Ozark Underworld

by Raye Nilius and
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Cave crayfish
USFWS photo

The Ozarks region of northern Arkansas, northeastern Oklahoma, and southern Missouri is known for its brilliant autumn foliage, forested slopes, whitewater streams, icy cold springs, and caves. Springs, sinkholes, and caves are just a few examples of the types of karst features commonly found in the limestone and dolomite geology of this region. The term karst is derived from Krs, a place in Slovenia known for limestone geology (Elliott 2000). In the 17th century, eyeless white salamanders occasionally washed up out of caves in that region, and inhabitants believed they were the young of dragons that lived in the earth (Culver et al. 2000). Karst features are formed when slightly acidic groundwater dissolves the soft stone, carving out spaces and cavities below the surface. Over time, larger and larger voids may be created.

Karst provides a labyrinth of specialized habitats for a group of highly adapted underground species. Aquatic karst species such as cavefish and cave crayfish are well adapted to their nutrient poor environment, have lower metabolic and reproductive rates, and lack pigments and eyes. Changes in temperature, groundwater flow or chemistry, or other habitat disturbances in karst systems can have severe impacts on resident aquatic species. The unique adaptations that ensure their survival in this underground world limit their ability to tolerate changes in their physical environment.

Of the 9,200 known caves in the Ozarks region, Arkansas has approximately 3,000, including Cave Springs Cave near Fayetteville, Arkansas. The human population in this region has increased dramatically in recent times, and development consumes hundreds of above-ground acres each year. Cave Springs Cave is home to a maternity colony of endangered gray bats *(Myotis grisescens)* and the largest known population of the threatened Ozark cavefish *(Amblyopsis rosae)*. Historically, the Ozark cave amphipod *(Stygobromus ozarkensis)* also was known to inhabit Cave Springs Cave, although recent surveys have not confirmed its survival at this site. The fragile karst habitat of Cave Springs Cave is continually exposed to, and threatened by, activities that occur above ground in the area that contributes water to the cave (the cave's recharge area). In 1984, in an effort to protect its sensitive resources, the Arkansas Natural Heritage Commission purchased the cave entrance and 15 acres (6 hectares) surrounding it.

Recharge areas contain streams that feed the karst underground through fractures in the stream beds, sinkholes

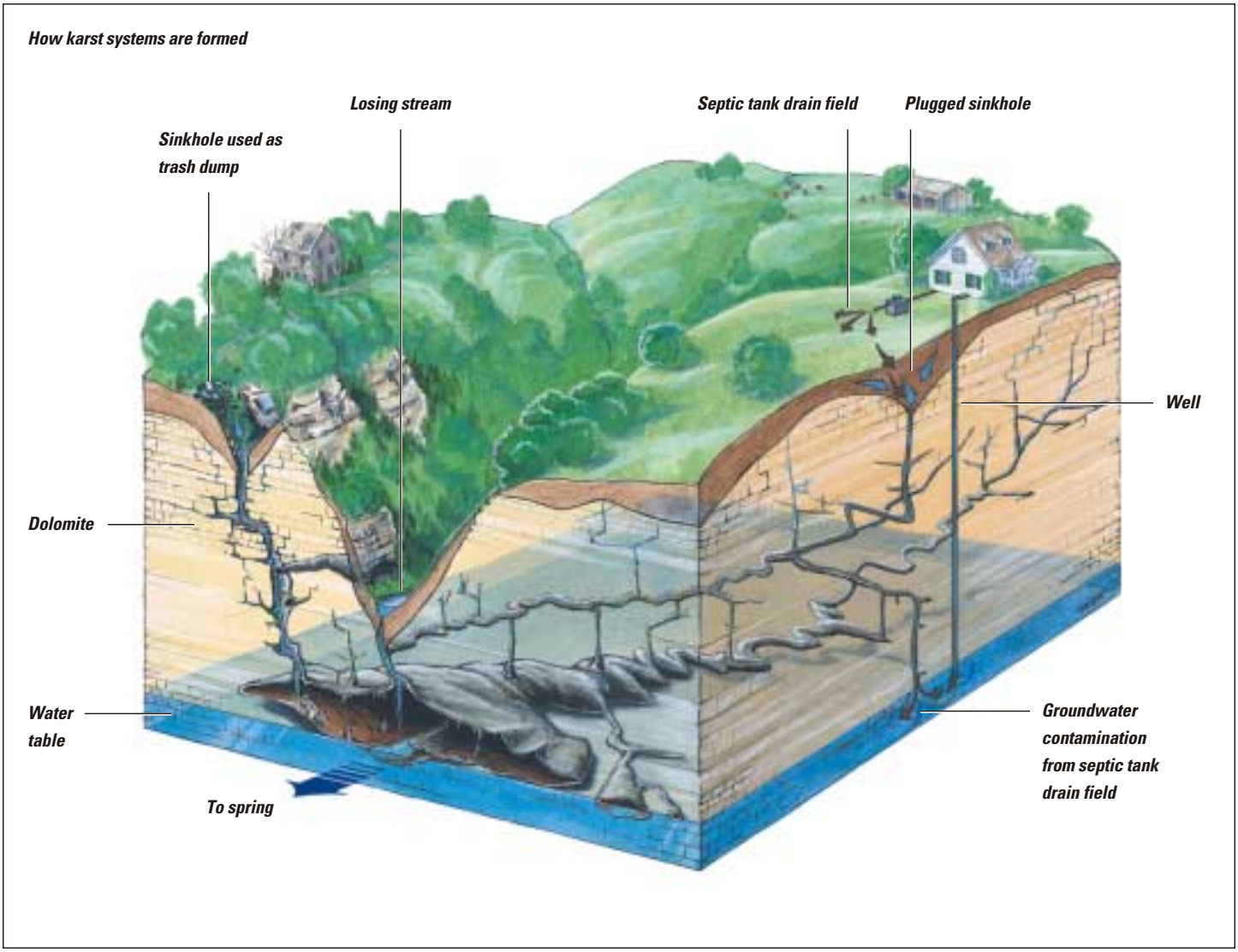

Illustration by Mark Raithel

that funnel precipitation into groundwater conduits, or fractured limestone overlain by thin layers of permeable soil. The Cave Springs Cave recharge area is estimated at approximately 23 square miles (60 sq. kilometers), and activities that occur in the recharge area up to 4 to 5 miles (6 to 8 km) from Cave Springs Cave can affect its sensitive aquatic species.

Groundwater recharge from sinkholes and streams can transmit more pollution than the recharge that filters through soil layers in non-karst regions. Because groundwater can move quickly into and through dissolved openings in a karst network, very little filtration occurs. Consequently, chemical spills and nutrients from chicken litter, sewage sludge, residential septic fields, or other sources can reach underground aquatic habitats within hours or even minutes. When the Ozark cavefish was listed as endangered in 1984, overcollection was listed as one of the primary threats. Today, habitat degradation from certain land use activities may be the most serious threat.

In the karst areas of Arkansas, poultry litter, other animal waste, and municipal sewage sludge are commonly spread onto pastures. Some of the nutrients are assimilated by vegetation and converted to foliage. The remaining nutrients and chemicals enter the groundwater system during rainstorms through sinkholes and streams, contaminating the aquatic habitat of cave species. Development can also have profound effects on water quantity as well as quality in karst systems. Parking lots and buildings convert the surface

from permeable soil to impermeable asphalt, concrete, or structures. After development, precipitation no longer percolates through the soil to recharge the groundwater. Instead, water is efficiently collected with culverts, concrete lined ditches, and storm drains, and diverted from recharge areas. The resultant changes in water volumes of karst systems can seriously affect cave life.

Art Brown and Geo Graening of the Department of Biological Sciences at the University of Arkansas in Fayetteville recently reported on their research into the environmental quality of Cave Springs Cave. Funded by the Arkansas Natural Heritage Commission, the research identified a number of potential environmental threats, including 15 years of increasing nutrient and bacterial pollution, and the occurrence of heavy metals in cave sediments and the tissues of cave organisms. Phthalates, industrial plasticizers that disrupt animal development, were also detected in resident crayfish. Fecal coliform measurements typically exceeded state water quality standards, sometimes by a factor of 1,000. In addition, some heavy metals exceeded acute or chronic water pollution levels. Concentrations of contaminants were found to be highest during storm events.

A crucial first step in protecting aquatic cave habitat is the identification of recharge areas. In many cases, karst groundwater may move from one surface stream basin to another. As a result, recharge area delineations require groundwater tracing studies, which are routinely performed using highly detectable (but not harmful) fluorescent dyes.

The solution to the problems affecting karst habitats is increased cooperation in the development of protective strategies by government agencies, private landowners, industry, and agriculture. With that in mind, the Arkansas Ecological Services Field Office of the Fish and Wildlife Service has introduced a karst conservation initiative for the Ozark Plateau region. Modeled after the highly successful Partners in Flight program, this group effort will apply an ecosystem approach karst conservation efforts in the Ozark Plateau region of Arkansas, Oklahoma, and Missouri.

The Arkansas Field Office is recruiting members for the working group, the Karst Resources Support Team (KaRST). Members will include Service representatives of the Ozark Plateau region (including the Service's Ozark Plateau and Arkansas Red River Ecosystem Teams; our Arkansas, Oklahoma, and Missouri Ecological Services Field Offices; and national wildlife refuges and national fish hatcheries), other government agencies, organizations, private landowners, academia, caving clubs, and elected officials. KaRST will work cooperatively to identify priority areas, establish goals and strategies, pool resources, and target research needs. All activities will be implemented with the cooperation of willing landowners and fine-tuned over time. Considered the ideal solution to a difficult issue, KaRST will lead conservation for Ozark Plateau karst habitats in the new century.

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References

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Except when humans are present, these Ozark cavefish live in a world without light, where there is no need for eyes or pigmentation. But they do need clean water, and are threatened by contamination in cave recharge zones.

Photo at left by Brian Wagner
Photo below by John and Karen Hollingsworth