New Advances in the Study and Management of Arkansas Caves

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Abstract

Research in Arkansas cave ecosystem ecology is being performed at several scales: population dynamics of Ozark cavefish, trophic dynamics of cave stream foodwebs, an ecoregional comparison of cave biodiversity, and a state-wide assemblage of a cave database. Monitoring and research efforts have focused on Cave Springs Cave, Arkansas, which is a recovery cave for the Ozark cavefish and a site where extensive disturbance has occurred. Research in this cave complex includes the use of occular surveys of the cavefish population, organic matter budgets, water quality monitoring, epifluorescence microscopy, and stable isotope assays. Habitat stressors include: a 15-year trend of increasing organic pollution, the presence of heavy metals and semi-volatile organic compounds, and continuous violations of state water quality regulations. Water quality monitoring over the last three years indicates that heavy metals may be concentrated in the sediments and bioaccumulating in the foodweb. The historic application of sewage sludge in the cave spring's recharge zone is implicated as a pollutant source. Concentrations of nitrate, ortho-phosphate, total phosphate, total coliforms, and several dissolved metals were all highly correlated to discharge and concentrations were highest during storm flows. Yet occular surveys indicate the Ozark cavefish population is recovering and present in densities higher than any published record. Furthermore, preliminary results of stable isotope assays indicate that traditional organic matter sources (e.g. guano, DOM) are dominant in the foodweb. At the state level, a biological survey of caves has begun and is focused on updating the status of rare and endangered stygobitic species. Concurrent physical, chemical, and geological data collection will be used to interpret the distribution of these species of concern. In particular, factors such as cave ownership, public use, water quality, proximity to faults, and abundance of organic matter inputs will be statistically compared to the abundance and diversity of cave fauna. Finally, a database (with restricted access) is being assembled to unify multiple-agency management efforts.

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Ozark cavefish recovery efforts have focused on Cave Springs Cave, Arkansas, which is home to the largest population of *Amblyopsis rosae* and is a site where extensive disturbance has occurred. Monitoring and research efforts, funded by the Arkansas Natural Heritage Commission and the Cave Conservancy Foundation, include annual visual surveys of the cavefish population, the construction of an organic matter budget, baseflow and stormflow water quality monitoring, the determination of microbial population dynamics using epifluorescence microscopy, and foodweb analyses using stable isotope assays. Several habitat stressors have been identified, and include a 15-year trend of increasing organic pollution, the presence of heavy metals and semi-volatile organic compounds (pthalates), and continuous viola-

tions of state water quality regulations (see Brown *et al.*, 1998; Graening and Brown, 1999). A significant increase in nitrate, specific conductance, and dissolved metals (auminum, barium, copper, iron, and lead) has been detected over 15 years of water quality sampling. Water quality monitoring from 1997 to 1999 reveals that total coliform densities continually exceed Arkansas State Water Quality Standards (Regulation 2), occasionally by a factor of 1,000. Significant amounts of nitrate are also present (with a yearly average of over 5 mg NO_3-N/L), and phosphate concentrations occasionally exceed Regulation 2 standards. Furthermore, beryllium, copper, lead, selenium, and zinc are present in concentrations in the cave water that exceed the Regulation 2 standards for chronic, and sometimes acute, toxicity to aquatic life. Sediment and tissue analyses indicate that heavy metals are concentrated in the sediments and bioaccumulating in the food web. The historic application of sewage sludge in the cave spring's recharge zone is implicated as a pollutant source. Concentrations of nitrate, ortho-phosphate, total phosphate, total coliforms, and several dissolved metals were all highly correlated to discharge. A recharge zone analysis was begun using a Geographical Information System, and will aid management and conservation practices. In spite of these disturbances, visual surveys indicate the Ozark cavefish population is recovering and is present in densities higher than any published record (166 individuals). Furthermore, preliminary results of stable isotope assays indicate that traditional organic matter sources (especially bat guano) remain dominant in the foodweb, despite significant loading of animal and/or septic waste.

At the state level, a biological inventory of caves has begun, and is focused on updating the status of rare and endangered cave species. This study is a cooperative effort between the Arkansas Game and Fish Commission, the Arkansas Natural Heritage Commission, the University of Arkansas, the USDA Forest Service, and the U.S. Fish and Wildlife Service. Concurrent physical, chemical, and geological data acquisition will be used in conjunction with a Geographical Information System to assess habitat quality and interpret the distribution of these species of concern. In particular, factors such as cave ownership, public use, water quality, proximity to faults, and the quantity and type of organic matter inputs will be statistically compared to the abundance and diversity of cave fauna. Hypotheses pertaining to the colonization and migration of stygobites through karst conduits will be tested. Preliminary results of the state-wide survey indicate that *Amblyopsis rosae's* status is stable, if not improving, and that the range of the cave crayfishes, *Cambarus aculabrum* and *C. setosus*, may be greater than previously recorded. Furthermore, one of the populations of *C. aculabrum* has apparently recovered from a minimum of two individuals, and is now equal to the maximum published for that cave (nine individuals).

At the regional level (the Springfield and Salem Plateaus), researchers, NSS grottos, The Nature Conservancy, and federal and state (Arkansas and Oklahoma) land managers are now meeting regularly to discuss mutual needs and to share resources. Cooperative products include new surveillance and gating techniques, the assemblage of a cave resource database (with restricted access), cave clean-ups, increased funding for research and recovery actions, and educational/public outreach programs. Such a collaboration is timely because the Ozarks are experiencing rapid growth and land-use changes, which will undoubtedly affect cave ecosystems. The goal of this consortium might be summarized as the attempt to guide these land uses and growing economies towards practices that preserve cave ecosystems and conserve the groundwater resource.

Literature Cited

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