

Bone Cave Harvestman
(Texella reyesi)

5-Year Review:
Summary and Evaluation

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

5-YEAR REVIEW

Bone Cave Harvestman (*Texella reyesi*)

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 information on the status of the species. This review was conducted by Cyndee Watson and Bill Seawell from the AESFO. This status review mostly relied on information summarized and cited in Balcones Canyonlands Preserve (BCP)¹ Annual Report (BCCP 2009a)² and the BCP cave assessment (BCCP 2009b). We also used the draft Bexar County Karst Invertebrate Recovery Plan (Bexar RP) (Service 2008), which contains new karst invertebrate research and preserve design concepts; the Recovery Plan for Endangered Karst Invertebrates in Travis and Williamson Counties, Texas (Travis and Williamson RP) (Service 1994), and cave data contained within AESFO's files.

As a basic first step in assessing whether caves that contain *T. reyesi* met the downlisting recovery criteria in the Travis and Williamson RP, we compiled a list of some basic characteristics (further described in Section 2.2.3). While the Travis and Williamson RP discusses broad concepts regarding preserve design, the draft Bexar RP has an appendix that is a compilation of research to help more specifically delineate preserve boundaries that follow those basic concepts (Service 2008). These preserve design principles and characteristics describe what is needed to protect each karst feature and its surrounding

¹ BCP - A system of preserves permanently set aside to conserve habitat for 8 endangered species (including *T. reddelli*) and 27 species of concern as part of a joint regional 10(A)(1)(B) incidental take permit PRT 788841, held by the City of Austin and Travis County.

² BCCP - The incidental take permit mentioned above is also referred to as the Balcones Canyonlands Conservation Plan (BCCP).

area. From the list of known locations of these species, we identified those that had the highest likelihood of meeting these characteristics. Our determinations (discussed in section 2.2.3) for each of these characteristics were based on site-specific information found in the AESFO files and on cave location and parcel data. Unless otherwise noted, all acreage estimates were calculated using Geographic Information Systems (GIS) (2008 digital aerial photography, 2006 Travis County parcel data, and 2005 Williamson County parcel data) and are subject to typical margins of error associated with GPS units, GIS, and transferring data from paper sources to digital media. These acreages and respective cave locations need to be ground-truthed (i.e., verified by site visits).

1.3 Background:

The Bone Cave harvestman, *Texella reyesi*, is a troglobite which is a species restricted to the subterranean environment. As typical of troglobites, this harvestman exhibits morphological adaptations to that environment, such as elongated appendages and loss of eyes and pigment. Troglotic habitat includes caves and mesocavernous voids in karst limestone (a terrain characterized by landforms and subsurface features, such as sinkholes and caves, which are produced by solution of bedrock) in Travis and Williamson Counties. Karst areas commonly have few surface streams; most water moves through cavities underground. Within this habitat this species depends on high humidity, stable temperatures, and nutrients derived from the surface. Examples of nutrient sources include leaf litter fallen or washed in, animal droppings, and animal carcasses. The harvestman is predaceous upon small or immature arthropods. It is imperative to consider that while these species spend their entire lives underground, their ecosystem is very dependent on the overlying surface habitat.

Texella reyesi was listed as endangered in 1988 based on the threats of: 1) habitat loss to development; 2) cave collapse or filling; 3) alteration of drainage patterns; 4) alteration of surface plant and animal communities, including the invasion of exotic plants and predators (i.e. the red-imported fire ant (RIFA), *Solenopsis invicta*), changes in competition for limited resources and resulting nutrient depletion, and the loss of native vegetative cover leading to changes in surface microclimates and erosion; 5) contamination of the habitat, including groundwater, from nearby agricultural disturbance, pesticides, and fertilizers; 6) leakages and spills of hazardous materials from vehicles, tanks, pipelines, and other urban or industrial runoff; and 7) human visitation, vandalism, and dumping; mining; quarrying (limestone); or, blasting above or in caves.

There are 168 caves known to contain *T. reyesi* in Travis and Williamson Counties, Texas (Table 1). Currently, *T. reyesi* faces the same threats that it did at the time it was listed.

1.3.1 FR Notice citation announcing initiation of this review: 75 FR 20134, April 23, 2007

1.3.2 Listing history

Original Listing

FR notice: 53 FR 36029

Date listed: September 16, 1988

Entity listed: Bone Cave harvestman (*Texella reyesi*)

Classification: Endangered

1.3.3 Associated rulemakings: In an August 18, 1993, Federal Register notice (56 FR 43818), the Service gave *T. reyesi* protection under the Act as a separate species. It had previously been listed as endangered as a part of the Bee Creek Cave harvestman (*Texella reddelli*), which was subsequently re-classified into two species, and this notice was made to ensure that it continued to receive protection under the Act.

1.3.4 Review History: Status reviews for *T. reyesi* were conducted in 1988 for the final listing of the species (53 FR 36029) and in 1994 for the Travis and Williamson RP (Service 1994).

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: Recovery Plan for Endangered Karst Invertebrates (Travis and Williamson Counties, Texas)

Date issued: 1994

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, the species is an arachnid, 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: The recovery plan only provides criteria for downlisting from endangered to threatened (Service 1994).

Recovery Criteria: Each species will be considered for reclassification from endangered to threatened when:

- (1) Three karst fauna areas (KFA) (if at least three exist) within each karst fauna region (KFR) in each species' range are protected in perpetuity. If fewer than three KFAs exist within a given KFR, then all KFAs within that region should be protected. If the entire range of a given species contains less than three KFAs, then they should all be protected for that species to be considered for downlisting.
- (2) Criterion (1) has been maintained for at least five consecutive years with assurances that these areas will remain protected in perpetuity.

There are seven KFRs (adapted from the karst fauna areas in Figure 19 of Veni & Associates' 1992 report and reproduced in Figure 2 of the Travis and Williamson RP) in Travis and Williamson counties that are known to contain listed karst invertebrate species. These regions are delineated based on geologic continuity, hydrology, and the distribution of rare troglobites.

Within each KFR, established karst preserves may be considered a KFA if they meet recovery criteria. For the purposes of the recovery plan, a KFA is an area known to support one or more locations of a listed species and 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 "protected", a KFA must be sufficiently large to maintain the integrity of the karst ecosystem on which the species depend(s). In addition, these areas must also provide protection from threats such as red-imported fire ants (*Solenopsis invicta*) (RIFA), habitat destruction, and contaminants.

Brief summary of preserve design principles:

Much of the conservation and recovery of this endangered and cryptic species is dependent upon the long-term preservation of its habitat. Because most endangered karst invertebrates are difficult to detect during in-cave faunal surveys, their conservation strategies focus on the delineation, study, and management of occupied KFAs. Regarding size and configuration of KFAs, the Travis and Williamson RP provides some conceptual guidelines on habitat conditions that are important to karst invertebrates,

including maintaining humid conditions, air flow, and stable temperatures in the air-filled voids. Also necessary are maintaining adequate nutrient supply; preventing contamination from the surface and groundwater entering the karst ecosystem; controlling the invasion of exotic species, e.g., RIFA; and allowing for movement of the karst fauna and nutrients through voids between karst features (Service 1994).

Additional scientific information and karst preserve design guidelines are presented in the draft Bexar RP and help to further define a protected KFA (Service 2008). According to these preserve design guidelines, KFAs should include the following: 1) surface and subsurface drainage basins of at least one occupied karst feature (i.e., cave); 2) ideally a minimum of 24 to 36 hectares (ha) (59 to 89 acres (ac)) of contiguous, unfragmented, undisturbed land to maintain native plant and animal communities around the feature and protect the subsurface karst community; 3) 105 meter (m) (345 foot (ft)) radius, undisturbed area, from each cave entrance for cave cricket foraging; and 4) at least 100 m (328 ft), undisturbed, from the cave footprint to the edge of the preserve to minimize deleterious edge effects (Service 2008). The Bexar RP also recognizes various qualities of KFAs. A medium quality KFA is 16 to 24 ha (40 to 60 ac) and a high quality KFA is 24 to 36 ha (60 to 90 ac). Any karst preserve less than 16 ha (40 ac) will not count toward meeting the minimum Bexar County RP recovery criteria (Service 2008). The quality of KFAs is defined based on probability of long-term survival of the species in that area and the amount of active management necessary to maintain those species. High quality KFAs tend to be larger, require less active management, and have a higher probability of long-term species survival. Medium quality KFAs have some compromised characteristics of a high quality preserve, but still have potential for reasonable remediation. Additionally, the Bexar RP outlines perpetual management, maintenance, and monitoring necessary for ensuring a high probability of species survival at each site (Service 2008). At a minimum, these activities should include: 1) controlling RIFA; 2) installing and maintaining fencing; 3) installing, if necessary, and maintaining cave gates; and 4) monitoring of karst invertebrates and the ecosystem upon which they depend (Service 2008).

Analysis regarding whether downlisting criteria have been met:

There are currently 168 caves known to contain *T. reyesi*, spanning all 7 established KFRs in Travis and Williamson Counties, Texas (Table 1). These caves are within the North Williamson (55 caves), Georgetown (35 caves), McNeil/ Round Rock (61 caves), Cedar Park (2 caves), Jollyville Plateau (12 caves), Central Austin (2 caves), and the South Travis (1 cave) KFRs. Based on a review of available data, one karst preserve in the North Williamson County KFR currently meets the definition of a protected KFA, Priscilla's Well KFA. Other than this one KFA, there are 20 additional tracts in the North Williamson (6 tracts), Georgetown (3 tracts), McNeil/Round Rock (6 tracts), Jollyville Plateau (4 tracts), and South Travis (1 tract) KFRs that may meet the definition of a KFA. However, more research is needed to delineate surface and/or subsurface drainage basins, confirm locations and tract acreage, and confirm management activities at all caves that have potential to be a KFA. Below is a discussion of these tracts/caves and a description of how they have the potential to meet KFA status.

North Williamson County KFR

Priscilla's Well KFA – The Williamson County Conservation Foundation owns this 20 ha (51 ac) Priscilla's Well tract³ that was recently acquired as a land donation as part of participation in the Williamson County Regional Habitat Conservation Plan (Williamson County RHCP) for the Ronald Reagan Boulevard extension. It has two caves (Priscilla's Cave and Priscilla's Well Cave) that contain *T. reyesi* and is considered a protected KFA by the Service. The cave entrances and footprints for both caves are more than 105 m (345 ft) from the nearest edge (i.e., disturbance e.g. road or a development) (SWCA 2008). The surface and subsurface drainage basins have been delineated based on topographic maps and are included in the preserve; however, onsite verification of the delineations has not been performed (SWCA 2008). As part of the management for these caves, the Williamson County Conservation Foundation will maintain fencing, conduct quarterly site visits looking for human intrusion and RIFA, and conduct annual cave fauna surveys.

Karankawa Cave and Polaris Cave

These privately-owned caves are located in a tract that is approximately 52 ha (130 ac) and have potential to meet the definition of a KFA because of the large amount of undeveloped land in and around this tract. The cave entrances for Karankawa Cave and Polaris Cave are located >700 m (>2,296 ft) and 609 m (2,000 ft) from the nearest edge, respectively. We do not have a map of the cave footprints so we cannot measure the distance to the nearest edge (i.e., disturbance via road or a development). To our knowledge the surface and subsurface drainage basins have not been delineated for either of these caves, so we do not know if they are inside this tract. Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Shaman Cave and Pow Wow Cave – This >40-ha (>100-ac) tract is owned by Sun City and several other owners. Two caves on this tract contain *T. reyesi* and both have potential to meet the definition of a KFA. The cave entrance and footprint for Shaman Cave are located within the tract (Verdorn 1994) and the nearest edge (i.e., disturbance via road or a development) is >210 m (>700 ft) from the cave entrance; however, the cave footprint is <15 m (<50) ft away from the property boundary (although the adjacent tract is currently undeveloped so there is a possibility of protecting the area 100 m from the cave footprint). The surface drainage basin is likely included within the preserve (Verdorn 1994); however, the subsurface drainage basin has not been delineated to our knowledge. The nearest edge to the entrance of Pow Wow Cave is 143 m (470 ft) and the cave footprint is about 126 m (415 ft) (Verdorn 1994 and aerial photos). We do not have delineations of the surface or subsurface drainage basin for this cave, so we do not know if they are included in the tract. Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Red Crevice Cave, Temples of Thor Cave, and Thor Cave

This 42 ha (105 ac) preserve is owned by Texas Cave Management Association (TCMA) and is known as the Godwin Ranch preserve. It was established as part of the mitigation

³ Tract – refers to a contiguous undeveloped piece of land.

for Lakeline Mall (Simon 1992). Three caves on this tract contain *T. reyesi* and each has the potential to meet the definition of a KFA. The cave entrance and footprint for Red Crevice Cave are located within the tract (Simon 1992) and the nearest edge (i.e., disturbance e.g. road or a development) is about 200 m (about 656 ft) from the cave entrance. The distance from the nearest edge to the entrance of Temples of Thor Cave and Thor Cave is 121 m (400 ft) and 192 m (630 ft) respectively. We do not have maps of the cave footprints of Temples of Thor Cave or Thor Cave so we are unsure how far they are to the edge of the preserve. The surface and subsurface drainage basins have not been delineated for these caves to our knowledge; therefore, we do not know whether they are included in this tract. As part of the management for these caves, TCMA contracts with ZARA Environmental to conduct RIFA treatment; however, no cave fauna surveys are being conducted (ZARA 2008).

Jensen Cave

This cave is located on a privately-owned tract that is about 60 ha (150 ac) in area and is known to contain *T. reyesi*. Due to the size of undeveloped land within and around this tract, it has potential to be a KFA. The cave entrance is located 190 m (625 ft) to the nearest edge (i.e., disturbance e.g. road or a development). We do not have a map of the cave footprint and we do not have information on whether the surface and subsurface drainage basins for this cave have been delineated, so we do not know if they are in the preserve. Also, we do not know if these caves receive any management including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Lobo's Lair Cave and Wolf's Rattlesnake Cave

These caves are located on a privately-owned tract that is about 117 ha (290 ac) and are known to contain *T. reyesi*. Due to the size of undeveloped land within and around this parcel, it has potential to be a KFA. The cave entrance is located 701 m (2,300 ft) and 806 m (2,646 ft) to the nearest edge (i.e., disturbance e.g. road or a development) from Lobo's Lair Cave and Wolf's Rattlesnake Cave, respectively. We do not have a map of the cave footprint for either cave and we do not have information on whether the surface and subsurface drainage basins for these caves have been delineated, so we do not know if they are in the preserve. Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Twin Springs

This recently-acquired preserve is on a 58 ha (145 ac) tract and contains 1 cave that is known to contain *T. reyesi* (Sunless City Cave) but it is too close to a road to be considered a KFA. However, a second cave (location needs to be verified) on the tract may contain *T. reyesi* pending taxonomic confirmation. Williamson County has indicated they plan to submit a detailed proposal as to how this area has the potential to be a KFA. Once we receive that information, we will consider whether this preserve has potential to be a KFA.

Georgetown KFR

Round Rock Breathing Cave

This privately-owned cave is located on a 21 ha (52 ac) tract and is known to contain *T. reyesi*. Due to the size of undeveloped land within this parcel, it has potential to be a KFA. The cave entrance is located 152 m (500 ft) from the nearest edge. We do not have a map of the cave footprint and we do not have information on whether the surface and subsurface drainage basins for this cave have been delineated, so we do not know if they are in the tract. Also, we do not know if this cave receives any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Steam Cave and Fence-line Sink

These two privately-owned caves are known to contain *T. reyesi* and are on a tract that is 60 ha (150 ac). Due to the size of undeveloped land within and around this tract, it has potential to be a KFA. The distance from the cave entrances are 396 m (>1,300 ft) and 274 m (900 ft) to the nearest edge (i.e., disturbance via road or a development) from Steam Cave and Fence-line Sink, respectively. We do not have maps of the cave footprints so we are unsure how far they are to the nearest edge. The surface and subsurface drainage basins have not been delineated for these caves to our knowledge; so we do not know whether they are included in this tract. Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Wilco and Millenium Preserve

The Wilco Preserve is a 52 ha (130 ac) tract that is adjacent to the Millennium preserve which is a 36 ha (90 ac) tract. These two preserves were established with funding from the Williamson County Conservation Foundation, the Act's Section 6 program, and Texas Department of Transportation (TxDOT) to offset impacts to *T. reyesi* from development and to provide recreational opportunities for the citizens of Williamson County. We do not have maps of the recreational facilities that are currently in place or future planned developments in relation to where the *T. reyesi* caves are on these preserves. However, Williamson County has indicated they plan to submit a detailed proposal as to how this area has the potential to be a KFA. Once we receive that information we will consider whether these two preserves have potential to be a KFA.

McNeil/Round Rock KFR

Blessed Virgin Cave

This privately-owned cave is located in a tract that is approximately 21 ha (52 ac) and has potential to meet the definition of a KFA because of the large amount of undeveloped land in and around this tract. The cave entrance is 359 m (1,180 ft) from the nearest habitat edge; however, it is <15 m (<50 ft) to the property line. We do not have a map of the cave footprints so we cannot measure the distance to the nearest edge. To our knowledge, the surface and subsurface drainage basins have not been delineated for this cave, so we do not know if they are inside this tract. Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Weldon Cave

This privately-owned cave is part of the BCP (BCCP 2009b) and is known to contain *T. reyesi*. It occurs on a tract that is 32 ha (80 ac) and has potential to be a KFA due to the large amount of undeveloped land in this tract. The distance from the cave entrance to the nearest edge is 106 m (350 ft) (BCCP 2009b). The distance from the nearest habitat edge to the cave footprint is 96 m (315 ft) (based on Elliott 1997 and aerial photos). The surface drainage basin has been delineated but we are unsure whether it is included in the tract (BCCP 2009b). The subsurface drainage basin has not been delineated (BCCP 2009b). Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Rockfall Cave

This privately-owned cave is located in a tract that is approximately 9 ha (24 ac) and has potential to meet the definition of a KFA only because of the large amount of undeveloped land adjacent to this tract. The cave entrance is located 185 m (610 ft) away from the nearest habitat edge and about 3 m (10 ft) from the property line. We do not have a map of the cave footprint so we cannot measure the distance to the nearest edge. To our knowledge the surface and subsurface drainage basins have not been delineated for this cave, so we do not know if they are inside this tract. Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Raccoon Lounge Cave

This privately-owned cave is located in a tract that is approximately 117 ha (290 ac) and has potential to meet the definition of a KFA due to the large amount of undeveloped land in this tract. There is a road going through this tract; however, it is about 243 m (800 ft) from the cave entrance, which is located 198 m (650 ft) away from the nearest edge (i.e., disturbance via road or a development). We do not have a map of the cave footprint, so we cannot measure the distance to the nearest edge to the cave footprint. To our knowledge the surface and subsurface drainage basins have not been delineated for this cave, so we do not know if they are inside this tract. Also, we do not know if this cave receives any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Wyoming Springs Corridor Caves

Two caves, WS 54 and WS 71a, occur on a privately owned tract that is 117 ha (290 ac). The adjacent privately-owned tract contains cave WS 65 and is 125 ha (310 ac). All three of these caves contain *T. reyesi* and have potential to meet the definition of a KFA due to the large amount of undeveloped land in these two tracts. While there is some disturbance (i.e., edge or disturbance by roads or development) in both of these tracts, the disturbance is located about 152 m (500 ft) from the closest cave entrance (WS 54a). The distance from the nearest edge to the cave entrance of caves WS 65 and WS 71a is 274 m (900 ft) and 198 m (650 ft) respectively. We do not have maps of the cave footprints, so we cannot measure the distance from the footprint to the nearest edge. To our knowledge the surface and subsurface drainage basins have not been delineated for these caves, so we do not know if they are inside this tract. Also, we do not know if these caves receive

any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Chaos Cave Preserve

This cave preserve was established to offset impacts to *T. reyesi* due to construction of State Highway 45 North (Consultation no. 2-15-1998-F-0205; TxDOT 2003). While this preserve is only 12 ha (30 ac) it is adjacent to large areas of undeveloped land, therefore it has potential to be a KFA. The 3 caves occurring on this tract, Chaos Cave, Under the Fence Cave, and Poison Ivy Cave, all contain *T. reyesi*; however, only the first 2 caves have the potential to be KFAs because Poison Ivy Cave is only 58 m (192 ft) from the nearest edge. The distance from the nearest edge (i.e., disturbance e.g. road or a development) to the cave entrance of Chaos Cave and Under the Fence Cave is 173 m (570 ft) and 137 m (450 ft), respectively (based on TxDOT 2003 and aerial photos). The distance from the cave footprint to Chaos Cave and Under the Fence Cave is 169 m (554 ft) and 136 m (446 ft) respectively (Veni 2003 and aerial photos). The surface drainage basin for Chaos Cave may be included in the preserve (Veni 2003); however, a detailed delineation has not been conducted. The surface drainage basin for Under the Fence Cave and the subsurface drainage basins have not been delineated for these two caves. Management for all three *T. reyesi* caves on this preserve includes biological surveys every three years, biannual cave cricket surveys, and biannual RIFA surveys (TxDOT 2003).

Jollyville Plateau KFR

Cuevas (Tomen Park)

This Travis County-owned tract contains several caves with listed species and three of these caves contain *T. reyesi* (Gallifer Cave, Tooth Cave, and McDonald Cave) and may meet the definition of a KFA. This cave cluster is within a tract that is 772 ha (1,909 ac) (BCCP 2009b). While Gallifer Cave, Tooth Cave, and McDonald Cave are the only three caves that have the potential to be considered a KFA for *T. reyesi*, all of the caves and karst features within this tract contribute to the long-term viability and stability of the KFA. The entrances and footprints for all of these caves are contained within this tract. The cave entrance for Gallifer Cave is 198 m (650 ft) and the cave footprint is about 189 m (620 ft) from the nearest edge (i.e., disturbance via road or a development) (Elliott 1997, Service 2008). The Tooth Cave entrance is 73 m (240 ft) from the nearest edge and the cave footprint is about 16 m (52 ft) from the nearest edge (Elliott 1997, Service 2008). The cave footprint distance for Tooth Cave was measured using the ground-penetrating radar map by Veni (2006). The cave entrance of McDonald Cave is 365 m (1,200 ft) to the nearest edge (BCCP 2009b) and the distance from the nearest edge to the cave footprint is about 335 m (1,099 ft) (based on Elliott 1997 and aerial photos). The surface and subsurface drainage basins for Gallifer Cave and Tooth Cave are included in this tract (Veni 2006). The surface drainage basin for McDonald Cave has been delineated and is included in the tract; however, the subsurface drainage basin has not been delineated (BCCP 2009b). As part of the management for these caves, the Travis County BCP staff conducts quarterly cave cricket exit counts, maintains the perimeter fences, and conducts biannual surface monitoring to look for signs of trespass and RIFA (BCCP 2009a). They also conduct an annual faunal survey at Gallifer Cave, quarterly

faunal surveys at Tooth Cave, and quarterly faunal surveys at McDonald Cave (BCCP 2009a).

Stovepipe Cave

The City of Austin owns this cave and it is part of the BCP (BCCP 2009a). It is known to contain *T. reyesi*. This 21 ha (52 ac) tract has a narrow connection to more than 1,695 ha (4,189 ac) of additional BCP land (BCCP 2009b) and the cave entrance and footprint are more than 105 m (345 ft) from any disturbance. The surface drainage basin is protected and included in the tract; however, the subsurface drainage basin has not been delineated (BCCP 2009a, b). As part of management for the cave, the City of Austin maintains the perimeter fence and conducts quarterly surface monitoring looking for human intrusion, implements RIFA control using boiling water, and conducts biannual cave fauna surveys (BCCP 2009a, b).

Four Points

This privately-owned and managed 21 ha (52 ac) tract has been preserved for the benefit of endangered karst invertebrates (Service 1994) and is considered part of the BCP⁴. Three caves in this tract contain *T. reyesi* (MWA Cave, Eluvial Cave, and Jollyville Plateau Cave), and have potential to meet the definition of a KFA. The distances from the nearest edge (e.g. road or development) are 128 m (420 ft), 152 m (500 ft), and 213 m (700 ft) from the entrance of MWA cave, Eluvial Cave, and Jollyville Plateau Cave, respectively (BCCP 2009b). The distances from the nearest edge to the cave footprint are 115 m (380 ft), 143 m (471 ft), and about 137 m (450 ft) to MWA Cave, Eluvial Cave, and Jollyville Plateau Cave, respectively (per aerial photography and Elliot 1997). This tract is adjacent to more than 162 ha (400 ac) of BCP land. The surface drainage basins have been delineated for all three of these caves but we are unsure if they are in the preserve (BCCP 2009b). The subsurface drainage basins have not been delineated (BCCP 2009b). As part of management for these caves, a perimeter fence was installed and RIFA are treated at least twice a year (ACI 2003, 2004, 2005, 2006, 2007).

Beard Ranch Cave

This City of Austin-owned cave is known to contain *T. reyesi* and is part of the BCP. It occurs on a tract that is 1,695 ha (4,189 ac) in area (BCCP 2009b). Due to the large amount of undeveloped land in this tract, it has the potential to be a KFA. The distance from the cave entrance to the nearest edge (i.e., disturbance due to road or a development) is 723 m (2,375 ft) (Dolph Scott, City of Austin, pers. comm., 2009). We do not have a map of the cave footprint, so we are unsure whether it is in the tract. The surface drainage basin is protected and included in the tract. The subsurface drainage basin has been delineated, but we are unsure whether it is in the tract (BCCP 2009b). As part of management for the cave, the City of Austin BCP staff conducts quarterly surface monitoring (BCCP 2009b).

⁴ If preserves are established within the BCCP acquisition boundaries, they are considered part of the BCCP and contribute to the total acreage of the preserve system (Rose Farmer, Travis County, pers. comm. 2008).

South Travis County KFR

Barker Ranch Cave No. 1

This cave is located on the City of Austin’s Water Quality Protection Lands on a tract that is 32 ha (81 ac) in area and contains *T. reyesi*. Due to the size of undeveloped land within and around this parcel, it has potential to be a KFA. The cave entrance is located 823 m (>2,800 ft) to the nearest edge (i.e., disturbance via road or a development). We do not have a map of the cave footprint and we do not have information on whether the surface and subsurface drainage basins for this cave have been delineated, so we do not know if they are in the tract. Also, we do not know if these caves receive any management, including looking for signs of trespass, RIFA, or monitoring of *T. reyesi*.

Table 1. Distribution of *T. reyesi*

Cave Name	Size of tract (ac)*	Notes
North Williamson KFR		
Priscilla's Well Cave	51	KFA
Karankawa Cave	130	potential KFA
Polaris Cave	130	potential KFA
Shaman Cave	100	10-ac setback in 100-ac undeveloped parcel; potential KFA
Pow Wow Cave	100	10-ac setback in 100-ac undeveloped parcel; potential KFA
Red Crevice Cave	105	Lakeline Mall mitigation; potential KFA
Temples of Thor Cave	105	Lakeline Mall mitigation; potential KFA
Thor Cave	105	Lakeline Mall mitigation; potential KFA
Jensen Cave	~150	potential KFA
Lobo's Lair	290	potential KFA
Wolf's Rattlesnake Cave	290	potential KFA
Flat Rock Cave	290	close to an edge
Twin Springs Cave	145	Williamson County Conservation Foundation
Sunless City Cave	145	close to a road
Snake Dancer Cave	130	1-ac setback
Prairie Flats Cave	3	3-ac setback
Abused Cave	15	
Williams Cave No. 1	15	
Cobb Drain Cave	?	close to road?
Coke Box Cave	?	close to road?
Duckworth Bat Cave	~10	
Cat Cave	~11	
Salt Lick Cave	6	
Salt Lick Cave	6	
3 Mile Cave	2	close to road?
Lizard's Lounge Cave	14	

Dwarves Delight Cave	14	
Apache Cave	5	
Double Dog Hole Cave	5	
Choctaw Cave	4	3-ac setback
Ute Cave	37	15-ac setback
Venom Cave	37	15-ac setback
Unearthed Cave	37	
Deliverance No. 1 Cave	26	13-ac setback
Deliverance No. 2 Cave	26	13-ac setback
Trail of Tears Cave	26	14-ac setback
Do Drop In Cave	8	5- ac setback
Dragonfly Cave	13	8-ac setback
Electro-Mag Cave	15	8-ac setback
Kiva Cave No. 1	3	
Medicine Man Cave	12	8-ac setback
Turner Goat Cave	30	4-ac setback
You Dig It Cave	30	2-ac setback
Woodruff's Well Cave	10	1-ac setback
Yellow Hand Cave	2	1-ac setback
Holler Hole Cave	6	4-ac setback
Viper Cave	?	
Buzzard Feather Cave	~30	
Hourglass Cave	~30	
Cassidy Cave	<1	
Pussy Cat Cave	<2	
Rattlesnake Inn Cave	>1000	close to road
Texella Cave	<1	
Waterfall Canyon Cave	2	close to edge
Georgetown KFR		
Round Rock Breathing Cave	52	potential KFA
Fortune 500 Cave	52	close to edge
Ominous Entrance Cave	52	close to a road
Steam Cave	~150	potential KFA
Fence-line Sink	~150	potential KFA
Mongo Cave	130	Wilco Preserve
Wilco Cave	130	Wilco Preserve
Wild West Cave	130	Wilco Preserve
Rock Ridge Cave	130	Millennium Preserve
Through Trip Cave	90	Millennium Preserve
Little Demon Cave	90	Millennium Preserve
Millennium Cave	90	developed; ~100' from road
Yamas Cave	<14	

Mayfield Cave	?	
Bone Cave	?	
Brown^s Cave	<1	
Elm Cave	<1	developed; close to houses
Formation Forest Cave	linear	<10-ac setback
Posh Cave	<10	<20' from road
Step-Down Cave	<2	
Inner Space Cavern	4	150' from road
Man-With-A-Spear Cave	12	
Mayor Elliott Cave	~60	In 5-ac greenspace
Mosquito Cave	5	In 5-ac greenspace
Onion Branch Cave	5	
Off Campus Cave	<1	
On Campus Cave	40	close to edge
Price Is Right Cave	<1	
Rootin Tootin Cave	<5	
Short Stack Cave	linear	
Sierra Vista Cave	<1	
Snowmelt Cave	<1	
Tres Amigos Cave	<2	
Zapata Cave	linear	
Flowstone Rift Cave	7	
McNeil/Round Rock KFR		
Blessed Virgin Cave	52	potential KFA
Weldon Cave	80	potential KFA
Rockfall Cave	24	potential KFA because adjacent to undeveloped land with adequate acreage to be KFA
Raccoon Lounge Cave	290	potential KFA
WS-54	290	potential KFA
WS-71a	290	potential KFA
WS-65310	310	potential KFA
Chaos Cave	30	Chaos Cave preserve; potential KFA because adjacent to undeveloped land
Beck Tex-2 Cave	41	
Beck Horse Cave	41	
Beck Pride Cave	41	
Beck Bat Cave	41	
Flint Wash Cave	?	
Beck Crevice Cave	?	
Beck Blowing Well Cave	?	
Beck Sewer Cave	10	
Beck's Tin Can Cave	10	
Black Cat Cave	10	

Beer Bottle Cave	42	
Beck Ranch Cave	?	
Beck Rattlesnake Cave	?	
Broken Zipper Cave	?	54-acre greenbelt
Joint Effort Cave	?	26-acre greenbelt?
Beck Bridge Cave	26	
Cat Hollow Bat Cave	2	
Cat Hollow Cave #1	3	
Cat Hollow Cave #2	26	
O'Connor Cave	26	in greenbelt
Cave Coral Cave	28	
Poison Ivy Cave (not all CCF)	30	Chaos Cave preserve
Under-the-fence Cave	30	Chaos Cave preserve
El Tigre Cave	?	
Crescent Cave	?	
Ensor Cave	?	
Eulogy Cave	?	
Leachate Cave	?	
Jackhammer Cave	?	
Scoot Over Cave	?	
Serta Cave	?	
Underdeveloped Cave	?	
Undertaker Cave	?	
Vericose Cave	?	
Wild Card Cave	?	
Joker Cave	?	
Hollow Oak Cave	?	
Lineament Cave	?	
McNeil Bat Cave	20	
No Rent Cave	150?	cave may be mapped incorrectly
Fossil Garden Cave	?	
Millipede Cave	?	in school courtyard
Mustard Cave	?	mapped incorrectly
Pecan Gap Cave	230	close to road
Pencil Cactus Cave	230	close to road
Rocky Horror Cave	32	close to road realignment
Sam Bass Hideaway Cave	?	close to road
Stepstone Cave	?	
Swarm Cave	?	
Hole-In-The-Road Cave	?	
Cold Cave	8	

War Party Cave	32	near 2 subdivisions
Cedar Park KFR		
Lakeline Cave	<1	
Underline Cave	developed	
Jollyville Plateau KFR		
Gallifer Cave	1,909	BCP; potential KFA
Tooth Cave	1,909	BCP; potential KFA
McDonald Cave	1,909	BCP; potential KFA
Root Cave	1,909	BCP; not KFA by itself but other caves in tract are potential KFAs
Stovepipe Cave	55	potential KFA
MWA Cave	52	Four Points; potential KFA
Eluvial Cave	52	Four Points; potential KFA
Jollyville Plateau Cave	52	Four Points; potential KFA
Beard Ranch Cave	4,189	BCP owned; potential KFA
Geode Cave	145	close to road
New Comanche Trail Cave	254	Travis County owns and will monitor the entrance and conduct faunal surveys; close to road
Twisted Elm Cave	3	
Central Austin KFR		
Cotterell Cave	20	
West Rim Cave	?	
South Travis County		
Barker Ranch Cave No. 1	81	City of Austin-owned

*Unless otherwise noted all acreage estimates were calculated using Geographic Information Systems (GIS) (2008 digital aerial photography, 2006 Travis County parcel data, and 2005 Williamson County parcel data) and are subject to typical margins of error associated with GPS units, GIS, and transferring data from paper sources to digital media. These acreages and respective cave locations need to be ground-truthed (i.e., verified by site visits). Also caves that appear to have enough acreage to qualify as a KFA did not meet all other recovery criteria, e.g. distance to edge, surface, or subsurface drainage basins were not included in the tract.

Climate Change

According to the Intergovernmental Panel on Climate Change (IPCC) (2007) “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.” Average Northern Hemisphere temperatures during the second half of the 20th century were very likely higher than during any other 50-year period in the last 500 years and likely the highest in at least the past 1300 years (IPCC 2007). It is very likely that over the past 50 years: cold days, cold nights and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent (IPCC 2007). It is likely that: heat waves have become more frequent over most land areas, and the frequency of heavy precipitation events has increased over most areas (IPCC 2007). To date, these changes do not appear to have had a negative impact on *T. reyesi*.

The IPCC (2007) predicts that changes in the global climate system during the 21st century are very likely be larger than those observed during the 20th century. For the next two decades a warming of about 0.2°C (0.4°F) per decade is projected (IPCC 2007). Afterwards, temperature projections increasingly depend on specific emission scenarios (IPCC 2007). Various emissions scenarios suggest that by the end of the 21st century, average global temperatures are expected to increase 0.6°C to 4.0°C (1.1°F to 7.2°F) with the greatest warming expected over land (IPCC 2007). Localized projections suggest the southwest may experience the greatest temperature increase of any area in the lower 48 States (IPCC 2007). The IPCC says it is very likely hot extremes, heat waves, and heavy precipitation will increase in frequency (IPCC 2007). There is also high confidence that many semi-arid areas like the western United States will suffer a decrease in water resources due to climate change (IPCC 2007). Milly et al. (2005) project a 10–30 percent decrease in precipitation in mid-latitude western North America by the year 2050 based on an ensemble of 12 climate models.

Although climate change was not identified as a threat to *T. reyesi* in the original listing document or in the recovery plan, the species’ dependence on stable temperatures and humidity levels opens the possibility of climatic change impacting this species. Therefore, while it appears reasonable to assume that *T. reyesi* may be affected, we lack sufficient certainty to know how climate change will affect this species.

2.3 Synthesis

According to recovery criterion (1) in the Travis and Williamson RP, three KFAs within each KFR should be protected. 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 RIFA, habitat destruction, and contaminants. Recovery criterion (2) requires at least five consecutive years of a cave meeting KFA status and that perpetual protection of these areas is in place. Since these species were listed in 1988, there have been significant steps toward protecting caves in which they occur and meeting the downlisting criteria.

Although *T. reyesi* is known from 168 caves occurring within 7 KFRs, at this time only 1 karst preserve, located in the North Williamson County KFR, meets the definition of a protected KFA - the Priscilla's Well KFA. Other than this 1 KFA, there are 20 other tracts distributed in the North Williamson, Georgetown, McNeil/Round Rock, Jollyville Plateau, and South Travis KFRs, that may meet the definition of a KFA. However, more research needs to be conducted to delineate surface and/or subsurface drainage basins, confirm locations and tract acreage, and confirm management activities at caves that have potential to be a KFA. Once the needed analysis is accomplished and these tracts demonstrate that they meet the full requirements of a KFA, the fulfillment of recovery criterion (1) can progress. If a cave is determined to be a KFA, then information relating to recovery criterion (2) should be gathered and/or implemented to meet downlisting status. Based on additional research and/or implementation/confirmation of certain management activities, we should be able to make this determination. Until such time, we do not recommend a change in listing status for these species.

3.0 RESULTS

3.1 Recommended Classification:

- Downlist to Threatened
- Uplist to Endangered
- Delist:
 - Extinction
 - Recovery
 - Original data for classification in error
 - No change is needed

3.2 New Recovery Priority Number: No change

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Within the **Jollyville Plateau KFR**, fulfillment of the following actions will meet qualifications for the creation of KFAs on City of Austin lands included in the BCP:
 - Delineate the subsurface drainage basin for Stovepipe Cave, Beard Ranch Cave, and McDonald Cave located in Cuevas (Tomen Park) tract.
 - Verify footprint and subsurface drainage of Beard Ranch Cave.
- Determine the footprint, surface and subsurface drainage basins, and establish RIFA control, management of trespass, and monitoring of *T. reyesi* for Barker Ranch Cave No. 1, located in **South Travis County KFR**, owned by the City of Austin.
- To progress toward KFA status, work with landowners or organizations to confirm locations and tract acreage, determine footprints, and/or delineate surface and subsurface drainage basins for the following privately-owned caves:
 - In **North Williamson County KFR**: Karankawa and Polaris; Shaman and Pow Wow; Red Crevice, Temples of Thor, and Thor; Jensen; Lobo's Lair; Wolf's

Rattlesnake

- In **Georgetown KFR**: Round Rock Breathing; Steam and Fence-line Sink
 - In **McNeil/Round Rock KFR**: Blessed Virgin; Weldon; Rockfall; Raccoon Lounge; Wyoming Springs Corridor; Chaos Cave Preserve
 - In **Jollyville Plateau KFR**: Four Points complex – MWA, Eluvial, Jollyville Plateau caves; Cuevas cave complex – Tooth, McDonald
- Confirm and/or implement RIFA control and other management activities with the cooperation of landowners at the following privately-owned caves to progress toward attaining KFA status:
 - In **North Williamson County KFR**: Karankawa and Polaris; Shaman and Pow Wow; Jensen; Lobo's Lair and Wolf's Rattlesnake
 - In **Georgetown KFR**: Round Rock Breathing; Steam and Fence-line Sink
 - In **McNeil/Round Rock KFR**: Blessed Virgin; Weldon; Rockfall; Raccoon Lounge; Wyoming Springs Corridor
 - Apply recovery criterion 2 to any caves that meet KFA status.
 - Draft delisting criteria and reevaluate the status of the species in accordance with those criteria.
 - Considering the geographic distance between northern (North Williamson, Georgetown, McNeil/Round Rock, Cedar Park, Jollyville Plateau, Central Austin KFRs) and southern (South Travis KFR) cave where this species occurs, the fact that they are separated by a major hydrologic divide (Colorado River), and that some northern caves overlap with the range of the closely related Bee Creek Cave harvestman (*Texella reddelli*), genetic analyses to confirm the presence of *T. reyesi* are needed.

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FISH AND WILDLIFE SERVICE
5-YEAR REVIEW for the Bone Cave Harvestman (*Texella reyesi*)

Current Classification: endangered

Recommendation resulting from the 5-Year Review:

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

Appropriate Listing/Reclassification Priority Number, if applicable: n/a

Review Conducted By: Cyndee Watson, Austin Ecological Services Field Office, Austin, Texas

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____

Date

6/26/09

REGIONAL OFFICE APPROVAL:

Assistant Regional Director, Ecological Services, Fish and Wildlife Service, Region 2

Signature _____

Date

12-4-09