SUMMARY OF ACTIVITIES THROUGH FY2023 ON THE BALCONES CANYONLANDS PRESERVE, AUSTIN, TRAVIS COUNTY, TEXAS



Searching a subterranean pool on the Balcones Canyonlands Preserve for stygofauna

Prepared for
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Abstract

This report details ongoing spring-related management activities performed by Wren Daytree LLC on the City of Austin Balcones Canyonlands Preserve through the 2023 fiscal year. Activities include documenting spring locations, characterizing springs, monitoring previously documented springs, and survey for stygofauna. Nine new spring locations were documented in FY2023. Project faunal survey has resulted in multiple new occurrence records, including BCCP species of concern and state species of greatest conservation need, for invertebrate aquifer fauna and range expansions for two species of federally listed *Eurycea* neotenic salamanders. Multiple specimens await further taxonomic scrutiny. Many areas of the Balcones Canyonlands Preserve await spring documentation and faunal survey.

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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, 2007j), monitoring springs for water quality and seasonal discharge (BCP 2007b, 2007g, 2007h, 2007j), protecting springs (BCP 2007b, 2007d, 2007h, 2007i, 2007j), controlling invasive species (BCP 2007g, 2007h, 2007i, 2007j), and monitoring for populations of aquatic target species (BCP 2007b, 2007c, 2007h, 2007j). 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). “Management of, and policy development for, groundwater-dependent ecosystems cannot go forward if springs, seeps, wetlands, gaining reaches of streams, groundwater-dependent terrestrial ecosystems and phreatophytes, aquifer ecosystems, and cave ecosystems have not been located, identified, surveyed, and monitored (Kreamer et al. 2015).”

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). The stygophilic Jollyville Plateau salamander (*Eurycea tonkawae*), Barton Springs salamander (*Eurycea sosorum*), and the undescribed "Pedernales River springs" salamander are not listed as species of concern by the 1996-issued BCCP permit; however, the BCCP does list these species as additional species of concern with potential distributions within the permit area 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 and state listed as threatened, and is an imperiled state species of greatest conservation need (USFWS 2013, TPWD 2020). Numerous populations are found on the BCP and monitoring Jollyville Plateau salamanders is specifically prescribed in the management objectives (BCP 2007f, 2007h). The BCP does possess a USFWS 10(a)(1)(A) permit for research and recovery purposes for *E. tonkawae*. The Barton Springs salamander was listed as endangered in 1997 and is covered under a separate USFWS Section 10(a)1(B) permit issued to the City of Austin in 1998 (USFWS 1997, Permit PRT-839031). The state lists this species as endangered and a critically imperiled state species of greatest conservation need (TPWD 2020). The "Pedernales River springs" salamander is an undescribed neotenic *Eurycea* species (*Eurycea* sp. 1) occurring in springs along the lower Pedernales River in Blanco, Travis, and Hays Counties (Devitt *et al*. 2019). This salamander was recently petitioned for federal listing and is presently undergoing status review (Datri et al. 2021, USFWS 2022). 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 2017
[2] BCP 2007a.

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

Common name	Scientific Name	Conservation Status	Federal Status	State Species of Greatest Conservation Need
Amphipod	*Stygobromus russelli*	Vulnerable		
Bifurcated cave amphipod	*Stygobromus bifurcatus*	Vulnerable		
Jollyville Plateau salamander	*Eurycea tonkawae*		Threatened	Imperiled
Barton Springs salamander	*Eurycea sosorum*		Endangered	Critically imperiled
“Pedernales River springs” salamander	*Eurycea sp. 1*		In review	N/A

[1] Hutchins 2017.
[2] Texas Parks and Wildlife Department 2020.

There is insufficient data on the taxonomy, distribution, and ecology of stygofauna. Springs 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, invasive species, or other threats.

BCP staff initiated documenting and characterizing springs in FY 2017. In FY 2018, BCP staff continued to document and characterize spring locations, began monitoring springs, and established a geospatial springs database. These activities were

expanded to include survey for stygofauna with the initiation of a contract agreement with permitted biologist, Crystal Datri, owner, Wren Daytree LLC. Management activities in FY 2019 included locating and characterizing undocumented springs, monitoring previously documented springs, survey for stygofauna, prioritizing sites for protection from feral hogs, refining methods, and establishing a system of curation for collections. Management activities for FY 2020 included documenting and characterizing undocumented springs (expanded to include the Pedernales and South Lake Austin macrosites), monitoring previously documented springs, survey for stygofauna, site protection from feral hogs, and refining methods. Management activities for FY 2021 included documenting and characterizing undocumented springs (expanded to include the West Austin macrosite), monitoring previously documented springs, survey for stygofauna, and refining methods. Management activities for FY 2022 included documenting and characterizing undocumented springs (expanded to include the Barton Creek Habitat Preserve), monitoring previously documented springs, survey for stygofauna, updating the springs database, and refining methods. This annual report details activities through FY 2023 including documenting and characterizing springs, monitoring springs, survey for stygofauna, refining methods, and overhauling the data collected to date.

Methods

Spring-related features are defined for this project as follows: Springs are ecosystems at the land surface where groundwater discharges. Spring sources are often multiple; therefore, we refer to these features in the plural form as “springs” or “springs ecosystems”. The orifice is the springs point(s) of emergence or the opening through which groundwater discharges. Seeps are small springs where discharge is immeasurably diffuse (Stevens *et al*. 2016). Given that seeps are a type of spring that is low-flow or diffuse-flow, and that that flow may change with environmental conditions, we neither define nor attempt to differentiate springs ecosystems as seeps; however, seepage conditions may be used as a descriptor. Many previously documented springs have been described as seeps. Swallets or swallows are natural recharge features indicating the place where losing (or sinking) streams infiltrate into the subsurface.

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. Previous fiscal years have included spring survey on Travis County, LCRA, and Nature Conservancy BCP tracts. Previously documented spring locations were considered to identify gaps in COA springs data. Biologists traversed streams, canyons, ravines, and their tributaries, searching for physical[1] or geologic indications[2] of springs. In some cases, locations were documented and sampled that were not identified as springs. Positions of all features were documented with a commercial handheld Global Positioning System (GPS) receiver and checked with field maps based on digital imagery.

Characterizing Springs

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. 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 searched and described. The following have been collected 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, notable species observed, and other water quality parameters. 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 orifice was assessed as a visual estimate of the 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);

[1] Physical indicators of springs: sounds of flowing water, measurable flow, a pool of water, the presence of a hydrophytic plant community, the mineralization of calcium carbonate such as travertine and/or tufa, or the detection of a water temperature gradient in a stream or pool

[2] Geologic indicators of springs: lithologic contacts and structural features such as a fracture, a conduit, a fault zone, or a bedding plane

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. Other water quality parameters were collected when possible with a Hanna HI98194 meter and included: pH, ORP, DO, conductivity, resistivity, total dissolved solids, salinity, temperature, and atmospheric pressure. Weather conditions were noted at the beginning and the end of the survey day. Local temperature and humidity were recorded from the nearest reported Wunderground weather station. Researchers visually estimated cloud cover. Wind speed was estimated using the Bufort scale.

Due to the record drought occurring in 2023, an effort was made in late summer 2023 to identify which springs still had flow and monitor their water quality conditions, with priority given to those springs known to be occupied by salamanders.

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 surface 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 judgment.

Drift nets and cotton mop-head material (mops) were used to sample for fauna as appropriate according to spring morphology and location accessibility. On retrieval, mops were carefully removed and visually searched for both salamanders and macro invertebrates. Drift nets consisted of 150 to 200 micron, mesh filter bags. Drift nets were checked at least once per week. On retrieval, nets were rinsed into a 250 micron sieve and then visually searched for any remaining macroinvertebrates. Sieve material was sorted and visually searched, both with the unaided eye and in combination with a 2x lens.

Specimen Collection and Curation

Macroscopic invertebrate stygofauna were collected and fixated in 95% nondenatured ethyl alcohol. Samples were sorted by COA staff and assigned specimen numbers by Wren Daytree LLC. Samples were then sent to the University of Texas Rio Grande Valley at Edinburg (gastropods), USFWS San Marcos Aquatic Resources Center (*Stygobromus*), Edwards Aquifer Research and Data Center at San Marcos (*Assellidae*), the Texas Natural History Collection at the University of Texas at Austin (troglofauna), and the Amphibian and Reptile Diversity Research Center, University of Texas Arlington (salamanders) for further taxonomic scrutiny and curation. Epigean fauna was provided to City of Austin Wildlands Conservation Division staff for their curation.

Data Collection

Data is collected on paper field sheets and entered in Excel. Methods have been revised and refined since the project began. In FY 2023, an effort was begun by Wren Daytree LLC to overhaul all existing data to ensure the entire dataset meets standardized definitions and methods. Entry of raw data into GIS-based systems has been performed solely by COA staff.

Results

Spring Documentation and Characterization

Nine new spring locations were documented in FY2023 on the City of Austin Balcones Canyonland Preserve. Tracts surveyed in FY 2023 include: Kent Butler, Forest Ridge/Bull Creek Park, Bull Creek Greenbelt, St. Edward, Sam Hamilton, Lanier, Franklin, and Little Bee Creek Preserve (Ullrich), and Starks North Mine (Travis Co. BCP). This brings the total number of documented springs on City of Austin BCP tracts to approximately 395 since FY 2017.

Drought Monitoring

Visits were made to select springs during the summer 2023 extreme drought to document whether springs were flowing and water quality conditions (Hanna HI98194) when water was found. Intensive faunal survey was not performed during these visits

due to concern over potentially further stressing animals during the extreme weather event. A summary of this effort follows:

Death by Poison Ivy was visited 1 August 2023. These springs emerge from the cliff wall that the Lower Bull Creek Greenbelt Trail follows, forming a stream that flows for approximately 75 meters before converging with a major tributary to the main stem of Bull Creek. Flows were observed from the orifices in the cliff wall. The stream was stagnant and did not flow to the aforementioned tributary. Feral hog damage and elephant ear were observed.

Sam Hamilton Memorial Reserve West tract was visited 22 August 2023. Hamilton Road West, a *E. tonkawae* site, was dry. Unnamed Seep had no apparent flow, but a 40 x 12 cm puddle. Honeycomb Spring flowed into a 90 x 80 cm puddle and stopped. Anoles were observed drinking at both Unnamed Seep and Honeycomb Spring.

Sam Hamilton Memorial Reserve West and Lanier tracts were visited 28 August 2023. No inflows or outflows were observed at Plunge Pool Spring, but it did have a puddle with a water level approximately 0.5 m below the saturated zone of the banks. Feral hog damage was observed. The Lanier 90 ft Riffle *E. tonkawae* site was dry with feral hog damage observed. Retreating flows were observed at Lanier Spring, a *E. tonkawae* site. Outflows were observed from an orifice outside of the fenced area, ~1.5 m below the stream gauge. A faunal search was not performed; however, a single salamander was observed swimming near this outflow.

The Franklin tract was visited on 31 August 2023. A 3.5 x 3 m puddle with no outflows was observed at Franklin Spring. Two puddles downstream of this site, apparent orifices revealed by the drying stream bed, were documented. A previously undocumented spring, 60 m upstream of Buzzard Spring was found to be flowing into a 5 x 4 m pool and continuing downstream. Leopard frogs and feral hog damage were observed here. Pit Spring, a *E. tonkawae* site, was dry. The stream bed was dry from Franklin Spring to Pit Spring.

Kiki Spring and Wrens Faery Garden, *E. tonkawae* sites, were visited on 21 Sep 2023. Both springs showed similar conditions: flows were still apparent but visually decreased, some areas of dry tufa, signs of drought stress to vegetation (brown ferns, dry moss). Salamanders were not observed at either site.

Stark's North Mine was visited to assist and train Travis County BCP staff in stygofauna survey methods. No stygofauna were observed. City of Austin staff performed water

quality testing during the visit and reported wastewater components (see City reporting).



Figure 1. City and Wren Daytree biologists observe a drip in Stark's North Mine. 21 June 2023.



Figure 2. Crystal Datri searches a subterranean pool in Stark's North Mine. 21 June 2023

Fauna

Two new locations for *Eurycea* salamanders have been identified at two new spring locations through this research effort. A single Jollyville Plateau salamander (*Eurycea tonkawae*) was documented at Wren's Faerie Garden 1 October 2018 (Figure 3), and a single Barton Springs salamander (*Eurycea sosorum*) was found and collected on the City of Austin Balcones Canyonlands Preserve Little Bee Creek Preserve (Ullrich tract) on 11 January 2022 (Figure 4). Further details on the latter finding can be found in the "New Barton Springs Salamander Location, Little Bee Creek, Travis County, Texas" report prepared for the Wildland Conservation Division (Datri 2022).



Figure 3. A single individual Jollyville Plateau salamander was found at Wren's Faerie Garden. Photo by Crystal Datri, 1 October 2018



Figure 4. The Barton Springs salamander collected by biologist Crystal Datri from the City of Austin Balcones Canyonlands Preserve Little Bee Creek Preserve. Photo by Dr. Jean Krejca, Zara Environmental LLC, 11 January 2022.

A table of all invertebrate stygofauna collected through FY 2023 with their current lowest level of taxonomic identification is found in Appendix 1. A summary of invertebrate stygofauna identified through this research effort follows:

Multiple *Stygobromus* species have been collected in BCP springs, including *Stygobromus balconis* from Injured Spring, Chips Duet, John's Hollow, Amphipod Trickle, Gate Spring, Mixon's Manumit (Figure 5), and Brandon's Sweetwater (Figure 6); *Stygobromus russelli* from Squeaking Juniper, Greenbriar, Shutdown Stygos, Source of Giants, Watering Pool, Pegaeae, and Altar Spring (Figure 7); and *Stygobromus bifurcatus* from Surprise Amphipool, Robin's Secret, Sanders Sow, Misnamed Spring, and Mixon's Manumit. Individuals from three springs (Squeaking juniper, Steiner Sanctuary, and Giant Isopod) were identified to the *Stygobromus tenuis* group because they were juveniles and/or too small to distinguish to species. This group includes *S. balconis*, *S. bifurfactus*, and *S. russelli*. A map of the distribution of collected *Stygobromus* species is shown in Figure 8.



Figure 5. *Stygobromus balconis*, collected from a drift net at Mixon's Manumit spring on the Forest Ridge/ Bull Creek Park tract. Photo by COA staff Colin Strickland, 13 October 2021.



Figure 6. *Stygobromus balconis* found free-living at Brandon's Sweetwater Spring on the Barton Creek Habitat Preserve by S. Donelson, N. Bendik, C. Datri, M. Westbrook, and S. Hiers. Photo by COA staff Colin Strickland, 27 September 2022.



Figure 7. *Stygobromus russelli*, found in mop material at Altar Spring on the Little Bee Creek Preserve. Photo by COA staff Colin Strickland, 27 September 2022.

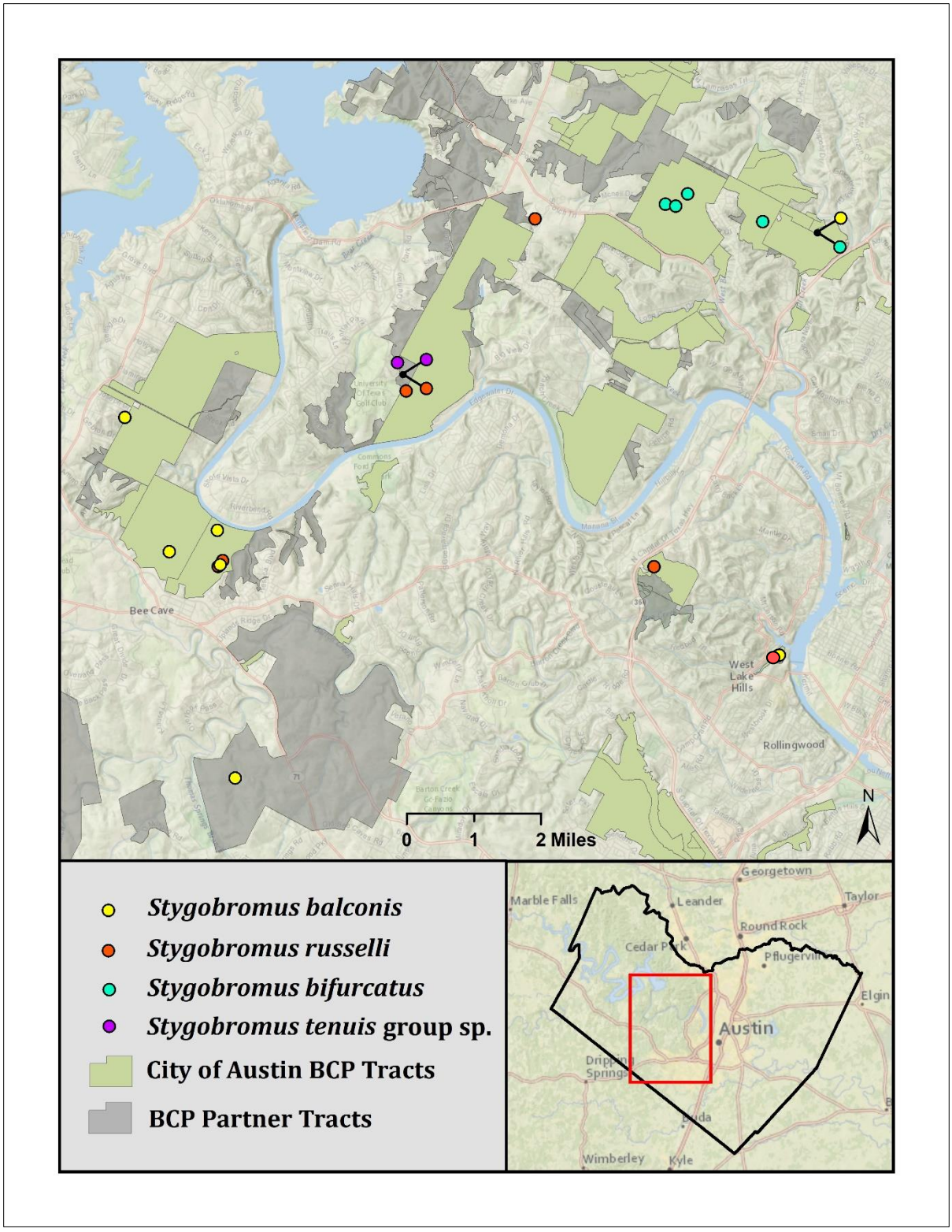


Figure 8. The distribution of *Stygobromus* species collected on City of Austin BCP tracts. Map by COA staff Colin Strickland.

Two stygobitic isopods have been collected: *Lirceolus hardeni* and *Caecidotea reddelli*. *L. hardeni* has been collected from Greenbriar and John's Hollow. These locations are mapped in Figure 9. *C. reddelli* has been collected from Springs of Promise, Robin's Secret, Greenbriar, Squeaking Juniper, Steiner Sanctuary, Giant Isopod, Source of Giants, John's Hollow, and Box Spring. These locations are mapped in Figure 10. A gravid female *Lirceolus hardeni* collected from Greenbriar Spring is shown in Figure 11-left. Figure 11-right depicts *Caecidotea reddelli* and *Lirceolus hardeni* indviduals, both collected from John's Hollow. Figures 12-15 depict select additional stygobitic isopods observed and collected on the BCP.

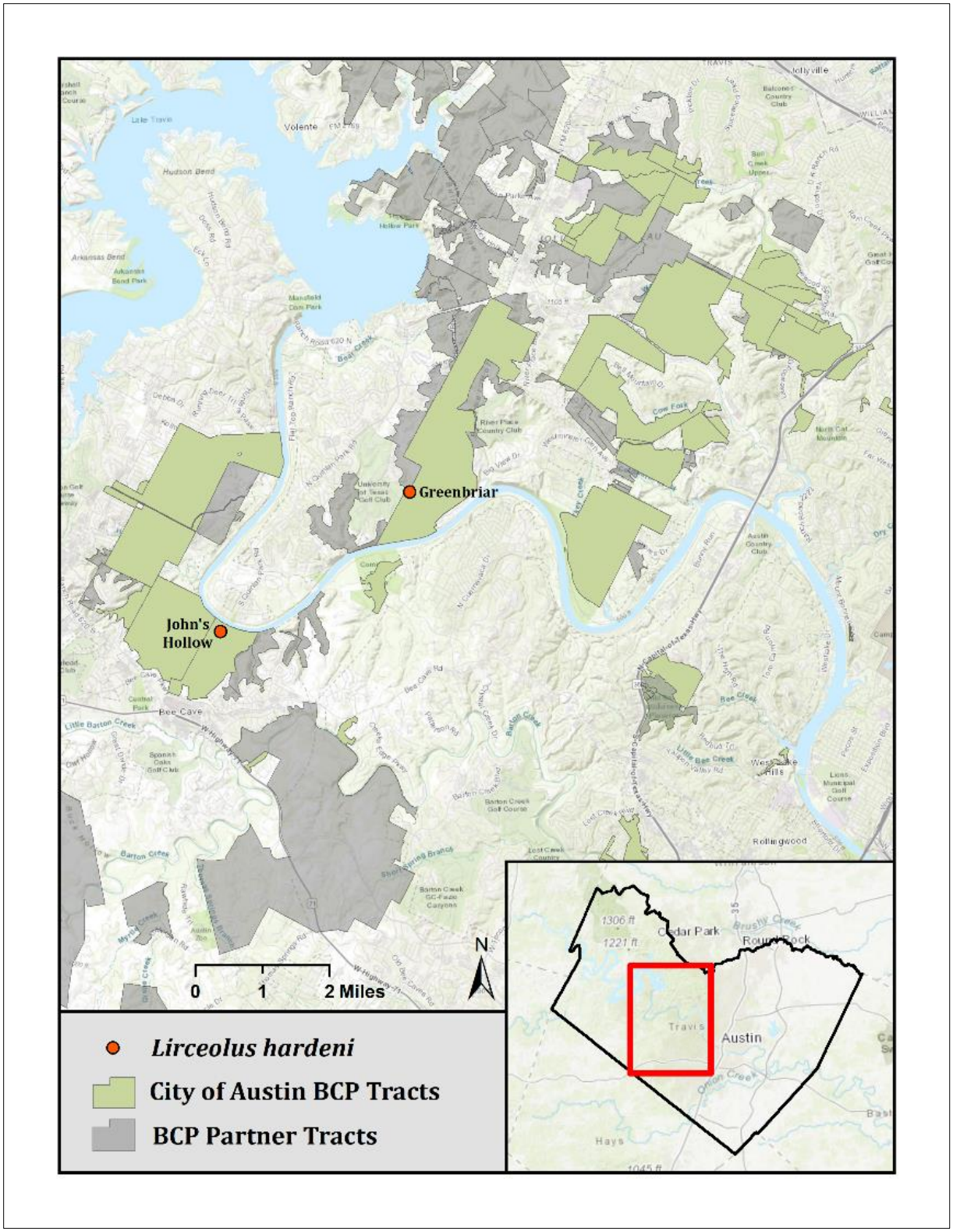


Figure 9. *Lirceolus hardeni*, one of two stygobitic isopod species collected at springs on the City of Austin Balcones Canyonlands Preserve. Map by COA staff Colin Strickland.

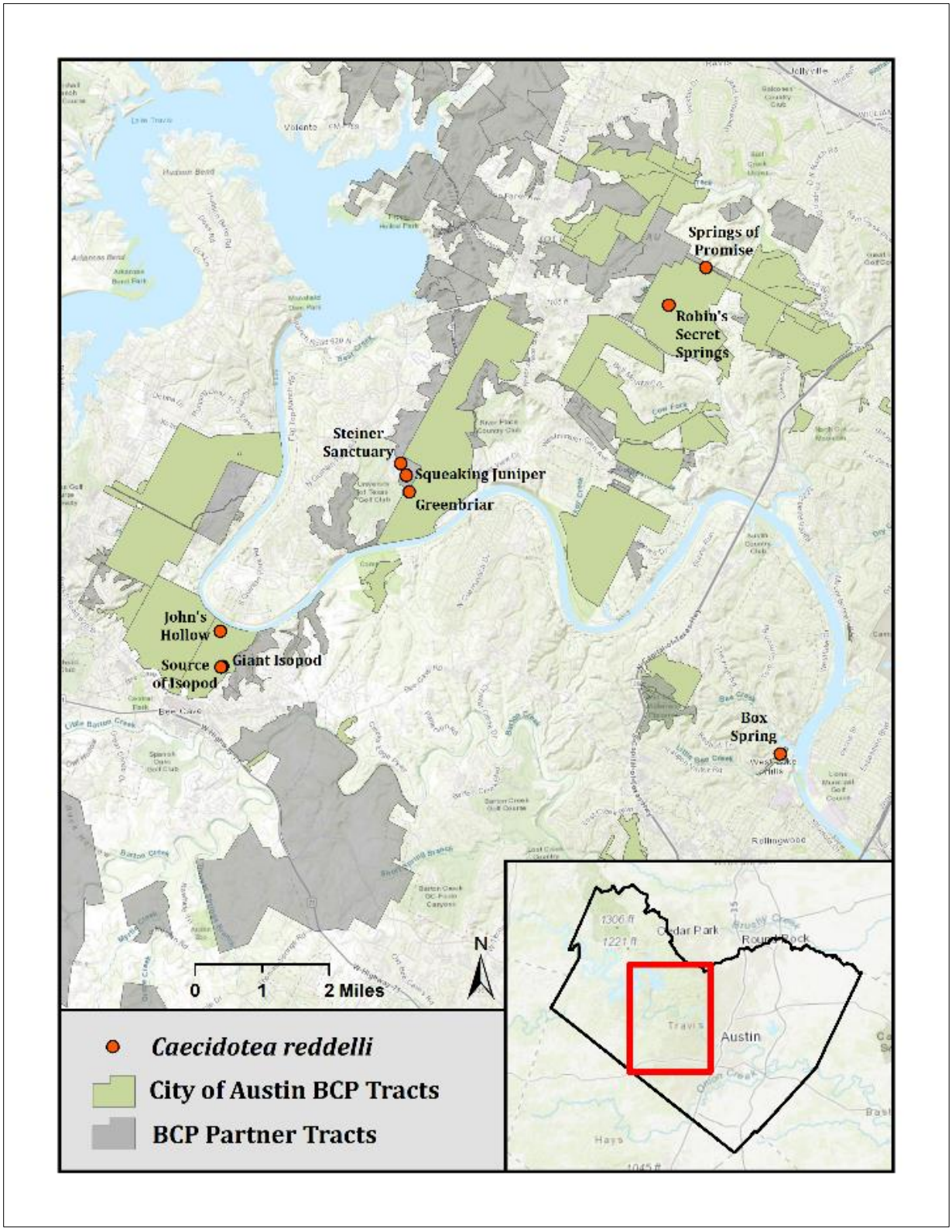


Figure 10. *Caecidotea reddelli*, a stygobitic isopod protected by the Balcones Canyonlands Conservation Plan was collected from multiple springs across the Balcones Canyonlands Preserve. Map by COA staff Colin Strickland.



Figure 11. Stygobitic isopods collected from springs on City of Austin Balcones Canyonlands Preserve. A gravid female Lirceolus hardeni collected from Greenbriar Spring on the Cortaña tract (photo left). The photo-right shows a size comparison between *Caecidotea reddelli* (left) and Lirceolus hardeni (right), both collected from John's Hollow on the Bohls tract. Photos by species expert Will Coleman, 18 October 2021.

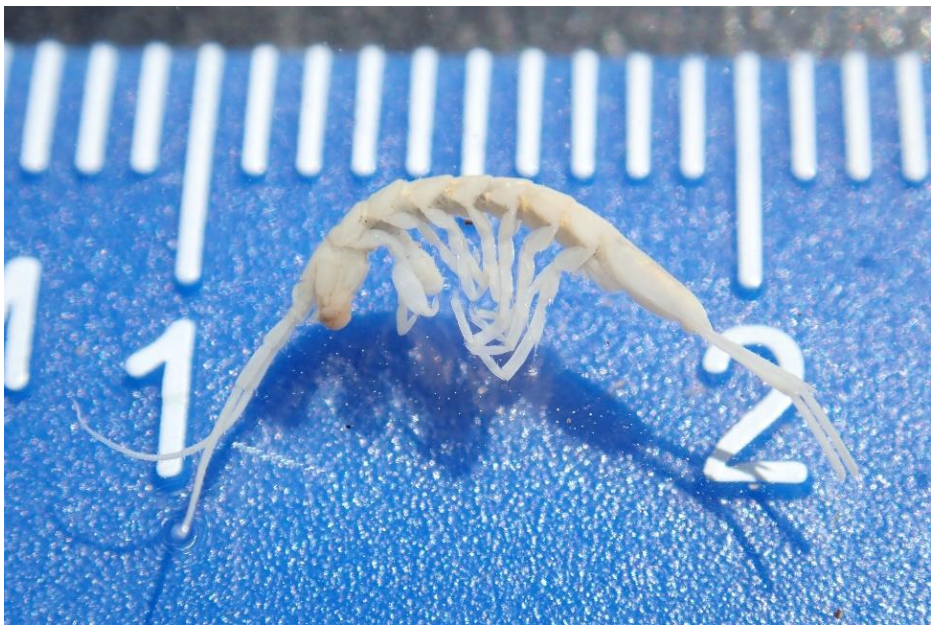


Figure 12. *Caecidotea reddelli* collected from Box Spring on the Ulrich Tract. Photo by COA staff Colin Strickland, 13 October 2021.



Figure 13. *Caecidotea reddelli* collected from Box Spring on 11 January 2022. Photo by COA staff Colin Strickland, 27 September 2022.



Figure 14. Asellid in situ observed but not collected at Box Spring. Photo by COA staff Colin Strickland, 10 March 2022.



Figure 15. *Caecidotea reddelli*, a species of concern protected by the Balcones Canyonlands Conservation Plan, observed in Chip's Duet spring. Photos by COA staff Colin Strickland. FY2020 report

Phreatodrobia nugax was collected from Steiner Sanctuary and Squeaking Juniper springs (Travis County BCP Steiner Ranch tract), Greenbriar (COA BCP Cortaña tract), and John's Hollow (COA BCP Bohls tract) (mapped in Figure 16). Figure 17 depicts snails collected from Altar Spring in FY2022 that are queued for identification. Eyeless flatworms were collected from Steiner Sanctuary (Travis County's Steiner Ranch tract). These specimens await further taxonomic scrutiny. Their locations are mapped in Figure 18. *Hyalella azteca*, an eyed amphipod, was collected from Greenbriar spring on the Cortaña tract (mapped in Figure 19).

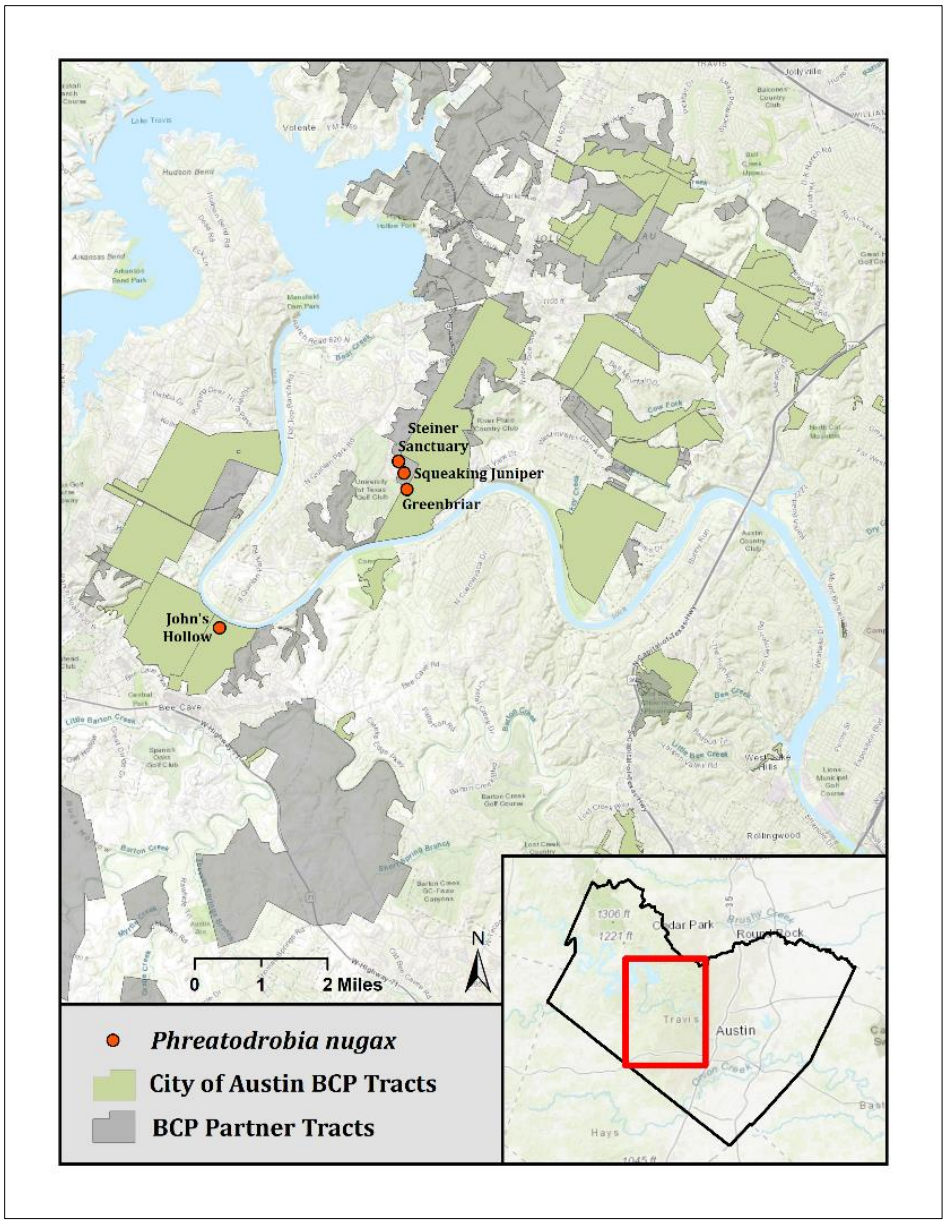


Figure 16. New locations for *Phreatodrobia nugax*, a stygobitic snail found in springs on the Bohl's, Cortaña, and Steiner Ranch tracts. Map by COA staff Colin Strickland.

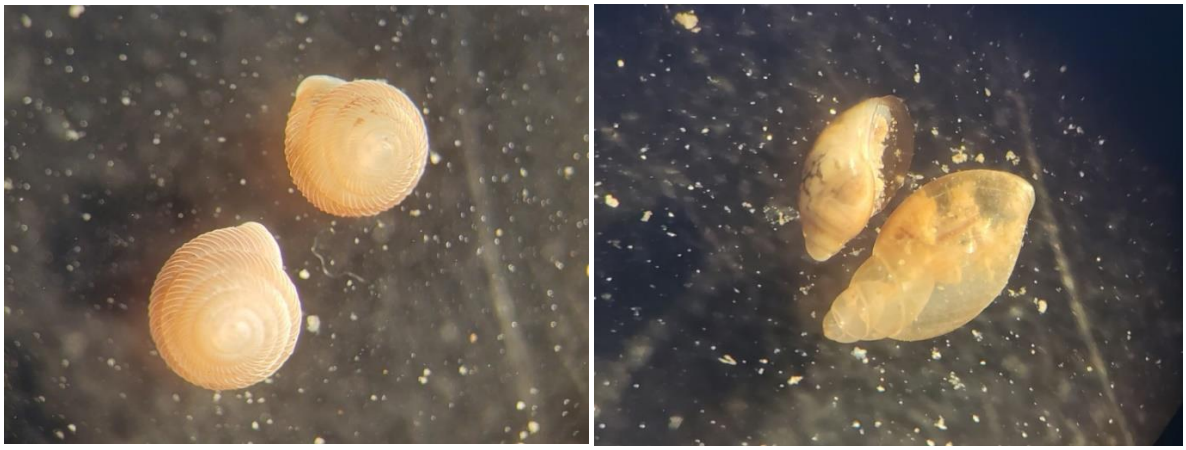


Figure 17. Snails collected from Altar Spring on 11 January 2022 that await identification. Photos by COA staff Colin Strickland, 27 September 2022.

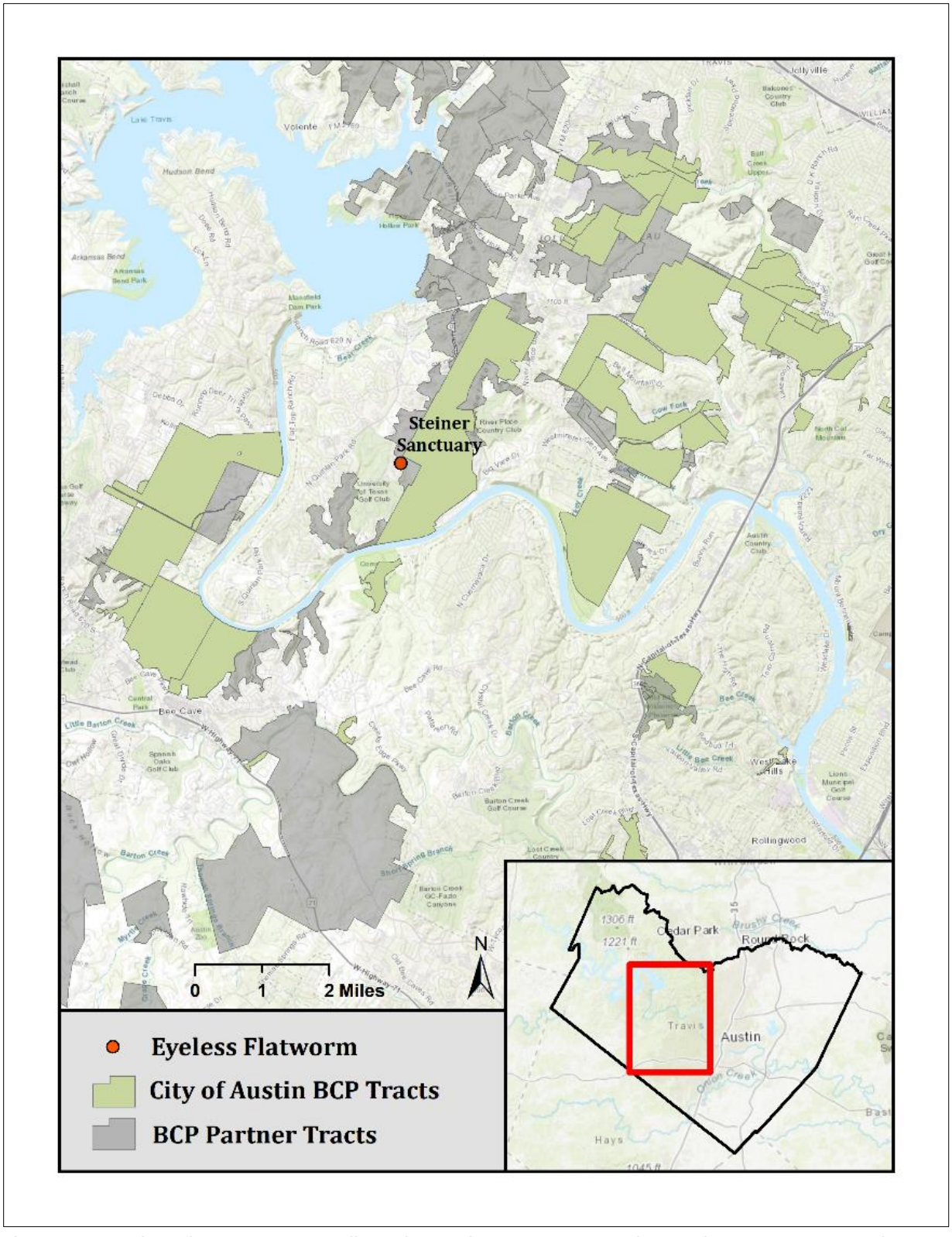


Figure 18. Eyeless flatworms were collected at Steiner Sanctuary spring on the Cortana tract. These specimens await further taxonomic scrutiny, but may be *Sphalloplana mohri*, a species protected by the Balcones Canyonlands Conservation Plan. Map by COA staff Colin Strickland.

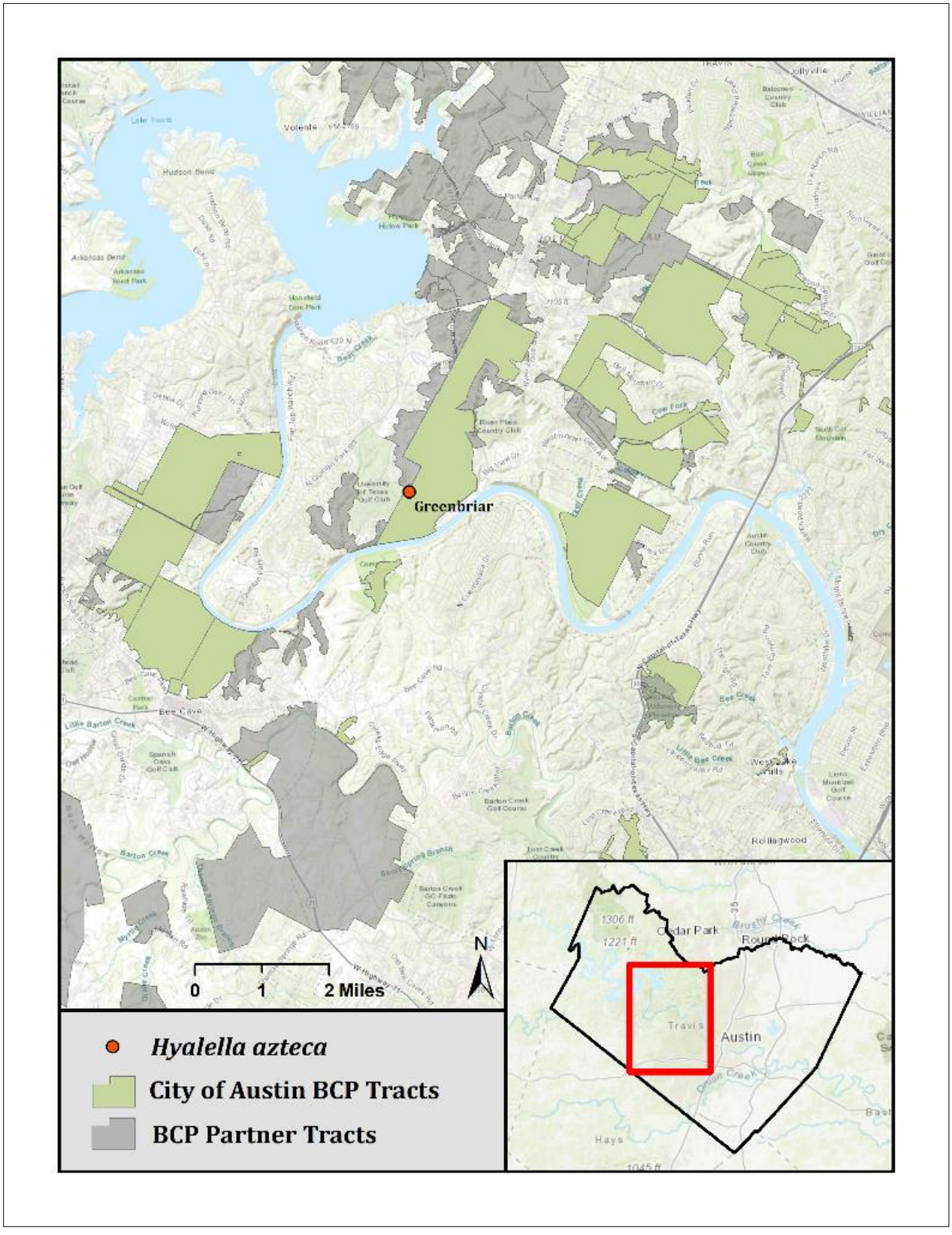


Figure 19. *Hyalella azteca* was collected on the Cortaña tract. Map by COA staff Colin Strickland.

Other species of interest were collected at springs in addition to stygofauna. An epigean sucking millipede (order Siphonphorida) was collected in a drift net at Steiner Sanctuary Spring. This individual is depicted in Figure 20.



Figure 20. An epigean sucking millipede of the order Siphonphorida collected from a drift net at Steiner Sanctuary spring. Photo by COA staff Colin Strickland, 18 October 2021.

Multiple troglobitic species were collected in springs. The locations for collected eyeless millipedes (pictured in Figure 21), cave isopods (family Trichoniscidae), and eyeless springtails are mapped with nearby USFWS Karst Faunal Regions in Figures 22 through 24.



Figure 21. Troglobitic millipedes collected from a drift net at Steiner Sanctuary, a spring on the Travis County Steiner Ranch tract. Photos by COA staff Colin Strickland, 18 October 2021.

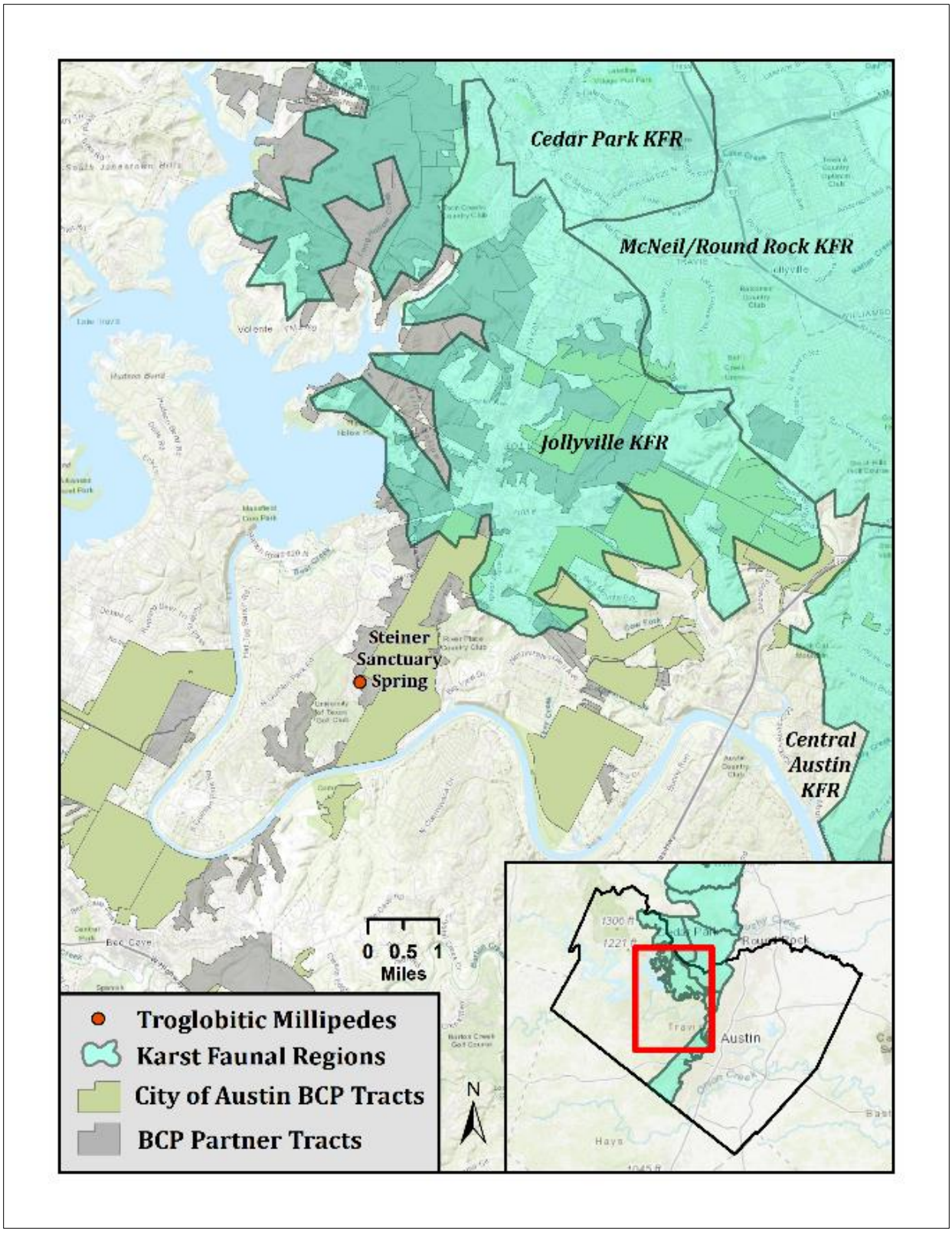


Figure 22. White, eyeless millipedes were collected from a spring on the Travis County Steiner Sanctuary tract outside of USFWS Karst Faunal Regions. Map by COA staff Colin Strickland.

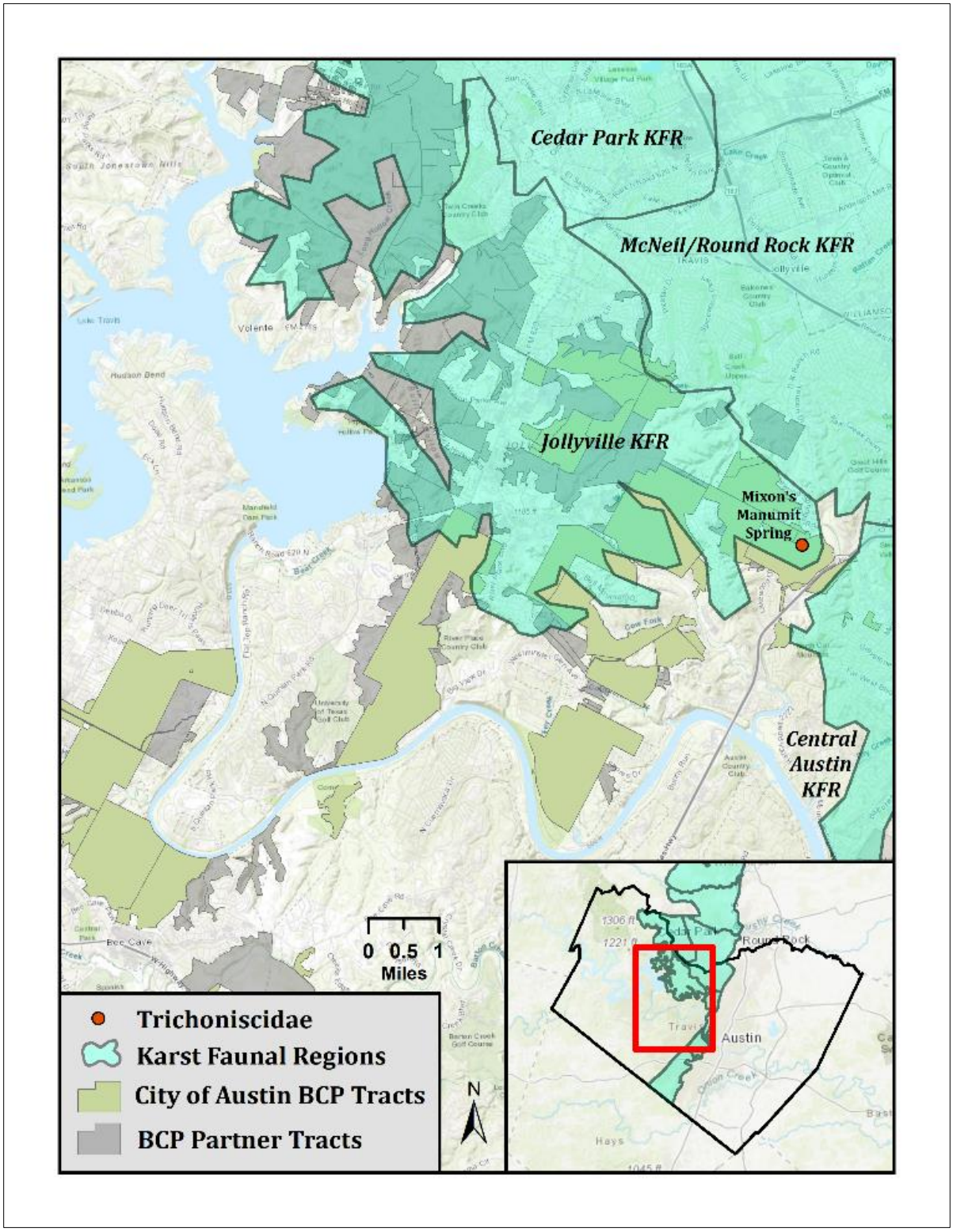


Figure 23. Troglobitic isopods were collected from drift nets in Mixon's Manumit, a spring on the Forest Ridge/Bull Creek Park tract. Map by COA staff Colin Strickland.

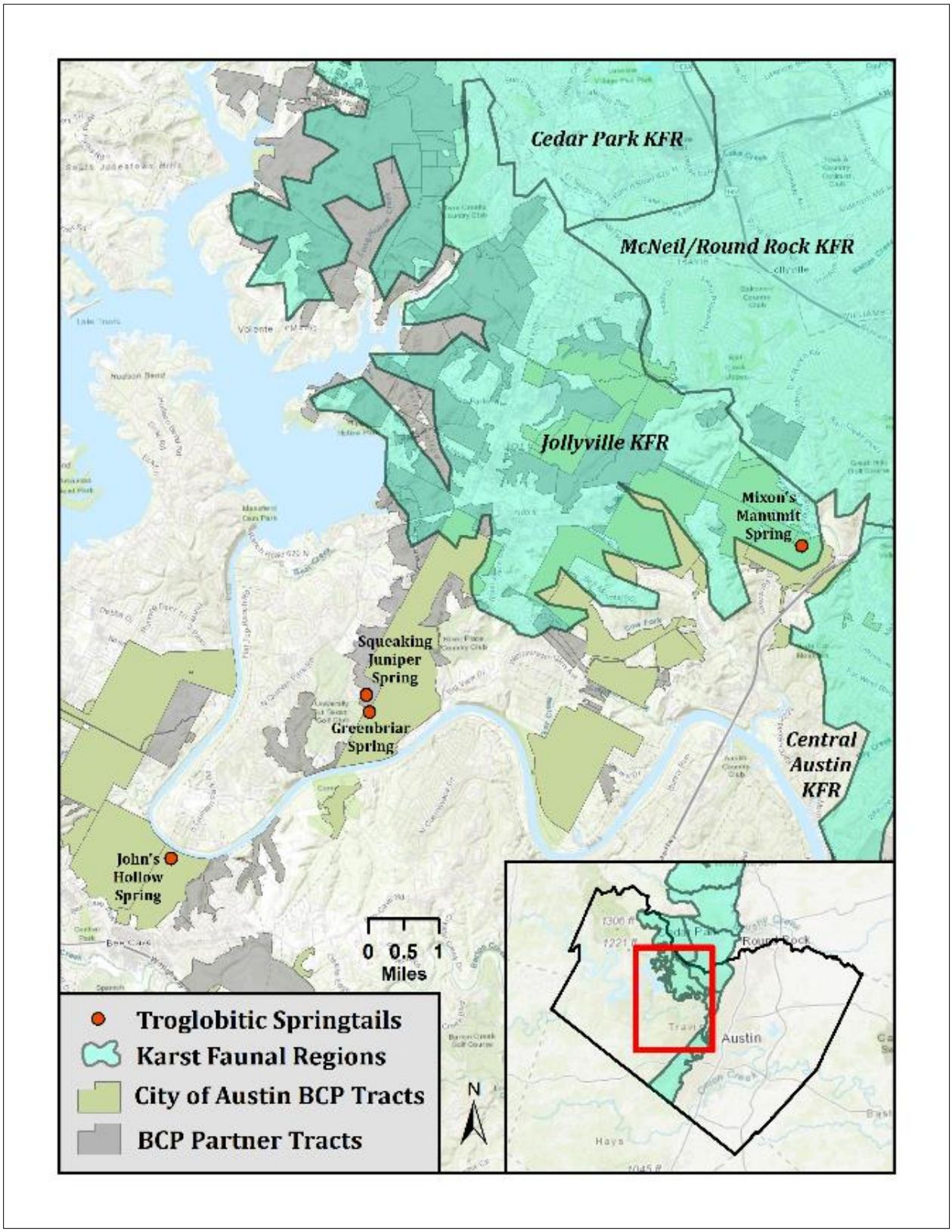


Figure 24. Eyeless springtails were collected at springs outside of USFWS Karst Faunal Regions. Map by COA staff Colin Strickland.

Discussion

Research goals continue to be met with the continued expanded assessment and monitoring of spring locations. Nine preserve tracts were visited on the Balcones Canyonlands Preserve in FY2023. Nine new spring locations were documented bringing the total number of documented springs on City of Austin BCP tracts to approximately 395 since FY 2017. The entire rough dataset for this project is currently being overhauled to ensure all documented spring locations meet standardized definitions and methods and to remove duplicates and other errors before providing a finalized dataset to the City. The final number of springs documented through this research effort is expected to change with this effort.

Research goals continue to be met with the continued expanded assessment of aquatic target species. The Barton Springs salamander is federally endangered (USFWS 1997) and is a critically imperiled state species of greatest conservation need (TPWD 2020). The finding on the City of Austin Balcones Canyonlands Preserve Little Bee Creek Preserve is a range expansion for the species (Devitt and Nissen 2018). The previously undocumented Wren's Faerie Garden spring is a range expansion for the Jollyville Plateau salamander. This federally threatened species is identified as an additional species of concern by the BCCP and is a vulnerable-imperiled state species of greatest conservation need (USFWS 2013, BCP 2007a, TPWD 2012).

Caecidotea reddelli is a species of concern protected by the Balcones Canyonlands Conservation Plan (BCP 2007a). The collection of *Stygobromus russelli* at Pegaeae and Altar Springs in FY2022 are new occurrence records for these species. *Stygobromus russelli* is identified as an additional species of concern by the BCCP and a species status of vulnerable (BCP 2007a, Hutchins 2017). The Balcones Cave amphipod, *Stygobromus balconis*, is a Texas state species of greatest conservation need with a conservation status of imperiled (TPWD 2020, Hutchins 2017). The BCCP identifies *Stygobromus bifurcatus* as an additional species of concern and it has a conservation status of vulnerable (BCP 2007a, Hutchins 2017). The individuals identified to the *Stygobromus tenuis* group were juveniles and too small to distinguish to species. This group includes *S. balconis*, *S. bifurfactus*, and *S. russelli*. *Phreatodrobia nugax* has a conservation status of vulnerable (Hutchins 2017).

The majority of isopods collected were *Caecidotea reddelli*, with only two locations for *Lirceolus hardeni*. This may be the result of sampling bias as *C. reddelli* is larger than *L. hardeni* and may thus be easier to visually locate.

Sphalloplana mohri is a BCCP species of concern with a conservation status of vulnerable (BCP 2007a, Hutchins 2017). White, eyeless flatworms have been collected from Steiner Sanctuary spring and observed in Testudo Tube cave. White, eyeless flatworms are assumed to be *Sphalloplana mohri*, being that it is the only stygobitic flatworm species described in Texas, with the exception of *Dendrocoelopsis americana* reported from Rockwell County (B. Hutchins pers. comm.); however, there is not currently a taxonomic expert available to confirm the identities of these collections.

Numerous other non-stygobitic species of interest were collected at springs. The sucking millipede (order Siphonophorida) collected from a drift net in Steiner Sanctuary spring is a terrestrial species occasionally observed in caves of the north Austin, Texas area (M. Sanders pers. comm.). In addition, multiple troglobitic specimens were collected in springs, including trichoniscids and white, eyeless millipedes and springtails. The BCCP lists the Speodesmus N. S. as a species of concern; however, preliminary identification indicates that the millipedes collected appear to be of the *Cambala* genus (C. Strickland pers. comm. 2021). In addition, the BCCP lists Trichoniscinae N. S. as a species of concern. We await further taxonomic scrutiny of these troglobitic species collected by species experts.

Drought monitoring, Death by Poison Ivy: Stygofauna have yet to be observed at this site. The orifices in the cliff wall are challenging to place traps on. These springs contribute to a Bull Creek tributary stream. The impetus to visit this site in late summer 2023 was that there were potentially more orifices in the stream bed that would be revealed in drought; however, this was not observed. There is City water infrastructure upstream of this site. Leaking pipes could be contributing to these springs. City BCP staff are considering sampling this site for the presence of tap water.

Water scarcity due to population growth (U.S. Census Bureau 2022) and climate change (Konapala et al. 2020, Kundzewicz et al. 2008) is expected to exacerbate. The reduction in spring flow and lack of regulatory mechanisms is a state-wide phenomenon that threatens groundwater fauna (Datri et al. 2023). The range counties of Travis, Williamson, and Hays are all ranked as having the warmest on record for July through September 2023. For precipitation over these same past three months, Williamson county is ranked as the 10th driest, Travis county as the 4th driest, and Hays county as the 2nd driest on record (NOAA 2023). The director of the Texas Center for Climate Studies and the Texas State Climatologist says “the chances of exceeding the drought of record are probably increasing year by year” (Randall 2020, Nielson-Gammon et al. 2020, Dickens 2022). Body length shrinkage due to drought has been documented in federally threatened Jollyville Plateau salamanders (Bendik

and Glusenkamp 2012). Groundwater fauna, including listed invertebrates and salamanders, is understudied. The only known humanly accessible subterranean habitat for the Barton Springs salamander is currently closed to study. The lack of data on taxonomy, distribution, and ecology of stygofauna is reiterated by the numerous range expansions and new occurrence records found through this research project. Decreasing populations, even extirpations, are likely to have occurred or be occurring without scientific documentation.

The management activities conducted through this research effort 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, much of the BCP awaits survey for springs and groundwater fauna while the threats from climate change and development continue to grow. We recommend continued survey and documentation of springs and their associated fauna to provide data for sound management decisions related to species recovery.

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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
(BCP 2007j) Tier III, City of Austin South Lake Austin Tracts (Reicher Ranch, Double J&T, Bohls) South Lake Austin Macrosite

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Appendix A. Faunal Table

Summary of invertebrates collected at springs on the Balcones Canyonlands Preserve for FY 2017 through FY 2022

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Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
Surprise Amphipool	Jester	11-Sep-2018	*Stygobromus bifurcatus*	C. Strickland	2-Dec-2019	Free living at orifice (no trap)
Springs of Promise	Kent Butler	1-Oct-2018	*Caecidotea reddelli*	T. Jackson	2-Dec-2019	Free living at orifice (no trap)
Springs of Promise	Kent Butler	1-Oct-2018	*Leuctridae* stet.	T. Jackson	2-Dec-2019	Free living at orifice (no trap)
Robin's Secret	Kent Butler	11-Jun-2019	*Caecidotea reddelli*	T. Jackson	2-Dec-2019	Cotton mop material
Robin's Secret	Kent Butler	11-Jun-2019	*Stygobromus bifurcatus*	R. Gibson	2-Dec-2019	Cotton mop material
Robin's Secret	Kent Butler	11-Jun-2019	*Suragina* stet.	T. Jackson	2-Dec-2019	Cotton mop material
Robin's Secret	Kent Butler	11-Jun-2019	Stenelmis stet.	T. Jackson	2-Dec-2019	Cotton mop material
Sanders Sow	Kent Butler	12-Jun-2019	*Stygobromus bifurcatus*	R. Gibson	2-Dec-2019	Cotton mop material
Sanders Sow	Kent Butler	12-Jun-2019	Ostracoda stet.	T. Jackson	2-Dec-2019	Cotton mop material

Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
Sanders Sow	Kent Butler	12-Jun-2019	*Chimarra* stet.	T. Jackson	2-Dec-2019	Cotton mop material
Sanders Sow	Kent Butler	12-Jun-2019	*Tipula* stet.	T. Jackson	2-Dec-2019	Cotton mop material
Sanders Sow	Kent Butler	12-Jun-2019	Chironomidae stet.	T. Jackson	2-Dec-2019	Cotton mop material
Frog Spring	Vaught Ranch	13-Aug-2019	*Stenelmis* stet.	T. Jackson	2-Dec-2019	Free living at orifice (no trap)
Frog Spring	Vaught Ranch	13-Aug-2019	*Marilia* stet.	T. Jackson	2-Dec-2019	Free living at orifice (no trap)
Frog Spring	Vaught Ranch	13-Aug-2019	*Dugesia* stet.	T. Jackson	2-Dec-2019	Free living at orifice (no trap)
Avian Assembly Right	Cortana	14-Jan-2020	Invertebrate eggs	B. Hutchins	11-Mar-2020	Free living at orifice (no trap)
Avian Assembly Right	Cortana	14-Jan-2020	*Hyalella* stet.	C. Strickland	13-Oct-2020	Free living at orifice (no trap)
Greenbriar	Cortana	10-Feb-2020	*Caecidotea reddelli*	C. Strickland	25-Feb-2020	Drift net: 150 micron
Greenbriar	Cortana	10-Feb-2020	*Phreatodrobia nugax*	B. Hutchins	25-Feb-2020	Drift net: 150 micron

Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
Greenbriar	Cortana	10-Feb-2020	*Hawaiia minuscula*	B. Hutchins	11-Mar-2020	Drift net: 150 micron
Squeaking Juniper	Cortana	13-Feb-2020	*Stygobromus russelli*	R. Gibson	30-Sep-2021	Cotton mop material
Squeaking Juniper	Cortana	13-Feb-2020	*Caecidotea reddelli*	C. Strickland	25-Feb-2020	Cotton mop material
Greenbriar	Cortana	18-Feb-2020	*Lirceolus hardeni*	W. Coleman	18-Oct-2021	Drift net: 150 micron
Greenbriar	Cortana	18-Feb-2020	*Caecidotea reddelli*	W. Coleman	18-Oct-2021	Drift net: 150 micron
Greenbriar	Cortana	18-Feb-2020	*Stygobromus russelli*	R. Gibson	12-Nov-2020	Drift net: 150 micron
Greenbriar	Cortana	18-Feb-2020	*Hyalella azteca*	R. Gibson	12-Nov-2020	Drift net: 150 micron
Greenbriar	Cortana	18-Feb-2020	Acariformes stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron
Squeaking Juniper	Cortana	18-Feb-2020	*Stygobromus* sp. juv.	R. Gibson	30-Sep-2021	Drift net: 250 micron
Squeaking Juniper	Cortana	18-Feb-2020	*Caecidotea reddelli**	C. Strickland	25-Feb-2020	Drift net: 250 micron

Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
Squeaking Juniper	Cortana	18-Feb-2020	*Phreatodrobia nugax*	B. Hutchins	25-Feb-2020	Drift net: 250 micron
Squeaking Juniper	Cortana	18-Feb-2020	*Euglandina* sp.	B. Hutchins	11-Mar-2020	Drift net: 250 micron
Squeaking Juniper	Cortana	18-Feb-2020	Philapotamidae stet.	C. Strickland	25-Feb-2020	Drift net: 250 micron
Steiner Sanctuary	Cortana	18-Feb-2020	*Stygobromus* sp. juv.	R. Gibson	30-Sep-2021	Drift net: 250 micron
Steiner Sanctuary	Cortana	18-Feb-2020	*Phreatodrobia nugax*	B. Hutchins	25-Feb-2020	Drift net: 250 micron
Steiner Sanctuary	Cortana	18-Feb-2020	*Caecidotea reddelli*	C. Strickland	25-Feb-2020	Drift net: 250 micron
Steiner Sanctuary	Cortana	18-Feb-2020	*Collembola* stet.	C. Strickland	25-Feb-2020	Drift net: 250 micron
Steiner Sanctuary	Cortana	18-Feb-2020	Diplopoda stet.	C. Strickland	13-Oct-2020	Drift net: 250 micron
Steiner Sanctuary	Cortana	18-Feb-2020	Diptera stet.	C. Strickland	13-Oct-2020	Drift net: 250 micron
Greenbriar	Cortana	24-Feb-2020	Hemiptera stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron

Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
Greenbriar	Cortana	24-Feb-2020	*Caecidotea reddelli*	W. Coleman	18-Oct-2021	Drift net: 150 micron
Greenbriar	Cortana	24-Feb-2020	Entomobryibae stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
Greenbriar	Cortana	24-Feb-2020	*Gastrocopta* sp.	K. Perez	22-Oct-2020	Drift net: 150 micron
Greenbriar	Cortana	24-Feb-2020	Tricladida stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
Squeaking Juniper	Cortana	24-Feb-2020	*Stygobromus russelli*	R. Gibson	12-Nov-2020	Drift net: 250 micron
Squeaking Juniper	Cortana	24-Feb-2020	Trichoptera stet.	C. Strickland	29-Sep-2020	Drift net: 250 micron
Steiner Sanctuary	Cortana	24-Feb-2020	Siphonophoridae stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron
Steiner Sanctuary	Cortana	24-Feb-2020	Diplopoda stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron
Steiner Sanctuary	Cortana	24-Feb-2020	*Caecidotea reddelli*	W. Coleman	18-Oct-2021	Drift net: 150 micron
Steiner Sanctuary	Cortana	24-Feb-2020	*Stygobromus tenuis* group*	R. Gibson	12-Nov-2020	Drift net: 150 micron

Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
Steiner Sanctuary	Cortana	24-Feb-2020	Hemiptera stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron
Steiner Sanctuary	Cortana	24-Feb-2020	Diptera stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron
Steiner Sanctuary	Cortana	24-Feb-2020	Odonata stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron
Greenbriar	Cortana	2-Mar-2020	*Stygobromus russelli*	R. Gibson	12-Nov-2020	Drift net: 150 micron
Greenbriar	Cortana	2-Mar-2020	*Caecidotea reddelli*	W. Coleman	18-Oct-2021	Drift net: 150 micron
Greenbriar	Cortana	2-Mar-2020	unknown	C. Strickland	29-Sep-2020	Drift net: 150 micron
Greenbriar	Cortana	2-Mar-2020	Trichoptera stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
Greenbriar	Cortana	2-Mar-2020	Planaria stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
Squeaking Juniper	Cortana	2-Mar-2020	*Stygobromus russelli*	R. Gibson	12-Nov-2020	PVC pipe trap with 250 micron net
Squeaking Juniper	Cortana	2-Mar-2020	Trichoptera stet.	C. Strickland	29-Sep-2020	PVC pipe trap with 250 micron net

Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
Steiner Sanctuary	Cortana	2-Mar-2020	Diplopoda stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
Steiner Sanctuary	Cortana	2-Mar-2020	*Caecidotea reddelli*	W. Coleman	18-Oct-2021	Drift net: 150 micron
Steiner Sanctuary	Cortana	2-Mar-2020	*Stygobromus tenuis* group	R. Gibson	12-Nov-2020	Drift net: 150 micron
Steiner Sanctuary	Cortana	2-Mar-2020	Acariformes stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
Steiner Sanctuary	Cortana	2-Mar-2020	Planaria stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
Steiner Sanctuary	Cortana	2-Mar-2020	Dytiscidae stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
Steiner Sanctuary	Cortana	2-Mar-2020	Diptera stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
Steiner Sanctuary	Cortana	2-Mar-2020	Planaria stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
Greenbriar	Cortana	5-Mar-2020	*Caecidotea reddelli*	W. Coleman	18-Oct-2021	Drift net: 150 micron
Greenbriar	Cortana	5-Mar-2020	*Stygobromus russelli*	R. Gibson	12-Nov-2020	Drift net: 150 micron

Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
Greenbriar	Cortana	5-Mar-2020	Entomobryibae stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron
Greenbriar	Cortana	5-Mar-2020	Trichoptera stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron
Greenbriar	Cortana	5-Mar-2020	Dytiscidae stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron
Injured Spring	JJ&T	5-Mar-2020	*Stygobromus balconis*	R. Gibson	12-Nov-2020	Drift net: 150 micron
Injured Spring	JJ&T	5-Mar-2020	Stratiomyidae stet.	T. Jackson	29-Sep-2020	Drift net: 150 micron
Injured Spring	JJ&T	5-Mar-2020	Odonata stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
Squeaking Juniper	Cortana	5-Mar-2020	*Caecidotea reddelli*	W. Coleman	18-Oct-2021	PVC pipe with 250 micron net
Squeaking Juniper	Cortana	5-Mar-2020	*Stygobromus tenuis* group*	R. Gibson	12-Nov-2020	PVC pipe with 250 micron net
Squeaking Juniper	Cortana	5-Mar-2020	Entomobryibae stet.	C. Strickland	13-Oct-2020	PVC pipe with 250 micron net
Squeaking Juniper	Cortana	5-Mar-2020	Symphypleona stet.	C. Strickland	13-Oct-2020	PVC pipe with 250 micron net

Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
Squeaking Juniper	Cortana	5-Mar-2020	Diplopoda stet.	C. Strickland	13-Oct-2020	PVC pipe with 250 micron net
Steiner Sanctuary	Cortana	5-Mar-2020	*Caecidotea reddelli*	W. Coleman	18-Oct-2021	Drift net: 150 micron
Steiner Sanctuary	Cortana	5-Mar-2020	*Stygobromus tenuis* group	R. Gibson	12-Nov-2020	Drift net: 150 micron
Steiner Sanctuary	Cortana	5-Mar-2020	Diplopoda stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron
Steiner Sanctuary	Cortana	5-Mar-2020	Diptera stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron
Steiner Sanctuary	Cortana	5-Mar-2020	Hemiptera stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron
Shutdown Stygos	Bohls	27-Mar-2020	*Stygobromus russelli*	R. Gibson	12-Nov-2020	Free-living at orifice (no trap)
Shutdown Stygos	Bohls	27-Mar-2020	Gastropoda indet.	K. Perez	22-Oct-2020	Free-living at orifice (no trap)
Chips duet	Bohls	31-Mar-2020	*Stygobromus balconis*	R. Gibson	12-Nov-2020	Free-living at orifice (no trap)
Giant Isopod	Bohls	31-Mar-2020	*Caecidotea reddelli*	W. Coleman	18-Oct-2021	Free-living at orifice (no trap)

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Giant Isopod	Bohls	31-Mar-2020	*Stygobromus* stet.	C. Strickland	28-Sep-2020	Free-living at orifice (no trap)
Giant Isopod	Bohls	31-Mar-2020	Tricladida stet.	C. Strickland	28-Sep-2020	Free-living at orifice (no trap)
Giant Isopod	Bohls	31-Mar-2020	Entomobryomorpha stet.	C. Strickland	28-Sep-2020	Free-living at orifice (no trap)
Source of Giants	Bohls	6-Apr-2020	*Caecidotea reddelli*	W. Coleman	18-Oct-2021	Free-living at orifice (no trap)
Source of Giants	Bohls	6-Apr-2020	*Stygobromus russelli*	R. Gibson	12-Nov-2020	Free-living at orifice (no trap)
John’s Hollow	Bohls	13-May-2020	*Stygobromus balconis*	R. Gibson	12-Nov-2020	Drift net: 150 micron
John’s Hollow	Bohls	13-May-2020	*Lirceolus hardeni*	W. Coleman	18-Oct-2021	Drift net: 150 micron
John’s Hollow	Bohls	13-May-2020	*Gastrocopta sp.*	K. Perez	22-Oct-2020	Drift net: 150 micron
John’s Hollow	Bohls	13-May-2020	Dytiscidae stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron
John’s Hollow	Bohls	13-May-2020	Coleoptera stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron

Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
John's Hollow	Bohls	19-May-2020	*Stygobromus balconis*	R. Gibson	12-Nov-2020	Drift net: 150 micron
John's Hollow	Bohls	19-May-2020	*Caecidotea reddelli*	W. Coleman	18-Oct-2021	Drift net: 150 micron
John's Hollow	Bohls	19-May-2020	*Lucidella* sp.	K. Perez	22-Oct-2020	Drift net: 150 micron
John's Hollow	Bohls	19-May-2020	*Glyphyalinia* sp.	K. Perez	22-Oct-2020	Drift net: 150 micron
John's Hollow	Bohls	19-May-2020	*Gastrocopta* sp.	K. Perez	22-Oct-2020	Drift net: 150 micron
John's Hollow	Bohls	19-May-2020	*Fossaria* sp.	K. Perez	22-Oct-2020	Drift net: 150 micron
John's Hollow	Bohls	19-May-2020	Entomobryibae stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
John's Hollow	Bohls	19-May-2020	Dytiscidae stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
John's Hollow	Bohls	19-May-2020	Trichoptera stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
John's Hollow	Bohls	19-May-2020	Entomobryomorpha stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron

Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
John's Hollow	Bohls	19-May-2020	Odonata stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
John's Hollow	Bohls	19-May-2020	Trichoptera stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
Tunnel	Bohls	19-May-2020	*Physa* sp.	K. Perez	22-Oct-2020	Drift net: 150 micron
Tunnel	Bohls	19-May-2020	Trichoptera stet.	C. Strickland	28-Sep-2020	Drift net: 150 micron
Tunnel	Bohls	19-May-2020	Tabanidae stet.	C. Strickland	28-Sep-2020	Drift net: 150 micron
Tunnel	Bohls	19-May-2020	Polycentropodidae stet.	C. Strickland	28-Sep-2020	Drift net: 150 micron
John's Hollow	Bohls	26-May-2020	*Stygobromus balconis*	R. Gibson	12-Nov-2020	Drift net: 150 micron
John's Hollow	Bohls	26-May-2020	*Caecidotea reddelli*	W. Coleman	18-Oct-2021	Drift net: 150 micron
John's Hollow	Bohls	26-May-2020	*Gastrocopta* sp.	K. Perez	22-Oct-2020	Drift net: 150 micron
John's Hollow	Bohls	26-May-2020	*Physa* sp.	K. Perez	22-Oct-2020	Drift net: 150 micron

Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
John's Hollow	Bohls	26-May-2020	*Glyphyalinia* sp.	K. Perez	22-Oct-2020	Drift net: 150 micron
John's Hollow	Bohls	26-May-2020	*Helicodiscus* sp.	K. Perez	22-Oct-2020	Drift net: 150 micron
John's Hollow	Bohls	26-May-2020	*Lucidella* sp.	K. Perez	22-Oct-2020	Drift net: 150 micron
John's Hollow	Bohls	26-May-2020	*Phreatodrobia nugax*	K. Perez	22-Oct-2020	Drift net: 150 micron
John's Hollow	Bohls	26-May-2020	Trichoptera stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
John's Hollow	Bohls	26-May-2020	Trichoptera stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
John's Hollow	Bohls	26-May-2020	Entomobryomorpha stet.	C. Strickland	29-Sep-2020	Drift net: 150 micron
Tunnel	Bohls	26-May-2020	Tricladida stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron
Tunnel	Bohls	26-May-2020	Culcidae stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron
Tunnel	Bohls	26-May-2020	Diptera stet.	C. Strickland	13-Oct-2020	Drift net: 150 micron

Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
John's Hollow	Bohls	4-Jun-2020	*Caecidotea reddelli*	W. Coleman	18-Oct-2021	Drift net: 150 micron
John's Hollow	Bohls	4-Jun-2020	*Lirceolus hardeni*	W. Coleman	18-Oct-2021	Drift net: 150 micron
John's Hollow	Bohls	4-Jun-2020	*Stygobromus balconis*	R. Gibson	12-Nov-2020	Drift net: 150 micron
John's Hollow	Bohls	4-Jun-2020	*Glyphyalinia* sp.	K. Perez	22-Oct-2020	Drift net: 150 micron
John's Hollow	Bohls	4-Jun-2020	*Helicodiscus* sp.	K. Perez	22-Oct-2020	Drift net: 150 micron
John's Hollow	Bohls	4-Jun-2020	*Phreatodrobia nugax*	K. Perez	22-Oct-2020	Drift net: 150 micron
John's Hollow	Bohls	4-Jun-2020	*Physa* sp.	K. Perez	22-Oct-2020	Drift net: 150 micron
John's Hollow	Bohls	4-Jun-2020	Philopotamidae stet.	C. Strickland	28-Sep-2020	Drift net: 150 micron
John's Hollow	Bohls	4-Jun-2020	Coleoptera stet.	C. Strickland	28-Sep-2020	Drift net: 150 micron
John's Hollow	Bohls	4-Jun-2020	Reduviidae stet.	C. Strickland	28-Sep-2020	Drift net: 150 micron

Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
John’s Hollow	Bohls	4-Jun-2020	Dytiscidae stet.	C. Strickland	28-Sep-2020	Drift net: 150 micron
John’s Hollow	Bohls	4-Jun-2020	Curculionoidea stet.	C. Strickland	28-Sep-2020	Drift net: 150 micron
Only 1 Pig	JJ&T	21-Jul-2020	*Strobilops* sp.	K. Perez	22-Oct-2020	Drift net: 250 micron
Only 1 Pig	JJ&T	21-Jul-2020	*Carychium* sp.	K. Perez	22-Oct-2020	Drift net: 250 micron
Only 1 Pig	JJ&T	21-Jul-2020	*Gastrocopta* spp.	K. Perez	22-Oct-2020	Drift net: 250 micron
Only 1 Pig	JJ&T	21-Jul-2020	*Hawaiia minuscula*	K. Perez	22-Oct-2020	Drift net: 250 micron
Amphipod Trickle	Reicher Ranch	23-Jan-2021	*Stygobromus balconis*	R. Gibson	19-Oct-2021	Free-living at orifice (no trap)
Box Spring	Ulrich	9-Mar-2021	*Caecidotea reddelli*	B. Hutchins	15-Nov-2021	Free-living at orifice (no trap)
Gate Spring	Ulrich	9-Mar-2021	*Stygobromus balconis*	R. Gibson	19-Oct-2021	Free-living at orifice (no trap)
Sander's Sow	Kent Butler	3-May-2021	Gastropoda stet.	C. Strickland	24-Sep-2021	Cotton mop material

Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
Sander's Sow	Kent Butler	3-May-2021	Hemiptera stet.	C. Strickland	24-Sep-2021	Cotton mop material
Misnamed Spring	Kent Butler	6-May-2021	*Stygobromus bifurcatus*	R. Gibson	19-Oct-2021	Drift net: 200 micron
Misnamed Spring	Kent Butler	6-May-2021	Gastropoda stet.	C. Strickland	23-Sep-2021	Drift net: 200 micron
Mixon's Manumit	Forest Ridge/Bull Creek Park	25-May-2021	*Stygobromus bifurcatus**	C. Strickland	24-Sep-2021	Two drift nets: 150 & 200 micron
Mixon's Manumit	Forest Ridge/Bull Creek Park	25-May-2021	Gastropoda stet.	C. Strickland	24-Sep-2021	Two drift nets: 150 & 200 micron
Mixon's Manumit	Forest Ridge/Bull Creek Park	25-May-2021	Chironomidae stet.	C. Strickland	24-Sep-2021	Two drift nets: 150 & 200 micron
Watering Pool	Vireo Research Area	26-May-2021	*Stygobromus russelli*	R. Gibson	19-Oct-2021	Free-living at orifice (no trap)
Watering Pool	Vireo Research Area	26-May-2021	Gastropoda stet.	C. Strickland	23-Sep-2021	Free-living at orifice (no trap)
Mixon's Manumit	Forest Ridge/Bull Creek Park	1-Jun-2021	*Stygobromus balconis*	R. Gibson	19-Oct-2021	Two drift nets: 150 & 200 micron
Mixon's Manumit	Forest Ridge/Bull Creek Park	1-Jun-2021	Gastropoda stet.	C. Strickland	23-Sep-2021	Two drift nets: 150 & 200 micron

Spring Locality	BCP Tract	Date of Collection	Identification	ID By	ID Date	Collection Method
Mixon's Manumit	Forest Ridge/Bull Creek Park	1-Jun-2021	Gastropoda stet.	C. Strickland	23-Sep-2021	Two drift nets: 150 & 200 micron
Mixon's Manumit	Forest Ridge/Bull Creek Park	1-Jun-2021	Gastropoda stet.	C. Strickland	23-Sep-2021	Two drift nets: 150 & 200 micron
Mixon's Manumit	Forest Ridge/Bull Creek Park	1-Jun-2021	Gastropoda stet.	C. Strickland	23-Sep-2021	Two drift nets: 150 & 200 micron
Mixon's Manumit	Forest Ridge/Bull Creek Park	1-Jun-2021	Trichoniscidae stet.	C. Strickland	23-Sep-2021	Two drift nets: 150 & 200 micron
Mixon's Manumit	Forest Ridge/Bull Creek Park	1-Jun-2021	Collembola stet.	C. Strickland	23-Sep-2021	Two drift nets: 150 & 200 micron
Mixon's Manumit	Forest Ridge/Bull Creek Park	1-Jun-2021	Chironomidae stet.	C. Strickland	23-Sep-2021	Two drift nets: 150 & 200 micron
Mixon's Manumit	Forest Ridge/Bull Creek Park	1-Jun-2021	Trichoptera stet.	C. Strickland	23-Sep-2021	Two drift nets: 150 & 200 micron
Mixon's Manumit	Forest Ridge/Bull Creek Park	1-Jun-2021	Collembola stet.	C. Strickland	23-Sep-2021	Two drift nets: 150 & 200 micron
Pagaeae	Riverplace	12-Oct-2021	*Stygobromus russelli*	R. Gibson	9-Nov-22	Drift net: 150 micron
Pagaeae	Riverplace	12-Oct-2021	Oxidus gracilis	C. Strickland	27-Sep-2022	Drift net: 150 micron

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Pagaeae	Riverplace	12-Oct-2021	Gastropoda stet.	C. Strickland	27-Sep-2022	Drift net: 150 micron
Pagaeae	Riverplace	12-Oct-2021	Tricladida stet.	C. Strickland	27-Sep-2022	Drift net: 150 micron
Gate Spring	Little Bee Creek Preserve	28-Oct-2021	Possible bone			
Box Spring	Little Bee Creek Preserve	28-Oct-2021	*Caecidotea reddelli*	B. Hutchins	7-Oct-2022	Free-living at orifice (no trap)
Elm Puddles	Parke West	15-Nov-21	Tricladida stet.	C. Strickland	27-Sep-2022	Free-living at orifice (no trap)
Altar Spring	Little Bee Creek Preserve	11-Jan-2022	*Stygobromus russelli*	R. Gibson	9-Nov-2022	Cotton mop material
Altar Spring	Little Bee Creek Preserve	11-Jan-2022	Gastropoda stet.	C. Strickland	27-Sep-2022	Cotton mop material
Box Spring	Little Bee Creek Preserve	11-Jan-2022	*Caecidota reddelli*	B. Hutchins	7-Oct-2022	Free-living at orifice (no trap)
Brandon's Sweetwater	Barton Creek Habitat Preserve	10-Feb-2022	*Stygobromus balconis*	R. Gibson	9-Nov-2022	Free-living at orifice (no trap)
Box Spring	Little Bee Creek Preserve	15-Feb-2022	Gastropoda stet.	C. Strickland	27-Sep-2022	Free-living at orifice (no trap)

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Box Spring	Little Bee Creek Preserve	15-Feb-2022	Tricladida stet.	C. Strickland	27-Sep-2022	Free-living at orifice (no trap)