2019 SUMMARY OF SPRING MANAGEMENT ACTIVITIES ON CITY OF AUSTIN OWNED TRACTS OF THE BALCONES CANYONLANDS PRESERVE



Searching a spring run

Crystal Datri, Biologist, Wren Daytree LLC, Austin, Texas
Colin Strickland, Biologist, Wildlands Conservation Division, Austin Water, City of Austin, Austin, Texas

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Abstract

This annual report details the Balcones Canyonlands Conservation Plan (BCCP) springs management activities performed during the 2019 fiscal year. The BCCP protects 27 species of concern, of which are three stygobitic invertebrates: the flatworm *Sphalloplana mohri*, the ostracod *Candona sp. nr. stagnalis*, and the isopod *Caecidotea reddelli.* Three stygofaunal species are identified as additional species of concern by the BCCP: the federally threatened Jollyville Plateau salamander (*Eurycea tonkawae*) and two stygobitic amphipods, *Stygobromus russelli* and *Stygobromus bifurcatus.* Biologists monitored for populations of these aquatic target species as part of the BCCP spring management obligations. Additional, on-going management activities for FY 2019 include mapping and characterizing newly documented springs, monitoring previously documented springs, survey for stygofauna, prioritizing sites for protection from feral hogs, updating the springs database, refining methods, and the preparation of this annual report. Biologists documented 145 new spring locations in FY2019. Stygobitic isopods, including the species of concern *Caecidotea reddelli*, were found at two of these newly documented locations. *Stygobromus birfucatus* were found at two of these newly documented locations. *Eurycea tonkawae* was found at one newly documented location.

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Introduction

The Balcones Canyonlands Preserve (BCP) is a regional system of preserve tracts created for the protection of federally listed species and species of concern as specified by the Balcones Canyonlands Conservation Plan (BCCP). The BCCP is a regional 10(a)(1)(B) permit jointly issued to the City of Austin and Travis County by the U.S. Fish and Wildlife Service (USFWS) under the endangered species act. The regional permit addresses the stewardship of habitat for the permanent protection of eight federally listed endangered species (two songbirds and six invertebrates) and twenty-seven species of concern (two plants and twenty-five invertebrates). Should the species of concern become federally listed, no additional mitigation would be required by the permittees with the full implementation of all BCCP protections (BCP 2007a, USFWS 1996).

The permit area, or Balcones Canyonlands Preserve, is located in Western Travis County on the eastern edge of the Edwards Plateau ecoregion. This area comprises part of the Balcones Canyonlands, characterized by steep streams and canyons deeply dissecting the Balcones Escarpment. The karstic limestone found here is highly fractured and pocked with numerous solution cavities and springs. These subterranean features and spring-fed drainages support unique ecological niches and a high degree of endemism (BCP 2007a).

Balcones Canyonland Conservation Plan (BCCP) spring management obligations include: identifying spring locations (BCP 2007e, 2007g), monitoring springs for water quality and seasonal discharge (BCP 2007b, 2007g, 2007h), protecting springs (BCP 2007b, 2007d, 2007h, 2007i), controlling invasive species (BCP 2007g, 2007h, 2007i), and monitoring for populations of aquatic target species (BCP 2007b, 2007c, 2007h). These management obligations include research goals that specify improving understanding of the ecology of preserve species and aquatic and subterranean environments (BCP 2007b). Those topics that contribute to management practices and permanent protection for listed species and species of concern are emphasized. The BCCP cites a lack of information regarding karst species and karst habitat management and specifically encourages research regarding aquatic life within the aquifer (BCP 2007c).

The animals that occur in subsurface water are referred to as stygofauna. This report addresses the two categories of stygofauna found on the Balcones Canyonlands Preserve: the stygophiles that exploit aquatic subsurface environments for some portion of their life cycle, and the stygobites that complete their entire life cycle in subsurface waters (Malard *et al.* 2002).

Among the twenty-seven species of concern protected under the BCCP, three are stygobitic: the flatworm *Sphalloplana mohri*, the ostracod *Candona sp. nr. stagnalis*, and the isopod *Caecidotea reddelli*. Further, the BCCP identifies additional species of concern (BCP 2007a). Of these are two stygobitic invertebrates: the amphipods *Stygobromus russelli* and *Stygobromus bifurcatus*. Both amphipods have a conservation status of vulnerable (Hutchins 2017), and *S. russelli* is a critically imperiled state species of greatest conservation need (TPWD 2012). The stygophilic Jollyville Plateau salamander (*Eurycea tonkawae*) is not listed as a species of concern by the 1996-issued BCCP permit; however, the BCCP does list this species as an additional species of concern and indicates that *Eurycea* salamanders may deserve further scrutiny throughout the term of the permit (BCP 2007a). The Jollyville Plateau salamander has since been federally listed as threatened and is a vulnerable-imperiled state species of greatest conservation need (USFWS 2013, TPWD 2012). Numerous populations are found on the BCP and monitoring Jollyville Plateau salamanders is specifically prescribed in the management objectives (BCP 2007f, 2007h). Table 1 and Table 2 summarize the conservation status of the stygofauna of the BCCP.

TABLE 1. The stygofauna protected under the BCCP along with their most recently assessed conservation status[1]. These species may merit federal listing if the BCP does not adequately protect their habitat[2].

Common name	Scientific Name	Conservation Status	Federal Status	State Species of Greatest Conservation Need
Flatworm	*Sphalloplana mohri*	Vulnerable		
Ostracod	*Candona sp. nr. stagnalis*			
Isopod	*Caecidotea reddelli*	Apparently secure		

[1] Hutchins, Benjamin 2017. The conservation status of Texas groundwater invertebrates. Biodiversity and Conservation. 10.1007/s10531-017-1447-0.

[2] Balcones Canyonlands Preserve 2007a. Balcones Canyonlands Preserve Land Management Plan, Tier I, Balcones Canyonlands Preserve Overview, Austin, Texas.

TABLE 2. The stygofauna the BCCP names as additional species of concern along with their most recently assessed conservation status[1].

Common name	Scientific Name	Conservation Status	Federal Status	State Species of Greatest Conservation Need
Jollyville Plateau salamander	*Eurycea tonkawae*		threatened	Imperiled/Vulnerable
Bifurcated cave amphipod	*Stygobromus bifurcatus*	Vulnerable		
amphipod	*Stygobromus russelli*	Vulnerable		Critically Imperiled

[1] Hutchins, Benjamin 2017. The conservation status of Texas groundwater invertebrates. Biodiversity and Conservation. 10.1007/s10531-017-1447-0.

There is insufficient data on the taxonomy, distribution, and ecology of stygofauna. Spring outflows provide access points or "windows" into aquatic subterranean ecosystems (Malard 2002). The City of Austin (COA) wishes to establish baseline physical condition data for all COA BCP springs and assess these springs for aquatic target species, with the long-term goal of monitoring sites for changes that could be in response to the surrounding growing urban population, climate change, or invasive species.

BCP staff initiated mapping and characterizing springs in FY 2017. In FY 2018, BCP staff continued to map and characterize spring locations, began monitoring springs, and established a geospatial springs database. These activities were expanded to include increased survey for stygofauna with the initiation of a contract agreement with permitted biologist, Crystal Datri, owner, Wren Daytree LLC. On-going management activities for FY 2019 include mapping and characterizing newly documented springs, monitoring previously documented springs, survey for stygofauna, prioritizing sites for protection from feral hogs, updating the springs database, refining methods, and the preparation of this annual report. Management activities completed during FY 2019 include establishing a repository and a system of curation for the recent invertebrate stygofauna collection. This annual report details the springs management activities performed during the 2019 fiscal year.

Methods

Here we define springs following Springer and Lawrence (2009): ecosystems where groundwater reaches the Earth's surface either at or near the land-atmosphere

interface or the land-water interface. Seeps are small springs where discharge is immeasurably diffuse (Stevens *et al.* 2016). The source of the spring or its point of emergence is referred to as the orifice (Springer and Lawrence 2009).

Identifying Undocumented Springs

Biologists selected locations to search for springs by identifying canyons and ravines within City of Austin (COA)-owned tracts of the Balcones Canyonlands Preserve (BCP) using topographic maps. Previously documented spring locations were considered to identify gaps in COA springs data. Priority was given to those tracts in proximity to the range of the Jollyville Plateau salamander (*Eurycea tonkawae*). Biologists systematically traversed streams, canyons, ravines, and their tributaries, visually searching as well as listening for signs of springs (e.g. maidenhair fern (*Adiantum* sp.) presence). Spring locations were documented when water issuing from an orifice was observed. Seeps were documented where there was not an obvious orifice of flowing water, but indications of diffuse seepage. Location coordinates were recorded using a Garmin inReach Explorer + or a Garmin GPSmap 62s.

Characterizing Springs

Location accessibility and spring morphology limit the types of data that can be collected for characterization. The rugged Balcones Canyonland Preserve system has few trails and roads. Locating springs requires long hikes that include crawling and scrambling through steep canyons and ravines in heavy brush. The majority of springs located thus far have water depths insufficient for existing discharge measuring devices (< 1 cm). FY2019 field survey consisted of a single researcher searching for spring locations and collecting data based on the equipment they could hike with and the nature of the unique conditions encountered at each site. Environmental characteristics are documented as protocols are developed and refined, equipment is obtained, and staff are trained. Researchers focused on documenting those characteristics in the immediate vicinity of the spring orifice; however, in many cases, descriptions of spring-run habitat deemed suitable for stygofauna was additionally described. The following were collected in FY2019 as possible: size and description of orifice morphology, photographs, water depth, substrate composition, rock cover, calcium carbonate cementation, water temperature, ambient temperature, some measure of water quantity, and notable flora and fauna. Discharge was measured by capturing spring outflow for time. Spring outflow could be directly captured at a rock-face pour-off in a graduated cylinder or

diverted for capture using laminated paper or plastic sheeting. A visual estimate of percentage of flow captured was recorded. When outflow could not be captured, a description of the wetted perimeter and flow characteristics was described. Substrate in the immediate vicinity of the spring outlet was assessed as a visual estimate of the percentage of particles that fall within each category of the modified Wentworth scale. Rock cover and calcium carbonate cementation was measured by modifying established methods for Jollyville Plateau salamander occupancy surveys (Bendik et al. 2016). Researchers measured as a visual estimate of the percentage of rocks available (i.e. unembedded) for salamander cover (>8 mm) at the substrate surface in the immediate vicinity of the spring orifice. Calcium carbonate cementation was visually estimated as being in one of four categories: (1) no carbonate build-up; (2) low to moderate build up (but <50% area); (3) moderate to high build up (>50% area); and (4) complete covering of area with carbonate and tufa, in the immediate vicinity of the spring orifice. Water depth was measured at the thalweg of the spring orifice. Ambient temperature was measured within 0.5 meters of the spring orifice. Water temperature was measured as far into the spring orifice as a handheld probe thermometer (Reotemp K79-7) could reach. Weather conditions were noted at the beginning and the end of the survey day. Local temperature and humidity was recorded from the nearest reported Wunderground weather station. Researchers visually estimated cloud cover. Wind speed was estimated using the Bufort scale. Geologic formation was noted according to elevation *a posteriori*.

Stygofauna

Researchers searched for salamanders and macroscopic invertebrate stygofauna by removing and replacing all cover objects such as rocks and leaf litter within the wetted perimeter in the immediate vicinity of the spring orifice where water accumulated enough to provide useable habitat as pools, streams, or within surveyable portions of karst features. Search area and time were recorded. Submerged spring orifices can be difficult to discern. Further, Jollyville Plateau salamanders are known to range widely (500m+) in spring-influenced stream habitats (Bendik 2016). While traversing stream runs in search of spring locations, researchers frequently stopped to informally search what they evaluated as suitable habitat using their best judgement. Because locations were not known *a priori*, survey sites were not delimited, and searching times were not noted in these cases.

Certain established methods of trapping (such as bottle traps and drift nets) for stygofauna are inappropriate for many springs found here so far due both to their small orifices and accessibility that renders frequent retrieval difficult. Further, traps left *in situ* must be protected from feral hogs. Mop material traps were used where biologists

deemed the site appropriate. On retrieval, mops were carefully removed and visually searched for both salamanders and invertebrates.

If salamanders were observed at a previously undocumented location, animals were captured and photographed in translucent boxes with fresh water placed on top of 1 cm grid paper and immediately released. If stygobytic invertebrates were observed at a previously undocumented spring location, a specimen of each discernable family was collected and preserved in 95% alcohol.

Specimen Collection and Curation

Macroscopic invertebrate stygofauna were collected and fixated in 95% ethyl alcohol. In some cases, epigean invertebrates were collected along with stygofauna. Specimens are frozen at the City of Austin Wildland Conservation Division office Reicher Ranch, Austin. City staff will sort specimens, identifying them to the lowest possible taxonomic level before further scrutiny and deposition with the Edwards Aquifer Research and Data Center, San Marcos.

Testudo Tube

Bi-annual monitoring events at Testudo Tube cave for Jollyville Plateau salamanders were conducted on January 28, 2019 and August 14, 2019. Two biologists exhaustively searched a previously delineated monitoring zone of stream passage (Figure 1). Animals were captured with pool nets and held in mesh boxes in the water until they were photographed. Animals were photographed in an acrylic tray filled with water, set on top of 1 cm grid background (Figure 2). These images can later be used to identify individuals and measure body length (Figure 3). Animals were released within the immediate vicinity of their capture. On the August 14 survey, water temperature, specific conductivity, pH, and dissolved oxygen were measured with a hydrolab (need model name) (Figure 4).

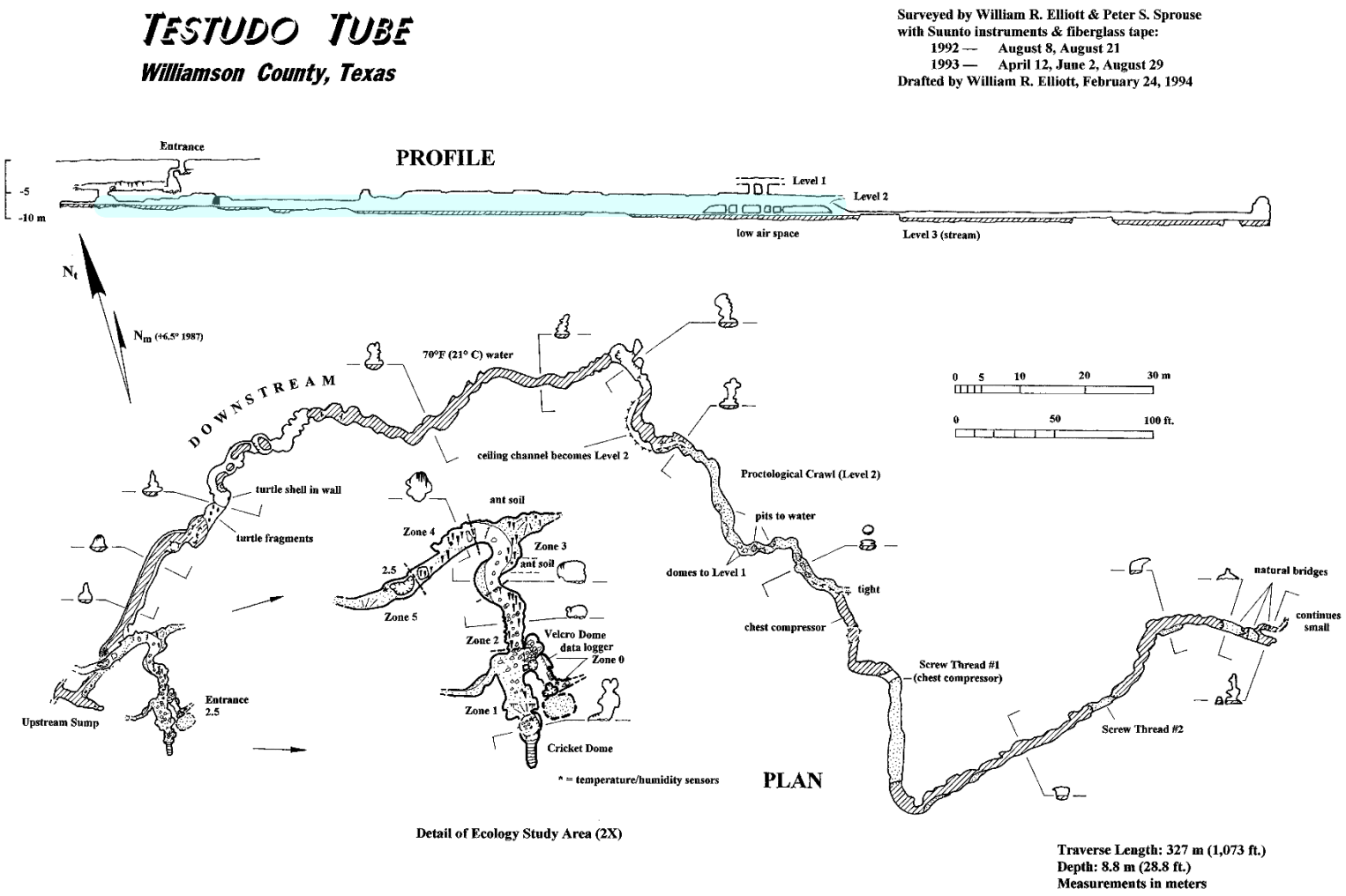


Figure 1. Map of Testudo Tube cave. The monitoring zone is highlighted in blue in the profile view.

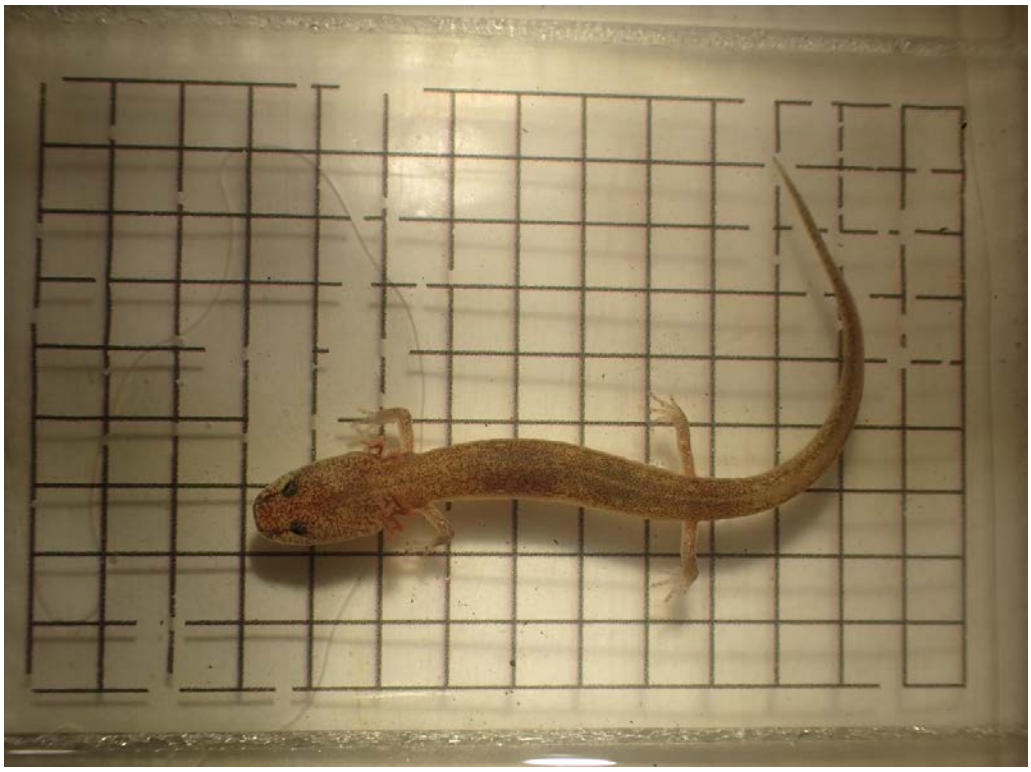


Figure 2. Jollyville Plateau salamander captured in Testudo Tube cave. Photo by Colin Strickland.

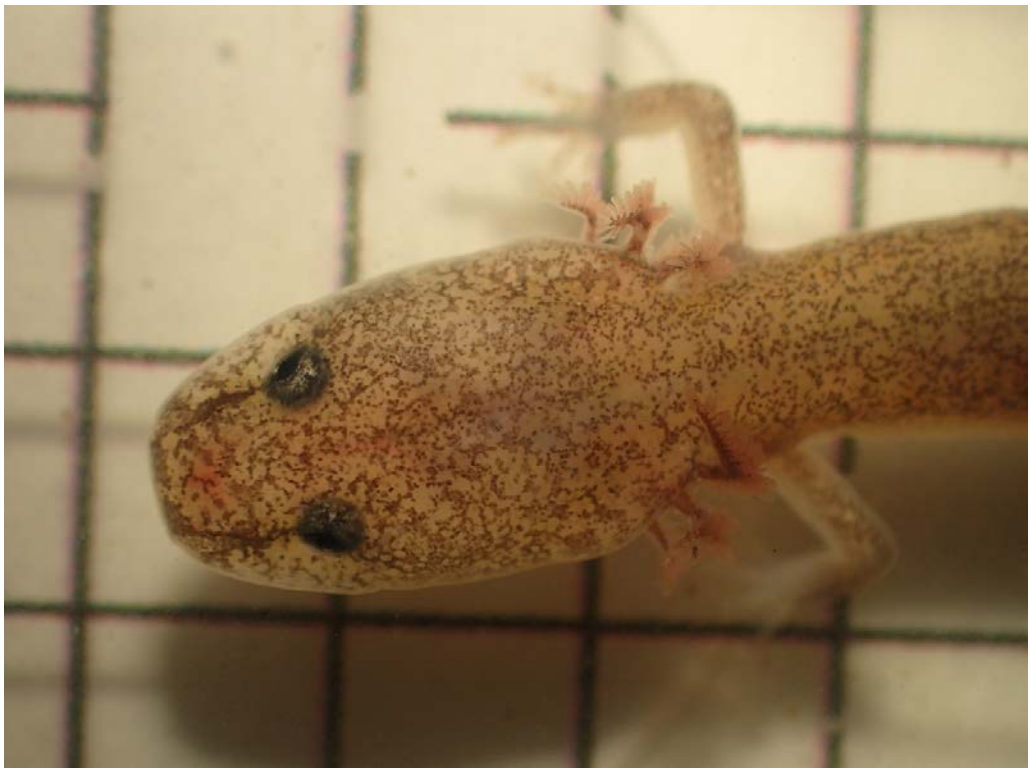


Figure 3. Close-up of the head of a Jollyville Plateau salamander captured in Testudo Tube cave. These images can later be used to identify individuals. Photo by Colin Strickland.

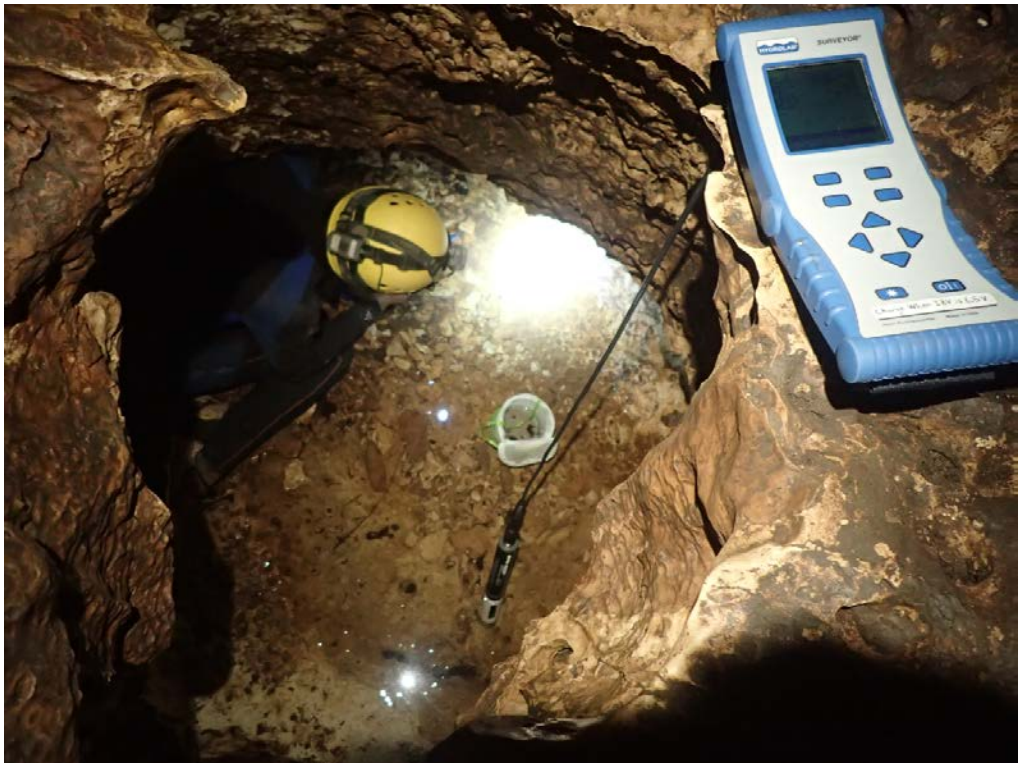


Figure 4. COA biologist Jonathan Scalise searches for Jollyville Plateau salamanders in Testudo Tube cave while Colin Strickland collects water chemistry data. Photo by Colin Strickland.

Springs Database

The Wildlands Conservation Division Springs Database was established by city staff biologist Colin Strickland in 2018. Colin compiled all known COA BCP springs data into a single format in ArcGIS and continues to add BCP springs data as collected.

Priority for Feral Hog Protection

Certain spring sites are more easily protected from rooting and wallowing action by feral hogs due to their morphology and accessibility. In FY2019 biologists began identifying those sites that could feasibly be fenced-off for protection from feral hogs.

Results

Identifying Undocumented Springs

145 new spring locations were documented in FY2019. Maps of these locations are shown in Figures 5 through 10. 16% of these locations were revisited at least once in FY2019. Location and characterization data are housed with the City of Austin Wildlands Conservation Division.

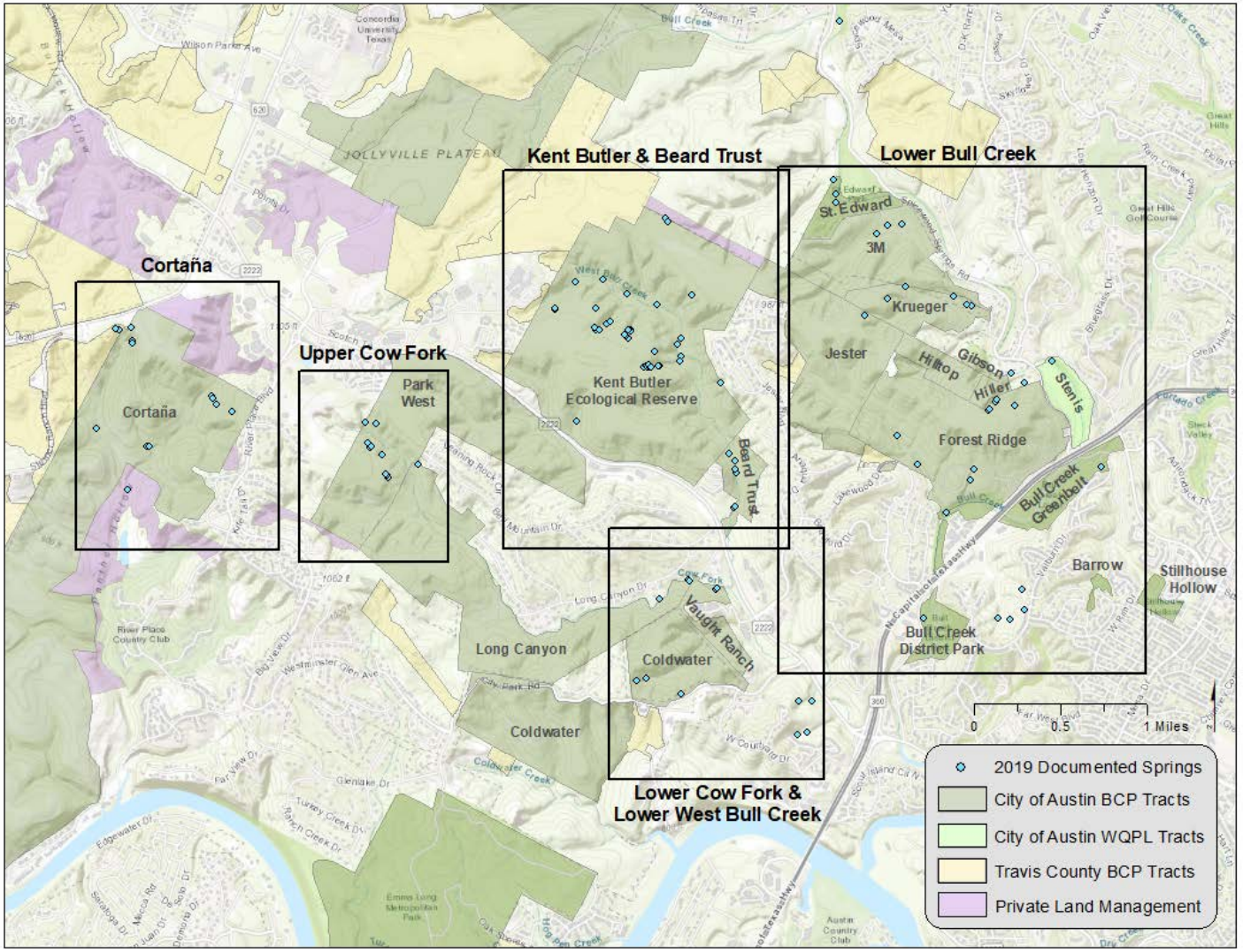


Figure 5. Overview of newly documented springs for FY2019. Close-up maps of the outlined areas are depicted in Figures 6 through 10. Map by Colin Strickland.

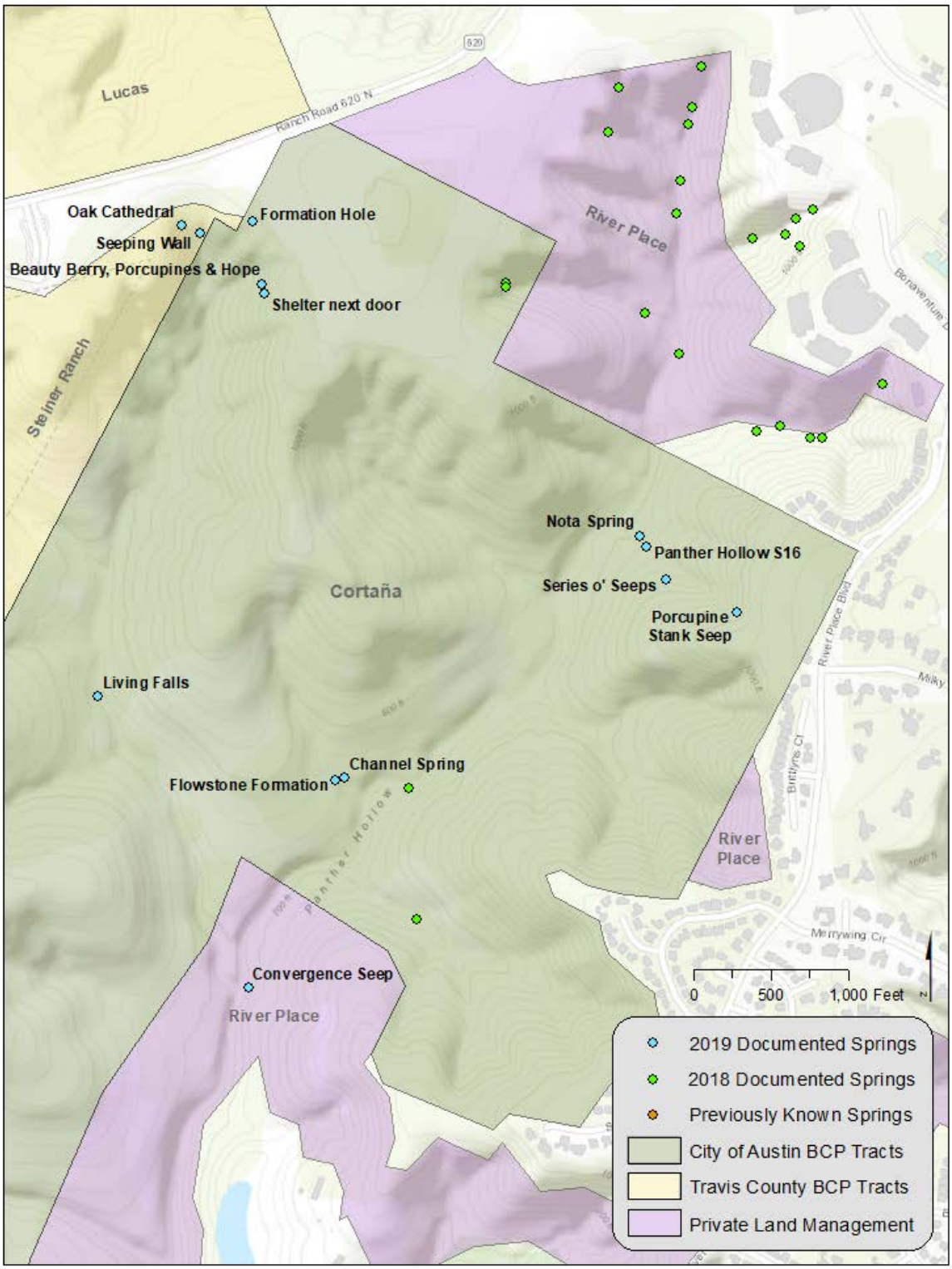
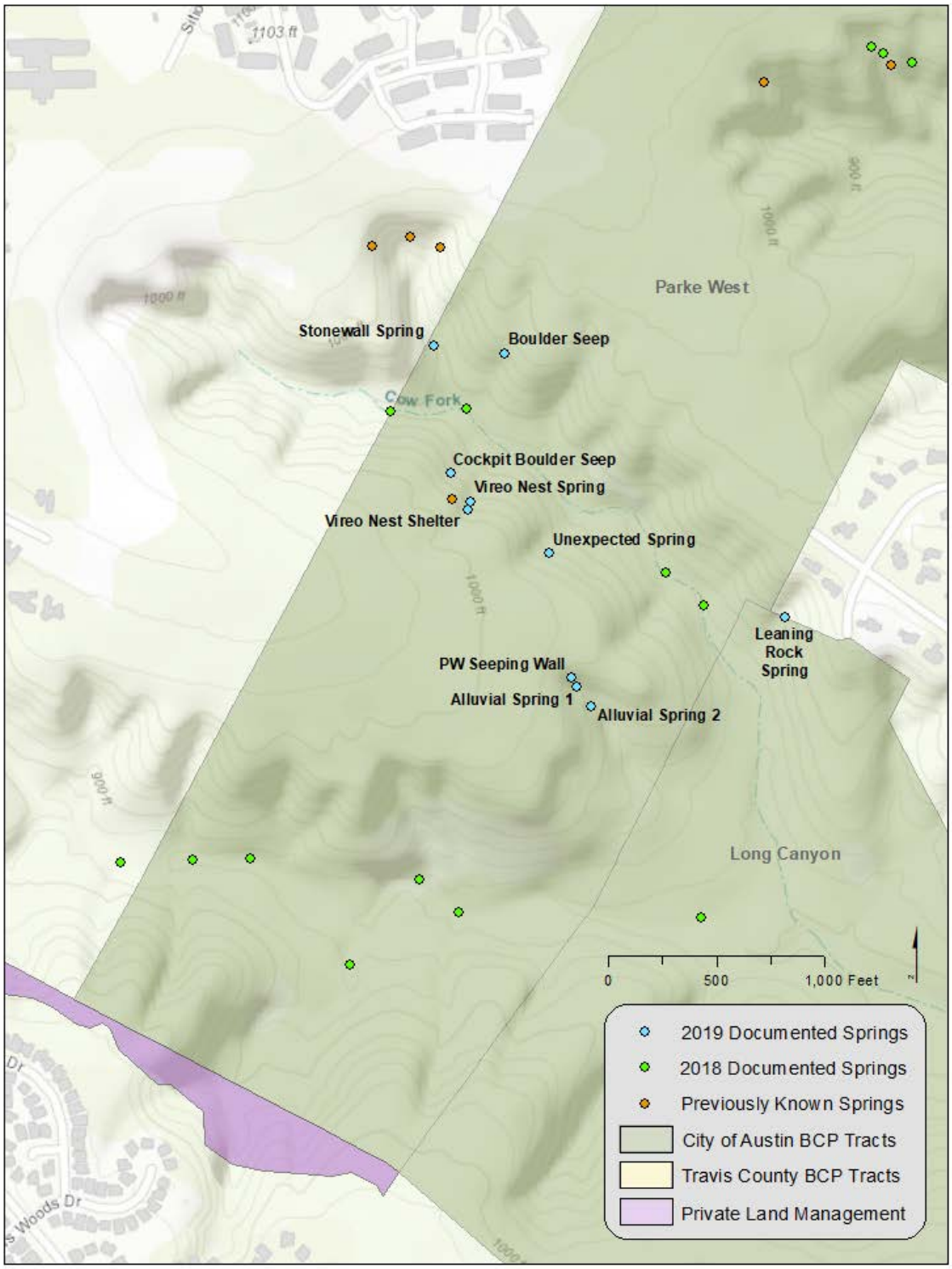


Figure 6. Springs documented on the Cortaña tract. Map by Colin Strickland.



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Figure 7. Springs documented on the upper Cow Fork watershed. Map by Colin Strickland.

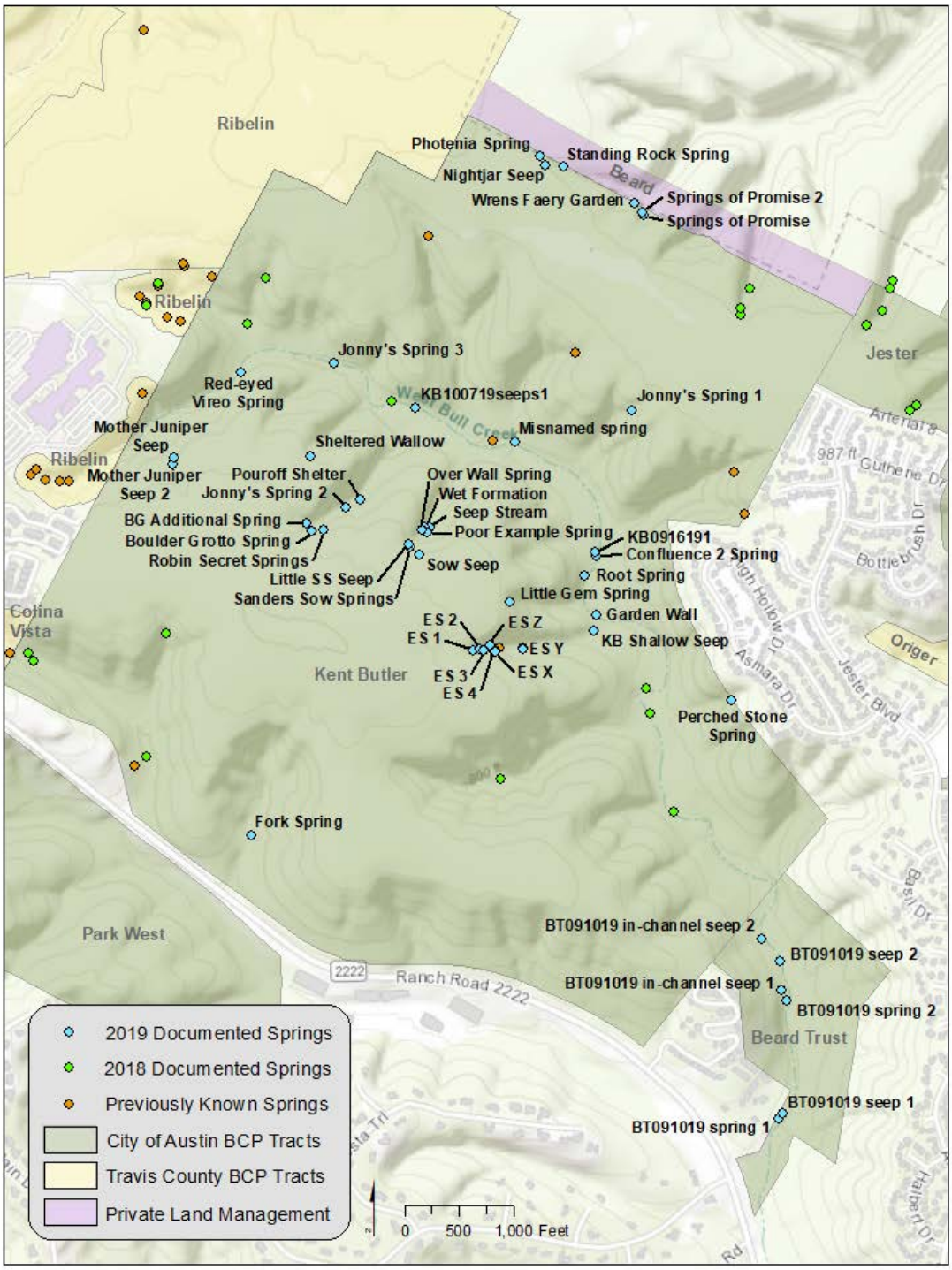


Figure 8. Springs documented on the Kent Butler and Beard Trust tracts. Map by Colin Strickland.

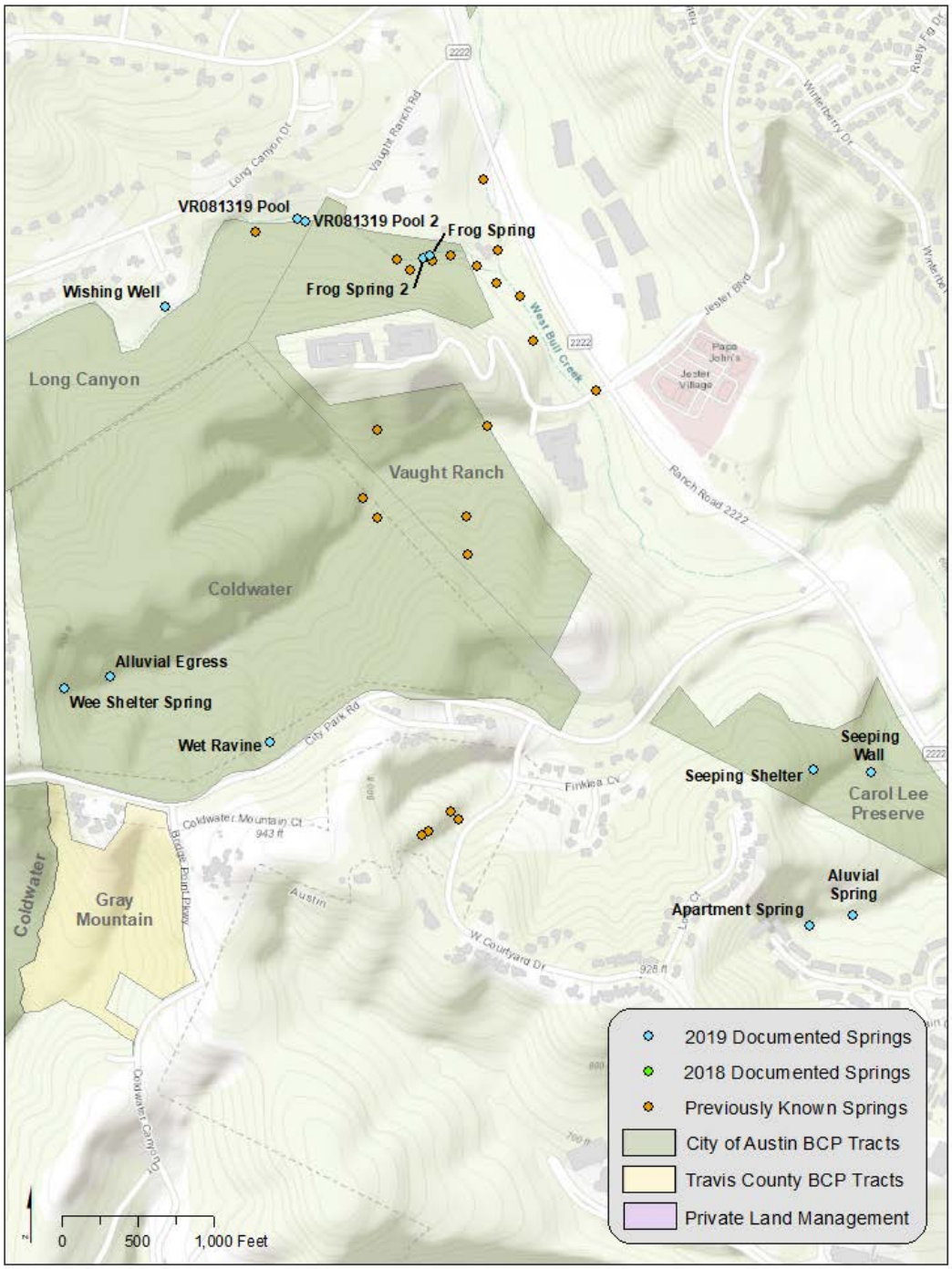


Figure 9. Springs documented in the lower Bull Creek watershed and the lower Cow Fork watershed.

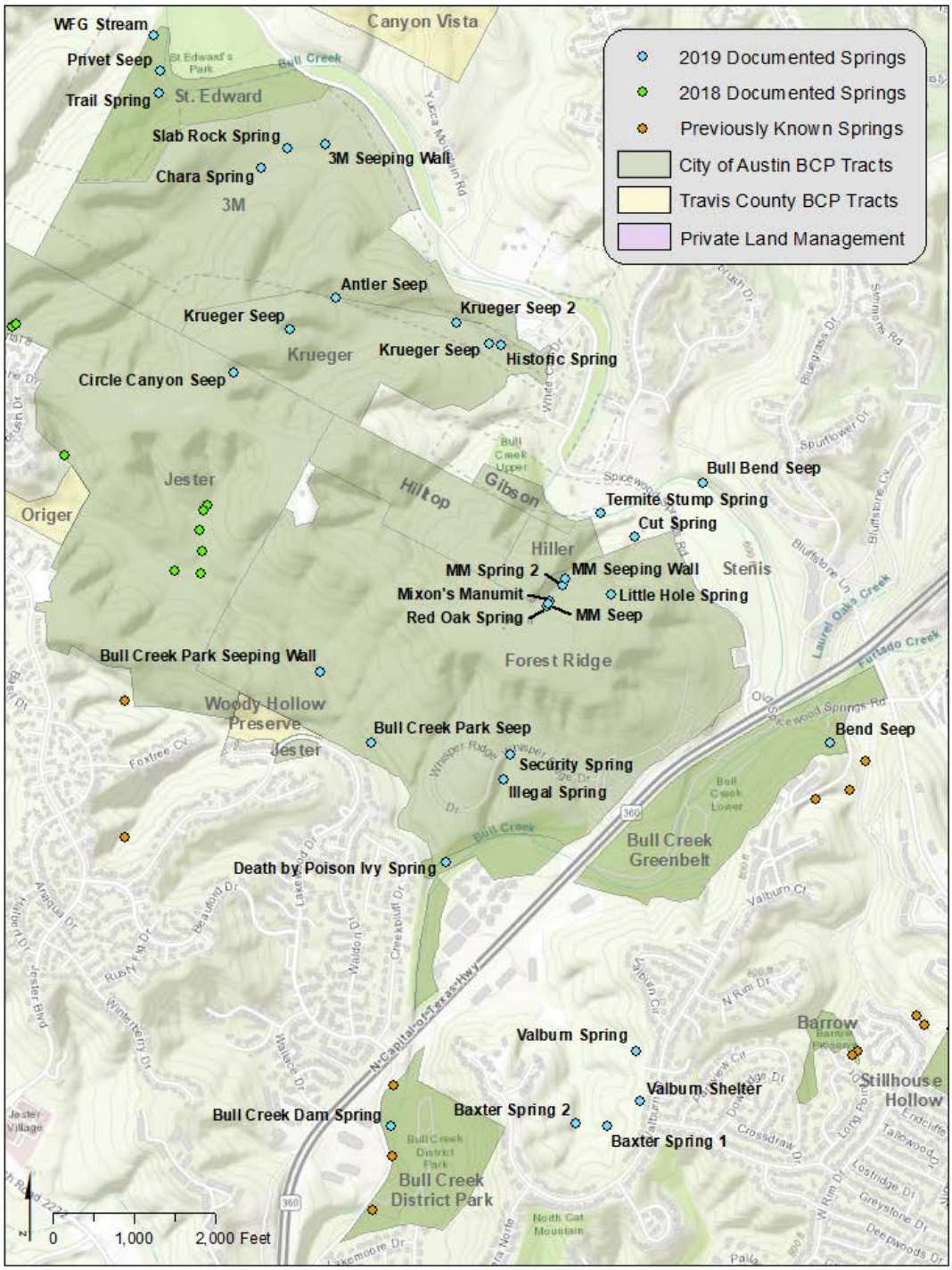


Figure 10. Springs documented in the lower Bull Creek watershed.

Stygofauna

One Jollyville Plateau salamander was documented at one new spring location: Wren's Faery Garden. Invertebrate stygobites were collected at three new spring locations: Springs of Promise, Robin's Secret Spring, and Sander's Sow Spring. Table 3 summarizes newly documented stygofauna locations for FY2019.

TABLE 3. Summary of new faunal locations for FY2019.

Feature Name	Date	Stygofauna	Other collected fauna
Springs of Promise	Oct 1, 2018	Asellidae stet.	Leuctridae stet.
Wren's Faery Garden	Oct 1, 2018	*Eurycea tonkawae*	
Robin's Secret Spring	Jun 11, 2019	*Stygobromus bifurcatus* *Caecidotea reddelli*	*Suragina* stet. *Stenelmis* stet.
Sanders Sow Spring	Jun 12, 2019	*Stygobromus bifurcatus*	*Chimarra* stet. *Tipula* stet. Chironomidae stet. Ostracoda stet.

The invertebrates collected at Robin's Secret Spring and Sander's Sow Spring were found in mop material traps. Sander's Sow Spring was searched twice for stygofauna before the mop trap was placed. Stygofauna were recovered on a subsequent check of mop material. Robin's Secret Spring was searched once before the mop trap was placed. Stygofauna were recorded on a subsequent check of mop material.

Testudo Tube cave

On the 1/28/2019 survey, 12 Jollyville Plateau salamanders were captured and photographed (Figure 11). On the 8/14/2019 survey, 19 Jollyville Plateau salamanders were counted. 17 of these were captured and photographed.



Figure 11. Jollyville Plateau salamander in Testudo Tube stream passage. Photo by Colin Strickland

Discussion

The invertebrate stygobites collected in FY2019 include isopods at two newly documented spring locations. *Caecidotea reddelli*, found at Robin's Secret Spring, is a species of concern protected by the Balcones Canyonlands Conservation Plan. The isopods collected at Springs of Promise have been identified to the family Asellidae, which contains the species *Caecidotea reddelli*. We await further identification of these specimens. FY2019 collections also include the stygobitic amphipod *Stygobromus bifurcatus* from two locations. This species is identified as an additional species of concern by the BCCP and it has a state conservation status of vulnerable (BCP 2007a, Hutchins 2017).

The on-going management activities for FY2019 are in accordance with the Balcones Canyonland Conservation Plan spring management obligations and research goals that contribute to the knowledge, recovery, and protection of BCP species; however, there is more work to be completed.

Spring Management Activities Planned for FY2020

Biologists will continue to search COA BCP for undocumented spring locations and continue to refine methods of spring characterization including developing methods to measure discharge at a greater number of springs. Sites will be prioritized for further characterization. Biologists will revisit some previously documented locations to assess springs incorporate seasonal data. Searching stream channels in dry times can reveal spring orifices often inundated by stream water. The collection of samples at some springs for water quality analysis is anticipated. Researchers will continue prioritizing spring sites that could feasibly be protected from rooting by feral hogs.

Researchers will continue to refine methods of assessing aquatic target species with the goal of developing more representative sampling to include microscopic species as well as those not likely to colonize mop material traps. Faunal survey may include beginning trapping on existing wells on COA BCP tracts. As more COA BCP tracts are surveyed, assessment for aquatic target species could include the yet described Pedernales River springs salamander that the BCCP lists as an additional species of concern.

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(BCP 2007c) Tier II A, Chapter IX Karst Species Management
(BCP 2007d) Tier II A, Chapter X Animal Management
(BCP 2007e) Tier II A, Chapter XI Water Quality Management
(BCP 2007f) Tier II C, Bull Creek Macrosite
(BCP 2007g) Tier III, City of Austin Cortana Tract, North Lake Austin Macrosite
(BCP 2007h) Tier III, City of Austin Lower Bull Creek, Bull Creek Macrosite
(BCP 2007i) Tier III, City of Austin Cowfork/Coldwater Tracts (Park West, Long Canyon, Coldwater) North Lake Austin, Macrosite

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