Community Conservation Assessment for Cave Streams and Associated Rare Animal Species

(photo by J. Lewis)

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HOOSIER NATIONAL FOREST

This Conservation Assessment was prepared to compile the published and unpublished information on cave stream habitats and associated rare animals species in the Hoosier National Forest. It does not represent a management decision by the U.S. Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the subject community and associated taxa, please contact the Eastern Region of the Forest Service Threatened and Endangered Species Program at 310 Wisconsin Avenue, Milwaukee, Wisconsin 53203.

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EXECUTIVE SUMMARY

The purpose of this document is to provide the background information necessary to prepare a Conservation Strategy, which will include management actions to conserve cave stream habitats and communities. Presently listed as Regional Forester Sensitive Species that occur in stream communities on the Hoosier National Forest are the copepod Cauloxenus stygius, amphipod Crangonyx packardi, crayfish Orconectes inermis and Northern cavefish Amblyopsis spelaea. Rare cavernicolous species present in stream communities to be recommended as Regional Forester Sensitive Species are the amphipods Crangonyx undescribed species #1, Crangonyx undescribed species #2, flatworm Sphalloplana weingartneri, and ostracod Sagittocythere barri.

DESCRIPTION OF HABITAT AND COMMUNITY

Like surface streams, Indiana cave streams differ widely in size. Typically following a dendritic pattern, cave streams grow in size as they gain flow after becoming confluent with other streams. In some cases a single stream passage is present through the length of a ridge with few side passages bringing in water, e.g., Spring Springs Cave, Dillon Cave or Gypsy Bill Allen Cave. In more complex caves dozens of side passages contribute water and there may be parallel cave river, such as in the Wesley Chapel Gulf Cave System. Cave streams are three dimensional in nature, with water also coming in from above via sinkholes or vertical shafts.

Cave streams in the Hoosier National Forest usually have at least two microhabitats: gravel riffles with intervening pools. The riffles may be of variable length and composed of sediment sizes ranging from silt or sand, through various sizes of gravel and cobbles, up to slabs of breakdown or boulders. The two most common rock types in the Hoosier National Forest are limestone and sandstone, each having characteristic surfaces as potential microhabitats. The pools between riffles range in depth from a few inches to the deep basins of Springs Spring Cave that are deeper than a person is tall.

Cave streams are important as the sources of nutrients in cave ecosystems. The streams can possess a wide range of organic material, varying from dissolved organics or suspended detritus up to entire trees entering via large swallowholes.

The subterranean community in a cave stream is usually a function of the size of the stream. In headwater streams size limits the community to the isopod Caecidotea stygia, amphipods Crangonyx spp., and flatworms Sphalloplana weingartneri. With increasing size the crayfish Orconectes inermis and Cambarus laevis may be added. In these deeper habitats the amphipods Crangonyx undescribed species or Crangonyx forbesi usually occur in the surficial waters, while Crangonyx packardi usually occurs down in the gravels. In habitats where deeper stream pools occur, the cavefish Amblyopsis spelaea or the sculpin Cottus carolinae may be found. Cave stream biodiversity increases with the addition of crayfish and cavefish since this adds the ectocommensal ostracods and copepods that occur on these species.

Accidental fauna is commonly found in cave streams, coming from sinkhole ponds or surface streams. Common constituents are flatworms, leeches, insect larvae, micro-crustaceans, and fish. Anything that can wash or fall into a hole potentially ends up in a cave stream, thus the entire surface fauna is potentially accidental cave fauna.

ENVIRONMENTAL CONDITIONS

Camacho (1992) listed a number of summarized characteristics of caves streams:

(1) Temperature--Dependent on the latitude, altitude, cave size and ventilation. In southern Indiana the temperature of a large stream in the interior of Binkley Cave monitored monthly for a year at multiple sites varied from 52.4 to 56.0 degrees, averaging 54.5 F.
(2) Light—absent, and therefore photosynthetic plants.
(3) Flow, velocity and level—These are three interconnected factors linked to atmospheric factors. A cave stream can change from base flow conditions of low velocity flow and level to a raging torrent filling a cave passage in a short period of time.
(4) pH—The interplay between dissolution and redeposition of calcite in caves is a function of the acidity/alkalinity of the water. In general cave stream water tends to be at or near neutral pH of 7.0. Microclimatic changes, such as the loss of dissolved gases as the water flows over riffles, may cause the solubility constant of the water to change with the deposition of rock in the form of rimstone dams or lime incrustations. The microchemistry of cave water is a complex topic. Hobbs (1995) reported pH ranging from 7.0 to 8.4 in caves in the Hoosier National Forest.
(5) Dissolved oxygen—The quantity of oxygen found in cave water is a function of passive diffusion at the water/air contact, in the absence of plants and photosynthetic oxygen production. Diffusion of oxygen into the water increases with agitation in riffles or waterfalls, and decreases with the metabolic demands of aquatic biota. In riffle areas the dissolved oxygen level is usually at or near saturated, decreasing in pools.
(6) Organics—Upon entering the cave the organic content of water is usually at its highest level and decreases as a function of distance into the cave as it is deposited or consumed by the biota.
(7) Other chemistry—The concentration of anions/cations in cave streams is dependent upon the source of the water and the level of contamination. Carbonate hardness reported by Hobbs (1995; and presumably bicarbonate hardness not reported) of cave stream water in a few caves in the Hoosier National Forest ranged from 46 to 441 mg/l, with concomitant elevations in conductivity. Nitrate and phosphate levels are usually <1.0 mg/l unless contaminated water is present.

CURRENT COMMUNITY CONDITION, DISTRIBUTION AND ABUNDANCE

Due to the presence of karst topography in the Hoosier National Forest cave streams and their communities are relatively common, although scarce in comparison to their surface equivalents. Many valleys formed in the karst of the Hoosier National Forest contain a cave stream that appears on the surface as a spring, although in many cases the cave remains unenterable to humans. In many cases little visitation occurs in these caves and the habitat and community remain in excellent condition.

Examples of caves with significant streams in the different areas of the Hoosier National Forest are: Patton Cave, Deam Wilderness, Monroe County; Elrod Cave and Wesley Chapel Gulf Cave, Wesley Chapel Gulf Special Area, Orange County; Henshaw Bend Cave, adjacent to the Tincher Special Area, Lawrence County; Gypsy Bill Allen Cave, Gypsy Bill Allen Special Area, Martin County; Mesmore Spring Cave, Hemlock Cliffs Special Area, Crawford County.

REGIONAL FORESTER DENDITIVE SPECIES

The copepod Cauloxenus stygius, amphipod Crangonyx packardi, crayfish Orconectes inermis and Northern cavefish Amblyopsis spelaea are presently listed as Regional Forester Sensitive Species that occur in stream communities on the Hoosier National Forest. Rare cavernicolous species present in stream communities to be recommended as Regional Forester Sensitive Species are the amphipods Crangonyx undescribed species #1, Crangonyx undescribed species #2, flatworm Sphalloplana weingartneri, and ostracod Sagittocythere barri.

POTENTIAL THREATS

Cave stream communities are particularly susceptible to disturbance from water-born contaminants and other disturbances. Potential contaminants include (1) sewage or fecal contamination, including sewage plant effluent, septic field waste, campground outhouses, feedlots, grazing pastures or any other source of human or animal waste (Harvey and Skeleton, 1968; Quinlan and Rowe, 1977, 1978; Lewis, 1993; Panno, et al 1996, 1997, 1998); (2) pesticides or herbicides used for crops, livestock, trails, roads or other applications; fertilizers used for crops or lawns (Keith and Poulson, 1981; Panno, et al. 1998); (3) hazardous material introductions via accidental spills or deliberate dumping, including road salting (Quinlan and Rowe, 1977, 1978; Lewis, 1993, 1996). Habitat alteration due to sedimentation is a pervasive threat potentially caused by logging, road or other construction, trail building, farming, or any other kind of development that disturbs groundcover. Sedimentation potentially changes cave habitat, blocks recharge sites, or alters flow volume and velocity. Keith (1988) reported that pesticides and other harmful compounds like PCB's can adhere to clay and silt particles and be transported via sedimentation. Observation of muddy brown floodwaters entering the Wesley Chapel Gulf Cave System are testimony to potential sedimentation problems. In areas like Elrod Cave where floodwaters apparently pond, large mudbanks have been

deposited. The degree to which this sedimentation is being augmented by the agricultural and other uses of the surrounding karst by man is unknown.

Impoundments may detrimentally affect cave species. Flooding creates changes in stream flow that in turn causes siltation and drastic modification of gravel riparian habitats (Duchon and Lisowski, 1980; Keith, 1988). Conditions in some Tucker Dam Quarry Cave (Springs Valley Recreation Area) was reported to change in response to the height of the adjacent Tucker Lake (Fee, 1992b). One of the caves known from the Deam Wilderness has apparently been covered by the impoundment creating Lake Monroe.

Fire and smoke are potential sources of airborne particulate contamination and hazardous material introduction to the cave environment. Elliott (1998) reviewed the possible insecticide effects of cigarette smoke from cave visitors and the numerous harmful chemicals present in it (Feinstein, 1952; Howarth, 1983). Many caves have active air currents that serve to inhale surface air from one entrance and exhale it from another. Ashes in the entrance of Patton Cave attest to campfires being built there. This activity produces a dead zone due to the heat involved and alters the habitat as well as making smoke.

Numerous caves have been affected by quarry activities prior to acquisition. For example, the entrance to Tucker Dam Quarry Cave was apparently created by quarrying, and the original cave was cut into two pieces (Fee, 1992b). Roadcut construction for highways passing through national forest land is a similar blasting activity and has the potential to destroy or seriously modify cave ecosystems. Indirect effects of blasting include potential destabilization of passages, collapse and destruction of stream passages, changes in water table levels and sediment transport (Keith, 1988).

Cave ecosystems are unfortunately not immune to the introduction of exotic species (Elliott, 1992; 1998). Out-competition of native cavernicoles by exotic facultative cavernicoles is becoming more common, with species such as the exotic milliped Oxidus gracilis (Lewis, et al., 2002 in press) that most heavily affects riparian communities . In some cases this milliped literally over-runs the habitat with its sheer numbers.

With the presence of humans in caves comes an increased risk of vandalism or littering of the habitat, disruption of habitat and trampling of fauna, introduction of microbial flora non-native to the cave or introduction of hazardous materials, e.g., spent carbide, batteries (Peck, 1969; Elliott, 1998).

SUMMARY OF LAND OWNERSHIP AND EXISTING HABITAT PROTECTION

Numerous cave streams and their communities are protected on the Hoosier National Forest. Prominent examples are: Patton Cave, Deam Wilderness, Monroe County; Elrod Cave and Wesley Chapel Gulf Cave, Wesley Chapel Gulf Special Area, Orange County; Spring Springs Cave and Dillon Cave, Little Africa area, Orange County; Tucker Lake Spring Cave, Springs Valley Recreation Area, Orange Co.; Gypsy Bill Allen Cave,

Gypsy Bill Allen Special Area, Martin County; Mesmore Spring Cave, Hemlock Cliffs Special Area, Crawford County. Forest service special areas and wilderness areas have restricted management criteria to protect the ecosystems within these areas (USDA Forest Service, 1991; 2000).

SUMMARY OF MANAGEMENT AND CONSERVATION ACTIVITIES

Cave and karst habitat located on the Hoosier National Forest are subject to standards and guidelines for caves and karst protection and management as outlined in the Hoosier National Forest Land and Resource Management Plan (Forest Plan) (USDA Forest Service, 1991). These standards and guidelines include the following:

> *Caves are protected and managed in accordance with the Federal Cave and Karst Resources Protection Act of 1988, Forest Service Manual 2353, Memorandums of Understanding between the forest service and the National Speleological Society, the Indiana Karst Conservancy, Inc., the Forest Cave Management Implementation Plan, and individual specific cave management plans.
>
> *Except where modified by an existing cave management prescription, vegetation within a 150-200 foot radius of cave entrances and infeeder drainages with slopes greater than 30 percent will generally not be cut. No surface disturbing activities will be conducted on any slopes steeper than 30 percent adjacent to cave entrances. Similar protection areas will be maintained around direct drainage inputs such as sinkholes and swallow holes known to open into a cave's drainage system of any streams flowing into a known cave.
>
> *Allow no sediment from erosion of access roads and drilling sites to wash into caves or karst features.
>
> *Seismic surveys requiring explosives shall not be conducted directly over known cave passages or conduits.
>
> *All caves will be managed as significant.
>
> (USDA Forest Service, 1991)

The forest plan includes a cave and karst management implementation plan. This management plan places an emphasis on cave resource protection and mitigation. Understanding of the caves is established through mapping, bioinventory, cataloging of resources (e.g., archaeological, paleontological, speleothems, etc.), and estimating use levels and trends. Protection zones or other mitigation measures recommended by a management prescription will be established around caves entrances, sinkholes and swallowholes. Specific criteria will include consideration for protection of entrance and cave passage microclimate, animals inhabiting the cave, physical and chemical parameters and aesthetic values associated with the cave.

RESEARCH AND MONITORING

A bioinventory of subterranean habitats of the Hoosier National Forest is being conducted in which stream communities are being sampled (Lewis, et al., 2002; and in progress). The Northern cavefish and its associated stream communities are also be evaluated (Pearson, in progress).

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