ZARA
ENVIRONMENTAL LLC
1707 West FM 1626
Manchaca, Texas 78652
512-291-4555
www.zaraenvironmental.com

2015 SUMMARY OF CAVE MANAGEMENT ACTIVITIES AT PENNIE'S CAVE, TRAVIS COUNTY, TEXAS



Sculptured calcite speleothems in the lower pit of Pennie's Cave

Prepared for
Brandywine Realty Trust
1501 South MoPac Expressway, Suite 310
Austin, Texas 78746

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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 currently is known to contain 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 includes new cave management measures initiated in 2014 and continuing through 2015. Management activities conducted in 2015 include biological monitoring and red imported fire ant control. Numerous karst invertebrate species were encountered during the monitoring event, including a *Speodesmus* N.S., a species covered under the Balcones Canyonlands Conservation Plan, and other troglobites including *Texoreddellia* silverfish and eyeless *Cicurina* spiders. The numbers of observed red imported fire ant mounds have decreased over time during each treatment event since first treating at the Pennie's Cave management area in October 2014.

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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, previously 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, construction of a cave gate, and development of a cave map. Ongoing management activities remaining in the plan include conducting in-cave biological monitoring for karst invertebrate species, performing red imported fire ant (*Solenopsis invicta*; RIFA) control work, and submitting annual summary reports to the BCP. Management activities completed during 2015 include two biological monitoring events, two RIFA control events, and the preparation of this annual report summarizing the activities completed during 2015.

Methods

The project in 2015 consisted of two primary cave management services: conducting in-cave biological monitoring and performing RIFA control activities. The methods used to complete these services are described below.

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 delineated previously into five separate biological monitoring zones identified by marked orange flagging tape. Personnel experienced in invertebrate biology visually inspected all surfaces in each zone for karst invertebrate species paying particular attention to the undersides of rocks, clumps of dried substrate, decaying skeletons, animal scat, and pools of water. 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 *Karst Preserve Management and Monitoring Recommendations* (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 to avoid treatment of native colonies.

Results

Biological monitoring events were performed in Pennie's Cave during 2015 on 18 February and 21 April. Red imported fire ant control activities were conducted on 29 April and 13 November. Additional details regarding the results of these activities performed during 2015 are provided below.

Biological Monitoring

One troglobitic species of concern covered under the BCCP, *Speodesmus* N.S., was detected at Pennie's Cave during the February and April 2015 biological monitoring events. Other troglobitic species were detected, including *Texoreddellia* silverfish (February 2015) and eyeless *Cicurina* spiders (February and April 2015). No federally listed species were observed. A complete list of taxa observed and collected in Pennie's Cave during 2015 is presented in Table 1.

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

Common Name	**Lowest Taxonomic Identification**	**Biomonitoring Zone**
Snails	*Helicodiscus* sp.	1, 2
Earthworms	Oligochaeta	1
Spiders	*Cicurina* sp. (eyeless) Araneae *Eidmanella* sp.	2, 3, 4 1, 2 2
Harvestman	*Leiobunum townsendii*	1
Centipedes	Lithobiomorpha Chilopoda	1, 3 1
Millipedes	*Speodesmus* sp. *(BCCP Species of Concern)*	2, 3

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

Common Name	Lowest Taxonomic Identification	Biomonitoring Zone
Springtails	Collembola	1, 2, 3, 4
Silverfish	*Texoreddellia* sp.	2, 4
Crickets	*Ceuthophilus secretus* *Ceuthophilus cunicularis* Nymph Sub-Adult	1, 2, 3 1, 2, 3, 4 1, 2, 3, 4, 5 2, 3, 4
Cockroaches	Blattaria	3
Woodlice	*Porcellio* sp. *Armadillidium* sp.	1 1
Gnats	*Diptera* sp.	1, 3, 4
Frogs	*Eleutherodactylus marnockii* *Bufo nebulifer*	1 2
Salamanders	*Plethodon albagula*	1, 2

During previous surveys most fauna were encountered in zone 1 and zone 2 of the cave, with fewer species detections occurring in zone 3, and no fauna observed in zones 4 and 5 (Figure 1). During the February 2015 biomonitoring, typical trogloxenes such as cliff chirping frogs (*Eleutherodactylus marnockii)* and a western slimy salamander (*Plethodon albagula)* were observed in zone 1. Zone 2 yielded the most observations with 22 individuals covering eight separate species, two of which are known troglobites: an eyeless spider (*Cicurina* sp.) and millipede (*Speodesmus* sp.). Twenty-two individuals, including the troglobitic *Texoreddellia,* from eight separate species were identified in zone 4 whereas the prior survey observed no fauna in this area. No karst species were detected in the pit environment of zone 5 although suitable habitat is present.

During the week preceding the 21 April 2015 biological monitoring, approximately 0.86 inch of precipitation occurred in the area (Menne et al. 2012). The upper levels of the cave were slightly wet and similar to previous visits that occurred during periods of drier weather; however, zone 5 exhibited numerous drips and more standing water than during previous surveys. Most species observations occurred in zone 1 during this round of biomonitoring, with 34 individuals consisting of eleven different species. Thirty individuals from seven species were documented in zone 2 including two western slimy salamanders (Figure 2) and two *Speodesmus* sp. More individuals were observed in zone 3 during this biomonitoring event than the preceding February event, including double the amount of observed species. There were 15 individuals from eight different species including two *Speodesmus* sp. Three individuals from three separate species were documented from zone 4, a decrease from the prior survey; however, an eyeless *Cicurina* sp. (Figure 3) was observed in the pit passageway for the first time in this zone. As with previous visits, no species observations were recorded in zone 5.

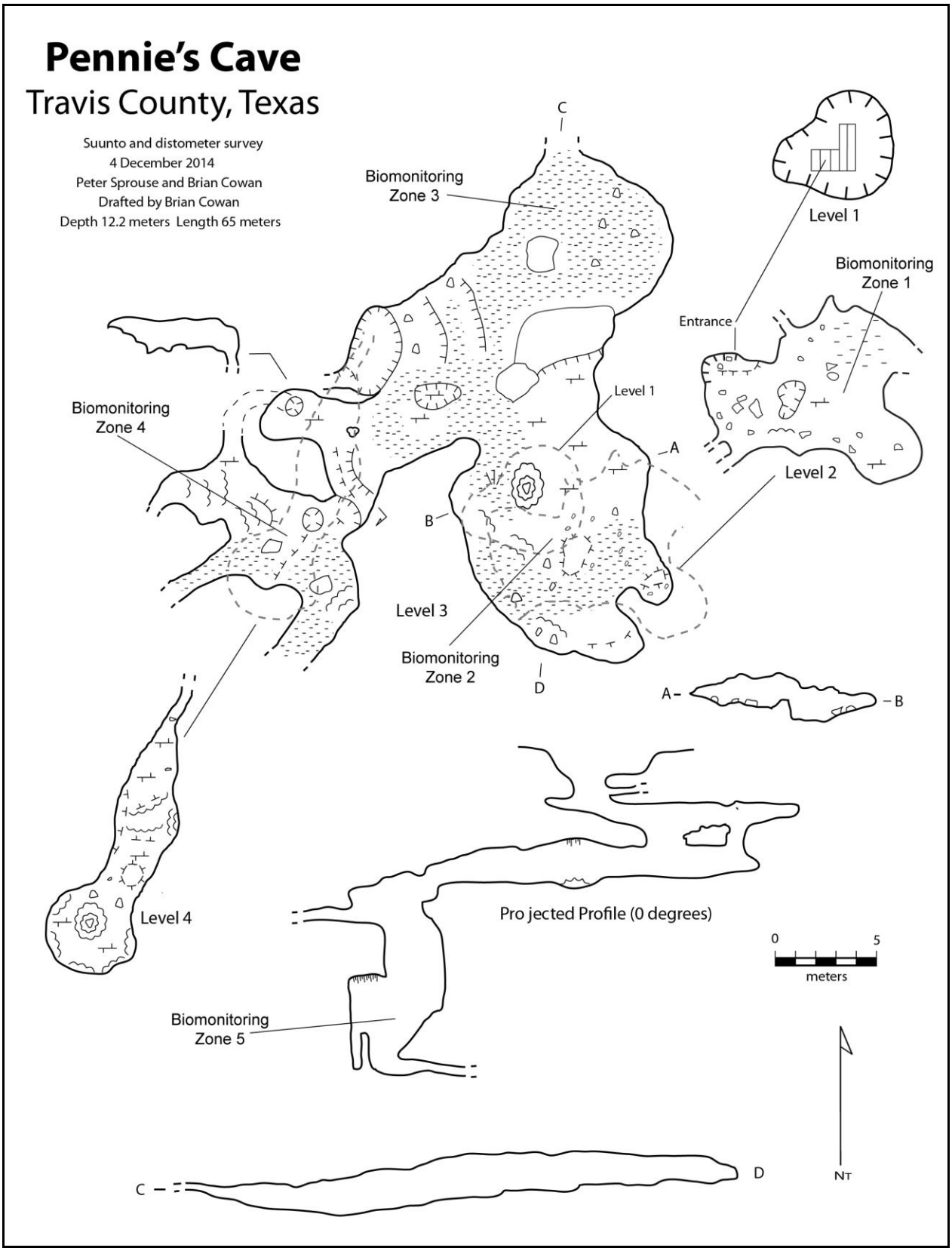

Figure 1. Map of Pennie's Cave including biomonitoring zones.



Figure 2. A western slimy salamander (*Plethodon albagula*) observed in Pennie's Cave.



Figure 3. An eyeless *Cicurina* sp. spider observed in Pennie's Cave.

The air quality during the February and April surveys was considerably better (i.e., adequate levels of oxygen/acceptable levels of carbon dioxide) than during the August and December 2014 biological monitoring events, thereby allowing surveyors to stay longer and survey the deeper portions of the cave more comfortably. Microclimate data collected during the biological monitoring events are presented in Table 2.

Table 2. Biological observations and collections at Pennie's Cave on 18 February 2015.

Common Name	Lowest Taxonomic Identification	# Observed	Collected Y/N? (#)
Snails	*Helicodiscus* sp.	7	N
Spiders	*Cicurina* sp. (eyeless)	2	N
Millipedes	*Speodesmus* sp. *(BCCP Species of Concern)*	3	N
Springtails	Collembola	7	N
Silverfish	*Texoreddellia* sp.	1	N
Crickets	*Ceuthophilus secretus* *Ceuthophilus cunicularis* *Ceuthophilus* sp. (Nymph) *Ceuthophilus* sp. (Sub-Adult)	11 11 29 5	N N N N
Woodlice	*Porcellio* sp.	2	Y (1)
Gnats	*Diptera* sp.	2	N
Frogs	*Eleutherodactylus marnockii*	4	N
Salamanders	*Plethodon albagula*	1	N

Table 3. Biological observations and collections at Pennie's Cave on 21 April 2015.

Common Name	Lowest Taxonomic Identification	# Observed	Collected Y/N? (#)
Earthworms	Oligochaeta	2	N
Spiders	*Cicurina* sp. (eyeless) Araneae	1 2	N
Mites	Acarina	3	N
Centipedes	Lithobiomorpha Chilopoda	1 1	N N
Millipedes	*Speodesmus* sp. *(BCCP Species of Concern)*	4	N
Springtails	Collembola	18	N
Crickets	*Ceuthophilus secretus* *Ceuthophilus cunicularis* *Ceuthophilus* sp. (Nymph) *Ceuthophilus* sp. (Sub-Adult)	0 12 25 3	N N N N
Cockroaches	Blattaria	1	N
Woodlice	*Armadillidium* sp.	1	N
Gnats	*Diptera* sp.	1	N
Frogs	*Bufo nebulifer*	1	N
Salamanders	*Plethodon albagula*	2	N

Table 4. 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
18 February 2015	09:59	Surface	9.5	13.5	1,029	59.0
18 February 2015	10:25	Zone 1	14.0	14.5	1,029	94.7
18 February 2015	10:53	Zone 2	25.5	26.0	1,028	96.0
18 February 2015	11:21	Zone 3	16.0	16.25	1,028	97.5
18 February 2015	11:50	Zone 4	18.0	18.5	1,027	95.3
18 February 2015	12:20	Zone 5	20.0	19.5	1,027	95.5
21 April 2015	11:10	Surface	16.5	22.5	1,016	53.8
21 April 2015	11:17	Zone 1	18.9	20.8	1,016	83.6
21 April 2015	11:42	Zone 2	18.25	19.2	1,016	91.3
21 April 2015	12:05	Zone 3	17.5	18.0	1,015	95.2
21 April 2015	12:27	Zone 4	18.5	19.0	1,015	95.4
21 April 2015	13:23	Zone 5	19.9	21.25	1,015	93.9

NM = not measured

Red Imported Fire Ant Control

A total of 60 active RIFA mounds, 50 in April and 10 in November, were identified and treated during the two 2015 RIFA control events. The number of counted RIFA mounds, approximate colony sizes, and the approximate volume of hot water used to date during control activities are presented in Table 5. The RIFA mound survey was performed during a period of cooler, wetter weather, thus facilitating the identification of RIFA activity (i.e., mound rebuilding). 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 4). The resulting density of active RIFA mounds equates to one mound per 284.90 m^2 for the April treatment event and one mound per 1,424.50 m^2 for the November event. No active or abandoned/inactive RIFA mounds were identified within the 10-m infestation threshold radius. One colony inhabited by the native *Leptogenys elongata* ant was recorded during each of the 2015 treatment events.

Table 5. 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
29 April 2015	13	8	20	12	10	0	63	63	50	115
13 November 2015	0	4	3	1	2	0	63	10	10	10

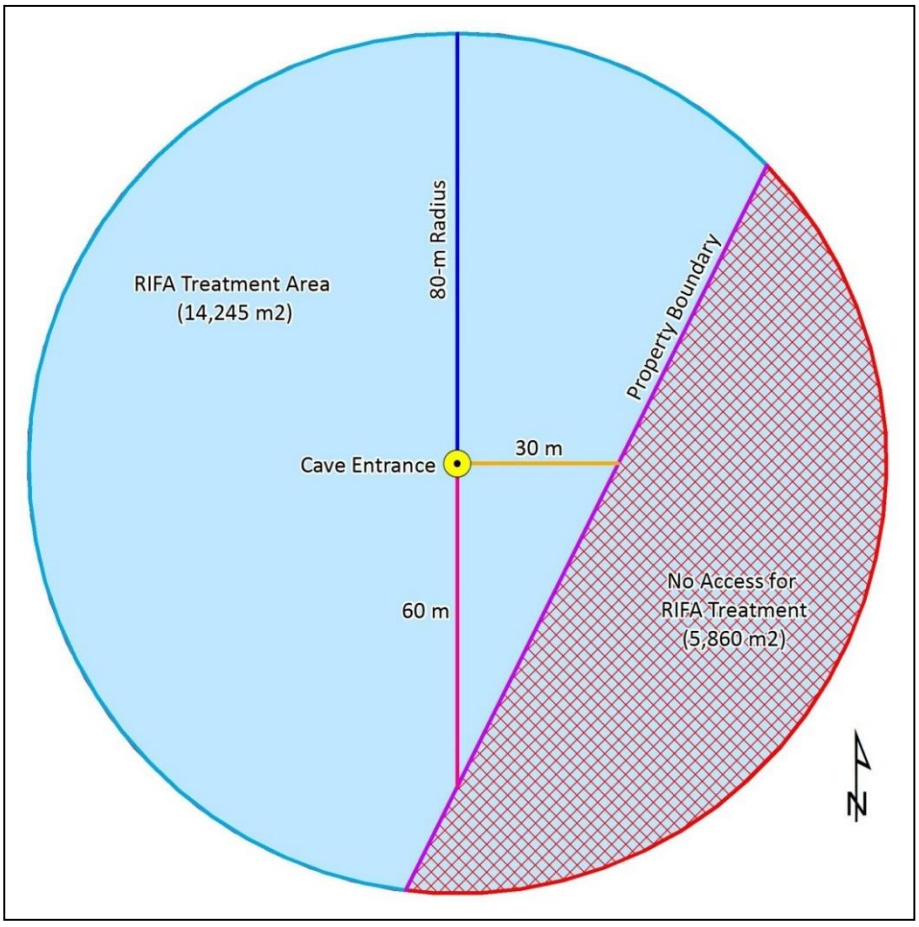

Figure 4. Diagram illustrating the entrance to Pennie's Cave, 80-m radius from the cave entrance, adjacent property boundary, RIFA treatment area, and inaccessible area located at the adjacent property.

Discussion and Recommendations

Numerous karst invertebrate species were encountered during the 2015 monitoring events, including a BCCP species of concern (*Speodesmus* N.S.) and a troglobitic *Texoreddellia* silverfish. Eyeless *Cicurina* spiders were also detected. As discussed in Zara (2014), 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). 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 was 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 previous documentation of this species in Pennie's Cave (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) during either of the 2015 treatment events. The resulting densities of observed RIFA mounds equates to one mound per 284.90 m^2 for the April treatment event and one mound per 1,424.50 m^2 for the November event, which are 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). The numbers of observed RIFA mounds have decreased over time during each treatment event since first treating at Pennie's Cave management area in October 2014, with a sharp decrease occurring between April and November of 2015 (Table 5). 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 2016 at Pennie's Cave include the continuation of biological monitoring. As of late 2015, the biological monitoring program was reduced to annual surveys (once per year) from the quarterly surveys that were initiated at the cave. The next planned biological monitoring will occur in December 2015 or early 2016 in the winter due to the presence of bad air in the cave during the warmer months. Additional RIFA control activities are also planned for spring 2016. The results of the RIFA control activities will be reviewed after this treatment, which concludes 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 2016 will be prepared and submitted to the Travis County Transportation and Natural Resources Department for inclusion in the BCCP annual report for 2016.

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