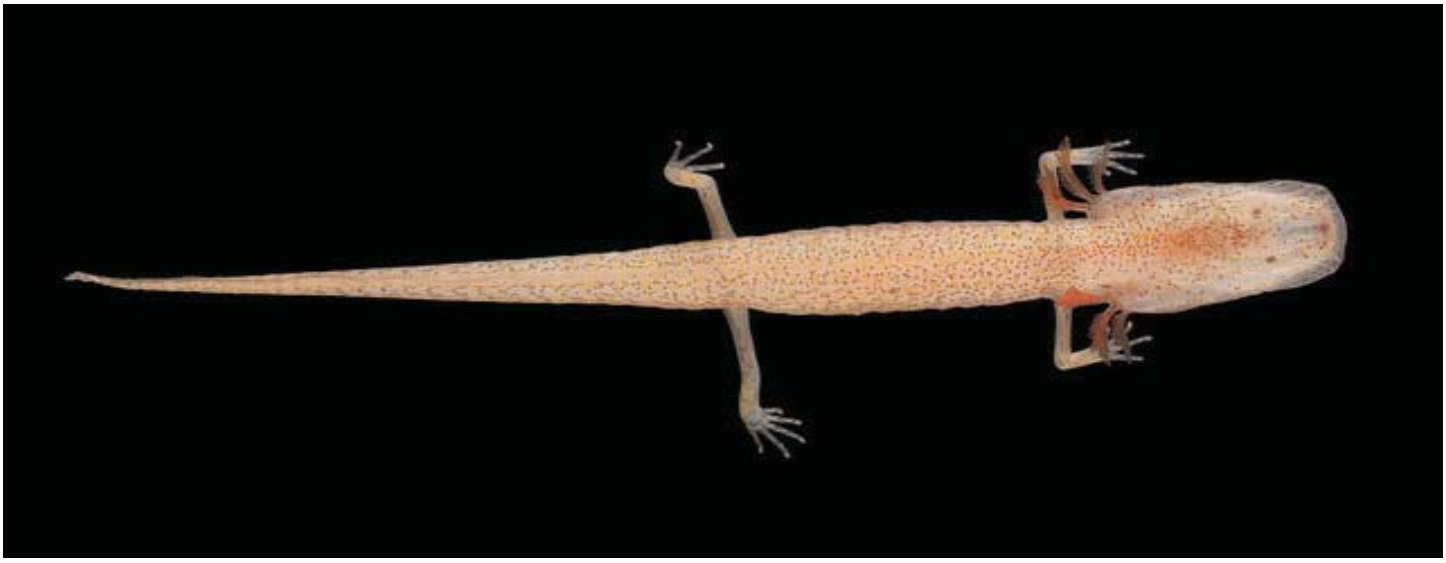

photo by Alan Cressler - The USFWS is conducting a status review to determine whether the Georgia blind salamander should be listed under the ESA.

With the petition from CBD came a wave of interest among Florida and Georgia state wildlife agencies to determine the blind salamander's status. The question was how does one go about finding a species that inhabits such a challenging environment? The answers can be found in plastic bottles, environmental DNA, and cave divers.

The first method employs plastic soda bottles, weighted and sunk into the aquifer through monitoring wells. The bottles, which are checked daily, are baited with cashews and shrimp to entice the salamanders. This method has captured Texas blind salamanders, however, it took 200 to 300 hours of trapping time to catch two individuals from that species, so fast results are generally not to be had with this survey technique. A recent study done in 2014-2015 involved setting traps in 18 wells in 10 Georgia counties. Though no blind salamanders were caught, 32 Dougherty Plain cave crayfish, another species of concern, came in for the nut and shrimp baits.

The second strategy involves the remarkable new technology of environmental DNA collection. All living organisms are constantly shedding hair and skin and if these bits can be collected, then matched with reference DNA obtained directly from other individuals of a species, confirmation of presence can be established. The challenges with this method are that one, a species must live in great enough densities to increase the amount of body material available for collection, and two, the collection point needs to be downstream from the animals. If a species is present in an area, but in low numbers and upstream from where water is sampled, the results will be erroneously negative. Georgia blind salamanders have yet to be documented with environmental DNA analysis, though water samples have been taken from wells and springs at numerous locations.

Because of the limitations inherent with these inventory methods, most of the documentation of the species has come from visual observations.

People swimming and squeezing their way into these serpentine caves and passageways and taking photographs have confirmed the blind salamander at 36 locations in Georgia and northern Florida. Scientists play a role in this work, but so do cave divers, a small and passionate subset of the greater technical diving community. “They’re not biologists,” says John Jensen, “but they really enjoy having a conservation excuse for doing what they love.” In terms of knowing more about the blind salamanders, it is fortunate they do. Cave divers face similar dangers that regular cavers face, and also have to contend with silt, a limited air supply, and even alligators resting at cave entrances. But for the few involved in this sport, the rewards are many and the privileges of exploring and conserving cave habitats and cave wildlife far outweigh the hazards.

Guy Bryant, a retired pharmacist and computer programmer from Valdosta, Georgia, has been cave diving for 44 years. He can’t remember a time in his life when he wasn’t interested in caves. “Before I began scuba diving,” he says, “I was exploring dry caves, so it was natural that I would incorporate underwater caves into my activities.” Bryant’s cave diving experiences are not for the easily claustrophobic person. One particularly memorable experience came when he and his partner, Lee Sams, were exiting from a tunnel in a place called Thunder Hole. The passage was so tight and the silt so thick that they could see nothing as they followed their exploration line back to the entrance. At one point, Sams, in the lead, became stuck. For five minutes he worked to get through a constriction in the rocks.

“Five minutes being stuck,” says Bryant, “doesn’t sound like much, but when you’re 155’ deep and have no visibility trying to get through a tight place, you can use a lot of air.”

This, then, is the world of the Georgia blind salamander, as well as other stygobitic species, such as the Dougherty Plain blind crayfish, the freshwater eel, and the Florida chub. Each cave, according to Bryant, with its unique geology and shape, has its own personality. The type of limestone in the cave, hard or soft, and the amount of impurities, including tannins, provides different coloration for each cave, while the thickness of the limestone can determine whether a cave system becomes deep or stays shallow. The water current inside a cave can make swimming hard or easy and plays a role in how much silt forms on the bottom. Regarding “tight spots,” Bryant says modestly, “Sometimes I’ve had to remove my tanks and push them in front of me to fit through.”

Bryant has seen Georgia blind salamanders in two cave systems: Radium Springs, the largest natural spring in Georgia, and Hole in the Wall Spring, an electrifying blue water world in northern Florida. “In the past,” he says, “we used quartz lights, which would give off a lot of heat. When the salamanders felt this heat, they would take evasive action by swimming upward then spiraling back down. The LED lights we use today don’t give off much heat, so I don’t see them doing this anymore.” What Bryant has seen are the salamanders resting quietly in the silt or rocks along the cave floor, while other wildlife make their presence conspicuously known. At Thunder Hole and another cave called The Cracks, Bryant and his fellow divers have encountered huge numbers of crayfish.

“There were so many as we swam through one cave that literally hundreds rained down on us from the ceiling!”

Not knowing the status of a species while being fully aware it is being adversely affected by pollutants in the aquifer and water drawdown poses challenges in terms of conservation. While John Jensen, his crews, and cave divers document salamanders as best they can, others are thinking ahead to a time when the results of inventories may show the salamanders to be in grave trouble.

Danté Fenolio is the vice president of Conservation and Research at the San Antonio Zoo and has been working with subterranean salamanders for more than 25 years. Beginning with a Master’s project examining the ecology of Grotto Salamanders, also known as “ghost lizards,” in the Ozark Mountains, Fenolio now manages projects examining the status of groundwater fishes and salamanders in China, assembling bioinventories of cave fauna in the Appalachian Mountains and the Ozarks, and working with blind salamanders and crayfish in Georgia, Florida, and Texas. One of his current endeavors includes heading up a team devoted to breeding Georgia blind salamanders in captivity. Conserving subterranean species can be particularly challenging because of an animal’s limited dispersal capabilities and limited alternative habitat available if areas become uninhabitable, either due to natural or anthropogenic causes. “This is the first attempt,” says Fenolio, “to breed and raise these salamanders, and one of the main goals of the program is to develop a set of best practices for their husbandry.”

Similar to other programs to conserve imperiled wildlife, the “captive assurance colony” at the San Antonio Zoo is an insurance policy for blind salamanders against environmental catastrophe. Yet, having animals available for release will not be enough to secure the species’ future. Quality habitat must also remain for them to survive long-term, with ample resources available, including food and clean water.

In the late 1990s, the US Geological Survey designated the Floridan aquifer “at-risk” due to nitrogen accumulate from fertilizer runoff. Cave-diver Bryant has seen first-hand changes to caves as a result of such input to the system. “More nitrogen causes a decrease in water clarity,” he explains. “I’ve also seen clean walls at one cave change to bacteria and fungus-covered walls from nitrogen.”

The second major threat to the aquifer is its drawdown for human use. The Floridan aquifer supplies daily water needs to several large cities in Georgia and Florida, including Savannah, Tallahassee, Orlando, and St. Petersburg, as well as numerous smaller, rural communities. The aquifer also supplies water for industrial and irrigation purposes. With so many obvious human uses for the water, the needs of other species inhabiting this dark, underground world have gone unnoticed. Jensen notes that most people he talks to don’t even know subterranean salamanders exist. “Some have seen blind cave animals in magazines or on TV shows,” he says, “but they don’t realize we have them right here under our own feet. Heck, they’re even surprised there’s any life at all in aquifers.”

Fenolio agrees that people lack knowledge and understanding of cave wildlife, but he also has hope in a younger generation that values the environment and wants to make a difference. The conservation challenges are great and time is running out for many animals, but the reality of the connectedness of all species remains true today as it has for millennia. “Blind salamanders, as well as all the other species living underground,” says Fenolio, “can’t be untangled from the humans living above them.”