# United States Fish and Wildlife Service, Section 10(a)(1)(A) Scientific Permit Requirements for Conducting Presence/Absence Surveys for Endangered Karst Invertebrates in Central Texas

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This document provides guidance on when you might be at risk of "taking" a species while conducting karst invertebrate surveys and when it is advisable to have a Section 10(a)(1)(A) permit issued by the Service under the Endangered Species Act of 1973, as amended (Act) to be covered for "take." The ultimate decision to apply for a permit is yours. Individuals engaged in activities that have the potential to "take" listed species are responsible for determining whether the likelihood of "take" is great enough to need a section 10(a)(1)(A) permit (see "*When a Section 10(a)(1)(A) Scientific Permit is needed*" below for the definition of "take").

If you choose to apply for a permit, this document outlines the U.S. Fish and Wildlife Service's (Service) process and requirements for conducting presence/absence surveys for federally-listed endangered, terrestrial karst invertebrate species (herein referred to as "karst invertebrates") in Travis, Williamson, and Bexar counties, Texas, as conditions of holding a section 10(a)(1)(A) permit. See Table 1 for a list of endangered karst invertebrates (53 FR 36029-36033; 65 FR 81419-81433) in these three counties. Section 10(a)(1)(A) permits, also referred to as recovery, enhancement of survival, or scientific permits, allow for "take" of listed species that may or will occur while conducting research to further the recovery of a listed species (see *When a Section 10(a)(1)(A) Scientific Permit is Needed* below). This document outlines methods to be used, information to be included in final reports, and minimum qualifications for personnel conducting presence/absence surveys for endangered karst invertebrates under a section 10(a)(1)(A) permit.

The objective of this document is to identify survey methods that will produce sound scientific information upon which to base decisions and actions for the conservation of these endangered species. Using consistent survey methodology will also allow for greater comparison and analysis of results, and thereby increase our understanding of these species and their habitat requirements. Please note, this document supersedes any previous guidance from the Austin Ecological Services Office on conducting presence/absence surveys for federally endangered karst invertebrates. Information that relates to the effectiveness of these survey guidelines in conserving endangered karst species is welcome. We will consider modifications of, or alternatives to, these methods and qualifications on a case-by-case basis.

Since one of the first steps in determining presence/absence of endangered karst invertebrates is to survey for karst features that may have suitable habitat, this document also outlines the Service's recommendations for conducting surveys for karst features that may contain suitable habitat for endangered karst invertebrates. Since no "take" of listed species is anticipated while conducting initial surface walking karst feature surveys, this activity does not necessitate a section 10(a)(1)(A) permit. However, the potential for "take" exists with entry into a void or cave where endangered karst invertebrates may occur. Therefore, the Service recommends that all personnel excavating, entering,

and/or collecting in a void or cave that may contain suitable habitat for endangered karst invertebrates to conduct conservation work hold a valid 10(a)(1)(A) permit for the endangered karst invertebrates in the county being surveyed.

**When a Section 10(a)(1)(A) Scientific Permit is Needed**

Collecting endangered species is a form of "take" and therefore, is prohibited under section 9 of the Endangered Species Act of 1973, as amended, unless the "take" is covered under a Section 10(a)(1)(A) scientific permit. "Take" is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." In addition to collecting, forms of "take" that could occur in the process of conducting karst invertebrate surveys and related tasks, such as mapping or excavating a cave, include crushing individuals; compaction of habitat and oviposition sites; destruction of webs; disturbance of cover objects; harm or harassment that may occur with the introduction into the environment of noise, light, chemicals, and biological substances, such as microbes normally found on the surface or in other caves, and possibly other actions that would cause individuals to flee, seek shelter, or alter or cease normal foraging, anti-predation, or reproductive behavior. For information on how to apply for a 10(a)(1)(A) permit contact Stephanie Weagley and Melissa Castiano at Stephanie_Weagley@fws.gov and Melissa_Castino@fws.gov.

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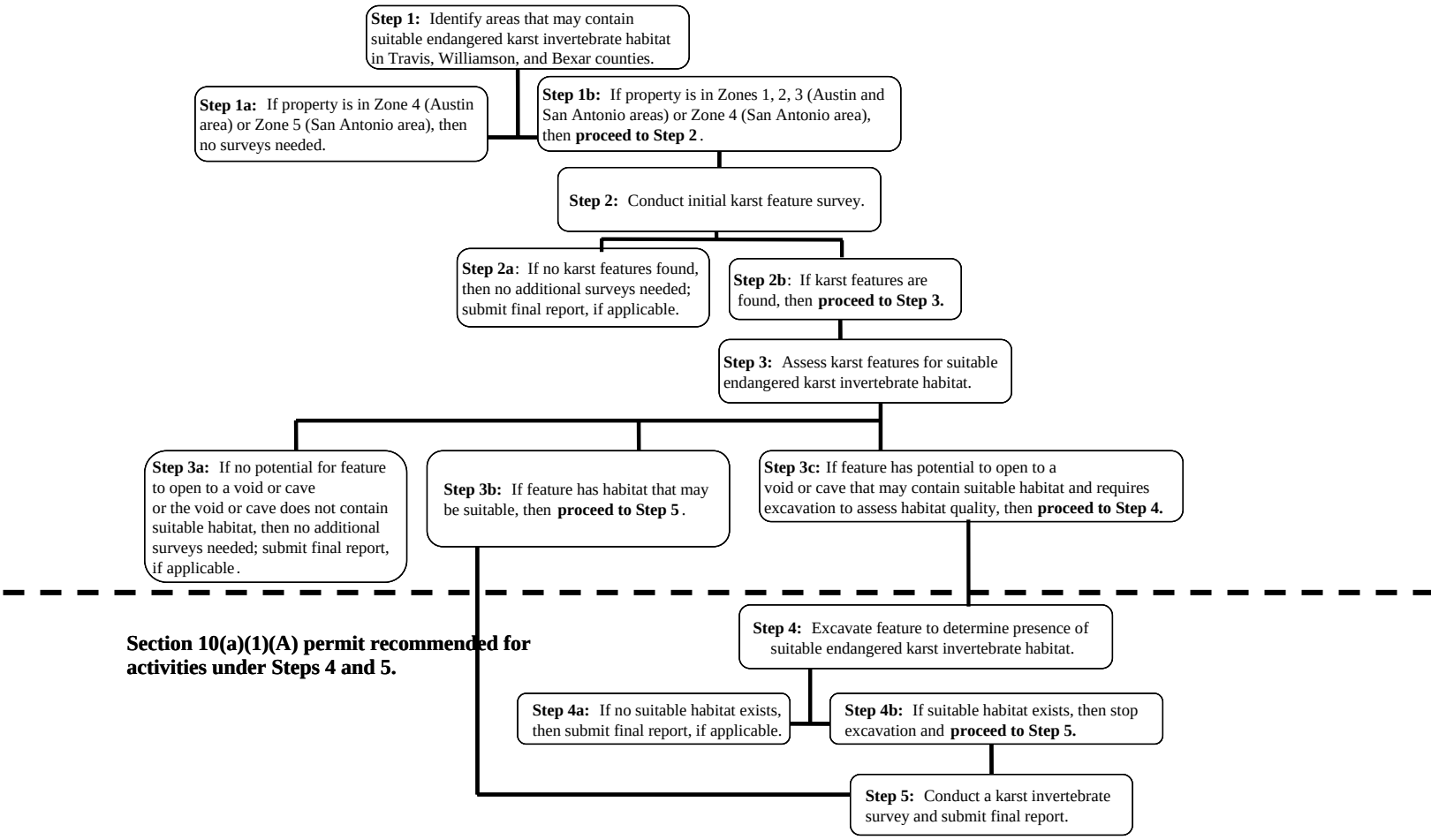
Table 1. Federally endangered terrestrial karst invertebrates from Central Texas (Final Rule for Travis and Williamson Counties - 53 FR 36029-36033; Bexar County - 65 FR 81419-81433; technical corrections – 58 FR 43818-43820).

| Common Name | Species | County of Occurrence |
|---|---|---|
| Madla Cave meshweaver | *Cicurina madla* | Bexar |
| Robber Baron Cave meshweaver | *Cicurina baronia* | Bexar |
| Braken Bat Cave meshweaver | *Cicurina venii* | Bexar |
| Government Canyon Bat Cave meshweaver | *Cicurina vespera* | Bexar |
| Government Canyon Bat Cave spider | *Neoleptoneta microps* | Bexar |
| Cokendolpher cave harvestmen | *Texella cokendolpheri* | Bexar |
| Ground Beetle (no common name) | *Rhadine exilis* | Bexar |
| Ground Beetle (no common name) | *Rhadine infernalis* | Bexar |
| Helotes mold beetle | *Batrisodes venyivi* | Bexar |
| Bee Creek Cave harvestmen | *Texella reddelli* | Travis |
| Kretschmarr Cave mold beetle | *Texamaurops reddelli* | Travis |
| Tooth Cave pseudoscorpion | *Tartarocreagris texana* | Travis |
| Tooth Cave spider | *Leptoneta myopica* | Travis |
| Tooth Cave ground beetle | *Rhadine persephone* | Travis and Williamson |
| Bone Cave harvestmen | *Texella reyesi* | Travis and Williamson |
| Coffin Cave mold beetle | *Batrisodes texanus* | Williamson |

## How to Determine if Karst Invertebrates May be Present

Figure 1 outlines a five-step approach for determining presence/absence of endangered karst invertebrates and karst features that may contain suitable habitat for endangered karst invertebrates in central Texas. See text following the figure for a more complete description of each step.

Figure 1: Five-step approach for determining presence/absence of endangered karst invertebrates and karst features that may contain suitable habitat for endangered karst invertebrates in central Texas.



**Step 1[1]. Identify areas that may contain suitable habitat for endangered karst invertebrates in Travis, Williamson, and Bexar counties.** Four karst zones have been delineated in the Austin area (Travis and Williamson counties) (Veni 1992) and five karst zones have been delineated in the San Antonio area (Bexar County) in Texas (Veni 1994). The karst zones in the San Antonio area were updated and revised in Veni (2002). These karst zones are a useful first step in determining if karst features containing endangered invertebrates are likely to occur on a particular property. The karst zone maps are available online at www.fws.gov/ifw2es/AustinTexas/ or upon request from the Austin Ecological Service Field Office.

Table 2. Definitions of Karst Zones (modified from Veni 1992; 1994; 2002)

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|---|---|
| In both the San Antonio and Austin areas: | **Zone 1** is defined as areas known to contain endangered karst invertebrate species. |
| | **Zone 2** is defined as areas having a high probability of containing suitable habitat for endangered karst invertebrate species. |
| | **Zone 3** is defined as areas that probably do not contain endangered karst invertebrate species. |
| In the San Antonio area: | **Zone 4** is defined as areas that require further research but are generally equivalent to Zone 3, although they may include sections that could be classified as Zone 2 or Zone 5 as more information becomes available. |
| | **Zone 5** is defined as areas, both cavernous and non-cavernous, that do not contain endangered karst invertebrate species. |
| In the Austin area: | **Zone 4** is defined as areas, both cavernous and non-cavernous, that do not contain endangered karst invertebrate species. |

**Step 1a.** If the subject property is in Zone 4 (Austin area) or Zone 5 (San Antonio area), then it lies within an area, either cavernous or non-cavernous, that does not contain the endangered karst invertebrates and no surveys are needed.

**Step 1b.** When conducting a karst invertebrate survey under a Section 10(a)(1)(A) permit, the surface survey for karst features is not expected to result in "take." However, while not required, certain procedures for surface surveys are recommended as part of the scientifically sound process for assessing the presence/absence of karst invertebrates. In karst zones 1, 2, 3 (Austin and San Antonio areas) and 4 (San Antonio area), we recommend an initial karst feature survey be conducted on the entire property within these zones; **proceed to Step 2** for more on conducting these surveys.

[1] Since "take" is unlikely to occur during activities conducted under Steps 1 and 2, a section 10(a)(1)(A) permit is not needed.

**Step 2[1]. Conduct an initial karst feature[2] survey.** If you are in zones 1 or 2, we recommend that a survey be conducted by a qualified individual, as defined by Texas Commission on Environmental Quality (TCEQ),[3] with demonstrated experience in karst geology. In zone 3 (in Austin and San Antonio areas) where the presence of endangered karst invertebrates is possible but unlikely, we recommend that, at a minimum, the landowner or their designated representative visually inspect their property for karst features. In zone 4 (in San Antonio area) where sections of Zone 2 may occur, we recommend a survey be conducted by a qualified individual, as defined by TCEQ,[3] with demonstrated experience in karst geology.

To conduct karst feature surveys, follow methods outlined in section II-A of *Procedure For Conducting a Geologic Assessment* in TCEQ's *Instructions to Geologists for Geologic Assessments (GA)* as revised October 1, 2004. Applicable portions of those procedures are included here in Appendix III. Note, we intend for you to use the GA to locate features only and not to assess whether a feature has the potential to lead to karst invertebrate habitat. Guidance on assessing a features potential to contain suitable karst invertebrate habitat is discussed in Step 3 below. If you have questions regarding the GA you may contact the TCEQ Austin Regional Office (512-339-2929), the San Antonio Regional Office (210-490-3096) or on the internet at http://www.tceq.state.tx.us

- If a GA has previously been conducted on the subject site following TCEQ's October 1, 2004, guidelines, then it may serve as an initial karst feature survey.
- If a GA is not required on the subject site by TCEQ (for example, the site is not located on the Edwards Aquifer recharge or transition zones) then we recommend that the initial karst feature survey be conducted following the methods outlined in those portions of section II-A of *Procedure For Conducting a Geologic Assessment* in TCEQ's GA (October 1, 2004) that are contained in Appendix III herein.
- All surveys should be conducted such that the likelihood of overlooking any karst feature is very low.

**Step 2a.** If no karst features are found during the initial karst feature survey, no additional survey work is needed. While no permit report is required on this part of the survey, we do encourage surveyors to report these results (including negative results) to the Service to increase understanding about these species and to increase the database upon which to make conservation and management decisions.

**Step 2b.** If karst features are found during the initial survey, **proceed to Step 3**.

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[2] Karst Feature – geomorphic, topographic, and hydrological feature formed by solution of limestone by water. Caves, solution cavities, sinkholes, swallow holes, solution enlarged fractures are common types of karst features; many more can be found in a textbook or glossary of karst terms. (Texas Commission for Environmental Quality (TCEQ), Instructions to Geologists for Geologic Assessments (GA) as revised May 1, 2002, Section IV).

[3] Geologist - a person who has received a baccalaureate or graduate degree in the natural science of geology from an accredited university and has training and experience in groundwater hydrology and related fields, or has demonstrated such qualifications by registration or licensing by a state, professional certification, or completion of accredited university programs that enable that individual to make sound professional judgments regarding the identification of sensitive features located in the recharge zone or transition zone. Since September 1, 2003 geologists conducting assessments are expected to be licensed according to the Texas Geoscience Practice Act (TCEQ, GA as revised Ocotber 1, 2004, Section IV).

**Step 3[4]. Assess karst features for suitable endangered karst invertebrate habitat.** The potential for each identified karst feature to provide or lead to suitable habitat for endangered karst invertebrates should be assessed by a qualified individual, as defined by TCEQ,[3] with demonstrated experience in karst geology and the ability to identify certain cave - adapted species. To accomplish this assessment, some features may require a reconnaissance excavation.[5] If reconnaissance excavations are conducted as described below they are not expected to result in take. See Step 4 for more on excavating features. Once a feature is located using the TCEQ's GA, the following factors outlined in Veni and Reddell (2002) should be considered when determining if a feature has potential to lead to a void or cave[6] with suitable karst invertebrate habitat:

- If a feature is filled, or partly filled, by leaf litter, loose, modern soils, and a few rocks, it should be subjected to a reconnaissance excavation, prior to its evaluation for its potential to lead to a cave. A rod at least 30 centimeters (1 foot) long should be used to probe into the soils of a feature in search of shallow voids and to quickly and further estimate the feature's origin and permeability. If a site seems likely to contain culturally or paleontologically significant materials, action related to the feature should first be coordinated with the Texas Historical Commission (THC), before determining if excavation is appropriate (http://www.thc.state.tx.us).

- If a feature exhibits airflow, channelized recharge of water, development by soil or bedrock collapse, loose soil or rock fill to a depth of at least 30 centimeters (1 foot), or clean-washed rocks at its base, then it may lead to a void. The presence of *Ceuthophilus cunicularis* cave crickets, *Cicurina varians* spiders, or cave-adapted species found during the reconnaissance excavation also indicates the presence of a void. Therefore, we recommend that the surveyor conducting the karst feature assessment be able to recognize such cave-adapted species.

If none of the above factors are present, then any combination of at least two of the following factors should be considered justification for further excavation of a feature (Veni and Reddell 2002):
- There is development along a fracture related to the karst feature.
- The feature is more than 2 meters (6.6 feet) in length or diameter.
- The feature is more than 1 meter (3.3 feet) deep.
- Morphology of the feature is similar to the pre-excavation appearance of a nearby known cave in the same geologic setting.
- A humanly or potentially humanly enterable void is visible.

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[4] Since the potential for "take" exists for activities outlined in Steps 4 and 5, we recommend that all personnel entering, excavating, and/or collecting in features with potential to contain endangered karst invertebrates to conduct conservation activities for the species hold a valid section 10(a)(1)(A) permit for the listed karst invertebrates in the county being surveyed (see *Appendix II* for surveyor qualifications.) For information on how to apply for a 10(a)(1)(A) permit contact Stephanie Weagley and Melissa Castiano at Stephanie_Weagley@fws.gov and Melissa_Castino@fws.gov.

[5] Reconnaissance Excavation – hand removal of loose soil, rocks, and leaf litter not exceeding 1 foot in depth and 1 foot in diameter and is for the purpose of distinguishing actual karst features from non-karst depressions such as old weathered stump holes, animal burrows, and latrine pits (Veni and Reddell 2002).

[6] Cave - a naturally occurring, humanly enterable cavity in the earth, at least 5 m in length and/or depth, and where no dimension of the entrance exceeds the length or depth of the cavity (www.texasspeleologicalsurvey.org)

Other factors that should be considered justification for further excavation of a feature (Veni and Reddell 2002):

- The feature is close to caves known to contain endangered species.
- The feature is in karst zone 1 or 2.
- The physical characteristics, for example, size, appearance, catchment basin, conduits, air flow, and mammal etchings suggest the presence of a cave.
- The appearance of fill does not match surrounding area, which may indicate the presence of artificial material in a feature.
- The feature is located near structural features that may promote cave and karst features to develop, such as a fault, photolineament (possible bedrock feature indicated by aerial photographs), or an area of relatively high fracture density.
- Vegetation in the area includes certain plants, especially trees, that may preferentially grow in cave entrances and other karst features.
- Past land use activities (for example, agricultural) may indicate the presence of false features.

Characteristics of karst features not likely to contain suitable habitat for endangered karst invertebrates:

The following guidance is based on Veni and Reddell (2002) and is provided as guidance for determining when karst features are not likely to contain habitat for endangered karst invertebrates. Each of the factors listed below indicates conditions unfavorable to the listed species, but individually, none of these factors rule out their occurrence. A "no further action" determination requires that all of these factors occur together, making habitat for the listed species unlikely.

- Features that have all, or nearly all, floors, walls, and ceilings covered with calcite speleothems and lacking black sediment, are highly unlikely to provide habitat for listed species. The calcite speleothems may block the species and nutrients for the species from entering the feature.
- Features with floors that occur less than 1.5 meter (4.9 feet) below the surface are unlikely to contain suitable habitat for the listed invertebrate species (Veni and Reddell 2002). Such features occur in a zone where they will become significantly warmer and drier during the summer, and cooler and drier during the winter than features at greater depths. The listed species usually live in deeper voids where temperatures and humidity are more stable. Also, these shallow depths are more prone to invasion by non-native species, particularly red-imported fire ants that may compete with or prey upon the listed species.
- The absence of non-listed troglobites[7] or troglophiles[8] suggests conditions are unsuitable for the listed troglobites. To determine if this criterion is met, the evaluation must be conducted or directly supervised by someone with experience recognizing these species.

[7] Troglobites - a species of animal that is restricted to the subterranean environment and typically exhibits morphological adaptations to that environment, such as elongated appendages and loss or reduction of eyes and pigment (Veni 2002).

[8] Troglophiles - a species of animal that may complete its life cycle in the subterranean environment but may also be found on the surface (Veni 2002).

- Features must be "dry," meaning that the apparently normal condition of the feature has no pools, water flow, notable moisture or discernible dampness on the walls, floors, ceilings, or sediments. Since it may not be possible to observe the feature after periods of rainfall, it should be examined for water-formed features that would indicate at least episodic occurrence of significant moisture. Such features include, but are not limited to: recently formed scallops and pitting of sediments and bedrock, sediment depositional patterns exhibiting flow and/or ponding, and recent speleothem resolution and growth.
- Fewer than 10 cave crickets have been found in the feature. These animals are often important components of ecosystems containing the listed species, and their absence or minimal presence suggest conditions unsuitable for the listed species.
- Absence of discernible airflow suggests that the feature does not connect to a cave or significant voids that might contain the listed species. The presence of airflow usually indicates the existence of such voids, but its absence does not indicate the opposite. Several factors may prevent airflow when significant voids are present.
- The feature is not collapse-formed or related to a collapse. If a feature is part of a collapsed area of bedrock, it is part of a deeper, more extensive cave or series of voids that produced the collapse and are more likely to contain suitable habitat for the listed species.

**Step 3a.** If, after a thorough assessment, you determine there is no potential for the feature to open to a void or cave or the void or cave does not contain suitable habitat, then no additional surveys are needed.

**Step 3b.** If the karst feature is a cave or has habitat that may be suitable for endangered karst invertebrates, then **proceed to Step 5**.

**Step 3c.** If the karst feature has potential to open to a void or cave that may contain suitable habitat for endangered karst invertebrates and requires excavation to assess habitat quality, then **proceed to Step 4**.

**Step 4.[4] Excavating features:** Considering that excavation of features could result in "take," we recommend surveyors conducting excavations beyond the scope of a reconnaissance excavation should hold a 10(a)(1)(A) permit. Excavation may be performed by a technician under the supervision of a qualified geologist who takes responsibility for work and receives daily reports (geologist does not have to be present at time of excavation). The geologist should determine if the feature leads to a cave or other void and will require removal of fine sediments, collapsed rocks, calcite deposits, and/or bedrock. Excavation with hand tools should be used whenever possible to minimize disturbance of a feature's environment. Explosives may be needed to excavate collapsed rocks, calcite deposits, and/or bedrock but should be used strategically under the supervision of experienced personnel and in small amounts to selectively remove obstructions. Backhoes or related heavy machinery may be needed where large rocks or volumes of sediments are impractical and/or unsafe for removal by hand.[9] The

[9] [**NOTE:** Excavation or any other activity that alters or disturbs the topographic, geologic, or existing recharge characteristics of a site, is regulated under the TCEQ's Edwards Aquifer Program and may require a Water Pollution Abatement Plan (WPAP). TCEQ's regional office should be consulted prior to either blasting or using a backhoe to excavate any feature occurring in the Edwards Aquifer recharge and transition zones. For more information, contact TCEQ at 512-239-1000 or access the Internet at http://www.tceq.state.tx.us/EAPP]

size of excavations should be kept as small as possible while allowing space for efficient excavation efforts and creating an area safe for entry. Multiple entrances dry out caves and unneeded excavated entrances should be sealed with natural fill equivalent in permeability to what was excavated. (Also see *Restoring Excavated Features* below). To minimize promotion of fire ant activity and siltation of streams, excavated material from all features should be evenly distributed downslope of, and at least 5 meters (16 feet) from, the features. Sediments should be distributed in thicknesses of no more than 1-2 centimeters (0.39-0.78 inches) to allow rapid integration into the existing soils and stabilization by vegetation.

Excavation should cease upon encountering (1) a cave (caves may require further excavation during biological surveys, see Step 5), (2) solid bedrock with no conduits, (3) packed clay with no airflow present (the passage should be checked several times under different surface temperature conditions (for example, cool mornings, warm evenings) before determining there is no airflow), (4) potential archaeological or paleontological materials, or (5) where continued excavation would be dangerous (for example, due to a large, overhanging rock or high levels of $CO_2$). If the $CO_2$ level is high, consider having fresh air blown in or re-surveying during more favorable weather conditions (such as during the winter months, especially after strong cold fronts, which pushes $O_2$ deeper into the cave displacing $CO_2$).

If a significant void or cave that may contain suitable habitat for endangered karst invertebrates is encountered during excavation, excavation should stop and a qualified individual (see *Appendix II*) holding a valid section 10(a)(1)(A) scientific permit issued by the Service should survey for endangered karst invertebrates and conduct further excavations within the cave, if needed. However, we recommend immediate collection, by an individual holding a section 10(a)(1)(A) permit, of any karst invertebrates observed within the entrance area during the initial excavation (see *Appendix II*).

Other techniques to assess the presence of karst features and endangered species:
Remote sensing techniques, such as video cameras or geophysical techniques such as electrical resistivity, microgravity, ground penetrating radar, or natural potential, may be helpful in assessing the presence of a void or the extent of a known feature that may contain suitable habitat. It should be noted that use of such techniques cannot determine the presence of endangered invertebrates. If using these techniques detects inaccessible voids that have potential to lead to a cave, coreholes or boreholes should be drilled in and near the voids to allow for baiting (see *Baiting* under Step 5 below). Please note that some karst invertebrate species, such as spiders and harvestmen, are less likely to be captured by baiting (George Veni, George Veni & Associates, in litt. 2003). Therefore, coreholes should be large enough to allow for human-access to conduct surveys. The results of such samples will assist in determining whether endangered karst invertebrates are likely to be present. However, finding only non-endangered invertebrates in borehole samples does not necessarily imply there are no listed species present. After all necessary biological surveys have been conducted, coreholes should be returned to a state most beneficial for the cave ecosystem (see *Restoring excavated features* below).

Restoring excavated features: Features that are excavated into caves should be left open enough that human access for biological surveys is possible. However, openings larger than 1 meter (3.28 feet) to relatively small caves may be detrimental to the karst ecosystem by increasing drying and temperature fluctuation. Excavation sites that may contain suitable habitat should be covered with material to

prevent drying of the habitat in between times when the feature is being actively evaluated. A plastic tarp covered with a light colored blanket would likely meet this need. After all necessary biological surveys have been conducted, features, caves, or boreholes should not necessarily be refilled but should remain in, or be returned to, a state most beneficial for the karst ecosystem, which may include but is not limited to (1) returning the entrance to its pre-excavated condition (for example to reduce air flow if the original entrance was small) or (2) installing a cave gate to prevent large mammal access (for example, feral hogs).

**Step 4a.** If no suitable habitat for endangered karst invertebrates exists, then no further excavation is necessary. A final karst feature survey report should be provided to the Service if excavation is conducted under a 10(a)(1)(A) permit (see *Appendix I* for reporting requirements). The requirement to report both positive and negative findings is a condition of obtaining a section 10(a)(1)(A) permit for these species. These data are important, even if findings are negative, for the conservation and recovery of the species. We would also appreciate receiving copies of karst feature survey reports, even if not conducted under a 10(a)(1)(A) scientific permit, to further our understanding of these species and their habitat requirements.

**Step 4b.** If suitable habitat for endangered karst invertebrates exists, then stop excavation and **proceed to Step 5**.

**Step 5[4]. Conduct a Karst Invertebrate Survey.** Since collection of federally-listed endangered species constitutes "take" and is a violation of section 9 of the Act without a permit, species surveys should be conducted by persons holding a valid 10(a)(1)(A) permit. The following section outlines the required survey methodology for conducting presence/absence surveys for endangered karst invertebrates in central Texas under a section 10(a)(1)(A) permit. Once the survey(s) are complete, a comprehensive report should be submitted whether endangered karst invertebrates were encountered or not (See *Appendix I* for reporting requirements). The requirement to report both positive and negative findings is a condition of obtaining a section 10(a)(1)(A) permit for these species. These data are important, even if findings are negative, for the conservation and recovery of the species.

**NOTE:** Any work in a cave is inherently dangerous. The presence of pits and ledges; large, unstable, overhanging rocks; and high levels of $CO_2$ present danger to researchers. Surveyors should use their best judgment to determine when conditions are safe to proceed. If invertebrate surveys are limited or discontinued due to safety concerns, this should be made clear in the report. Baiting (see *Baiting* below) may be recommended as an alternative under these conditions, if it can be done safely by the biologist.

Number of sampling occasions: To determine the presence/absence of listed karst invertebrates, survey all caves and significant features at least three times. Each survey should occur no sooner than one week apart during suitable sampling conditions (see *Suitable sampling conditions* below).

Sampling events should be separated by sufficient time to account for changes in life cycles, trends in seasonal nutrient input, and/or changes in weather conditions that may cause the species to be more or less available to collectors. However, notable differences in species abundance have been observed within as little as a week within caves that cannot be accounted for by rainfall or other surface

condition (George Veni, George Veni & Associates, in litt. 2003). Veni suggests that observed differences in species abundance may be due to life cycle changes or some other factors that we don't yet understand.

Suitable sampling conditions: The entire cave should be searched when conditions in the cave are appropriate for finding the listed karst invertebrates, generally avoiding temperature extremes and low humidity.

- The recommended time of year is spring (March through June) or fall (September through January). Ideally at least one sample should be conducted in each of the two seasons to observe species that may be more active or visible in one season or the other. *Rhadine* beetles appear to be more abundant in the spring, indicating that fall surveys may not be as useful for these species (James Reddell, Texas Memorial Museum, pers. comm. 2002).

- Recommended weather conditions include:
  - Average weather (temperature and rainfall) for time of year.
  - Surface air temperatures during the previous week should not have been greater than 37.8°C (100°F) or less than 4.4°C (40°F).
  - Lack of drought conditions.
  - Recent rainfall.
  - Absence of recent, extensive, local flooding.

Surveys conducted outside of times defined as suitable sampling conditions during which no listed species are found may not count as one of the three recommended surveys. Please contact the Service if surveys cannot be conducted during the appropriate time of year or during appropriate weather conditions.

Sampling diligence and thoroughness:
- The void/cave should be searched thoroughly.
- Search times should be proportional to the size of the void/cave.
- For caves that have large volume rooms, it may be necessary to search using a system of transects or other method to ensure the entire cave is thoroughly searched.

Thoroughness: Because karst invertebrates are small, have low population sizes, and may have behaviors that make them difficult to find, such as retreating under rocks or into passages too small for humans, it is necessary to ensure that sufficient time and effort have been spent surveying before any listed species are judged as being absent. Where applicable, the following should be done:
- Check under all loose and easily moveable rocks; rocks should be moved with care to ensure species are not injured. All rocks should be returned to their original position immediately after examination.
- Check under clumps of dried, cracked sediment; these should also be moved with care and returned to their original position after examination.
- Look in crevices, on ceilings, and walls as much as logistically possible.
- Hand-sift samples of loose sediment and look on, and in, scat and dead animals.
- To the extent practicable, search all habitat types, not only those that are believed to be the

preferred habitat of the listed species, because habitat profiles are incomplete, and this will also provide information on habitat selection by the listed species.

Specimen collection and preservation: Because the endangered karst invertebrates may not be possible to distinguish in the field from closely related species, specimens should be collected for identification by a qualified taxonomist.

- No more than ten specimens of any one species should be collected in any one cave. We also encourage the collection of up to ten specimens of any non-listed invertebrate species that cannot be identified to species in the cave. **NOTE**: Entry and collection in caves known to contain endangered karst invertebrates is not authorized, even under a section 10(a)(1)(A) permit, unless a monitoring or research plan has been approved by Austin Ecological Services Field Office.
- These collections should be identified as specifically as possible and sent to the Texas Memorial Museum, in Austin, Texas (or other appropriate museum or university) for taxonomic determination and curation (see *Appendix I, Specimen Deposition* for address).
- Adult specimens should be preserved in 70-80 percent ethanol to allow for taxonomic study. Because blind *Cicurina* and *Texella* species require adult specimens of a specific gender for positive identification (using morphological techniques), immature specimens of these species, along with any other specimens being collected solely for molecular study, should be preserved in 100 percent non-denatured ethanol.
- Specimens collected should be immediately placed in a cooler and kept there until transferred to a freezer. Before transfer to a freezer, the preservative should be discarded and replaced with new ethanol. All preserved specimens should be stored in, at a minimum, a standard freezer (-11ºC (12ºF) to -22ºC (-8ºF)) until shipped for taxonomic or molecular analysis.
- All specimens should be stored in separate vials to prevent misidentification in the event that appendages become separated from the body.
- Immature specimens collected alive with the intent of rearing them to adulthood for positive identification (for example, blind *Cicurina* and *Texella* species) should be sent to a taxonomist immediately. To promote specimen viability, surveyors should coordinate shipments with taxonomists so they will know when to expect them and can prepare accordingly.

Baiting: Baits may attract fire ants into the cave and, therefore, should be used with caution when using as an invertebrate survey technique. If baiting is used:

- Baits should be used in leads that are inaccessible for visual examination and more than 2 meters (6.5 feet) deep. Baits should be set for three to seven days and only checked at the end of that period. However, the area around the baited void should be checked daily. Any fire ant mounds found prior to, or during, baiting should be treated immediately with boiling water.
- Baits may also be used when suitable habitat is present yet multiple active searches (at least three) have not resulted in species occurrence.
- Please note that some karst invertebrate species, such as spiders and harvestmen, are less likely to be captured by baiting (George Veni, George Veni & Associates, in litt. 2003).

Reporting: Reports documenting activities under a section 10(a)(1)(A) scientific permit are to be provided to the Service annually. Reporting requirements are outlined in *Appendix I.*

**Literature Cited**

Texas Speleological Survey. 2006. Definition of a cave. http://www.txspeleologicalsurvey.org

Veni, G. 1992. Geological controls on cave development and the distribution of cave fauna in the Austin, Texas, region. Report prepared for U.S. Fish and Wildlife Service, Austin, Texas. George Veni and Associates, San Antonio, Texas. 77 pp.

Veni, G. 1994. Geological controls on cave development and the distribution of endemic cave fauna in the San Antonio, Texas, region. Report prepared for Texas Parks and Wildlife Department, Austin, Texas, and U.S. Fish and Wildlife Service, Austin, Texas. George Veni and Associates, San Antonio, Texas. 99 pp.

Veni, G. 2002. Delineation of hydrogeologic areas and zones for the management and recovery of endangered karst invertebrate species in Bexar County, Texas. Report prepared for the U.S. Fish and Wildlife Service, Austin, Texas. George Veni and Associates, San Antonio Texas. 75 pp.

Veni, G. 2003. Comments on the 12-16-03 draft Karst Survey Guidelines. December 28, email to U.S. Fish and Wildlife Service, Austin, Texas.

Veni, G. and J.R. Reddell. 2002. Protocols for Assessing Karst Features for Endangered Invertebrate Species. Report by George Veni and Associates, San Antonio, Texas. 7 pp.

# Appendix I:
# United States Fish and Wildlife Service, Section 10(a)(1)(A) Karst Feature and Endangered Karst Invertebrate Surveys:
# Report Requirements

An annual permit report is required for 10(a)(1)(A) permit holders. For information that should be included in these reports see Karst Invertebrate Survey Report below.

A section 10(a)(1)(A) scientific permit is not required to conduct surface walking surveys to determine the presence/absence of karst features, as no "take" of listed species is likely to occur. However, we would appreciate receiving karst feature reports. These data are important, even if findings are negative, for the conservation and recovery of the species. See Karst Feature Survey Report below for information that we would find helpful in these reports.

**KARST INVERTEBRATE SURVEY REPORT:** This report is **required** by 10(a)(1)(A) permittees and should include, but is not limited to, the information described below. This information will benefit the conservation of these species by furthering our knowledge of the biology and ecology of these species.

## Personnel

- Names of all persons involved in the surveys and their duties.
- Each person's section 10(a)(1)(A) scientific permit number, if applicable.
- A brief summary of experience, education, and certification for each person **NOT** holding a section 10(a)(1)(A) scientific permit.
- Person(s) directly responsible for writing the report.

## Location

- Location of caves and features surveyed and the property boundaries on either a USGS topographic map (7.5 minute or larger scale) or, if possible, in a GIS (Geographic Information System) layer with georeferenced location data (using global positioning system (GPS)), including references such as roads and political boundaries.
- If GPS is used, then include GPS location information for each cave or feature surveyed. Also, report the GPS unit model and its accuracy, and if any real time correction or post processing was done.
- Georeferenced data should be collected in lat-long (decimal degrees). North American Horizontal Datum 1983 (NAD 83) is preferred. If collected in an alternate coordinate system, please report the coordinate system and datum the information was collected in.

## Methods

- Describe survey methodology using standards consistent with a scientific, peer-reviewed publication.
- Report whether the entire cave was surveyed or surveys were conducted along transects or following another statistical sampling method and describe that methodology.
- Report use of baiting. Include a description of the methodology used including the type(s) of bait

used, the location of bait, and the amount of time baits were left out.
- Report total time spent searching (in person-hours) specifically for karst invertebrates.
- Report date and time of day each survey was conducted.
- Report temperature and humidity on the surface and at locations inside the feature as indicated below in the section titled "Caves and Karst Features." Indicate the brand and model of the equipment used and the equipment's accuracy (degree of accuracy).
- Report weather conditions on the survey day and previous week.

**Caves and Karst Features**
- Describe each cave or feature surveyed and include a detailed, scaled cave map with plan and profile views.
  - Description or map should include:
    - The approximate passable length of the cave or feature.
    - Possible leads or breakdown areas that could be invertebrate habitat, but are not humanly passable.
    - The approximate heights and widths of passages
    - Locations of any standing or flowing water.
  - Describe the interior of each cave or feature surveyed including:
    - Principle formations and whether they are active.
    - Make-up of the cave floor in each section (for example, mud, breakdown with approximate sizes, powder).
    - Approximate area and depth for standing water and approximate width, length, depth, and flow rate.
    - Temperature (to the nearest 0.1°F) and relative humidity (to the nearest 1 percent). Indicate the brand and model of the equipment used and the equipment's accuracy (degree of accuracy). Temperature and relative humidity should be taken at a minimum just inside the entrance and at the deepest/farthest humanly accessible part of the cave or feature. Several locations are preferred, particularly for large caves or those with multiple rooms, and should be referenced to labeled locations on the cave map.
    - Report any indications of "bad air," (for example, high $CO_2$ levels or any noxious gas) and reference to labeled locations on the cave map.
- Report the result of any excavation, including reasons for discontinuing excavation.
- Describe the methodology used for restoring excavated features, if applicable.

**Species and Biotic Karst Community**

Report the presence of all species, listed and unlisted, observed or collected during surveys or any other activity such as during the initial karst feature survey following the TCEQ GA, including:
- Identify species (vertebrate and invertebrate) as specifically as possible, preferably to species level, including:
  - Troglobites - a species of animal that is restricted to the subterranean environment and typically exhibits morphological adaptations to that environment, such as elongated appendages and loss or reduction of eyes and pigment (Veni 2002).
  - Troglophiles - a species of animal that may complete its life cycle in the subterranean environment but may also be found on the surface (Veni 2002).

  - Trogloxenes – a species of animal that inhabits caves but must return to the surface for food and other necessities (Veni 2002).
  - Accidentals – species that may wander into caves but cannot survive there.
- Report listed species behavior when observed (for example, feeding, sedentary, moving, etc.).
- Report the presence of dead specimens (vertebrate and invertebrate) and identify them to the lowest taxonomic level possible.
- Report numbers of each species (listed and unlisted) encountered on each survey date. For highly abundant species, approximations are acceptable.
- Describe the microhabitat where species (listed and unlisted) were found, including:
  - Type of substrate the specimen was found on (for example, large breakdown; dry, fine silt; under a fist-sized rock; on the ceiling).
  - Type of rock/soil the specimen was found on.
  - Organic material found in the cave (for example, scat, bat or cricket guano, dead animals, plant material, fungus) with a reference on the cave map to where the organic material was found.
  - Proximity to water.
  - For listed species, indicate location(s) found on the cave map.
- Report any previous collections in the cave, regardless of the listing status of those species.
- Provide a description and sketch of the area immediately around the cave entrance (approximately 10 meters (32.8 feet)), including approximate percent cover by bedrock versus soil, approximate percent cover by trees or shrubs versus herbaceous plants, and approximate percent cover by deciduous versus coniferous trees.
- Also, report locations where caves/features were searched but no listed species were found and any additional information above that is available.

**Species Identification**

If specimens are only tentatively identified as listed species in the field and are sent to a taxonomist for verification, the final report should include the results of the taxonomist's identification. If taxonomic results are not back at the time your report is due, identify where the specimens were sent, the date they were sent, and how many specimens were included. The report should include a list of species collected (listed and unlisted species to the Genus level) and/or encountered during collections, name of collector(s), date of collection, and method of preservation/storage.

**Specimen Deposition**

- All specimens should be deposited with the Texas Memorial Museum at the following address or in other appropriate curated museum collections for the specimens in question:

Texas Memorial Museum
Curator of Entomology
J.J. Pickle Research Center
10100 Burnet Rd, Building 176
Austin, Texas 78758
Phone 512-471-1075

- Include date of deposition and collection number, if available, in final report.

**KARST FEATURE SURVEY REPORT:** While a report on the surface survey for features is not required, we would appreciate if you prepared and submitted a comprehensive written report following the completion of karst feature surveys. This information will increase our understanding of these species and will assist in making decisions on management and conservation and in evaluating and refining scientific survey procedures for determining presence/absence. In addition to the information required by the TCEQ's GA, the following information would be helpful to include:

**Personnel**

- Names of all persons involved in the surveys and their duties in the karst feature survey report.
- Each person's section 10(a)(1)(A) scientific permit number, if applicable.
- Person(s) directly responsible for writing the report.

**Feature Survey Methodology**

Describe survey methodology using standards consistent with a scientific, peer-reviewed publication. Please include in the report:

- Total time spent searching for karst features and spacing and direction of all transects.
- A map of the survey location with transects and features identified.
- Results of reconnaissance excavations and methodology used for restoring excavated features, if applicable. (Note: for excavations that go below 30 centimeters (1 foot) deep, we recommend the surveyor have a 10(a)(1)(A) permit because take is more likely to occur below this depth.)

**Supporting information**

- Citations for all references used or consulted in the final report.
- Definitions of any terminology that would not be common knowledge to persons with general scientific, non-geology specific backgrounds including terminology specifically used by or for agencies other than the Service, for example, the Texas Commission on Environmental Quality (TCEQ).
- Results of any additional studies related to the karst investigations, for example, biological observations, remote sensing for subsurface voids, hydrological studies, etc.

## Appendix II:
## United States Fish and Wildlife Service, Section 10(a)(1)(A) Endangered Karst Invertebrate Surveys: Surveyor Qualifications

The following levels of expertise are required for issuance of a section 10(a)(1)(A) scientific permit to conduct presence/absence surveys for endangered karst invertebrates in central Texas. The Service will consider, on a case-by-case basis, granting a section 10(a)(1)(A) scientific permit to individuals who do not meet these qualifications but who have demonstrated adequate/appropriate experience to conduct this work.

**1.** To be considered qualified by the Service to conduct unsupervised presence/absence surveys for listed karst invertebrates and to supervise others in the field, conditions described below should be met:

- The person has extensive experience collecting and identifying both endangered and non-endangered karst invertebrates in Texas, with at least one year of experience collecting and accurately identifying, at least to genus, the endangered karst invertebrates in the county being surveyed, where all collections were properly documented, verified by an expert taxonomist, and deposited in a museum or university collection, for example, the Texas Memorial Museum. Also, the person can provide at least one letter of recommendation from a taxonomist or collection curator to whom their collected specimens were regularly sent. Equivalent collection experience in caves outside of Texas may be acceptable; the Service will review these on a case-by-case basis.

**2.** To be considered qualified by the Service to conduct presence/absence surveys for endangered karst invertebrates under the on-site supervision of an individual with a permit to conduct unsupervised presence/absence surveys, the following condition should be met:

- The person has completed adequate field training to be able to collect and identify, at least to genus, the endangered karst invertebrates in the county being surveyed under the supervision of an individual with a permit to conduct unsupervised presence/absence surveys and can provide at least one letter of recommendation from these individuals.

The individual supervising is responsible for ensuring that the assistant is capable of not only identifying, to genus, endangered karst invertebrates, but also of the assistant's ability to spot the karst invertebrates in the field (particularly those less than 0.5 mm ( 0.019 inch)).

**NOTE:** Other individuals may be permitted to accompany permittees into caves to gain experience or for the reasons of caving safety. These individuals are **not** permitted to collect endangered karst invertebrates. Also, a section 10(a)(1)(A) permit may be issued to a qualified geologist with demonstrated experience in karst geology covering "take" of endangered karst invertebrates that may occur during a habitat assessment and/or excavation and for the collection of endangered karst invertebrates encountered while conducting these activities. However, the above surveyor qualifications must be met for issuance of a permit to conduct presence/absence surveys for endangered karst invertebrates.

# Appendix III:
# Section II-A of the TCEQ Procedure For Conducting a Geologic Assessment TNRCC-0585-Instructions (Rev. 5-1-02) to Geologists for Geologic Assessments on the Edwards Aquifer Recharge/Transition Zones

**[Note: we have appended applicable portions of Section II-A that we recommend you use to locate karst features. In some places, the text here may be modified slightly from that in the TCEC document. For TCEQ purposes, please see their original and most current document.]**

## *A. Procedure For Conducting A Geologic Assessment*

The general procedure for conducting a geologic assessment is to perform the following steps: research information, perform a field survey, evaluate data, return to the site if necessary, make conclusions, and make a report with your feature assessments and recommendations. A geologic map, notes, photographs and/or sketches should be made while in the field. These data may be used and included in your final report.

### Research information

Published reports and maps of area geology should be studied prior to performing the field survey. A literature or database search should be conducted for the presence of documented caves or other *karst features* on the property or in proximity to the property boundary. Information may be found about known *caves*, such as mapped extent, depth or elevation or orientation, on the subject property or on adjacent tracts. Some commonly used data sources for geologic maps and cave location and interpretation are included in the "Citations for Sources of Further information" in these Instructions [See TCEQ, GA for these citations.]

Evaluate former land use practices and modifications. Interview persons knowledgeable about historical activities such as well drilling, irrigation or water control ditches or trenches, pit or structure construction, episodes of brush clearing and tree pulling, and cave filling or excavation. In ranches that have been occupied for a long time, manmade features can be degraded and overgrown and be confused with natural features. Human activities also may obscure indicators of natural processes that otherwise could be used to determine the sensitivity of a feature.

Aerial photos may be examined for the presence of structural features that should be field checked and plotted on the map.

### Perform a field survey

The entire subject site must be walked to survey the ground surface for the presence of geologic and manmade *features*. It is recommended that the site be walked systematically in spaced transects 50 feet apart or smaller, paying close attention to streambeds and structural features observed on aerial photographs. The transect pattern should be adapted to insure that the geologist is able to see features and will vary with topography and vegetation on the site. Streambeds, including dry drainages, are significant because runoff is focused to them. Not only are features in streambeds likely to receive large volumes of recharge, but they are likely to be part of hydrologically integrated flowpaths because

past flow has preferentially enlarged and maintained conduits. Features in streambeds are likely to be obscured by transported soil or gravel (swallets or swallow hole). Structural features such as faults and fracture zones have influenced karst processes in the Edwards recharge zone, and awareness of these structures may be helpful in completing a high-quality assessment. The assessment must include the path of any proposed sewer line that extends outside of the WPAP assessed area, plus 50 feet on either side. Any features identified should be marked where possible with flagging or stakes, accurately located, preferably using a GPS, assigned a unique number, the location accurately plotted on the geologic map.

[Note: After all karst features are located and mapped, please return to Step 3 of the "United States Fish and Wildlife Service, Section 10(a)(1)(A) Scientific Permit Requirements for Conducting Presence/Absence Surveys for Endangered Karst Invertebrates in Central Texas" to determine if potential karst invertebrate habitat may be present.]