Human Impacts on Groundwater Quality and Subterranean Aquatic Biota in Southwestern Illinois

Groundwater under much of Illinois receives recharge water through the slow process of percolation through thick glacial till and loess. These layers filter out suspended sediments and bacteria, and allow time for breakdown of chemicals. But around the western and southern edges of Illinois, soluble carbonate bedrock is covered with only a thin layer of soil (or none), and there is little or no filtration of surface runoff before it reaches the shallow aquifer in the bedrock. Over time, the action of slightly acidic water enlarges cracks, fissures, and bedding planes in the limestone bedrock to create a system of conduits that can rapidly transport water from funnel-shaped sinkholes at the surface, through caves and smaller conduits, to resurge at springs in nearby valleys. In the Salem Plateau of Monroe and St. Clair counties this terrain, known as karst, is extremely vulnerable to environmental perturbations affecting groundwater quality and the aquatic communities.

Don Webb of INHS collecting monthly groundwater chemistry data (Monroe Co., Illinois).

Photo by Steve Taylor, INHS Center for Biodiversity

Caves and other smaller subterranean cavities in the Salem Plateau are home to a variety of unique organisms found nowhere else in Illinois. Flatworms, snails, isopods, amphipods, pseudoscorpions, millipedes, and springtails have adapted to this environment of constant darkness and fairly constant temperature. Many of these animals have lost body pigments and functional eyes and have evolved attenuated appendages, heightened tactile and chemosensory abilities, and lowered metabolic rates relative to their surface cousins. Among these creatures is the Illinois cave amphipod *(Gammarus acherondytes)*, a federally endangered crustacean found only in the subterranean streams of Monroe and St. Clair counties. The increasing pressure from urban development associated with the growth of the St. Louis metropolitan area threatens the Illinois cave amphipod and the health of the subterranean aquatic community.

As more people build homes in the hilly karst terrain, roads are widened, wood lots are cleared, farm fields give way to new suburbs, and the demand for water increases. Because most of this development is rural, and because it is taking place at such a rapid pace, there is no centralized sewage treatment system. Instead, most homes have private septic systems that do not always adequately treat the sewage before

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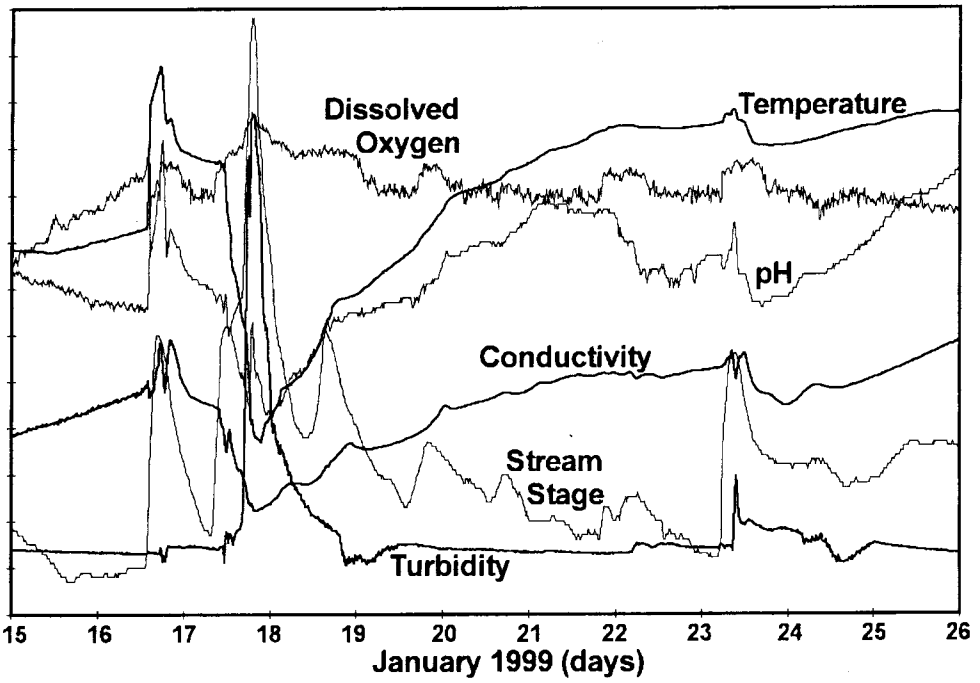
releasing it into the shallow soils or, worse, directly into sinkholes leading into the underground streams. This partially treated water ends up in the groundwater almost instantaneously and without filtration or chemical breakdown. We are concerned about the potential impacts of this septic waste, as well as runoff from lawn-care and agricultural pesticide and fertilizer applications, sedimentation associated with farming and development, and fecal material associated with livestock.

Our current research focuses on developing a more complete understanding of the shallow groundwater in four drainage basins in which the Illinois cave amphipod has been reported. Using two Hydrolab data loggers, we monitor pH, specific conductivity, dissolved oxygen, stream stage, temperature, and turbidity every 10 minutes throughout the year. These data provide a detailed picture of how the cave stream responds to rainfall events, how the water chemistry changes throughout the year, and allows comparisons to be made between caves. In addition, monthly collections of water and sediment samples are tested for bacteria, pesticides, heavy metals, and cations and anions.

We are beginning to see a variety of factors implicated as potential threats to the subterranean community: high turbidity during spring floods may reflect upon agricultural practices and development; herbicides show peak levels in water samples during the late-spring applications to row crops; and alarmingly high levels of fecal coliform and fecal streptococcus bacteria during the springtime indicate that fecal waste from livestock and/or humans is entering the groundwater rapidly and with little filtration. Use of springs and shallow wells as a source of drinking water can pose a serious health risk, especially during the rainy season, when bacteria such as *Enterococcus* (formerly *Streptococcus) faecium*, *Enterococcus faecalis*, *Escherichia coli*, *Klebsiella pneumoniae*, and *Staphylococcus aureus* are more abundant. The Hydrolab data also point towards a problem with oxygen depletion in one of the caves, probably in association with unnaturally high levels of organic inputs into the system. Because the aquatic cave community is adapted to low levels of nutrient input (there are no primary producers in these systems), increasing the organic input increases the competitive advantage of less cave-adapted, more opportunistic species, changing the community structure.



Ten days worth of data from the Hydrolab datalogger in Stemler Cave (St. Clair Co., Illinois). The data clearly record a major flood pulse event during January 17–19.

As we gradually learn more about the groundwater in the karst region, we are also learning more about the amphipods, their life histories, and microhabitat usage. Improving our understanding of the threats from human activities in the karst region will lead to the development of more objective strategies for the recovery of the amphipod and for the management and protection of the ecologically unique karst of Illinois' Salem Plateau. A major emphasis on education is crucial if we are to effectively implement changes in land-use practices associated with urbanization and agricultural activities in this area, and changes that help sustain the aquatic cave community will also improve the quality of life for Illinois residents in this karst area.

Cave amphipods foraging among stream gravels. Note how sediments can fill the spaces between the stones—spaces that are home to the amphipods.
Photo by Jeff Swayne

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