

**Helotes Mold Beetle**  
**(*Batrisodes venyivi*)**

**5-Year Review:**  
**Summary and Evaluation**

**U.S. Fish and Wildlife Service**  
**Austin Ecological Services Field Office**  
**Austin, Texas**

# 5-YEAR REVIEW

Helotes Mold Beetle (*Batrisodes venyivi*)

## 1.0 GENERAL INFORMATION

### 1.1 Reviewers

#### **Lead Regional Office:**

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### 1.2 Purpose of 5-Year Review:

The U.S. Fish and Wildlife Service (Service or USFWS) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing as endangered or threatened is based on the species' status considering the five threat factors described in section 4(a)(1) of the Act. These same five factors are considered in any subsequent reclassification or delisting decisions. In the 5-year review, we consider the best available scientific and commercial data on the species and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process including public review and comment.

### 1.3 Methodology used to complete the review

The Service provides notice of status reviews via the Federal Register and requests new information on the status of the species (e.g., life history, habitat conditions, and threats). Data for this status review were solicited from interested parties through a Federal Register notice announcing this review on July 26, 2019 (84 FR 36113). No new information was received from this solicitation. The Austin Ecological Services Field Office conducted this review and considered both new and previously existing information from federal and state agencies, municipal and county governments, non-governmental organizations, academia, and the public. Primary sources of information used in this review were recovery criteria and guidelines from the Bexar County Karst Invertebrates Recovery Plan (Service 2011a, pp. 16-26), Karst Preserve Design Recommendations (Service 2012, entire), and Karst Preserve Management and Monitoring Recommendations (Service 2014, entire). Unless otherwise noted, all acreage and distance estimates were calculated using Geographic Information Systems (GIS), 2020 digital aerial photography (Digital Globe 2020), and 2019 Bexar County parcel data (Strategic Mapping Program 2019). These estimates are subject to

typical margins of error (about 30 meters (m) [94.4 feet (ft)]) associated with Global Positioning Systems (GPS) units, GIS, and transferring data from paper sources to digital media.

#### 1.4 Background

The Helotes mold beetle (Coleoptera: Staphylinidae: Pselaphinae: *Batrisodes venyivi* Chandler 1992) is a small, eyeless beetle endemic to a restricted range in the karst landscape of northern Bexar County, Texas (Chandler 1992, pp. 241, 243-244, 247; Chandler and Reddell 2001, pp. 116, 127; Chandler et al. 2009, p. 136). The term “karst” refers to a type of terrain that is formed by the slow dissolution of calcium carbonate from surface and subsurface limestone, and other soluble rock types (e.g., carbonites and evaporates), by mildly acidic groundwater (Holsinger 1988, p. 148; Culver and Pipan 2009, pp. 5-15; Stafford et al. 2014, pp. 4-5). Flow of groundwater through conduits leads to the formation of an interconnected system of subterranean voids that become larger as bedrock is dissolved (Culver and Pipan 2009, pp. 5-8; Stafford et al. 2014, pp. 8-18). Rising waters (i.e., hypogenic) from depth have also played a role in cave formation in this region (Schindel and Gary 2018, pp. 80, 83-85).

The Helotes mold beetle is one of 25 species in the subfamily Pselaphinae associated with caves in Texas (Chandler et al. 2009, p. 126). Prior to 1992, two pselaphine species had been described from the state’s caves, *Batrisodes schneiderensis* from Kendall County (Park 1960, pp. 75-76) and *Texamaurops reddelli* from Travis and Williamson counties (Barr and Steeves 1963, pp. 118-120). Additional work by Chandler and Reddell (2001, entire) and Chandler et al. (2009, entire) described new species and increased the number of cave associated Pselaphinae known from Texas to 19 and then 25 species respectively.

Of the 25 Pselaphinae associated with caves in Texas, 14 are troglobitic (i.e., species adapted to subterranean habitats that must complete their life cycle underground) (Chandler et al. 2009, pp. 126, 136). These 14 species include *Texamaurops reddelli* and 13 species of *Batrisodes* in two subgenera: *Excavodes*, which includes the Helotes mold beetle, and *Babnormodes* (Chandler et al. 2009, pp. 126-127, 136). The six troglobitic *Batrisodes* currently described in the *Excavodes* subgenus are found in karst habitat between San Antonio and Georgetown, Texas while those in the *Babnormodes* subgenus are generally found in the Fort Hood area (Chandler et al. 2009, pp. 127, 136). The Helotes mold beetle is one of only two species of troglobitic *Batrisodes* known from Bexar County (Chandler et al. 2009, p. 136).

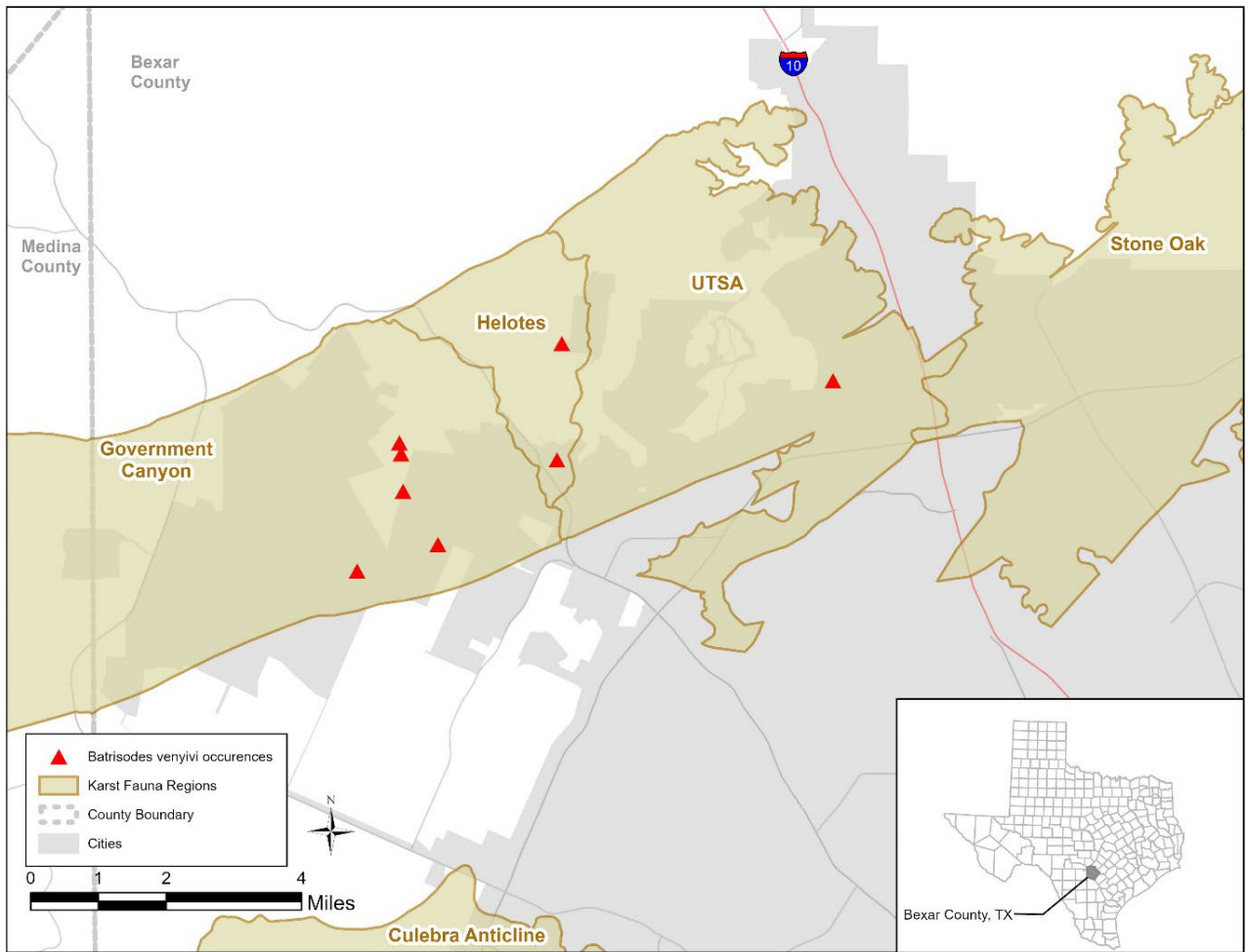
Cave-dwelling pselaphines, such as the Helotes mold beetle, occur primarily in the dark zone of caves, often in humid microhabitats (e.g., under rocks), and exhibit such troglomorphic traits (i.e., adaptations to subterranean environments) as absent or reduced eyes, elongated antennae and legs, and elongated sensory setae (i.e., hair-like structures) (Chandler 1992, pp. 241, 243, 247; Chandler and Reddell 2001, pp. 115, 118, 127; Chandler et al. 2009, p. 126). Studies indicate that troglobitic arthropods display preferences for higher relative humidity and/or lower air temperatures, underscoring a dependence on deep cave conditions (Bull and Mitchell 1972, pp. 375, 386; Yoder et al. 2011, p. 599; Mammola et al. 2015, pp. 246-247; Mammola and Isaia 2017, p. 3). Thus, the Helotes mold beetle likely requires subterranean habitats with high humidity and stable temperatures. Intact

networks of subterranean voids provide living space and a buffer or refugia from the effects of humidity and temperature extremes (Howarth 1980, pp. 397-398; Howarth 1983, p. 373; Martín and Oromí 1986, p. 384; Holsinger 1988, p. 147; de Freitas and Littlejohn 1987, pp. 558-560; Crouau-Roy et al. 1992, pp. 13-15; Tobin et al. 2013, p. 206; Mammola et al. 2015, pp. 243, 246; Mammola and Isaia 2016, pp. 26-27). Functional surface and subsurface drainage basins supply water that aids in the maintenance of high relative humidity (Hauwert 2009, p. 84; Veni 2003, p. 7).

Most pselpahines are predators and the Helotes mold beetle likely requires a source of food in the form of other invertebrates such as mites and springtails (Park 1960, p. 99; Newton and Thayer 1995, p. 303; Taylor et al. 2005, pp. 10, 29; Schomann et al. 2008, pp. 891-906; Ferro and Carlton 2014, p. 8). The majority of nutrients that support subterranean ecosystems originate from surface habitats, specifically the natural communities that overlay these systems (Barr 1968, pp. 47-48; Poulson and White 1969, pp. 971-972; Howarth 1983, p. 376; Culver and Pipan 2009, p. 23). Nutrients may take the form of animal or plant material washed in by water, blown by wind, or transported by animals (Barr 1968, pp. 51, 53; Howarth 1983, pp. 376-377; Holsinger 1988, p. 147; Culver and Pipan 2009, pp. 24, 27-39). Deposited organic matter provides a resource base for bacteria, fungi, and invertebrates that serve as prey for other invertebrates as well as vertebrates in caves (Barr 1968, pp. 53-60; Kane and Poulson 1976, pp. 799-800; Longley 1981, pp. 126-127; Howarth 1983, pp. 378-379; Ferreira et al. 2000, pp. 108-109). Availability of surface nutrients is an important factor in the maintenance of species richness in caves with greater amounts of nutrients supporting higher species richness (Jaffé et al. 2016, pp. 6, 9, 11; Jiménez-Valverde et al. 2017, pp. 10210-10212).

Cave crickets are contributors of nutrients in some subterranean ecosystems, including those of the Edwards Plateau (Barr 1968, pp. 51, 53; Peck 1976, p. 315; Veni et al. 1999, pp. 45-46; Reddell and Cokendolpher 2001, pp. 132-133; Taylor et al. 2004, pp. 9, 28, 31; Lavoie et al. 2007, p. 131; Peck and Wynne 2013, p. 314). Cave crickets roost in caves during the day, leaving at night to forage on animal and/or plant matter in the surrounding plant communities (Taylor et al. 2004, pp. 37-38; Taylor et al. 2005, p. 105). Nutrients obtained during foraging are transferred into the cave through defecation (i.e., guano), laying of eggs, predation of living crickets, and carcasses of dead crickets (Barr 1968, p. 53; Mitchell 1971, p. 259; Elliott 1994, p. 16; Poulson et al. 1995, pp. 226, 229; Lavoie et al. 2007, p. 131). Natural foraging habitat surrounding a cave is vital to the maintenance of cave cricket populations (Taylor et al. 2007, pp. 2, 37, 43). Declines in cave cricket populations can potentially lead to decreased abundances for other karst invertebrates (Taylor et al. 2007, pp. 2, 37, 41-44).

Known from three caves at the time, the Helotes mold beetle was listed as endangered on December 26, 2000, due to its restricted distribution and threats from urban development (65 FR 81419-81433). The stressors that most influence the Helotes mold beetle viability are habitat destruction, degradation, and fragmentation that results from urban development.



**Figure 1.** Current distribution of the Helotes mold beetle in Bexar County, Texas.

#### **1.4.1 FR Notice citation announcing initiation of this review:**

84 FR 36113, July 26, 2019

#### **1.4.2 Listing history**

##### Original Listing

**FR notice:** 65 FR 81419

**Date listed:** December 26, 2000

**Entity listed:** Helotes mold beetle (*Batrisodes venyivi*)

**Classification:** Endangered

#### **1.4.3 Associated rulemakings:**

Critical habitat was designated for seven of the nine listed Bexar County karst invertebrates, including the Helotes mold beetle, as announced in an April 8, 2003, Federal Register notice (68 FR 17156). On February 22, 2011, the Service proposed a revision of the previous critical habitat designations (68 FR 17156) and proposed critical habitat for the Government Canyon Bat Cave spider (*Tayshaneta* [= *Neoleptoneta*] *myopica*) and the Government Canyon Bat Cave meshweaver (*Cicurina vespera*) (76 FR 9872). A notice extending the comment period on the proposed revisions was published on August 2, 2011 (76 FR 46234), and the final notice announcing the revised designated critical habitat was published on February 14, 2012 (76 FR 8540).

#### **1.4.4 Review history:**

Status reviews for the Helotes mold beetle were conducted in 2000 for the final listing of the species (65 FR 81419) and 2011 in a 5-year review (Service 2011b, entire). The 2011 5-year review recommended no change in classification of endangered (Service 2011b, p. 19).

#### **1.4.5 Species' Recovery Priority Number at start of 5-year review:**

2C

#### **1.4.6 Recovery Plan or Outline**

**Name of plan or outline:** Bexar County Karst Invertebrates Recovery Plan

**Date issued:** September 2011

## **2.0 REVIEW ANALYSIS**

### **2.1 Application of the 1996 Distinct Population Segment (DPS) policy**

#### **2.1.1 Is the species under review a vertebrate?**

No, this species is an invertebrate, so the DPS policy does not apply.

## 2.2 Recovery Criteria

### 2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

Yes.

#### 2.2.1.1 Adequacy of recovery criteria.

Yes.

### 2.2.2 Adequacy of recovery criteria

#### 2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?

Yes.

#### 2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

Yes.

### 2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

Goal - The goal of the recovery plan is to reduce or remove threats to the species such that their long-term survival is secured in the wild, the species are no longer endangered or threatened, and can be delisted.

Objective 1 - Perpetually preserve a sufficient amount and configuration of habitat areas (karst fauna areas or KFAs) to preserve populations that span the range and provide representation of the genetic diversity of the species. This will help conserve their adaptive capabilities and will help protect the species survival in the event of catastrophic or other stochastic influences. When preserved, ensure these areas have a high probability of the species survival in perpetuity.

Objective 2 - Manage these areas to remove threats to the species' survival.

The following criteria were developed to measure our successes at accomplishing the objectives and reaching the goal above.

Criterion 1 (downlisting) - The location and configuration of at least the minimum quality and number of KFAs in each karst fauna region (KFR) for each species are preserved. Also, legally binding commitments are in place for perpetual protection and management of these KFAs. Overarching criteria that are applied per species include:

- (1) at least one high quality protected KFA per KFR;
- (2) at least three total medium or high quality protected KFAs per KFR;

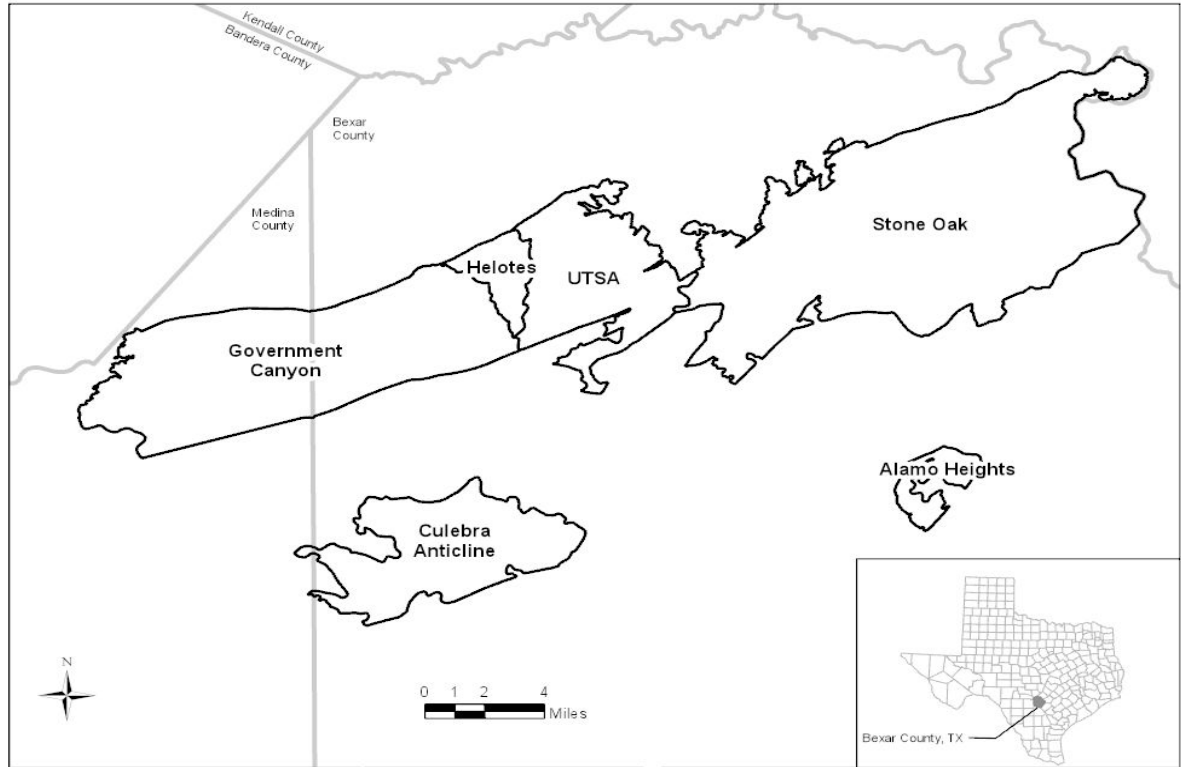
- (3) a minimum of six protected KFAs rangewide per species;
- (4) a minimum of three high quality KFAs;
- (5) all KFAs at least medium or high quality.

Criterion 2 - (delisting) - In addition to the downlisting criterion, monitoring and research have been completed to conclude with a high degree of certainty that KFA sizes, quality, configurations, and management are adequate to provide a high probability of the species survival (greater than 90 percent over 100 years). To assess adequacy, results should be measured over a long enough time that cause and effect can be inferred with a high degree of certainty.

For the purposes of the recovery program, a KFA is an area known to support one or more locations of a listed species. A KFA is distinct in that it acts as a system that is separated from other KFAs by geologic and hydrologic features and/or processes that create barriers to the movement of water, contaminants, and troglobitic fauna. Karst fauna areas should be far enough apart so that if a catastrophic event (for example, contamination of the water supply, flooding, disease) were to destroy one of the areas, that event would not likely destroy any other area occupied by that species.

To be considered adequate to contribute to meeting the recovery criteria, a KFA must be sufficiently large to maintain the integrity of the karst ecosystem on which the species depend(s). In addition, to be considered “protected” these areas must provide protection in perpetuity from threats such as RIFA, habitat destruction, and contaminants.

There are six KFRs in Bexar County that contain listed species. These regions are delineated based on geologic continuity, hydrology, and the distribution of rare troglobites (Veni 1994, entire). These six KFRs were used in the final rule to define the ranges of the listed species and are as follows: Stone Oak, University of Texas at San Antonio (UTSA), Helotes, Government Canyon, Culebra Anticline, and Alamo Heights (Figure 2).



**Figure 2.** Karst Fauna Regions of Bexar County, Texas

Based on current information, the Helotes mold beetle occurs in the Government Canyon, Helotes, and UTSA KFRs. In order to meet Criterion 1 (downlisting), there would need to be at least three protected KFAs in each of the three KFRs, with at least one in each of those KFAs in each KFR meeting the criteria for a high quality KFA (Table 1).

**Table 1.** KFAs needed per KFR.

<b>KFR</b>	<b>Minimum number of KFAs needed</b>	<b>Minimum number of high quality KFAs needed (out of the total)</b>
KFR 1	3	1
KFR 2	3	1
KFR 3	3	1

***Brief summary of preserve design principles:***

Much of the conservation and recovery of the Helotes mold beetle depends upon the long-term protection of surface and subsurface habitat. The study of troglobitic invertebrates is complicated by their cryptic nature, low observed abundances, and difficulty in accessing and adequately surveying subterranean habitats (Veni et al. 1999, p. 28; Culver et al. 2004, pp. 1222-1223; Schneider and Culver 2004, pp. 42-43; Krejca

and Weckerly 2007, pp. 8-10; Moseley 2009, pp. 50-51; Paquin and Dupérré 2009, pp. 6, 64; Schneider 2009, pp. 125-128; Wakefield and Zigler 2012, p. 25; Wynne 2013, p. 53; Pape and O'Connor 2014, p. 785; Stoev et al. 2015, p. 108; Souza and Ferreira 2016, p. 257; Trajano et al. 2016, p. 1822; Bichuette et al. 2017, p. 83; Jiménez-Valverde et al. 2017, p. 10213; Sendra et al. 2017a, p. 101; Sendra et al. 2017b, p. 49). Therefore, conservation strategies for the Helotes mold beetle focus on the delineation, protection, and management of occupied karst fauna areas.

The Bexar County Karst Invertebrate Recovery Plan provides guidelines on habitat conditions that are important to karst invertebrates (Service 2011a, pp. 6-8). Scientific information and additional karst preserve guidelines are further detailed in the Karst Preserve Design Recommendations (Service 2012, entire), and the Karst Preserve Management and Monitoring Recommendations (Service 2014, entire).

According to the Karst Preserve Design Recommendations, karst fauna areas should meet the following objectives (Service 2012, p. 1):

- Provide adequate quality and quantity of moisture to karst ecosystems
- Maintain stable in-cave temperatures
- Reduce or remove red-imported fire ant predation/competition
- Provide adequate nutrient input to karst ecosystems
- Protect mesocaverns to support karst invertebrate population needs, including adequate gene flow and population dynamics
- Ensure resiliency of karst invertebrate populations by establishing preserves large enough to withstand random or catastrophic events
- Provide a high probability of viable karst invertebrate population persistence in each preserve
- Minimize the amount of active management needed for each preserve

For a karst fauna area to count toward meeting recovery criteria, that area must be of a certain quality (i.e., high or medium). A legally binding mechanism must also assure management and perpetual protection of the area. The quality of a preserve is an indicator of how likely species are to survive for the long-term.

Details regarding preserve quality are as follows (Service 2012, p. 3):

#### **I. High Quality Preserve:**

High quality preserves have a higher probability of long-term survival of karst invertebrates. A high quality preserve is at least 40 hectares (ha) (100 acres [ac]) and includes the following components:

- The entire surface and subsurface drainage basin of caves and karst features
- The native surface plant and animal communities
- The cave or karst feature footprint, which should be over 105 m (345 ft) from the preserve edge

## **II. Medium Quality Preserve:**

A medium quality preserve is 16 to 40 ha (40 to 99 includes the following components:

- The entire surface and subsurface drainage basin of caves and karst features
- The native surface plant and animal communities
- The cave or karst feature footprint, which should be over 105 m (345 ft) from the preserve edge

## **III. Low Quality Preserve:**

A low quality preserve is less than 16 ha (40 ac). Low quality preserves should only be established in areas where conditions for high or medium quality preserves do not exist. While these preserves will not contribute to meeting the recovery criteria set forth for endangered karst invertebrate species, they help increase their probability of overall survival beyond what it would be without them; so they do have some value.

### ***Analysis regarding whether downlisting criteria have been met:***

At the time of the 2011 5-year review for the Helotes mold beetle, no karst fauna areas had been established for this species. The species was confirmed or potentially confirmed in eight caves in three KFRs. There was one potential high quality KFA in each of the Government Canyon and Helotes KFRs and no areas had the potential to meet the KFA criteria in the UTSA KFR.

Currently, there are seven caves or karst features known to contain or potentially contain the Helotes mold beetle in three karst fauna regions. These occur in one cave cluster and two individual caves in the Government Canyon KFR, two individual caves in the Helotes KFR, and one individual cave in the UTSA KFR. For simplicity, we will refer to all caves and karst features as caves although some of these may not meet the definition of a cave (i.e., karst features that consist of a natural opening in solid rock larger than 20 centimeters (cm) [ $> 8$  inches (in)] in diameter or cross-sectional dimension [Howarth 1983, p. 370; Culver and Pipan 2009, p. 4]).

The Service is working with the City of San Antonio to recognize two areas in the Government Canyon KFR as high quality KFAs. One additional area in that KFR has the potential to meet the definition of a medium quality KFA but could meet the definition of a high with additional monitoring and protection. In the Helotes KFR, there is a potential for one area to meet the definition of a medium quality KFA. No areas in the UTSA KFR have the potential to be either a high or medium quality KFA as the only cave known to be occupied by the Helotes mold beetle is believed to have been filled during construction of a commercial development in the mid 1990's.

**Table 2.** Potential, proposed, and protected karst fauna areas by karst fauna region.

<b>Karst Fauna Region</b>	<b>Potential Karst Fauna Area(s)</b>	<b>Proposed Karst Fauna Area(s)</b>	<b>Protected Karst Fauna Area(s)</b>
<b>Government Canyon</b>	1	2	0
<b>Helotes</b>	1	0	0
<b>UTSA</b>	0	0	0

Below is a discussion of these areas with a description of how they have the potential to contribute to meeting recovery criteria.

### **Government Canyon KFR**

#### Government Canyon State Natural Area

Lithic Ridge Cave and Sotol Pit both occur on Government Canyon State Natural Area, which is owned by Texas Parks and Wildlife Department. As mitigation for the Southern Edwards Plateau Habitat Conservation Plan, the City of San Antonio has worked with Texas Parks and Wildlife Department to establish high quality preserves surrounding several areas containing caves with listed species. Lithic Ridge Cave occurs in the approximately 90 ha (223 ac) Lithic Ridge, Dancing Rattler, and Hackberry Sink KFA area. This preserve encompasses the cave cricket foraging area and surface and subsurface drainage basins of this cave. Sotol Pit occurs in the approximately 40 ha (100 ac) 10K Cave KFA area. This preserve encompasses the cave cricket foraging area of this cave but the subsurface and surface drainage basins for this cave are unknown. Management for these preserves are being conducted under the Southern Edwards Plateau Habitat Conservation Plan Government Canyon State Natural Area Karst Fauna Areas Management and Monitoring Plan (Bowman Consulting 2017, entire) and through an inter-local agreement between Texas Parks and Wildlife Department and the City of San Antonio. The Service is working with the City of San Antonio to recognize these as high quality KFAs for the Helotes mold beetle.

#### Scenic Overlook Cave Cluster

Scenic Overlook Cave occurs on a 30 ha (75 ac) privately-owned parcel set aside and managed as part of the mitigation for the La Cantera Habitat Conservation Plan (Service 2001, entire). San Antonio Ranch Pit occurs on an adjacent 171 ha (423 ac) parcel purchased through the Section 6 HCP Land Acquisition Program. The cave cricket foraging areas and surface and subsurface drainage basins for these caves are undeveloped and occur within the boundaries of these two parcels. With confirmation of appropriate management and monitoring, there is enough area around these two caves to meet the criteria for a high quality KFA.

## **Helotes KFR**

### Helotes Hilltop Preserve

This 10 ha (25 ac) privately-owned preserve contains two caves, Helotes Blowhole and Helotes Hilltop Cave, and was set aside and is being managed as part of the mitigation for the La Cantera Habitat Conservation Plan (Service 2001, entire). The surface drainage basins of both caves are within the preserve; however, the subsurface drainage basins and cave cricket foraging areas are not. The cave cricket foraging area and subsurface drainage basin of Helotes Blowhole have been impacted by residential development but those of Helotes Hilltop Cave do not appear to have been impacted. With additional acreage and protection of the drainage basin and cave cricket foraging area of Helotes Hilltop Cave in perpetuity, this area could potentially meet the definition of a medium quality KFA.

## **UTSA KFR**

There are no areas in the UTSA KFR that meet or may meet the definition of a high or medium quality KFA.

## **2.3 Updated Information and Current Species Status**

### **2.3.1 Biology and Habitat**

#### **2.3.1.1 New information on the species' biology and life history:**

No new information.

#### **2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:**

No new information.

#### **2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):**

No new information.

#### **2.3.1.4 Taxonomic classification or changes in nomenclature:**

Newton and Thayer (1995, pp. 302-303) reduced the family Pselaphidae to a subfamily (i.e., Pselaphinae) within the family Staphylinidae (Bourchard et al. 2011, p. 31).

#### **2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g.**

**corrections to the historical range, change in distribution of the species within its historic range, etc.):**

At the time of the 2011 5-year review, our records indicated the Helotes mold beetle had been found in eight caves in three KFRs. Since the last review, the species has been documented in two additional caves and we have corrected several records. In the Government Canyon KFR, two additional caves, Lithic Ridge and Sotol Pit, have been documented to contain the Helotes mold beetle. In addition, as we have been unable to verify any collections of Helotes mold beetle from Tight Cave, it is not considered occupied for purposes of this review. In the Helotes KFR, we are not including the unnamed cave ½ mile northeast of Helotes as we believe that was listed in error. In addition, we are not including the unnamed cave ½ mi north of Helotes as it is now believed to refer to Helotes Hilltop Cave, a cave known to be occupied by the Helotes mold beetle. Finally, we believe the cave we referred to as an unnamed cave 5 miles northeast of Helotes in the UTSA KFR refers to La Cantera Cave No. 3. Chandler and Reddell (2001, p. 127) referred to a specimen collected from Cave 189, which we believe to be a different cave that occurs 4.5 mi (7.2 km) northeast of Helotes in the UTSA KFR. Thus, for this review, we are analyzing seven caves in three KFRs (Table 3).

An important consideration for this 5-year review was whether occupied caves warranted consolidation into single populations based on geographic proximity. Research indicates that troglobitic arachnids and insects may disperse through networks of subterranean voids (e.g., mesocaverns). In central Texas, some troglobitic beetles (i.e., *Rhadine*), bristletails (i.e., *Texoredellia*), and spiders (e.g., *Cicurina* and *Tayshaneta*=*Neoleptoneta*) have exhibited genetic connectivity among occupied caves (Avisé and Selander 1972, p. 15; Paquin and Hedin 2005, pp. 4-5, 14-15; Ledford et al. 2012, pp. 11, 18-23; Espinasa et al. 2016, pp. 233, 236, 238). Subterranean dispersal of troglobitic invertebrates, along with resultant gene flow in some cases, has been suggested to occur in cave systems of Australia (Moulds et al. 2007, pp. 958, 960), Brazil (Jaffé et al. 2016, pp. 11-12), and other regions of the United States (i.e., Kentucky; Turanchik and Kane 1979, pp. 65-67).

Ledford et al. (2012, pp. 11, 18-23, 51) documented significant genetic similarity (i.e., mitochondrial and nuclear DNA) among Tooth Cave spider populations at Gallifer, Root, and Tooth Caves and Tight Pit in Travis County. Genetic similarity among Tooth Cave spiders sampled from those sites implies dispersal of individuals between caves over time through interconnected subterranean dispersal corridors (e.g., fissures or mesocaverns) (Ledford et al. 2012, pp. 11, 51). The greatest distance between genetically similar Tooth Cave spider populations at Tight Pit and Gallifer, Root, and Tooth Caves is approximately 292 m (958 ft). Greater distances between genetically similar troglomorphic *Tayshaneta* (i.e., *T. anopica* and *T. sandersi*) species were noted by Ledford et al. (2012, pp. 11, 18-23) in Travis and Williamson counties. Individuals of *T. sandersi* sampled from three caves (i.e., District Park Cave,

Slaughter Creek, and Whirlpool Caves) in Travis County were found to be genetically identical, with an average distance of 698 m (2,290 ft) between those karst features (Ledford et al. 2012, p. 57).

For our assessment, we assumed that populations of the Helotes mold beetle, given adequate geological connectivity, are capable of subterranean dispersal and gene flow among karst features. To account for potential genetic connectivity of populations, we assigned a maximum dispersal radius of 300 m (984 ft) from each cave occupied by the species. Given the extent of geological connectivity surrounding caves, actual Helotes mold beetle dispersal distances may be greater or lesser than that value. Genetic analyses would be necessary to provide more certainty regarding actual dispersal distances.

For each cave occupied by the Helotes mold beetle, we established a 300 m (984 ft) radius around individual sites in ArcGIS with the entrance as a center-point. If the respective radiuses of adjacent caves over-lapped (or caves were within 600 m (1968 ft) of each other), those sites were grouped into what we refer to as a cave cluster and those caves were assumed to be part of the same interconnected Helotes mold beetle population. If a cave’s radius did not overlap with any other cave, we labeled that site an individual cave and considered it an isolated population. Based on that methodology, we grouped Helotes mold beetle occurrences into a total of one cave cluster and five individual caves (Table 3).

**Table 3.** Cave clusters and individual caves by karst fauna region.

<b>Cave Name</b>	<b>Cave Cluster</b>	<b>Karst Fauna Region</b>	<b>Ownership</b>
<b>Scenic Overlook Cave</b>	Scenic Overlook Cave Cluster	Government Canyon	Texas Parks and Wildlife Department (TPWD)
<b>San Antonio Ranch Pit</b>	Scenic Overlook Cave Cluster	Government Canyon	City of San Antonio
<b>Lithic Ridge Cave</b>	None	Government Canyon	TPWD
<b>Sotol Pit</b>	None	Government Canyon	TPWD
<b>Christmas Cave</b>	None	Helotes	Private
<b>Helotes Hilltop Cave</b>	None	Helotes	Private
<b>Cave 189</b>	None	UTSA	Private

**2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):**

The population needs of the Helotes mold beetle are the factors that provide for a high probability of population persistence over the long-term at an occupied location (e.g., low degree of threats and high survival and reproduction rates). Since population estimates for the Helotes mold beetle are unavailable, nor do

we know what reproductive rates sustain a healthy population, we applied measures of surface habitat elements (i.e., area of naturally vegetated open space, distance of cave entrance to nearest edge, and status of cave cricket foraging area and drainage basins) surrounding a cave as surrogates to assess population resiliency. For a full discussion of this methodology, see Service (2018, pp. 49-53).

Variables related to surface land uses and native vegetation can influence cave invertebrate communities, even at some distance (i.e., 50-250 m [164-820 ft]), from a cave's entrance (Pellegrini et al. 2016, pp. 23-34). Jaffé et al. (2018, pp. 9, 11) found that anthropogenic land use, in the form of agriculture, within 50 m (164 ft) of a cave significantly reduced troglobitic invertebrate species richness. Those researchers partially attributed reductions to chemical contamination in the form of herbicide, pesticide, and/or fertilizer use (Jaffé et al. 2018, p. 17). Reduction of nutrients into caves, due to loss of surrounding native vegetation to agricultural conversion, was cited as another potential contributor to reduced species richness (Jaffé et al. 2018, p. 17).

It is likely that urbanization may have similar impacts on cave systems (Pellegrini et al. 2016, p. 28). Construction of development projects (e.g., single- or multi-family housing, commercial buildings, and paved roadways) often entails the partial or complete mechanical removal of natural vegetation, and potentially topsoil, from a site (Theobald et al. 1997, p. 26; Zipperer 2011, pp. 188-189) followed by replacement with built structures, impervious cover, and/or non-native, managed landscaping (McKinney 2002, pp. 884, 886; McKinney 2008, p. 168). Once completed, such urban landscape features can have long-term impacts on surrounding natural communities (Theobald et al. 1997, pp. 27-28, 31-33). Compared to some other anthropogenic drivers of species decline, including agriculture, forestry, or grazing, the impacts of urbanization on native habitats are more persistent resulting in highly modified sites with decreased potential for maintenance or reestablishment of native species (Rebele 1994, p. 177; Theobald et al. 1997, p. 33; Huxel and Hastings 1999, p. 312; Marzluff and Ewing 2001, p. 281; McKinney 2002, pp. 883-886, 889; Hansen et al. 2005, pp. 1899-1900).

For this review, we evaluated 2020 aerial imagery of areas surrounding occupied caves in ArcGIS for the following habitat elements: amount of open space with natural vegetation contiguous with a cave entrance, distance of the cave entrance to nearest edge, and status of the cave cricket foraging area and surface and subsurface drainage basins, if known. As we lack maps of every cave's footprint, cave entrances served as center-points for measurements where they are missing.

We assigned each cave cluster and individual cave site to one of four resiliency categories, high, moderate, low, or impaired, based on values generated for each habitat element (Service 2018, p. 53). We also noted whether a site possessed legally binding perpetual protection along with the amount of acreage protected, if that information was available.

Habitat elements at high and moderate resiliency sites provide the greatest probability for persistence of Helotes mold beetle populations and the associated karst ecosystem. However, a sites' continued status as high or moderate resiliency is dependent on the perpetuation of the needed surface and subsurface habitat elements. A cave cluster with a high or moderate resiliency designation may contain an individual cave or caves with lower resiliency, but if at least one cave in the cluster was potentially capable of supporting a high to moderate resiliency population, we assigned that higher resiliency category to the entire cluster. Low resiliency and impaired cave clusters and individual caves potentially lack habitat elements of sufficient quality to support persistent populations of Helotes mold beetle over the long-term.

Impacts to a cave’s surface or subsurface drainage basin can be a significant source of stressors for Helotes mold beetle populations. To characterize habitat for a particular site, it is important to determine whether development activities are affecting drainage basins, altering either the quantity or quality of hydrologic inputs into the karst ecosystem. At this time, however, we do not have adequate assessments of drainage basins for all occupied sites. If drainage basins have been delineated for a cave, we used those areas. For those whose drainage basins have not been delineated, we assumed that larger tracts of open space were more likely to include intact drainage basins, particularly when the cave entrance was some distance from the edge. In using this approach, we recognize that drainage basin impacts may be occurring undetected even in high and moderate resiliency sites. Thus, it would be important to delineate and protect these areas in the future to ensure Helotes mold beetle persistence.

Based on this review, one cave cluster and two individual caves in the Government Canyon KFR and one individual cave in the Helotes KFR are currently of high to moderate resiliency with potential to support Helotes mold beetle populations over the long-term (Table 4). For the most part, these sites are in larger tracts of open space and have relatively unaltered cave cricket foraging areas and drainage basins.

**Table 4.** Current resiliency of Helotes mold beetle sites (cave clusters and individual caves) by karst fauna region.

<b>Karst Fauna Region</b>	<b>High</b>	<b>Moderate</b>	<b>Low</b>	<b>Impaired</b>	<b>Destroyed</b>
<b>Government Canyon</b>	3	0	0	0	0
<b>Helotes</b>	0	1	0	1	0
<b>UTSA</b>	0	0	0	0	1
<b>Total</b>	<b>3</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>1</b>

**2.3.1.7 Other:**

No new information.

## **2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)**

### **2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:**

The species' range in Bexar County which also includes a portion of the City of San Antonio continues to experience substantial human population growth and development (Neumann and Bright 2008, pp. 8-11, 13; Frey 2012, pp. 7, 8, 11; Potter and Hoque 2014, p. 5). During the period from 2007 to 2010, the San Antonio area was among the fastest growing metropolitan areas in the United States (Frey 2012, p. 8). In the period from 2010 to 2018, San Antonio grew from 1,326,768 people to 1,532,233 people (U.S. Census Bureau 2019).

Population projections from the Texas State Data Center predict many of the large urban counties will continue to experience high growth rates with Bexar County being one of the counties expected to add a million more people by the year 2050 (You et al. 2019, pp. 5-6). Bexar County is also one of three counties expected to grow faster than the state (You et al. 2019, p. 2). The human population in Bexar County increased between 1980 and 2018, from 988,800 people to 1,986,049 people (U.S. Census Bureau 1982, p. 8; U.S. Census Bureau 2019) and is expected to increase to 3,353,060 people by the year 2050 (Texas Demographic Center 2018).

Increased conversion of natural surface habitat to development or infrastructure has accompanied human population growth in Bexar County. Numbers of single and multi-family housing units in Bexar County increased by 281% over a 48-year period, from 249,025 units in 1970 to 700,132 units in 2018 (U.S. Census Bureau 2012, p. 6; U.S. Census Bureau 2018). Installation of infrastructure projects and non-residential commercial development can be expected to follow establishment of new housing units further expanding the urban, suburban, and exurban footprint (Cohen 1996 pp. 1051-1053; Brueckner 2000, pp. 166-167; Cowley and Spillette 2001, pp. 8-9; Heimlich and Anderson 2001, pp. 12, 18-19; Scheer 2001, pp. 31-35; Oguz et al. 2008, pp. 11-12; Landis 2009, pp. 157, 165).

The Helotes mold beetle, and its subterranean habitat, is reliant on functional surface ecological systems. The plant communities that overlay and surround cave systems aid in buffering subterranean ecosystems from stressors, support nutrient flow, and aid in the maintenance of microclimatic conditions (Barr 1968, pp. 47-48; Poulson and White 1969, pp. 971-972; Howarth 1983, p. 376; Culver and Pipan 2009, p. 23; Simões et al. 2014, p. 168; Pellegrini et al. 2016, pp. 28, 32-34). As a site is developed, native plant communities are often mechanically cleared and replaced with a highly modified urban to exurban landscape (Theobald et al. 1997, p. 26; McKinney 2002, pp. 884, 886; McKinney 2008, p. 168; Zipperer 2011, pp. 188-189).

Construction activities may also modify cave entrances and other openings to the surface (Watson et al. 1997, p. 11; Veni et al. 1999, p. 55; Waltham and Lu 2007, p. 17; Frumkin 2013, pp. 61-62; Hunt et al. 2013, p. 97), which could affect climatic conditions within the cave as well as water infiltration (Pugsley 1984, pp. 403-404; Elliott and Reddell 1989, p. 7; Culver and Pipan 2009, p. 202). The abundance and species richness of native animals may decline due to decreased foraging or sheltering habitat, increased predation, competition with non-native species, or lack of connectivity among populations (Rebele 1994, p. 177; McKinney 2002, pp. 885-886; Taylor et al 2007, pp. 2, 37, 41-44; Pellegrini et al. 2016, pp. 28, 34).

Direct and collateral impacts to surface and subsurface habitat from urbanization have the potential to reduce Helotes mold beetle population viability and the species' long-term persistence. Land conversion to residential and commercial development has already reduced and degraded surface habitats surrounding a number of occupied sites. Given population and urbanized land growth projections (Texas Demographic Center 2018; Nowak and Greenfield 2018, p. 170), it is likely that many of the remaining surface and subsurface habitats will be impacted in the absence of management and protection.

#### **2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:**

No new information.

#### **2.3.2.3 Disease or predation:**

Recent research underscores the importance of human disturbance to red-imported fire ant invasion. Although habitat disturbance facilitates red-imported fire ant establishment in affected natural communities (LeBrun et al. 2012, pp. 891-893; King and Tschinkel 2013, p. 73), the absence of disturbance does not preclude invasion of undisturbed areas. In southern Texas, LeBrun et al. (2012, pp. 891-892) noted that red-imported fire ants were able to establish colonies in undisturbed grassland and achieve abundances comparable to dominant native ant species. The prevalence of this non-native ant in those grasslands, however, was lower than in disturbed grasslands (LeBrun et al. 2012, p. 888). Red-imported fire ant prevalence can decline following the cessation of disturbance but several decades may be required before populations reach the lower levels observed in undisturbed habitats (LeBrun et al. 2012, p. 892).

Since the 2011, 5-year review, a new non-native invasive ant species has established colonies at sites in Bexar County. The tawny crazy ant (*Nylanderia fulva*), native to South America, was documented in Texas in 2002 and has established populations along the state's Gulf Coast and some central Texas counties (Wang et al. 2016, p. 4). This ant has exhibited a potential to affect native animal and plant communities (LeBrun et al. 2013, p. 2439; Wang et al. 2016, p. 5).

Tawny crazy ant colonies are often polygynous and can form dense infestations that dominate the local ant community (LeBrun et al. 2013, pp. 2430, 2433). Arthropod species richness and abundance may decline in areas infested by tawny crazy ants (LeBrun et al. 2013, pp. 2434-2435; Wang et al. 2016, pp. 5, 7). Tawny crazy ants also appear capable of eliminating red-imported fire ants from areas where the species co-occur (LeBrun et al. 2013, pp. 2436-2437). Unlike red-imported fire ants that generally prefer open-habitat types, the tawny crazy ant can reach high densities in forested habitats along with grasslands and other open-habitat types (LeBrun et al. 2013, pp. 2439-2440). Sites with dense canopies, therefore, would be afforded some decreased susceptibility to red-imported fire ants but not the tawny crazy ant.

LeBrun (2017, entire) assessed the effects of tawny crazy ants at two caves in Travis County, Texas. Based on observations at these two sites, use of caves by ants was tied to surface temperatures and moisture with tawny crazy ants most prevalent in caves during hot, dry summer conditions (LeBrun 2017, p. 35). Tawny crazy ants preyed on cave crickets and other karst invertebrates with one species, the spider *Cicurina varians*, experiencing decreased abundance associated with that ant's presence (LeBrun 2017, pp. 21-22, 35-36). No declines were noted for other karst invertebrates examined, although results may be limited by the small sample size (LeBrun 2017, pp. 22, 35). Additional research is needed to determine the potential for the tawny crazy ant to affect Helotes mold beetle populations.

#### **2.3.2.4 Inadequacy of existing regulatory mechanisms:**

No new information.

#### **2.3.2.5 Other natural or manmade factors affecting its continued existence:**

A National Oceanic and Atmospheric Administration (NOAA) report assessing the effect of climate change on Texas asserts that by the end of the 21st century even under lower emissions scenarios (e.g., RCP 4.5) the coldest years will feel like the warmest years today, and the warmest years will be about six degrees (Fahrenheit) warmer than the hottest year from the historical record (Runkle et al. 2017, p. 1). Warming under a higher emissions scenario (RCP 8.5) would lead to higher temperatures (Runkle et al. 2017, p. 1).

Model projections of future climate in southwestern North America also show a transition to a more arid climate that began in the late 20th and early 21st centuries (Seager et al. 2007, pp. 1,183). Milly et al. (2005, p. 349) project a 10% to 30% decrease in stream flow in mid-latitude western North America by the year 2050 based on an ensemble of 12 climate models.

Based on downscaling global models of climate change, Texas is expected to receive up to 20 percent less precipitation in winters and up to 10 percent more precipitation in summers (Jiang and Yang 2012, p. 238). However, most regions

in Texas are predicted to become drier as temperatures increase (Jiang and Yang 2012, pp. 240–242).

Extreme droughts in Texas are now much more probable than they were 40 to 50 years ago (Rupp et al. 2012, pp. 1,053–1,054). In both moderate and high greenhouse gas emissions scenarios, Cook et al. (2015, pp. 5-6) predict that the Central Plains and Southwest regions of the United States will experience a drought in the second half of the 21st century (2050-2099) more severe than any other in the past 1,000 years.

The climatic conditions of caves, while relatively stable compared to surface habitats, are subject to variation in prevailing relative humidity and air temperature (Culver 1982, p. 9; Culver and Pipan 2009, pp. 3-4). Cave morphology (e.g., size, shape, and volume), number and size of entrances, seasonal changes in airflow, and annual range of surface temperatures among other factors interact to influence subterranean climates (Tuttle and Stevenson 1978, pp. 110-120; de Freitas and Littlejohn 1987, p. 568). Troglotic arthropods, such as the *Helotes* mold beetle, may respond to seasonal shifts by moving to microclimates with higher humidity (i.e., mesocaverns) during dry conditions or into larger subterranean voids (i.e., macrocaverns) during wet periods (Park 1960, p. 99; Howarth 1983, p. 373; Crouau-Roy et al. 1992, p. 17; Mammola et al. 2015, p. 246); however, the exact limits of its temperature and humidity physiological tolerance for this species are unknown.

With increasing distance into the cave, climatic conditions stabilize within a narrow range of humidity and temperature (Poulson and White 1969, p. 972; Howarth 1980, p. 398; Howarth 1993, p. 69; Prous et al. 2004, pp. 377-378; Tobin et al. 2013, p. 206). These temperatures, however, are affected by the average local temperature of the area within which the cave occurs (Badino 2010, p. 429; Covington and Perne 2015, p. 365, Mammola et al. 2017, p. 7-EV). Thus, as average annual surface temperatures increase, it is reasonable to predict that increases in temperatures in caves will follow. However, the length of the lag time for this correlation under climate change scenarios, as well as the detailed mechanistic relationship between climate change and changes in temperatures for individual caves is not easy to predict. If surface temperature increases and longer dry periods and reduced soil moisture lead to changes in the climate of the deep cave zones, this could reduce or eliminate available habitat within occupied caves, thus affecting the *Helotes* mold beetle.

## 2.4 Synthesis

Based on a review of available data, one of the three KFRs that the *Helotes* mold beetle occurs in has three or more areas currently of sufficient resiliency with the potential to support *Helotes* mold beetle populations over the long-term. Larger tracts of open space with natural vegetation surround these caves, providing higher quality cave cricket foraging habitat and greater potential for connectivity among karst features to support cricket populations. Persistence of *Helotes* mold beetle populations at these sites, however, are dependent upon management and perpetual protection that maintains adequate open space,

sufficient buffering from edge effects, intact foraging areas for cave crickets, and sufficient quantity and quality of water from intact drainage basins.

Projections indicate that the human population of Bexar County area will continue to grow from 1,986,049 people in 2018 to 3,353,060 people in 2050 (Texas Demographic Center 2018). Such significant human population growth is projected to result in increased conversion of natural surface habitat to urban land uses through 2060 (Nowak and Greenfield 2018, p. 170). If adequate protections are not enacted, land clearing, residential and commercial construction, and installation of infrastructure will accompany this growth and degrade the resiliency of high and moderate resiliency sites over time.

Recovery criterion (1) in the Bexar County Karst Invertebrates Recovery Plan (Service 2011a, p. 25) recommends that at least three KFAs in each karst fauna region be protected, with at least one in each KFR being high quality in order to ensure the species' long-term survival in the wild is secure. Protection is defined as an area sufficiently large to maintain the integrity of the karst ecosystem on which the species depends. These areas must also provide protection from threats such as habitat destruction, red-imported fire ants, and contaminants. Recovery criterion (2) recommends conducting sufficient research to conclude that these areas provide a high probability of species long-term survival.

Currently, three areas in the Government Canyon KFR one in the Helotes KFR have the potential to meet either a high or medium quality KFA provided adequate management and protections are put in place. No areas in the UTSA have the potential to meet either a high or medium quality KFA. At present, recovery criteria for the Helotes mold beetle have not been achieved and threats from increasing development due to rapidly growing human populations in Bexar County are projected to continue. At this time, we do not recommend a change in listing status for the Helotes mold beetle.

### 3.0 RESULTS

#### 3.1 Recommended Classification:

Downlist to Threatened

Uplist to Endangered

Delist (*Indicate reasons for delisting per 50 CFR 424.11*):

*Extinction*

*Recovery*

*Original data for classification in error*

No change is needed

#### 3.2 New Recovery Priority Number: No Change (2C)

**Brief Rationale:** A Recovery Priority Number of 2C is indicative of a taxon with a high degree of threat, a high recovery potential, and the taxonomic standing of a species. The C indicates that the species' recovery conflicts with water demands, development projects, or other forms of economic activity. The Helotes mold beetle continues to be threatened by a high degree of habitat destruction, disturbance, and degradation across its range. However, we consider this species' potential for recovery to be feasible through the concerted efforts of Service personnel and our partners to restore, enhance, and protect habitat.

#### **4.0 RECOMMENDATIONS FOR FUTURE ACTIONS**

- I. Continue efforts to establish karst fauna areas or other protected sites for the Helotes mold beetle throughout its range.
- II. Apply recovery criterion 2 to karst fauna areas that qualify.
- III. Reassess the current karst fauna regions of Bexar County, Texas using current data and revise regions as necessary to better inform recovery efforts.

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**U.S. FISH AND WILDLIFE SERVICE**  
**5-YEAR REVIEW of the Helotes mold beetle**  
**(*Batrisodes venyivi*)**

**Current Classification:** Endangered

**Recommendation resulting from the 5-Year Review:**

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change needed

**Review Conducted By:** Jenny Wilson, Austin Ecological Services Field Office

**FIELD OFFICE APPROVAL:**

**Lead Field Supervisor, Fish and Wildlife Service**

Approve \_\_\_\_\_ Date \_\_\_\_\_