

TABLE 1.—CAVES KNOWN AS OF DECEMBER 23, 2002, TO CONTAIN ONE OR MORE OF THE NINE BEXAR COUNTY, TEXAS, KARST INVERTEBRATES FEDERALLY LISTED AS ENDANGERED—Continued

Species (# of caves)	Cave name
<i>R. infernalis ewersi</i> (3)	Flying Buzzworm Cave, Headquarters Cave, Low Priority Cave.
<i>R. infernalis</i> new subspecies (7)	Caracol Creek Coon Cave, Game Pasture Cave No. 1, Isopit, King Toad Cave, Obvious Little Cave, Stevens Ranch Trash Hole Cave, Wurzbach Bat Cave.
<i>R. infernalis infernalis</i> (19)	Bone Pile Cave, Dancing Rattler Cave, Government Canyon Bat Cave, Hackberry Sink, Lithic Ridge Cave, Surprise Sink, Christmas Cave, Helotes Blowhole, Logan's Cave, Madla's Cave, Madla's Drop Cave, Crownridge Canyon Cave, Genesis Cave, John Wagner Ranch Cave No. 3, Kamikazi Cricket Cave, Mattke Cave, Robber's Cave, Scorpion Cave, Three Fingers Cave.
Helotes mold beetle (<i>Batrises ventyivi</i>) (6)	San Antonio Ranch Pit, Scenic Overlook Cave, Christmas Cave, unnamed cave 1/2 mile N of Helotes, Helotes Hilltop Cave, unnamed cave 5 miles NE of Helotes.

Animal Community

Cave Crickets

Cave crickets are a critical source of nutrient input for karst ecosystems (Barr 1968; Reddell 1993). Cave crickets in the genus *Ceuthophilus* occur in most caves in Texas (Reddell 1966). Being sensitive to temperature extremes and drying, cave crickets forage on the surface at night and roost in the cave during the day. Cave crickets lay their eggs in the cave, providing food for a variety of karst species (Mitchell 1971b). Some karst species also feed on cave cricket feces (Barr 1968; Poulson *et al.* 1995) and on adults and nymphs directly (Cokendolpher, in press; Elliott 1994a). Cave crickets are scavengers or detritivores, feeding on dead insects, carrion, and some fruits, but not on foliage (Elliott 1994a).

Elliott (2000) studied the community ecology of three caves in protected areas of varying size in northwest Travis and Williamson Counties, Texas, from 1993 to 1999. The three caves are in areas protected as mitigation for two listed species found in Lakeline Cave during the development of Lakeline Mall. Lakeline Cave is located on a 0.9 hectares (ha) (2.3 acres (ac)) protected area and is surrounded by parking lots and a shopping center. Temples of Thor Cave and Testudo Tube are within much larger tracts of undeveloped land, being located on 42.5 ha (105 ac), and 10.5 ha (26 ac) of protected areas, respectively. During the monitoring study (1993–1999), the number of cave crickets drastically declined in Lakeline Cave, while they increased slightly or decreased moderately in the other two caves. Elliott (2000) concluded that drought, fire ants, and a decrease in racoon visitation caused the decline of the cave crickets. These results are consistent with reports of declines and extinctions of several invertebrates and small mammals (resulting from lower

survivorship, higher emigration, and/or lower immigration) from habitat patches ranging in size from 2 to 7 ha (5 to 17 ac) (Mader 1984; Tscharnitke 1992; Keith *et al.* 1993; Lindenmayer and Possingham 1995; Hill *et al.* 1996).

Elliott (1994a) evaluated cave cricket foraging within 50 m (164 ft) of cave entrances at his study sites and found crickets to the end of the 50 m sampling distance. On a few occasions he observed cave crickets beyond his sampling sites, and on one occasion he set a trap 60 m (197 ft) from the entrance and found one large adult. Elliott (1994a) concluded that the “largest adults probably are capable of traveling far beyond 60 m from the entrance,” but he did not have the data necessary to establish how far they go. During recent cave cricket surveys conducted for an ongoing project in central Texas, an adult cave cricket was found foraging 95 m (311 ft) from the study cave (Steve Taylor, Illinois Natural History Survey, pers. comm. 2002).

As troglonemes, cave cricket populations are dependent on the patchy distribution of karst voids. Therefore, cave cricket populations may have a metapopulation (subpopulations that interact via the dispersal of individuals from one subpopulation to others) or a source-sink population structure, and it may be important to protect multiple karst features that support cave crickets in a karst ecosystem (Helf *et al.* 1995). Metapopulation dynamics require movement among patches, and persistence requires interacting patches that undergo local extinctions and establishment of new subpopulations in areas previously devoid of individuals (Hanski 1999). “Source” populations are those that occur “in a high-quality habitat in which birth rate generally exceeds the death rate and the excess individuals leave as emigrants.” “Sink”

populations are those that occur “in a low-quality habitat in which the birth rate is generally lower than the death rate and population density is maintained by immigrants from source populations (Meffe *et al.* 1997). Because cave crickets are a key source of nutrient input for karst ecosystems, conserving adequate areas between karst patches in a manner that allows for movement of individuals among cave cricket populations is likely an important factor in long-term maintenance for karst ecosystems.

Subsurface karst areas may also be important to allow movement among cave cricket populations through the subsurface environment associated with continuous limestone blocks. For example, Caccone and Sbordoni (1987) studied nine species of North American cave crickets (genera *Eukadenoecus* and *Hadenoeus*) from sites in North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, Kentucky, and Alabama. Seven of the species were obligate cave-dwelling species that emerged at night to feed. Through genetic analyses of the cave-dwelling species, they found that species or groups of populations inhabiting areas where the limestone is continuous and highly fissured are genetically less differentiated than are populations occurring in regions where the limestone distribution is more fragmented, indicating more exchange of individuals in areas of continuous karst.

Helf *et al.* (1995) suggested that populations of an eastern species of cave cricket (*Hadenoeus subterraneus*) may be at risk because they do not recover quickly after events such as drought, floods, and temperature extremes that preclude or diminish foraging opportunities. These cave cricket populations may have source-sink population dynamics, with some