Government Canyon Bat Cave Meshweaver
(*Cicurina vespera*)

5-Year Review:
Summary and Evaluation

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

5-YEAR REVIEW

Government Canyon Bat Cave Meshweaver (*Cicurina vespera*)

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office: Southwest Regional Office, Region 2
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1.2 Methodology used to complete the review:

The U.S. Fish and Wildlife Service (Service) conducts status reviews of species on the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.12) as required by section 4(c)(2)(A) of the Endangered Species Act (16 U.S.C. 1531 et seq.). 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), 2019 digital aerial photography (Digital Globe 2019), 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.

1.3 Background:

The purpose of a 5-year review is to ensure that the Government Canyon Bat Cave meshweaver has the appropriate level of protection under the Endangered Species Act. The 5-year review examines new relevant information and documents a determination by the Service regarding whether the species status has changed since the last status review.

The review also provides updated information on the current threats to the species, ongoing conservation efforts, and the priority needs for future conservation actions.

The Government Canyon Bat Cave meshweaver (Arachinida: Araneae: Hahnidae: *Cicurina vespera* [Gertsch 1992]) is a small, eyeless, troglobitic spider endemic to a restricted range in the karst landscape of northern Bexar County, Texas (Gertsch 1992, p. 111; Cokendolpher 2004, pp. 24, 41, 53; Paquin and Dupérré 2009, pp. 27, 53; Hedin et al. 2018, p. 71). 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 Government Canyon Bat Cave meshweaver is one of 58 currently recognized species of eyeless *Cicurina* described within the subgenus *Cicurella,* all but four of which are found in Texas (Gertsch 1992, pp. 97-98, pp. 97-120; Cokendolpher 2004, pp. 38-56; Paquin and Dupérré 2009, pp 9-62; Hedin et. al. 2018, p. 50). Nine of the species found in Texas, including the Government Canyon Bat Cave meshweaver, are found only in Bexar County (Gertsch 1992, pp. 101, 103, 109, 111; Cokendolpher 2004, pp. 38-44, 46, 47-48, 51-56; Paquin and Dupérré 2009, pp. 15-17, 27-29, 33-34, 38, 52-53).

The eyeless species of *Cicurina* in Bexar County, including the Government Canyon Bat Cave meshweaver, are all troglobites (i.e., species that spend their entire life-cycle underground) and exhibit morphological adaptation to subterranean environments (i.e., troglomorphy) including the lack of eyes, large size, longer appendages, and lighter coloration (Cokendolpher 2004, p. 23). They all inhabit dark, moist areas of caves and other subterranean voids and do not occur at or very near twilight zones (Cokendolpher 2004, p. 20).

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 Government Canyon Bat Cave meshweaver 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).

Cicurinas are predators, biting and holding their prey with their chelicerae (jaw-like appendages) while the venom acts (Cokendolpher 2004, p. 21). Cricket nymphs and a range of other cavernicolous invertebrates, including *Brackenridgia* isopods, *Texoreddellia* silverfish, *Cambala* and Speodesmus millipedes, and *Pseudosinella* springtails, found in the dark zone of caves are potential food for the eyeless *Cicurinas* (Cokendolpher 2004, p. 21).

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; Jasinska et al. 1996, p. 518). 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 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 only from two caves at the time, the Government Canyon Bat Cave meshweaver 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 Government Canyon Bat Cave meshweaver viability are habitat destruction, degradation, and fragmentation that results from urban development.

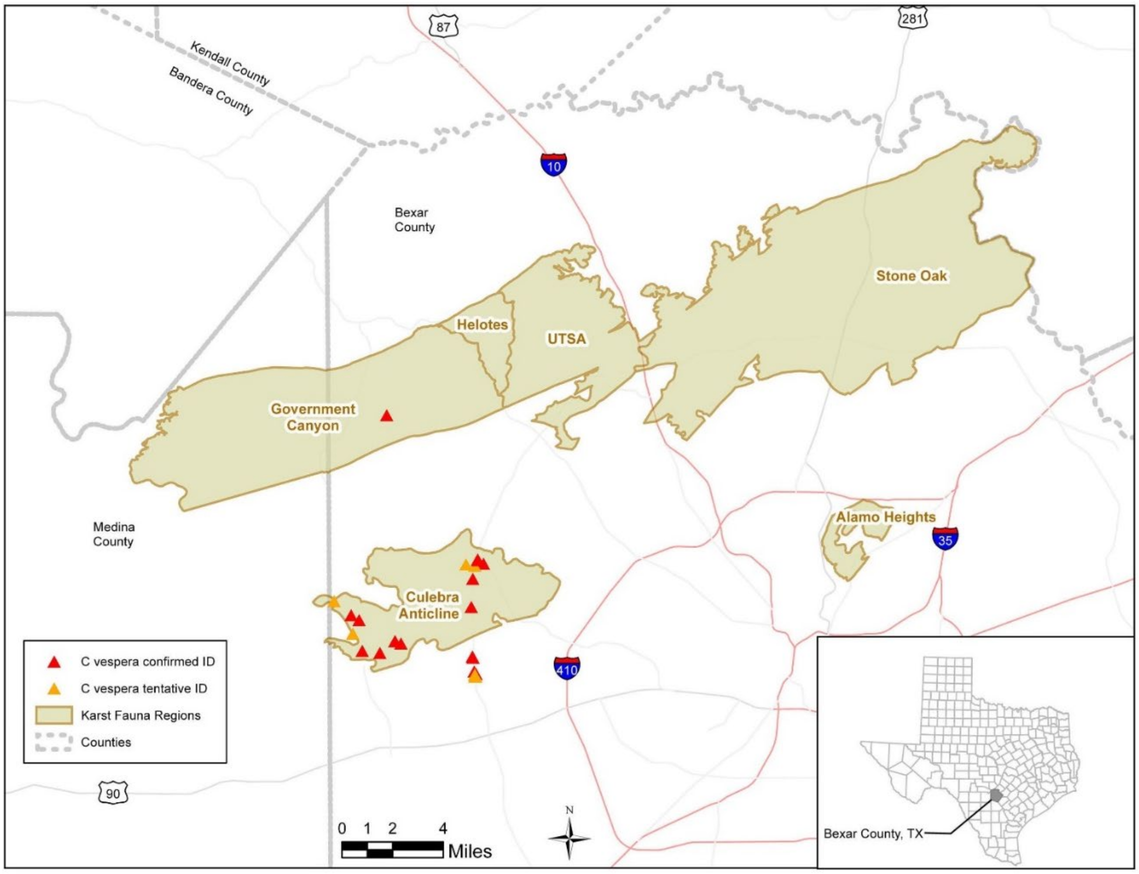


Figure 1. Current Distribution of the Government Canyon Bat Cave Meshweaver in Bexar County, Texas.

1.3.1 FR Notice citation announcing initiation of this review:

84 FR 36113, July 26, 2019

1.3.2 Listing history

<u>Original Listing</u>
FR notice: 65 FR 81419
Date listed: December 26, 2000
Entity listed: Government Canyon Bat Cave meshweaver (*Cicurina vespera*)
Classification: Endangered

1.3.3 Associated rulemakings:

Critical habitat was designated for seven of the nine listed Bexar County karst invertebrates, excluding the Government Canyon Bat Cave spider and the Government Canyon Bat Cave meshweaver, as announced in an April 8, 2003, Federal Register notice (68 FR 17156). In this critical habitat designation, the Service began using the new common names for six of the listed Bexar County invertebrates, due to changes in the common names of these species as a result of a meeting of the Committee on Common Names of Arachnids of the American Arachnological Society in 2000 (Breene et al. 2001, pp. 10, 12, 14, 15). Accordingly, we changed the common name of the vesper cave spider to the Government Canyon Bat Cave meshweaver (Breene et al. 2001, p. 12).

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 and the Government Canyon Bat Cave meshweaver (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).

1.3.4 Review history:

Status reviews for the Government Canyon Bat Cave meshweaver 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).

1.3.5 Species' Recovery Priority Number at start of 5-year review:

2C

1.3.6 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.

2.2.2 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

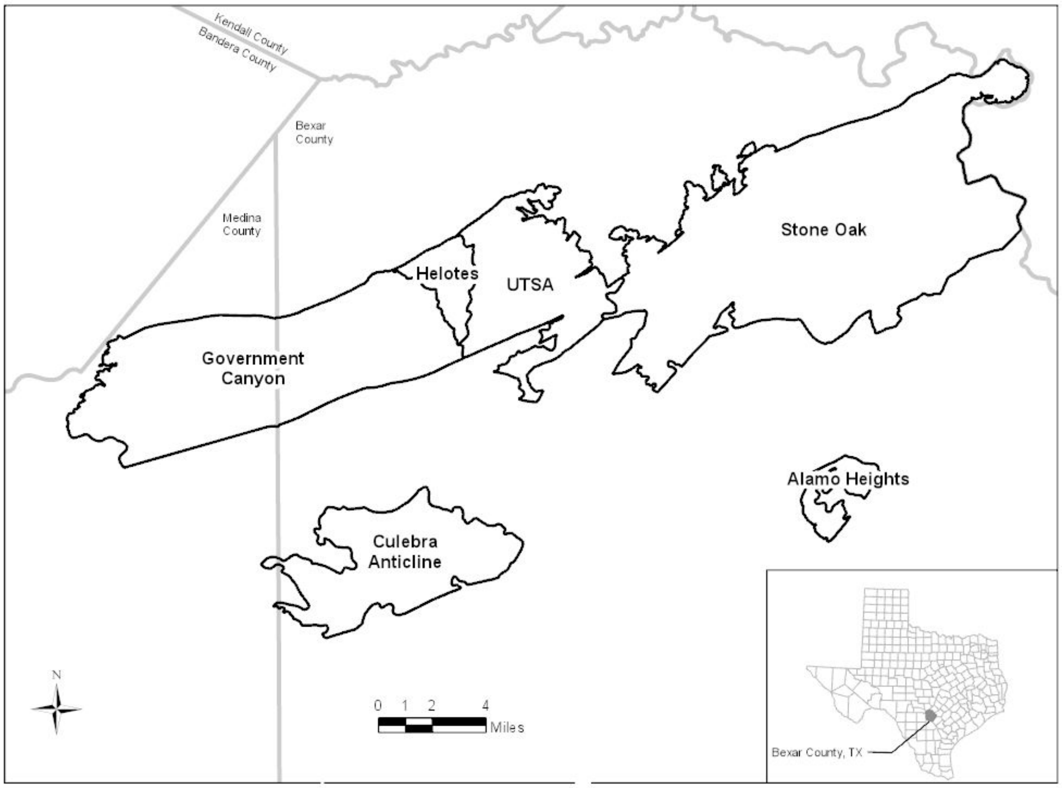
Criterion 2 - (delisting) – In addition to the downlisting criterion, monitoring and research have been completed to conclude with a high degree of certainty that KFA sizes, quality, configurations, and management are adequate to provide a high probability of the species survival (greater than 90 percent 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



Based on current information, the Government Canyon Bat Cave meshweaver occurs in either one or two recovery regions. It either occurs in just the Culebra Anticline Karst Fauna Region or in both the Government Canyon Karst Fauna Region and the Culebra Anticline Karst Fauna Region (see discussion under 2.3.1.5 for a more detailed explanation). In order to meet Criterion 1 (downlisting), there would need to be a minimum of six protected KFAs rangewide, with at least three of those meeting the criteria for a high quality KFA. If the species occurs in only the Culebra Anticline Karst Fauna Region, six KFAs would need to be protected in that region with at least three of those being of high quality. If it occurs both within the Government Canyon Karst Fauna Region and the Culebra Anticline Karst Fauna Region, three KFAs in each of the two regions would need to be protected with at a minimum of three high quality KFAs overall and at least one in each region (see Table 1).

Table 1. KFAs needed per KFR

KFRs species occurs in	KFAs needed in Government Canyon KFR	KFAs needed in Culebra Anticline KFR	Total number of high quality KFAs needed
Government Canyon and Culebra Anticline	3	3	3 (at least one per KFR)
Culebra Anticline only	6	0	3

Brief summary of preserve design principles:

Much of the conservation and recovery of the Government Canyon Bat Cave meshweaver 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; Mosely 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 Government Canyon Bat Cave meshweaver 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 meters (m) (345 feet [ft]) from the preserve edge

II. Medium Quality Preserve:

A medium quality preserve is 16 to 40 ha (40 to 99 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

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 Government Canyon Bat Cave meshweaver, no karst fauna areas had been established for this species. It was only known from one cave, Government Canyon Bat Cave, in the Government Canyon Karst Fauna Region.

Currently, there are 25 caves or karst features known to contain or potentially contain the Government Canyon Bat Cave meshweaver in two karst fauna regions. These occur in one cave site in the Government Canyon KFR and in six cave clusters and six individual cave sites in the Culebra Anticline 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 (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)).

Based on a review of known locations and available data, one area in the Government Canyon KFR meets the definition of a high quality KFA and one area in the Culebra Anticline has been proposed that would meet the definition of a high quality KFA provided the activities outlined in the proposal are completed. In addition, two areas in the Culebra Anticline have the potential to meet the definition of a medium quality KFA (Table 2).

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

Karst Fauna Region	Potential Karst Fauna Area(s)	Proposed Karst Fauna Area(s)	Protected Karst Fauna Area(s)
Government Canyon	0	0	1
Culebra Anticline	2	1	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

<u>Government Canyon Bat Cave KFA</u>

Government Canyon Bat Cave is located on the Government Canyon State Natural Area, which is owned by Texas Parks and Wildlife Department. As mitigation for the Southern Edwards Platea Habitat Conservation Plan, the City of San Antonio has worked with Texas Parks and Wildlife Department to establish a high quality preserve around this cave encompassing the entire critical habitat unit within which it occurs. This approximately 40.5 ha (100 ac) preserve encompasses the surface and subsurface drainage basins of the cave as well as the cave cricket foraging area. Management of this preserve is 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 interlocal agreement between Texas Parks and Wildlife Department and the City of San Antonio. The Service has recognized this preserve as a KFA for the Government Canyon Bat Cave meshweaver.

Culebra Anticline KFR

Steven Ranch Central Proposed KFA

As a part of the Steven Ranch Master Development Plan, a 79 ha (195 ac) area surrounding King Toad Cave and Steven Ranch Trash Hole Cave as well as a 16.2 ha (40 ac) area around Max and Roberts Cave has been proposed to be preserved. The surface and subsurface drainage basins and cave cricket foraging areas for King Toad Cave and Stevens Ranch Trash Hole Cave would be contained within the 79 ha (195 ac) preserve. The preserve around Max and Roberts Cave would protect the surface and subsurface drainage basin and most of the cave cricket foraging area for Max and Roberts Cave. The Service has reviewed and approved the proposed preserve management plan and is working with the Texas Department of Transportation to protect the Max and Roberts Preserve as mitigation for impacts from State Highway 211 which will be built between the two preserves. Once completed, the two preserves together would form the 95.1 ha (235 ac) Stevens Ranch Central KFA. The preserves would be managed under the Karst Preserve Management Plan for the Stevens Ranch Preserves (Pape Dawson 2017, entire).

Stevens Ranch Northern KFA

The cave known as 318 (Stevens Ranch) is located in the southwest corner of the 26.7 ha (66 ac) Stevens Ranch Northern KFA, recognized by the Service as a medium KFA for the federally endangered *Rhadine infernalis* (an unnamed ground beetle). The surface and subsurface drainage basin and a portion of the cave cricket foraging area of 318 (Stevens Ranch) is within the area currently protected by this KFA. With confirmation of the tentative identification of the Government Canyon Bat Cave meshweaver from this cave and additional acreage added that protected the remainder of the cave cricket foraging area, this area could be also be recognized as a medium quality KFA for the Government Canyon Bat Cave meshweaver. The preserve is currently being managed under the Karst Preserve Management Plan for the Stevens Ranch Preserves (Pape Dawson 2017, entire).

San Antonio Water System (SAWS) Pump Station Preserve

The cave known as S29 (SAWS) is located on an approximately 23.1 ha (57-ac) area protected by the San Antonio Water System through the San Antonio Water System Micron Pipeline and Water Resources Integration Program Habitat Conservation Plan (SWCA 2017, p. 56). The preserve, originally set aside for *Rhadine exilis* (an unnamed ground beetle), currently includes the surface and subsurface drainage basins and most of the cave cricket foraging area for S29. SAWS has committed to perpetual management and monitoring of this preserve consistent with the Service's Karst Preserve Management and Monitoring

Recommendations as a part of their habitat conservation plan (SWCA 2017, p. 60). This preserve could meet the criteria for a medium quality KFA with confirmation of the tentative identification of the Government Canyon Bat Cave meshweaver from this cave, confirmation of protection of the cave cricket foraging area for S29, and receipt of a final karst management plan.

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.):

Hedin (2015, entire) developed an integrative approach to species delimitation questions for troglobitic *Cicurina* including comparisons of multiple independent lines of evidence (e.g. mtDNA data, nuclear data, and morphology for selected species in Travis and Williamson counties. This included next-generation sequencing methods, such as sequence capture of ultra-conserved elements. Hedin et al. (2018, entire) extended these sequencing methods with some success to ethanol preserved spider museum specimens as well while utilizing this integrative approach to address species delimitation questions in Bexar County.

2.3.1.4 Taxonomic classification or changes in nomenclature:

Garrison et al. (2016, entire) conducted a phylogenomic analysis of spider relationship using a transcriptome-based data set comprising 70 ingroup spider taxa. In this analysis, *Cicurina* represented the Dictynidae family which was placed as a sister group to Hahiindae (Garrison et al. 2016, p. 25). Wheeler et al. (2017, entire), however, conducted a phylogenetic analysis of spiders using a dataset of 932 spider species, representing 115 families. Using six markers from the mitochondrial and nuclear genomes analyzed by multiple methods *Cicurina* was moved from Dictynidae to Hahniidae (Wheeler et al. 2017, p. 598). The placement of *Cicurina* in Hahnidae was accepted by the World Spider Catalog (World Spider Catalog 2019).

The Government Canyon Bat Cave meshweaver was originally described in 1992 from a single female specimen found in Government Canyon Bat

Cave in 1965 (Gertsch 1992, p. 111). One of only four cave-dwelling spiders of the genus *Cicurina* described from Bexar County at the time (Gertsch 1992, p. 98), it was differentiated from other *Cicurina* based on geographic location and specific morphological characters of the female epigyna (Gertsch 1992, p. 111).

Spider taxonomy in general relies largely on genitalic differences in adult specimens using a combination of male and female morphology to delimit species (Paquin and Hedin, 2004, p. 3240; Paquin et al. 2008, p. 139; Paquin and Dupérré 2009, p. 5; Hedin 2015, p. 347). Delimiting trogolobitic *Cicurina* species based on morphology is particularly difficult not only because of the inaccessibility of their habitat for gathering adequate samples (Moseley 2009, pp. 47-48, Paquin and Dupérré 2009, p. 4) but because most collections return immature specimens (Gertsch 1992, p. 80; Cokendolpher 2004, p. 15; Paquin and Hedin, 2004, p. 3240; Paquin et al. 2008, p. 140; Paquin and Dupérré 2009, pp. 5, 64).

In addition, the few adults that are collected are disproportionately female (Cokendolpher 2004, pp. 14, 15, 17-18; Paquin and Dupérré 2009, pp. 5, 64; Hedin 2015, p. 347). As females of troglobitic *Cicurina* exhibit variability in genitalic characters within and between caves, this makes it difficult to determine whether an individual represents a distinct species or intraspecific variation based on morphology alone (Cokendolpher 2004, pp. 30-32; Paquin and Dupérré 2009, pp. 5-6; Paquin et al. 2008, pp. 140, 143, 147; Paquin and Dupérré 2009, pp.4-6, 63-64).

Problems with species delimitation in *Cicurinas* utilizing genetic methods can also arise, such as extreme population genetic structuring found with constrained gene flow in cave restricted species and rare to non-existent cases of sympatry, making it difficult to test reproductive isolation among others (Hedin 2015, p. 347). In order to address difficulties in species delimitation of troglobitic *Cicurinas*, Hedin et al. (2018, entire) combined morphological, mitochondrial, and nuclear phylogenomic data to address phylogenetic and species delimitation questions with particular focus on the four listed Bexar County species including the Government Canyon Bat Cave meshweaver.

Nuclear phylogenomic analyses recovered two primary eyeless clades corresponding to previously described morphological groups based on the shape of the spermathecum in adult females (Hedin et al. 2018, pp. 55, 61). These include mostly elongate (ME) and rounded (R) spermathecae groups with the exception of two species represented by large even-sized rounded spermathecum (Cokendolpher 2004, pp. 23-24, Paquin and Dupérré 2009, p. 9, Hedin et al. 2018, p. 55). Consistent with previous studies, measurements of degree of troglomorphy, as measured by a ratio of leg length to body length, also supported the ME and R clade lineages with the

ME clade having a higher troglomorphic index than the R clade (Cokendolpher 2004, p. 18; Hedin et al. 2018, pp. 63-64).

The type specimen for Government Canyon Bat Cave meshweaver, an R clade member based on female morphology and troglomorphic index, was not included in the genetics portion of the study as DNA could not be collected from it due to age. Genetic results for three other specimens collected from the same locality, however, fall within the UCE genetic clade for the Madla Cave meshweaver (*C. madla*), an ME clade member (Hedin et al. 2018, pp. 57-58). Two additional specimens from this cave in the COI dataset also nest within the Madla Cave meshweaver clade (Hedin et al. 2018, pp. 57-58). This can either be explained if the Government Canyon Bat Cave meshweaver occurs in sympatry with the Madla Cave meshweaver or if the type locality for the Government Canyon Bat Cave meshweaver is incorrect. Evidence exists for ME and R clade sympatry with specimens identified morphologically and genetically as the Madla Cave meshweaver being documented as occurring in the same cave as an R clade member in the northern part of the Culebra Anticline KFR (Hedin et al. 2018 pp. 56, 58-59, 62, 65-67).

Based on comparison to the holotype specimens of the Government Canyon Bat Cave meshweaver, the female morphology and the troglomorphic index values of *C. loftini* were found to be alike (Hedin et al. 2018, p. 67). Previously, these species were separated on the basis of slight morphological variations and geographic allopatry with the Government Canyon Bat Cave meshweaver listed as occurring in the Government Canyon Bat Cave in the Government Canyon KFR and *C. loftini* occurring in Caracol Creek Coon Cave and SBC Cave the Culebra Anticline KFR (Cokendolpher 2004, pp. 41, 53; Paquin and Dupérré 2009, pp. 28, 58). Evidence exists, however, for species distribution across these KFRs as the Madla Cave meshweaver and another troglobitic spider, *Tayshaneta whitei* (no common name) both occur in the Government Canyon KFR and the Culebra Anticline KFR (Hedin et al. 2018, pp. 55-56; Ledford et al. 2012, pp. 63, 65).

Based on morphologic characteristics and mitochondrial and nuclear DNA results Hedin et al. (2018, pp. 68-71), synonomized *C. loftini* under Government Canyon Bat Cave meshweaver. This synonomy was accepted by the World Spider Catalog (World Spider Catalog 2019).

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.):

When the Government Canyon Bat Cave meshweaver was originally listed, it was thought to occur in two caves, Government Canyon Bat Cave in the

Government Canyon KFR and an unnamed cave referred to as ''5 miles northeast of Helotes" in the UTSA KFR (Gertsch 1992, p.111). In 2004, the specimen from the unnamed cave was assigned to *Cicurina neovespera* (Cokendolpher 2004, p. 48). Thus, at the time of the 2011 5-year review, the Government Canyon Bat cave meshweaver was known only from one cave in one KFR (Service 2011b, p. 7).

Using morphological, mitochondrial, and nuclear phylogenomic data, Hedin et al. (2018) synonomized *C. loftini* (no common name), which occurs in the Culebra Anticline, with the Government Canyon Bat Cave meshweaver, previously thought to only occur in the Government Canyon KFR. For this 5-year review, we considered a site occupied by the Government Canyon Bat Cave meshweaver if multiple lines of evidence supported identification of a specimen. Locations where a vouchered specimen of an adult female was identified morphologically and supported by either mitochondrial or nuclear genetic results or both and locations with unsexed juvenile specimens where both mitochondrial and nuclear results were available and agreed were considered confirmed identifications. Juveniles confirmed only by mitochondrial genetics are considered tentative at this time until additional work to determine the extent of the agreement between mitochondrial and nuclear genetic results across the range of the species can be completed. Including known and tentative identifications of individuals formerly known as *C. loftini*, the Government Canyon Bat Cave meshweaver is now confirmed from 17 caves and tentatively identified from eight more across two KFRs with eight of the 25 occurring outside of currently delineated KFRs (Table 3).

There is some uncertainty regarding the holotype locality for the Government Canyon Bat Cave meshweaver. The specimen from Government Canyon Bat Cave is the only R clade specimen known to date in the Government Canyon KFR and additional collected specimens from that locality have all matched the ME clade Madla Cave meshweaver morphologically and genetically (Paquin and Hedin 2004, p. 3249; Paquin and Dupérré 2009, p. 65; Hedin et al. 2018, p. 67). It has been hypothesized that that the specimen for the Government Canyon Bat Cave meshweaver was incorrectly labeled and does not occur in Government Canyon Bat Cave (Paquin and Dupérré 2009, p. 65) or that specimens of Government Canyon Bat Cave meshweaver and Braken Bat Cave meshweaver (*C. venii*) were switched at some point in the past and that the Government Canyon Bat Cave meshweaver was actually first collected in Bracken Bat Cave (Hedin et al. 2018, p. 67). Because evidence exists for sympatry between the Madla Cave meshweaver and the Government Canyon Bat Cave meshweaver (Hedin et al. 2018, p. 66) and because there is evidence of other troglobitic spider species distribution across the Government Canyon and Culebra Anticline KFRs (Hedin et al. 2018, pp. 55-56; Ledford et al. 2012, pp. 63, 65), for purposes of this 5-year review, we are maintaining the record of the Government Canyon Bat Cave meshweaver in the

Government Canyon KFR. Additional studies to confirm or correct this record are recommended in Section 4.0.

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 (Avise 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 troglomoprhic *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 Government Canyon Bat Cave meshweaver, 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 Government Canyon Bat Cave meshweaver 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 Government Canyon Bat Cave meshweaver, 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 Government Canyon Bat Cave meshweaver 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 occurrences into a total of six cave clusters and four individual caves (Table 3).

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

Karst Fauna Region	Cave Name	Ownership
Government Canyon		
	Government Canyon Bat Cave	Texas Parks and Wildlife Department
Culebra Anticline		
Cave Clusters		
SH 151 at Loop 1604	151-015	TXDOT[a]
	151-010	TXDOT[a]
	151-018	TXDOT[a]
	Clandestine Cupola Cave	Private
	S29 (SAWS)	San Antonio Water System
Oak Meadow Lane Cluster	Cave of the Bearded Tree	Private
	Cave of the Half Snake	Private
	Chimney Cricket Cave	Private
Game Pasture Cave Cluster	King Toad Cave	Private
	Stevens Ranch Trash Hole Cave	Private
Individual Caves		
	318 (Stevens Ranch)	Private
	AMA-006	TXDOT[a]
	Caracol Creek Coon Cave	Private
	Max and Roberts Cave	Private
	S99	Private
	Wissman Property	Location uncertain
Caves Not in KFRs		
Cave Clusters		
AMA-002 and AMA-005	AMA-002	TXDOT[a]
	AMA-005	TXDOT[a]

Karst Fauna Region	Cave Name	Ownership
SBC Cave Cluster	AMA-009	TXDOT[a]
	AMA-014	TXDOT[a]
	AMA-015	TXDOT[a]
	AMA-019	TXDOT[a]
	AMA-029	TXDOT[a]
	SBC Cave	TXDOT[a]

[a] Cave has been destroyed

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

The population needs of the Government Canyon Bat Cave meshweaver 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 Government Canyon Bat Cave meshweaver 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 (Pelligrini 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 2019 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 basin, 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 Government Canyon Bat Cave meshweaver 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 Government Canyon Bat Cave meshweaver over the long-term.

Impacts to a cave's surface or subsurface drainage basin can be a significant source of stressors for Government Canyon Bat Cave meshweaver 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 Government Canyon Bat Cave meshweaver persistence.

Based on this review, three cave clusters and three individual caves are currently of high to moderate resiliency with potential to support Government Canyon Bat Cave meshweaver populations over the long-term (Table 4). For the most part, these sites are located in larger tracts of open space and have relatively unaltered cave cricket foraging areas and drainage basins. The moderate resiliency SH 151 at Loop 1604 Cave Cluster, contains the S29 (SAWS) cave, which is discussed in 2.2.3 above. The high resiliency Game Pasture Cave Cluster contains two caves occupied by the species and is discussed along with the moderate resiliency Max and Roberts Cave above under the Stevens Ranch Central Proposed KFA above.

Two other currently high resiliency individual caves are 318 (Stevens Ranch) and S99. The discussion under Stevens Ranch Northern KFA above describes 318 (Stevens Ranch). The cave known as S99 currently meets our definition of high resiliency, however, once State Highway 211 is constructed, it will be reduced to low resiliency. As a part of construction of SH 211, TXDOT is planning to set aside a nine-acre tract within their right of way to preserve portions of the cave cricket foraging area, the surface drainage basin, and a portion of the subsurface drainage basin of this cave.

One cave cluster and one individual cave in the Culebra Anticline are low resiliency and impaired respectively. One individual cave in the Culebra Anticline and both cave clusters occurring outside the KFR boundaries have been destroyed.

Table 4. Current resiliency of Government Canyon Bat Cave meshweaver sites (cave clusters and individual caves) by karst fauna region.

Karst Fauna Region	**High**	**Moderate**	**Low**	**Impaired**	**Destroyed**
Government Canyon	1	0	0	0	0
Culebra Anticline	3	2	1	1	1
Outside KFR Regions	0	0	0	0	2
Total	**4**	**2**	**1**	**1**	**3**

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 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 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 Government Canyon Bat Cave meshweaver, 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 Government Canyon Bat Cave meshweaver population viability and the species' long-term persistence. Land conversion to 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 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, p. 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 Government Canyon Bat Cave meshweaver 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 6 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, p. 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). Troglobitic arthropods, such as the Government Canyon Bat Cave meshweaver, 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 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), however, these temperatures 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 Government Canyon Bat Cave meshweaver.

2.4 Synthesis

Based on a review of available data, one area in the Government Canyon KFR and three areas in the Culebra Anticline KFR are of sufficient resiliency with the potential to support Government Canyon Bat Cave meshweaver 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 Government Canyon Bat Cave meshweaver 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 six KFAs rangewide (at least three in each karst fauna region) be protected, with at least three of those 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, only one area in the Government Canyon KFR meets the definition of a high quality KFA as defined in recovery criteria (1). Three areas in the Culebra Anticline have the potential to meet either a high or medium quality KFA provided adequate protections are put in place. At present, recovery criteria for the Government Canyon Bat Cave meshweaver 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 Government Canyon Bat Cave meshweaver.

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*
__X__ 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 Government Canyon Bat Cave meshweaver 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 genetics work on C*icurina* specimens to ensure multiple lines of evidence exist to support species delimitation in known and new locations.

II. Resolve uncertainty regarding Government Canyon Bat Cave meshweaver type locality. This includes collection/locating additional specimens of *Cicurina* in and around Government Canyon State Natural Area, including juvenile museum specimens, and using genetic tests and measurements of troglomorphic index (when appropriate) to determine if R clade members are present in the Government Canyon KFR.

III. Continue efforts to establish karst fauna areas or other protected sites for the Government Canyon Bat Cave meshweaver throughout its range.

IV. Apply recovery criterion 2 to karst fauna areas that qualify.

V. 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 Government Canyon Bat Cave meshweaver (*Cicurina vespera*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ 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 9/4/19