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2017 SUMMARY OF CAVE MANAGEMENT ACTIVITIES AT PENNIE'S CAVE, TRAVIS COUNTY, TEXAS



The gated entrance to 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 currently is known to contain two karst invertebrate species covered under the Balcones Canyonlands Conservation Plan: a troglobitic ground beetle (*Rhadine austinica*), troglobitic millipede (*Speodesmus* N.S.), and, although currently unverified, a potential variant of the *Cicurina bandida* troglobitic spider. Ongoing cave management measures were initiated in 2014. Management activities planned for 2017 included biological monitoring and red imported fire ant control activities in the spring and fall. The in-cave air quality was determined to be unsafe for entry, so the biological monitoring event was not performed. Both red imported fire ant control events were conducted, however. The numbers of observed and treated red imported fire ant mounds appear to be decreasing over time since first treating at the Pennie's Cave management area in October 2014. However, two red imported fire ant mound were observed and treated within 10 m of the cave entrance, which is considered an infestation threshold under the *Karst Preserve Management and Monitoring Recommendations* issued by the U.S. Fish and Wildlife Service.

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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 for acquisition and protection within the BCCP 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 (species of concern [SOCs]: *Rhadine austinica* and *Speodesmus* N.S. (BCP 2016). The cave was first discovered by local cavers in the 1960s and had 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 [Zara] 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 initiated in 2014 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. Since the initiation of in-cave biological monitoring, the only karst invertebrate BCCP SOC detected is the troglobitic millipede, *Speodesmus* N.S. (Zara 2014, 2015, 2016). Although currently unconfirmed, it is possible that specimens of a variant of the *C. cueva* complex of troglobitic spiders, all of which were synonymized under *C. bandida* (Paquin and Hedin 2005; Paquin et al. 2008) and also SOCs covered under the BCCP, has been collected in Pennie's Cave during previous biological monitoring efforts (Zara 2014; Zara 2015; 2016).

Management activities completed during 2016 include a biological monitoring event, two RIFA control events, and the preparation of this annual report summarizing the completed activities for the year. This annual report details the methodologies, results, and a discussion of activities completed at Pennie's Cave. The discussion includes planned activities for 2017.

Methods

Biological Monitoring

Annual 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 (Zara 2014). 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 2015) 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. Unless otherwise directed by USFWS (2016), 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.

Microclimate data, including atmospheric pressure, temperature, and relative humidity (RH), were collected during the biological monitoring event. Before entering the cave, measurements were recorded within 5 m of the feature entrance, at ground level and in the shade. During the in-cave surveys, microclimate data were collected in each cave zone. Atmospheric pressure was measured using a digital barometer built into a Garmin GPSmap 60Csx unit or referenced from available hourly climate data (Menne et al. 2012). Temperature data were collected with either a fan-cooled wet and dry bulb psychrometer (Psychro-Dyne®, Industrial Instruments & Supplies, PO Box 416, County Line Industrial Park, Southampton, PA 18966) or a Kestrel® Environmental Meter 5000 with LINK (Nielsen-Kellerman, 21 Creek Circle, Boothwyn, PA 19061). The Kestrel unit provided a direct readout of both temperature and RH data, while the psychrometer provided wet and dry bulb temperatures for calculating RH using atmospheric pressure data and an online calculator (Scanlon 2015).

Red Imported Fire Ant Control

The RIFA control activities were performed in accordance with the USFWS *Karst Preserve Management and Monitoring Recommendations* (USFWS 2014) and set forth in the BCP Land Management Plan (BCP 2016). Fire ants typically do not maintain their mounds during the summer, making them more difficult to see, but they 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 (2014) 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 (USFWS 2014). 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 2014). The exceedance of these infestation thresholds may necessitate an increase in RIFA control frequency (USFWS 2014).

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. Abandoned mounds with no RIFA colonies were not treated.

Results

Biological Monitoring

The biological monitoring event was conducted in Pennie's Cave on 21 November 2017 following the passage of a strong cold front (Menne et al. 2012). Upon entering, the surveyors noted that the in-cave air quality near the entrance was noted as considerably worse (i.e., inadequate levels of oxygen/high levels of carbon dioxide) than previous efforts, particularly considering the recent change in weather. As such, surveyors were not able to safely enter Zone 1 of the cave beyond the initial entrance area (Figure 1). Therefore, biological and microclimate data were not collected during 2017.

A comprehensive list of all taxa observed by cave zone since the initiation of biomonitoring in 2014 is presented in Table 1. A comprehensive list of biological survey data, including number of observed BCCP species of concern, is provided in Table 2. Comprehensive microclimate data recorded since 2014 are presented in Table 3.

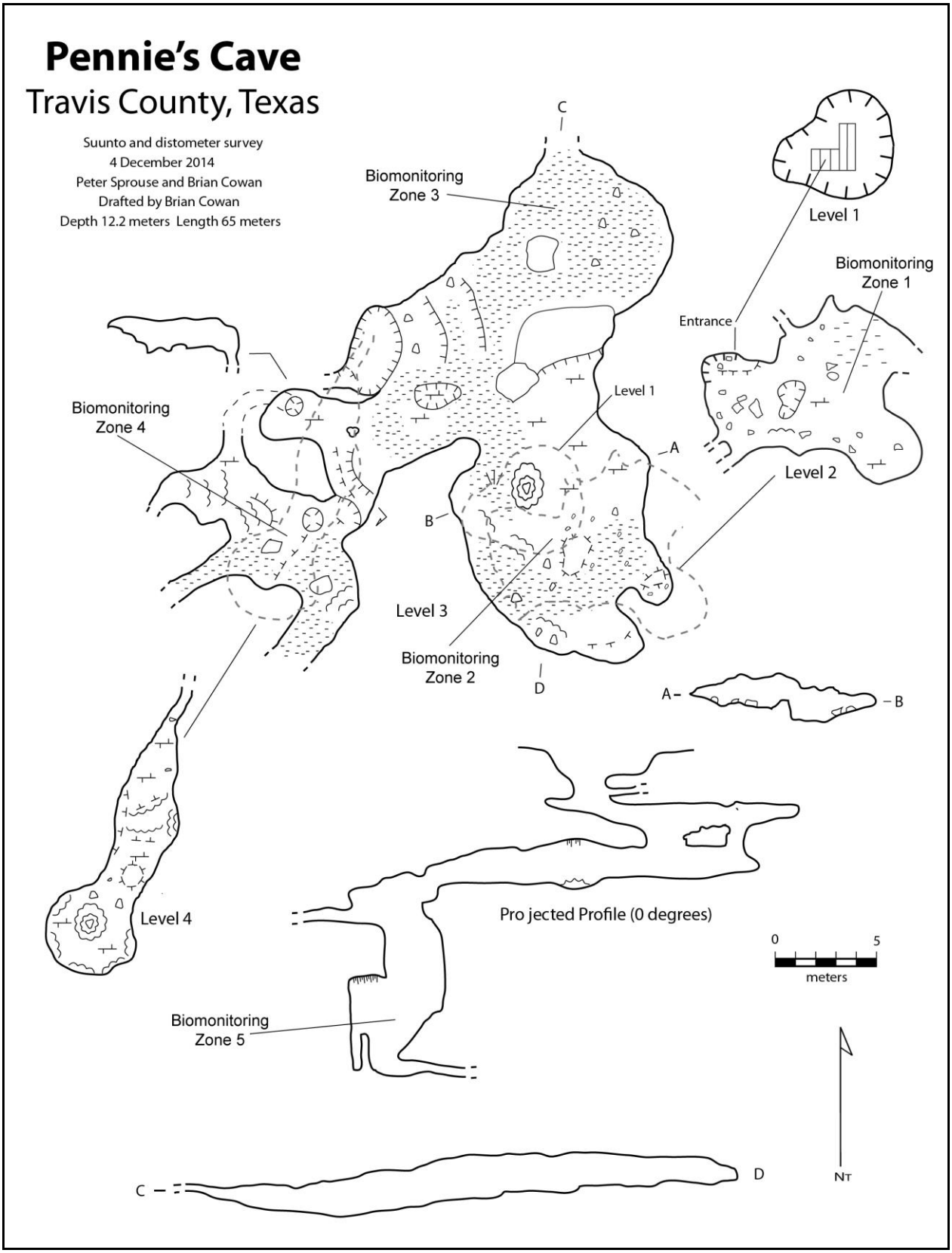


Figure 1. Map of Pennie's Cave including biomonitoring zones.

Table 1. Total biological observations and collections by cave zone at Pennie's Cave since 2014. Biological data were not collected during 2017 due to unsafe air quality in the cave.

Common Name	Lowest Taxonomic Identification	Biomonitoring Zone
Snails	*Helicodiscus* sp.	1, 2
Earthworms	Oligochaeta	1, 3
Spiders	*Cicurina* sp. (eyeless)[1] *Cicurina* sp. Araneae *Eidmanella* sp.	1, 2, 3, 4 2, 3 1, 2 2
Harvestman	*Leiobunum townsendii*	1
Centipedes	Lithobiomorpha Chilopoda	1, 3 1, 3
Millipedes	*Speodesmus* N.S.[2] Diplopoda	2, 3 1
Symphylans	Symphyla	1
Springtails	Collembola	1, 2, 3, 4
Silverfish	*Texoreddellia* sp.	2, 4
Crickets	*Ceuthophilus secretus* *Ceuthophilus cunicularis* *Ceuthophilus* sp. (Nymph) *Ceuthophilus* sp. (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, 2, 3, 4
Frogs	*Eleutherodactylus marnockii* *Bufo nebulifer* *Lithobates* sp.	1 2 2
Salamanders	*Plethodon albagula*	1, 2

[1] Potential BCCP species of concern
[2] BCCP species of concern

Table 2. Dates of biological monitoring events, total amount of survey effort, surveyed cave zones, and observations of species of concern covered under the Balcones Canyonlands Conservation Plan.

Survey Date	Total Person-minutes Surveyed	Surveyed Cave Zones[1]	Number of Observed *Speodesmus* N.S.[2]	Number of Observed *Rhadine austinica*[2]	Number of Observed *Cicurina* sp. (eyeless)[3]
7 August 2014	120	1, 2, 3, 4	3	0	0
4 December 2014	104	1, 2, 3, 4, 5	0	0	6
18 February 2015	215	1, 2, 3, 4, 5	3	0	2
21 April 2015	133	1, 2, 3, 4, 5	4	0	1
28 January 2016	100	1, 2, 3, 4	0	0	2
21 November 2017[4]	--	--	--	--	--

[1]All zones may not have been surveyed due to hazardous air conditions.
[2]BCCP species of concern
[3]Potential BCCP species of concern
[4]Data were not collected on this date due to unsafe air quality in the cave

Table 3. 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	Direct Read		Calculated	Direct Read
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	19.5	20.0	--	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	--
28 January 2016	10:50	Surface	--	--	17.5	1,024	--	30.5
28 January 2016	NM	Zone 1	--	--	NM	NM	--	NM
28 January 2016	11:22	Zone 2	--	--	17.0	1,023	--	89.7
28 January 2016	NM	Zone 3	--	--	NM	NM	--	NM
28 January 2016	12:08	Zone 4	--	--	19.3	1,022	--	95.2
28 January 2016	NM	Zone 5	--	--	NM	NM	--	NM
21 November 2017*	NM	--	--	--	NM	NM	--	NM

NM = not measured

*Microclimate data were not collected on this date due to unsafe air quality in the cave.

Red Imported Fire Ant Control

Red imported fire ant control activities were performed on 19 June 2017 and 24 October 2017. Both RIFA treatments were 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 2).

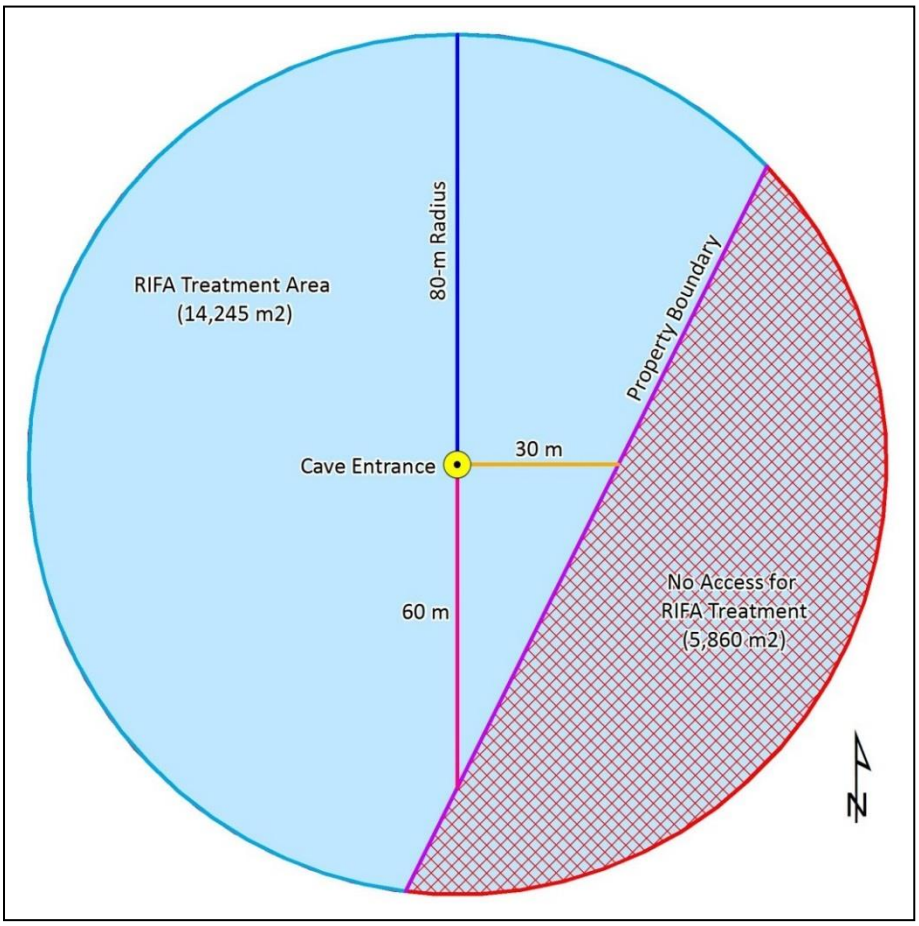


Figure 2. Diagram illustrating the entrance to Pennie's Cave, 80-m radius from the cave entrance, adjacent property boundary, RIFA treatment area, and inaccessible area located at the adjacent property.

A total of 44 active RIFA mounds, 18 in June and 26 in October, were identified and treated during the two control events in 2017. Eighteen abandoned mounds were identified (16 in June and two in October). The resulting density of active RIFA mounds equates to one mound per 791.4 m^2 for the June treatment event and one mound per 547.9 m^2 for the October event. Two active RIFA mounds were identified within the 10-m infestation threshold radius during the June treatment event, but none were observed within this radius during the October event. Native ant colonies were not identified within the treatment area during either of the 2017 RIFA control events.

The number of counted RIFA mounds, approximate colony sizes, the approximate volume of hot water used to date during control activities, and infestation threshold data are presented in Table 1. The comprehensive RIFA treatment results are also presented in Figure 3 and Figure 4.

Table 4. 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.

Treatment Date	Surveyed Mounds by Approximate Colony Size					Total Mounds Surveyed (Abandoned plus Active)	Total Mounds Treated (Active Only)	Volume of Hot Water Used (gal)	Total Active Mounds by Distance from Cave Entrance[1] (m)		Active Mound Density[2] (m^2 per mound)
	Abandoned (No ants)	<100	<500	<1,000	<5,000				<10	<80	
18 Oct 2014	21	44	12	3	0	80	59	150	0	80	241.4
29 Apr 2015	13	8	20	12	10	63	50	115	0	63	284.9
13 Nov 2015	0	4	3	1	2	10	10	10	0	63	1,424.5
05 May 2016	6	15	15	7	2	46	40	50	1	39	356.1
17 Nov 2016	8	16	14	5	0	43	35	40	0	35	407.0
19 Jun 2017	16	1	13	4	0	34	18	32	2	16	791.4
25 Oct 2017	2	7	10	7	2	28	26	32	0	26	547.9

[1] The presence of one or more mounds within 10 m of the cave entrance is considered an infestation threshold (USFWS 2014)
[2] Based on an estimated 14,245 m^2 treatment area; a density of one mound per 98.13 m^2 is considered an infestation threshold for areas beyond 10 m of the cave entrance (USFWS 2014).

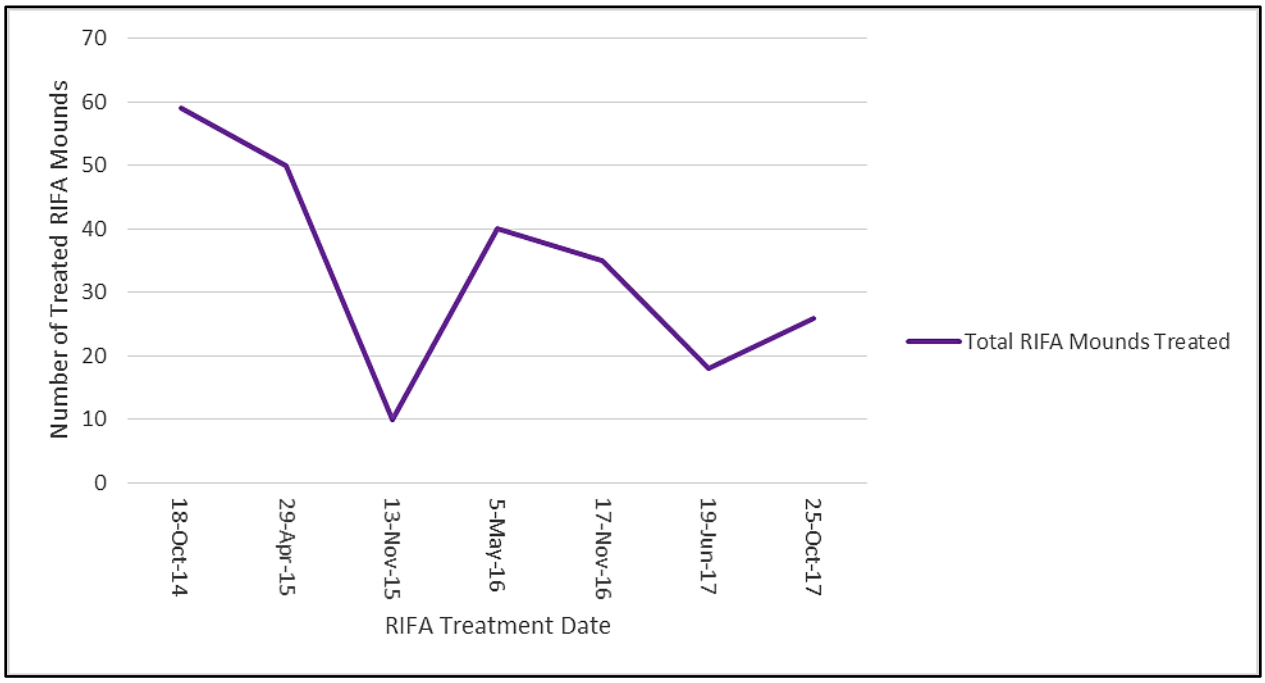


Figure 3. Total number of treated RIFA mounds by treatment date.

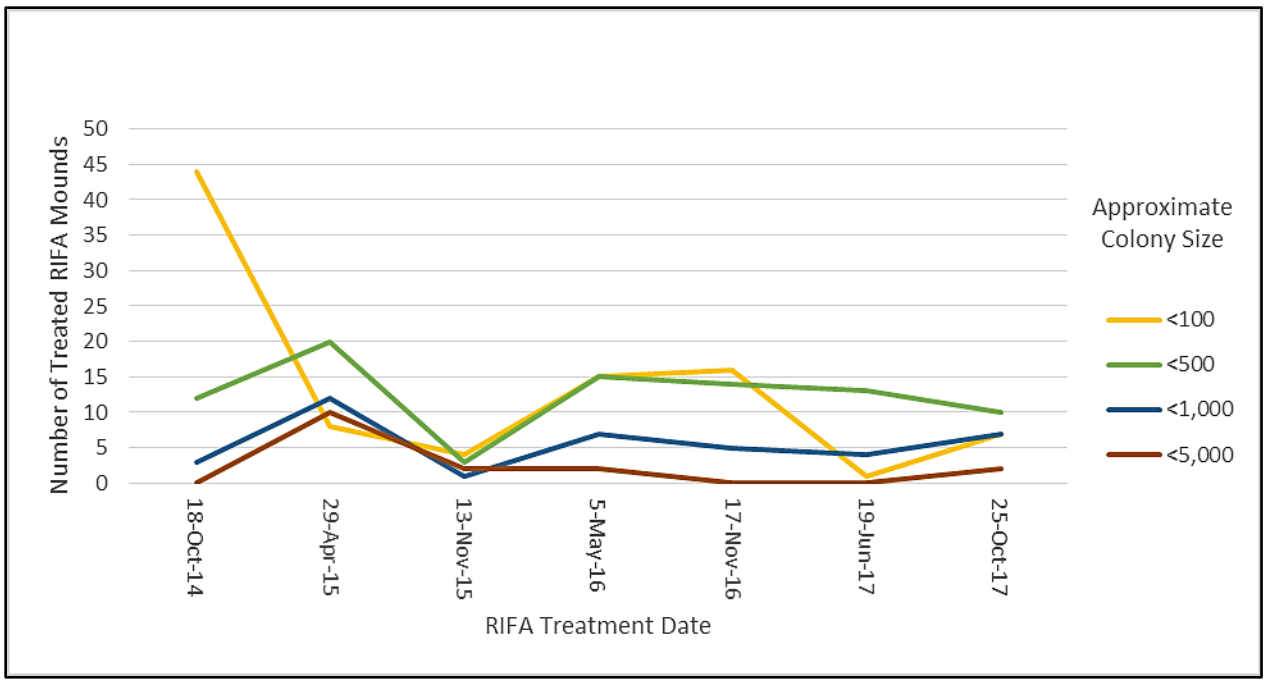


Figure 4. Number of treated RIFA mounds by treatment date and approximate colony size.

Discussion

Unfortunately, biological data were not collected during 2017 due to unsafe air conditions in Pennie's Cave. Surveyors were not able to access any parts of the cave beyond the immediate entrance. After three years of survey effort, it has been determined that it is nearly impossible to safely access the cave, even during the winter months and following a cold front (i.e., when subterranean air conditions tend to improve). Currently, the installation of a semi-permanent ventilation system is being considered to allow for safe and adequate access to the cave.

Despite the fluctuation in observed RIFA colonies over time, the total numbers of observed RIFA mounds generally are decreasing (Figure 3). While a recent decrease was noted in smaller colonies (less than 100 ants) during 2017, the distribution of colony size has remained somewhat consistent over time, with the exception of November 2015 and the initial treatment in October 2014 when a higher number of smaller colonies were observed (Figure 4). Future RIFA control activities will help determine whether mound densities will continue to remain below the infestation threshold density and whether the number of mounds continues to decrease. In June 2017, two active RIFA mounds were identified within the 10-m infestation threshold radius. Despite the recent occurrence of RIFA within 10 m of the entrance, no ants have been observed inside the cave since biological monitoring began in 2014.

Cave management activities planned for 2018 at Pennie's Cave include the continuation of annual biological monitoring. The next planned biological monitoring likely will occur following the installation of a semi-permanent ventilation system. In addition, bi-annual RIFA control activities are planned for the spring and fall of the upcoming year. The results of the RIFA control activities will be reviewed after each year of treatments to determine whether continued control activities

should continue on a bi-annual basis. Finally, an annual report summarizing the activities performed in 2018 will be prepared and submitted to the Travis County Transportation and Natural Resources Department for inclusion in the BCCP annual report for the year.

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