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2014 SUMMARY OF CAVE MANAGEMENT ACTIVITIES AT PENNIE'S CAVE, TRAVIS COUNTY, TEXAS



Entry room inside of Pennie's Cave

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Abstract

Pennie's Cave, located on private property in southern Travis County, is one of 62 caves included in the Balcones Canyonlands Conservation Plan, a multi-species regional conservation effort operating under a 10(a) permit issued by the U.S. Fish and Wildlife Service under the Endangered Species Act. Pennie's Cave contains two karst invertebrate species covered under the Balcones Canyonlands Conservation Plan: a troglobitic ground beetle (*Rhadine austinica*) and troglobitic millipede (*Speodesmus* N.S.). This report summarizes ongoing cave management activities from 2013 and new management activities initiated in 2014. Management activities include the development of a modern cave map, biological monitoring, and red imported fire ant control. Numerous karst invertebrate species were encountered during the monitoring events, including a *Speodesmus* N.S. and eyeless *Cicurina* spiders, which resulted in a new record of troglobites for the cave.

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Introduction

The Balcones Canyonlands Preserve (BCP) is a system of preserved land that exists as a multi-species regional conservation effort operating under a 10(a) permit issued by the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act. Ultimately, the permit goal is to set aside 30,428 acres in western Travis County as habitat for two federally listed endangered Neotropical migratory songbirds, six federally listed endangered karst invertebrates, and 27 species of concern. The Balcones Canyonlands Conservation Plan (BCCP) identified 62 caves within the BCP acquisition area that are known to contain listed karst species and/or species of concern, most of which occur on the highly karstic Jollyville Plateau (City of Austin and Travis County 1996). Forty-five of these 62 designated caves have some degree of protection in place.

Pennie's Cave, one of the 15 unprotected BCCP caves, is a site located in southern Travis County on private property and is known to contain two karst invertebrate species covered under the BCCP: *Rhadine austinica* and *Speodesmus* N.S. (BCP 2007). The cave was first discovered by local cavers in the 1960s and has never been managed for karst species since its discovery. In the 1980s the landowner completely filled the cave entrance after noticing evidence of unauthorized entry. The entrance was reopened in 2012 as part of an adaptive cave management plan for a development project (Zara Environmental LLC 2012). Other components of the management plan that have been completed since the cave's reopening include the establishment of a preserve area and construction of a cave gate. Incomplete management activities remaining in the plan before 2014 included creating a cave map, conducting in-cave biological monitoring for karst invertebrate species, performing red imported fire ant (*Solenopsis invicta*; RIFA) control work, and submitting an annual summary report to the BCP. Management activities completed during 2014 include the creation of a cave map, two biological monitoring events, one RIFA control event, and the preparation of this annual report summarizing the activities completed during 2014.

Methods

The project consisted of three primary cave management services: developing a cave map, conducting in-cave biological monitoring, and performing RIFA control activities. The methods used to complete these services are described below.

Cave Map

Pennie's Cave was mapped according to standard cave mapping methods (Dasher 1994) using Stanley Fat Max laser distance finders and Suunto Tandem compasses and clinometers. The passages and important features such as speleothems and potential leads were sketched. Survey notes and sketches were used to produce a cave map showing plan and profile views. The map produced for this study incorporates measured distance, azimuth, and inclination from a series of survey stations set up throughout the cave to ensure accuracy. The entrance of the cave was georeferenced using a handheld Garmin GPSmap 62Csx global positioning system unit.

Biological Monitoring

Quarterly biological monitoring for karst invertebrate species was conducted in effort to append the list of known species and to detect the presence of protected species previously recorded at Pennie's Cave. The cave was divided into biological monitoring zones, and the zones were marked using flagging tape. The zones were visually inspected for karst invertebrate species. All visible surfaces and the undersides of rocks were examined for fauna. Since there is no need to demonstrate absence of listed species in this study, not all protocols set forth in the USFWS document *Section 10(a)(1)(A) Scientific Permit Requirements for Conducting Presence/Absence Surveys for Endangered Karst Invertebrate Species* (USFWS 2014a) were followed. All fauna encountered were noted on field sheets, and specimens of fauna not previously known from the site were collected to facilitate identification. Specimens collected will be deposited in the Texas Natural History Collection, University of Texas at Austin, and the list of known species for this cave will be updated based on the updated specimen records from biomonitoring events.

Temperatures used to calculate relative humidity (RH) were measured using a fan-cooled wet and dry bulb psychrometer (Psychro-Dyne®, Industrial Instruments & Supplies, PO Box 416, County Line Industrial Park, Southampton, PA 18966). Atmospheric pressure was measured using a digital barometer built into a Garmin GPSmap 60Csx unit, or climate data from the Weather Underground weather service at the following web address: http://www.wunderground.com/history/. Measurements were taken in the shade at ground level within 5 m of the feature entrance, and inside the feature. Surface and subsurface RH values were calculated from bulb measurements and atmospheric pressure using a calculator and formulas available at the following web address: http://www.ringbell.co.uk/info/humid.htm.

Red Imported Fire Ant (RIFA) Control

The RIFA control activities were performed in accordance with the USFWS guidelines (2014b) and set forth in the BCP Land Management Plan (2007). Fire ants do not maintain their mounds during the summer, making them more difficult to see, but begin rebuilding them as soon as rains and cooler temperatures return (Vinson and Sorensen 1986). In addition, the ants may remain relatively inactive and deep within their mounds during long periods of drought or cold (Vinson and Sorensen 1986), making them more difficult to eradicate. Because of these behavioral characteristics, RIFA control activities were conducted at least once in the spring and at least once in the fall.

Control activities consisted of an ant mound survey and subsequent treatments with hot water to eradicate RIFA colonies inhabiting the identified mounds. The USFWS (2014b) recommends a distance of 80 m from the cave entrance for RIFA control activities, resulting in a total area of approximately 20,106 m^2. The circumference based on the 80-m radius was measured using a global positioning system unit and visibly delineated using pin flags. During the survey, all RIFA mounds within the delineated area were located by walking while visually scanning and marking the mounds with pin flags and paying particular attention to likely places for colonies such as clearings, stumps, cracks in rocks, and rotting logs. The survey methods are designed to yield an accurate account of RIFA mound densities. Any RIFA mounds within a 10-m radius of the cave entrance (an area of approximately 314 m^2) were distinguished from the remaining survey area, as the presence of only one mound within 10 m of the cave entrance is considered an infestation threshold. A density of 80 RIFA mounds within a 50-m radius (7,850 m^2), or one mound per 98.13 m^2, is considered as an infestation threshold for areas beyond 10 m of the cave entrance (USFWS 2014b). The exceedance of these infestation thresholds might necessitate an increase in RIFA treatment frequency (USFWS 2014b).

Eradication treatments were performed immediately following the mound survey during early to mid-morning when the queen(s) and larvae are likely to be near the top of the mound (Vinson and Sorensen 1986). Water was heated in the field either by heating metal buckets on propane-fired burners or using a diesel-fired pressure washer supplied by a 220-gallon water tank (if possible based on site and equipment accessibility). Disturbance to RIFA mounds was minimized before treatment, as this may cause the ants to move the queen(s) and larvae to deeper locations within the mound or to a remote location. Mounds were excavated slowly with a pickaxe to expose the colony chambers and tunnels, and boiling water was then immediately poured on the mound and emerging ants. These steps were repeated layer by layer, until the bottom of the colony was reached and ants ceased emerging from deeper chambers and tunnels. Care was taken to distinguish RIFA mounds from native ant mounds during control activities.

Results

Pennie's Cave was mapped on 4 December 2014. Biological monitoring events were performed in the cave on 7 August 2014 and 4 December 2014. Red imported fire ant control activities were conducted on 18 November 2014. Additional details regarding the results of these activities performed during 2014 are provided below.

Cave Map

The cave map developed for Pennie's Cave (Figure 1) accurately reflects the original description of the cave by Bill Russell in Elliott (1997). The original description of the cave in Elliott (1997) was:

> *The cave was entered through a two-foot-wide slot in the bottom of a shallow depression that dropped three feet to a dirt slope that led southeast to a small room, ten feet by 5 feet and two and one-half feet high. In the center of this room is a hole two feet in diameter that drops five feet into the main room of the cave, 60 feet long, 15 feet wide, and four- to seven-feet high that trends Northeast-Southwest. Twenty-five feet to the northwest along this room is a crawlway to the left that becomes low and then opens into the pit room. Off this room are two partly-explored passages, one of which may lead back to the main room. The floor of the pit room slopes down to a two-foot-in-diameter hole that opens into a fissure 25 feet long, five feet high, and 25 feet deep. Equipment is necessary to descend. A stream passage one and one-half by one and one-half feet leads north from the bottom of the fissure for 20 feet, then west for ten feet, then back north for ten feet to a crack four feet long and one foot wide. The crack drops eight feet into a ten foot long passage* (p. 75).

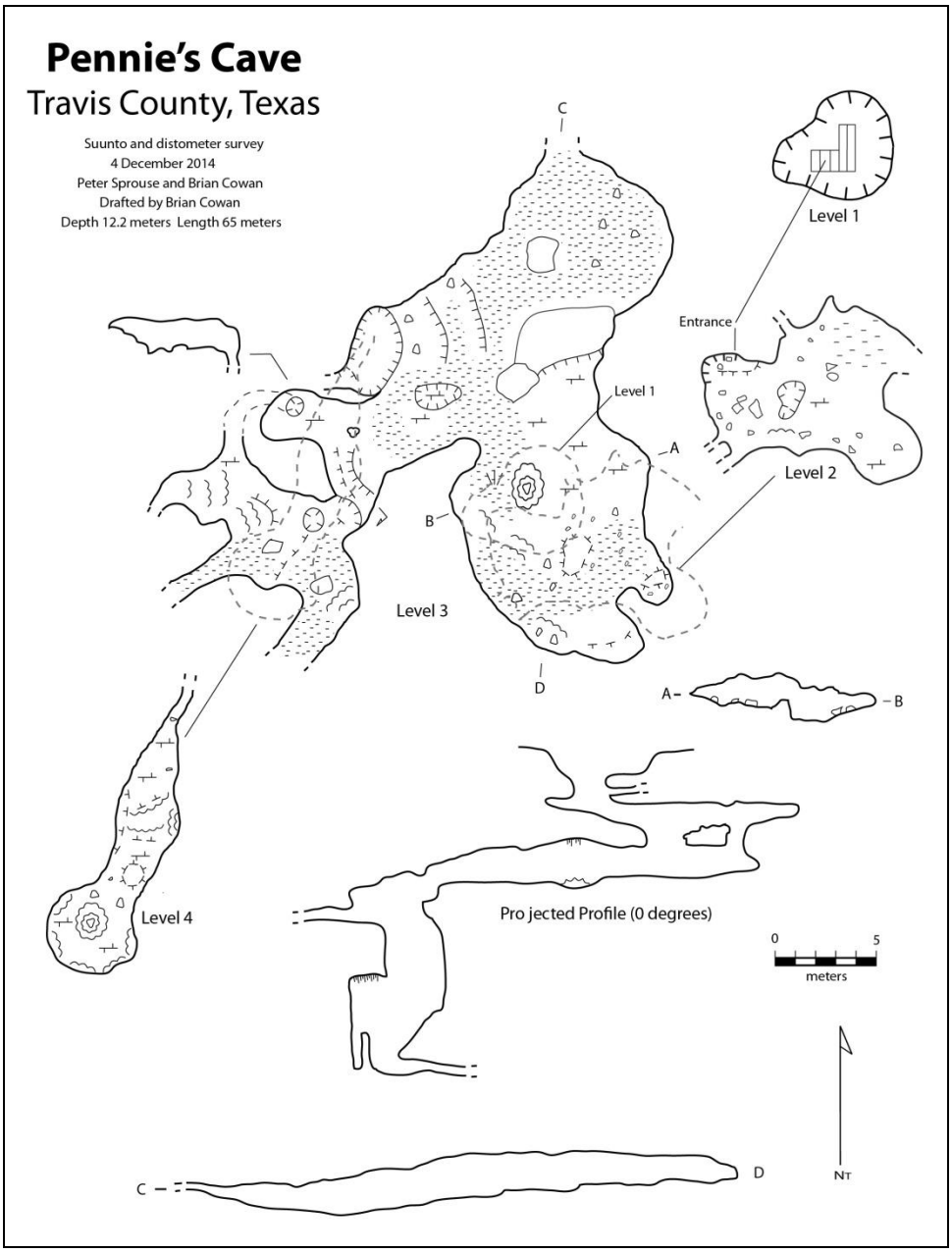

Figure 1. Map of Pennie's Cave.

Biological Monitoring

One troglobitic species of concern covered under the BCCP, *Speodesmus* N.S., was detected at Pennie's Cave during the August 2014 biological monitoring event. Other troglobitic species were detected, including *Texoreddellia* silverfish (August 2014) and eyeless *Cicurina* spiders (December 2014). No federally listed species were observed. A complete list of taxa observed and collected in Pennie's Cave during 2014 is presented in Table 1.

Within the five biomonitoring zones established for the cave, most fauna were encountered in zone 1 and zone 2, with fewer species detections occurring in zone 3. Troglobitic species were detected in zone 2 and zone 3. No fauna were detected in the deeper portions of the cave (zone 4 and zone 5) despite the presence of relatively good habitat in these areas.

Although high carbon dioxide levels were present during both the August and December 2014 biological monitoring events, the deeper areas of the cave (zone 5) were inaccessible in August due to carbon dioxide concentrations exceeding human health and safety standard levels. Weather information collected during the biological monitoring events is presented in Table 2.

Table 1. Biological observations and collections by cave zone at Pennie's Cave.

Common Name	Lowest Taxonomic Identification	Biomonitoring Zone
Harvestmen	*Leiobunum townsendi*	1
Spiders	*Cicurina* sp. (eyeless)** *Cicurina* sp. *Eidmanella* sp.	2, 3 2, 3 2
Springtails	Collembola	1, 2, 3
Crickets	*Ceuthophilus secretus* *Ceuthophilus cunicularis*	1 1, 2, 3
Millipedes	*Speodesmus* sp.*	2
Centipedes	Chilopoda**	3
Woodlice	*Porcellio* sp. Armadillidiidae	1, 2 1, 2
Frogs	*Eleutherodactylus marnockii* *Bufo nebulifer*	1, 2 2
Salamanders	*Plethodon albagula*	1
Ants	*Solenopsis invicta*	1
Silverfish	*Texoreddellia* sp.	2
Snails	*Helicodiscus* sp.	2

* indicates BCCP species of concern

** indicates collected specimen

Table 2. Dates of biological monitoring events, surface and void temperatures, and humidity calculations at Pennie's Cave.

Date	Time	Location	Temperature (°C)		Pressure (mb)	Relative humidity (%)
			Wet Bulb	Dry Bulb		
7 August 2014	14:32	Surface	25.7	37.6	1,012	38.2
7 August 2014	14:45	Zone 1	23.2	26.0	1,012	78.9
7 August 2014	14:58	Zone 2	21.2	24.2	1,012	76.5
7 August 2014	15:20	Zone 3	20.6	21.6	1,012	91.4
7 August 2014	15:25	Zone 4	20.7	22.0	1,012	89.0
7 August 2014	NM	Zone 5	NM	NM	NM	NM
4 December 2014	13:45	Surface	17.8	18.3	1,019	95.3
4 December 2014	13:55	Zone 1	29.0	29.5	1,019	96.3
4 December 2014	14:10	Zone 2	20.0	20.2	1,019	98.2
4 December 2014	14:27	Zone 3	21.5	21.7	1,019	98.3
4 December 2014	14:50	Zone 4	20.8	21.2	1,018	96.5
4 December 2014	15:55	Zone 5	NM	NM	1,018	NM

NM = not measured



Figure 2. An eyeless *Cicurina* sp. spider collected in Pennie's Cave.

Red Imported Fire Ant Control

A total of 59 active RIFA mounds were identified and treated during the 2014 RIFA control event. The number of counted RIFA mounds, approximate colony sizes, and the approximate volume of hot water used during control activities are presented in Table 3. The RIFA mound survey was performed during a period of cooler, wetter weather, thus facilitating the identification of RIFA activity (i.e., mound rebuilding). During the RIFA mound survey, it was noted that the 80-m RIFA control radius extended beyond the boundary of an adjacent, inaccessible property, resulting in a net total of approximately 14,245 m^2 that was surveyed and treated out of the intended 20,105-m^2 control area (Figure 3). The resulting density of active RIFA mounds equates to one mound per 241.44 m^2. Including abandoned/inactive RIFA mounds in the density calculation (80 mounds total) results in a rate of one mound per 178.06 m^2. No active or abandoned/inactive RIFA mounds were identified within the 10-m infestation threshold radius.

Table 3. Dates of control activities, number of RIFA mounds and approximate colony sizes counted by radius distance, and approximate volume of hot water used during control activities..

RIFA Control Date	Surveyed RIFA Mounds by Approximate Colony Size					RIFA Mounds by Distance from Cave Entrance (m)		Total RIFA Mounds Surveyed	Total RIFA Mounds Treated	Volume of Hot Water Used (gal)
	Abandoned (No ants)	<100	<500	<1,000	<5,000	<10	<80			
18 October 2014	21	44	12	3	0	0	80	80	59	150

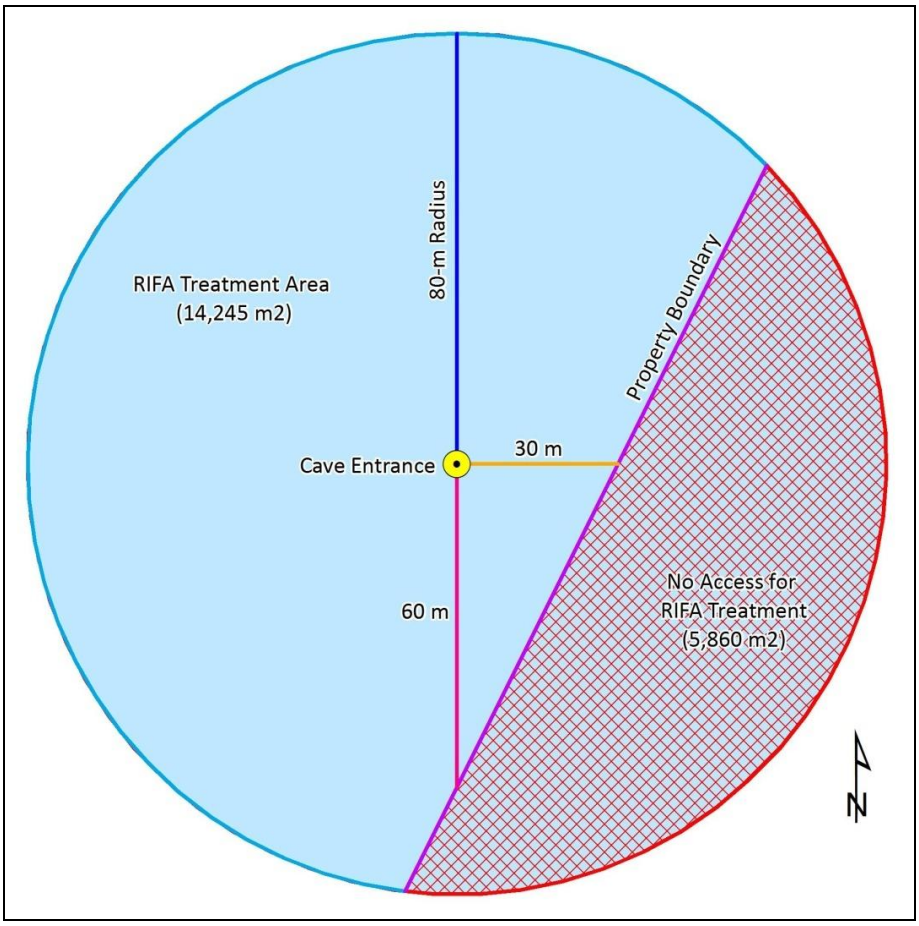

Figure 3. Diagram illustrating the entrance to Pennie's Cave, 80-m radius from the cave entrance, adjacent property boundary, RIFA treatment area, and inaccessible area located at the adjacent property.

Discussion and Recommendations

Numerous karst invertebrate species were encountered during the monitoring events, including a BCCP species of concern (*Speodesmus* N.S.) and a troglobitic *Texoreddellia* silverfish. Eyeless *Cicurina* spiders were also detected, resulting in a new record of troglobites for the site and potentially a new record of a BCCP species of concern. Pennie's Cave is situated within the currently understood range for a group of eyeless spiders that were described and named by Gertsch (1992) as *Cicurina cueva*, *C. bandida*, and *C. reyesi*, which are all listed as species of concern under the BCCP (2007). However, recent genetic and morphological studies suggest that these three spiders represent variants of a single species informally known as the *Cicurina cueva* complex (Paquin and Hedin 2005; Paquin et al. 2008). It is possible that the three formerly distinct species will be synonymized in the future, though it is acknowledged that additional studies are warranted to revise this complex and other difficult groups within the *Cicurina* genus (Paquin and Dupérré 2009). Although currently unconfirmed, it is possible that the eyeless *Cicurina* collected in Pennie's Cave is a variant of the *C. cueva* complex discussed in Paquin and Hedin 2005 and Paquin et al. 2008. The collected specimen will be sent to Dr. James Cokendolpher at Texas Tech University for identification and inclusion in an ongoing *Cicurina*

study. The troglobitic *Rhadine austinica* ground beetle was not observed during the biological monitoring events despite the recorded presence of this species (BCP 2007). Further sampling at the cave during future monitoring could result in detection of the species. No federally listed karst species were encountered at Pennie's Cave.

No active or abandoned/inactive RIFA mounds were identified within the 10-m infestation threshold radius (USFWS 2014b). The resulting density of identified, active RIFA mounds equates to one mound per 241.44 m^2, which is well below the secondary infestation threshold density of one mound per 98.13 m^2 (80 mounds per 7,850 m^2) as recommended by the USFWS (2014b). Including abandoned/inactive RIFA mounds in the density calculation (80 mounds total) results in a rate of one mound per 178.06 m^2, which is still well below the USFWS-recommended infestation threshold density. Future RIFA control activities will help determine whether mound densities will continue to remain below the infestation threshold density and whether mounds continue to remain outside of the 10-m infestation threshold radius. The USFWS recommends biannual treatments when RIFA thresholds are not exceeded.

Cave management activities planned for 2015 at Pennie's Cave include the continuation of quarterly biological monitoring in the winter and spring. Once these two events are concluded, the first full year of monitoring events will be completed. The subsequent biological monitoring schedule will be reduced to once per year following the first year of quarterly monitoring events. Additional RIFA control activities are also planned for spring 2015. The results of the RIFA control activities will be reviewed after two years of biannual treatments (i.e., four treatments) to determine whether continued control activities are needed. Finally, an annual report summarizing the activities performed in 2015 will be prepared and submitted to the Travis County Transportation and Natural Resources Department for inclusion in the BCCP annual report for 2015.

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