Travis County FY2018
Jollyville Plateau Salamander (*Eurycea tonkawae*)
Monitoring Report



Photo: Jollyville Plateau salamander by Piers Hendrie

Travis County
Department of Transportation and Natural Resources
Natural Resources and Environmental Quality Division

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Background

On May 2, 1996, the City of Austin and Travis County were jointly issued a U.S. Fish and Wildlife Service (USFWS) regional permit referred to as the Balcones Canyonlands Conservation Plan (BCCP). This permit allows “incidental take” of eight locally occurring endangered species in compliance with Section 10(a)1(b) of the Endangered Species Act (U. S. Fish and Wildlife Service 1996a). The thirty-year permit covers approximately 561,000 acres in western Travis County, Texas identified in the Habitat Conservation Plan (HCP) and Final Environmental Impact Statement (U. S. Fish and Wildlife Service 1996b). The permit also covers incidental take of 27 species of concern should any become listed as threatened or endangered during the life of the permit.

The Jollyville Plateau salamander (JPS) (*Eurycea tonkawae*) occurs within the Balcones Canyonlands Preserve (BCP) and the overall management of Travis County preserve lands benefits the conservation of this species. Although the BCCP 10(a) permit does not cover “take” of this species or require mitigation, the BCCP partners have pledged to protect the species wherever it is located within the BCP.

On September 19, 2013, the U.S. Fish and Wildlife Service listed JPS as threatened (U. S. Fish and Wildlife Service 2012 and 2013) under the Endangered Species Act and designated thirty-two units of critical habitat (totaling 4,331 acres) in portions of Travis and Williamson Counties (Figure 1). The most significant threat is degradation of aquatic habitats, primarily in the form of reduced water quality and alteration of natural flow regimes due to extremely rapid human population growth and urbanization within this small range (USFWS 2013). About half of the total stream catchment area for JPS range has been developed and studies show urbanization has a strong negative effect on density and relative abundance of JPS throughout its range (Bendik et al. 2014)

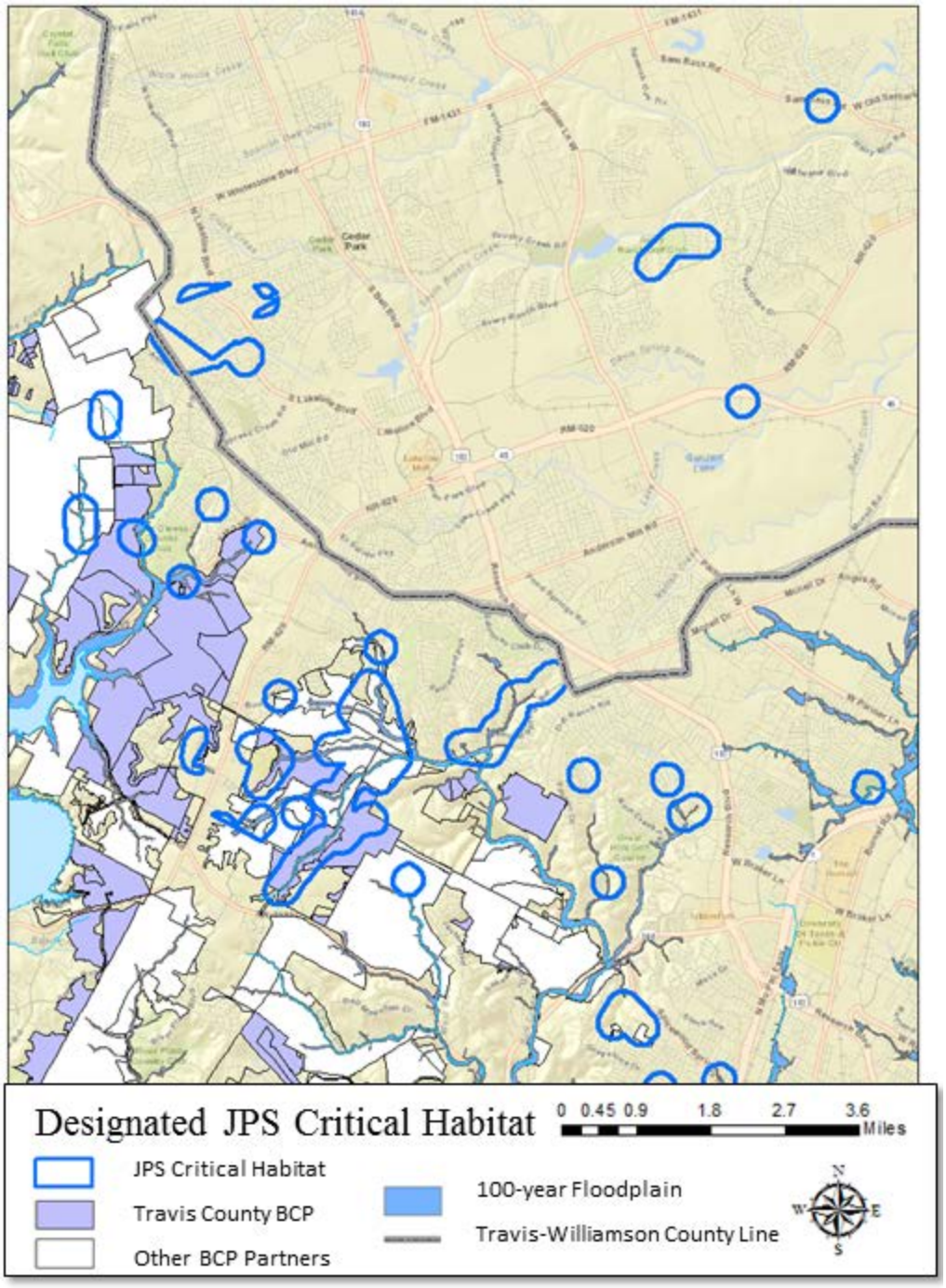

Figure 1. Critical Habitat Units designated for the Jollyville Plateau salamander in northwestern Travis and southern Williamson Counties. Surface critical habitat includes the spring outlet up to the high water line and 164-feet (50 m) downstream. Subsurface critical habitat includes a 984-foot (300 m) radius surrounding each spring.

Life History of JPS

The Jollyville Plateau Salamander is an aquatic, neotenic salamander that is endemic to the highly urbanized area of northwestern Travis and southern Williamson counties. As a perennibrachiate, these salamanders are restricted to karst-associated habitats such as surface springs, corresponding streams, and subsurface groundwater habitats. It is a member of the Plethodontidae, a large family in the order Caudata that is characterized by the absence of lungs.

JPS found in surface springs and streams have well developed eyes, a wide head, and dark greenish-brown body. Some cave-dwelling JPS exhibit reduced eyes, a flattened head, and loss of color (Chippendale *et al.* 2000). This study suggests a possibility of two lineages with a taxonomic split corresponding to major geologic and topographic features. The "plateau" clade occupies Bull, Walnut, Shoal, Brushy, South Brushy, and southeast Lake Travis watersheds. The "peripheral" clade is found in the Buttercup and northern Lake Travis watersheds. This finding was later confirmed (Devitt *et al.* 2018) with an "*E. tonkawae* (east)" group occupying Bull, Walnut, Shoal, and Brushy watersheds while an "*E. tonkawae* (west)" group occupies the Buttercup watershed as well as the Cypress and Long Hollow subwatersheds of the larger Lake Travis watershed. This taxonomic research also shows evidence of admixture contact of these eastern and western groups at SAS Canyon and Kretschmarr Cave. These sites occur along the divide separating Cypress and Bull drainages.

The eggs of JPS are rarely found on the surface, so it is possible that they are deposited underground (O'Donnell *et al.* 2005). The skin on the ventral side of the body is translucent so that eggs are visible in gravid female individuals which are often found on the surface.

It appears from the presence of juveniles on the surface in all seasons that they reproduce year round (Bendik 2011a, Hillis *et al*. 2001). However, juvenile abundance often increases in the spring and summer suggesting higher reproduction in the winter and early spring (Bowles *et al*. 2006). At hatching, JPS are about 15 mm total length and reach reproductive maturity around 45-70 mm total length within six months to a year.

Their diet consists of small invertebrates, including fly larvae, amphipods, ostracods, copepods, water mites, snails, aquatic beetles, and damselfly, caddisfly, mayfly, and

stonefly larvae. (COA 2001, Bendik 2011b, USFWS *in press*). If flatworms are present in JPS habitat, they may be part of the diet as flatworms are a primary food source of the Barton Springs salamander (Gillespie 2013). Their underground diet is likely more restricted to stygobitic invertebrates such as amphipods and isopods.

Predators of JPS may include centrarchid fish (sunfish and bass), crayfish, and large insects such as dragonfly nymphs and giant waterbugs (Bowles *et al.* 2006, Cole 1995). Adult cannibalism on juveniles has also been observed in the field and in captivity but is not thought to be a significant source of predation (personal observation).

Surface habitat of JPS consists of spring outlets, associated stream reaches, and in small hillside seeps. They can generally be found in the interstitial spaces underneath or between rocks, in vegetation or in leaf litter where they are hidden from predators. Like other Central Texas Eurycea, JPS also inhabit underground refugia including, subterranean streams and wet caves. Northwestern Travis and southern Williamson Counties encompass the nine watersheds containing known JPS localities: Brushy, Bull, Buttercup, Lake Creek, Lake Travis, Shoal, South Brushy, Walnut, and West Bull (Figure 2).

The narrow distribution of JPS has been explained by certain habitat requirements such as reliability of flow, minimal substrate siltation and calcium carbonate deposition, and availability of subsurface refugia (Dowling 1956, Rudolph 1978, Sweet 1982, Chippendale *et al.* 1993, Tumilson and Cline 1997, Bendik *et al.* 2016). Another requirement for survival and reproduction is well oxygenated groundwater with a narrow temperature range (Davis *et al.* 2001, Bowles *et al.* 2006, Bendik *et al.* 2016). Groundwater at JPS sites flow from the Northern Segment of the Edwards Aquifer and the Trinity Aquifer to local alluvial springs (Cole 1995). Groundwater in the Jollyville Plateau was characterized using water level monitoring, groundwater tracing, water chemistry and tritium dating. Results imply that the Jollyville Plateau Edwards Aquifer contains vadose zone conduits that transmit recharge water to springs and creeks with limited connection to the water table (Johns 2013).

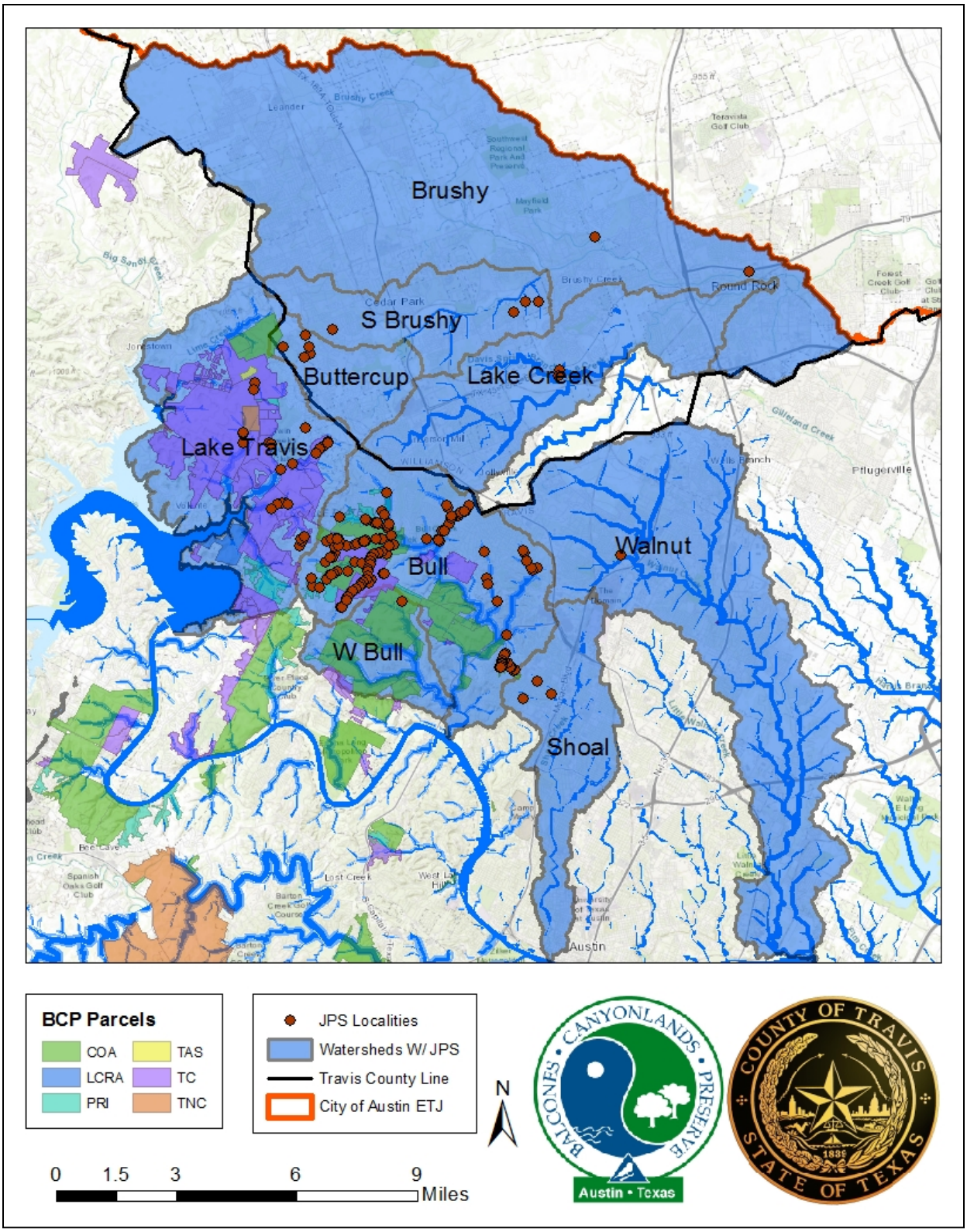

Figure 2. Nine watersheds containing JPS localities in Williamson and Travis Counties, Texas. Lake Travis Watershed is shown as subdivided to a smaller catchment area that incorporates all known JPS localities.

In Travis County, most known JPS localities are found within the Bull Creek and Cypress Creek catchments. In 2016, a working group comprised of biologists from the City of Austin, Travis County and TPWD decided more attention needed to be focused on broadening the spatial understanding of distribution compared to long-term monitoring at specific, spring-based, localities. This decision came after several manuscripts were recently published on specific populations of JPS (Bendik and Glusenkamp 2013a, Bendik *et al.* 2013b, Bendik *et al.* 2014, Gabor *et al.* 2016, Bendik 2017) and one (Bendik *et al.* 2016) showed occupancy and movement of JPS in the Bull Creek drainage differed from previous assumptions. For this reason, monitoring efforts will now focus on creek and tributary segments in terms of occupancy, specifically in the Cypress Creek and Long Hollow Creek drainages. The working group did continue to monitor three specific populations, Upper Ribelin, Lower Ribelin, and Testudo Tube, with capture-recapture methods. Continued monitoring of the first two sites is important for data associated with potential road construction nearby and the third remains important as a cave population where a capture-recapture study began in 2016.

Survey Methods

Occupancy surveys were conducted following protocol established in Bendik *et al.* 2016.
Sites were surveyed for JPS occupancy in late February and early March. Sites in the Bunten and Collins tributaries were spaced 70 m apart while sites in the Grandview Hills tributary and on Long Hollow Creek were spaced 140 m apart. The differences in spacing were according to stream length but Long Hollow Creek sites could have potentially been spaced at 70m because the creek was dry in much of the upstream segments. Three surveys were conducted at each site except Bunten sites were only surveyed twice due to only one site being wet throughout the study period.

Capture-recapture surveys were conducted by exhaustively searching all cover objects on the surface of the stream (e.g., rock cover, leaf litter, and woody debris), capturing each salamander if possible, and counting each salamander not captured. Salamanders that were captured were then photographed on a grid so they could later be measured using Image J software and photo-matched following Bendik *et al.* 2014. Salamanders that were not captured were only counted if they traveled behind the observer and size (< 1 inch, 1-2 inches, ≥ 2 inches) was visually estimated. This was done as a drive survey, whereby observers would begin downstream removing cover objects to create an open “line” perpendicular to the bank that moved upstream until all cover objects

were searched. To avoid double-counts, only salamanders that were chased (or captured and moved) downstream below the observer line were tallied. It was not possible to search the subsurface habitat for salamanders.

FY2018 Survey Sites and Results

The Travis County and City of Austin staff conducted occupancy surveys in two subwatersheds within the Lake Travis Watershed, three in the Cypress Creek drainage and one on Long Hollow Creek during FY2018 (Figure 3). Low rainfall in the summer months yielded extremely low spring and creek flow. This resulted in lower than expected occupancy on surveyed creeks.

The Collins tributary to Cypress Creek only yielded one occupied site of the 22 surveyed. However, while laying out occupancy sites for this tributary, salamanders were recorded from two new, spatially distinct localities. The Bunten tributary to Cypress creek only yielded one occupied site of the 17 surveyed. This site was immediately downstream of the previously-known and highly productive spring site, McDonald Well. It is noteworthy that the Collins tributary was always dry downstream of where it entered the Snowden tract and the Bunten tributary was always dry upstream of the McDonald Well site. We hypothesize that, under baseflow conditions, these two streams might be hydrologeologicaly connected underground, with the Collins tributary disappearing near the Collins/Snowden boundary then reemerging at McDonald Well (Figure 4). Dye tracing studies would aid in testing this hypothesis.

The Grandview Hills tributary yielded three occupied of the 22 surveyed, two of which were also occupied in 2017 (Figure 5). Like the Bunten tributary, the only new site was just downstream of a previously known locality, Lower SAS spring. Impoundments and dams, seemingly from when this area was ranched, are located between this site and the lower occupied sites. These stretches of creek are comprised of silty substrate with deep pools which are not known to be quality habitat of JPS. Restoration of this stretch of stream may encourage occupancy.

The Long Hollow Creek site yielded no occupied sites, including sites in or around previously surveyed sections with high abundance (Figure 6). This is likely due to draught conditions prior to surveys. The springs in Long Hollow Creek dry up very quickly in draught conditions and stay dry the longest relative to other JPS springs.

Capture-mark-recapture surveys showed Wheless Spring as the most variable in terms of abundance estimates although we do see individuals return after dry conditions, albeit emaciated and shrunken (Bendik *et al.* 2013a, Bendik 2017).

Travis County Natural Resources and City of Austin staff preformed capture-recapture surveys at three sites during FY2018: Lower Ribelin, Upper Ribelin, and Testudo Tube Cave. Table 1 lists the number of salamanders observed for these surveys. On average, 79 percent of the salamanders observed could be caught and photographed. These photos will be used to attempt to identify individuals between surveys and estimate population trends over time. The photos were taken on a grid for measuring and determining growth rates.

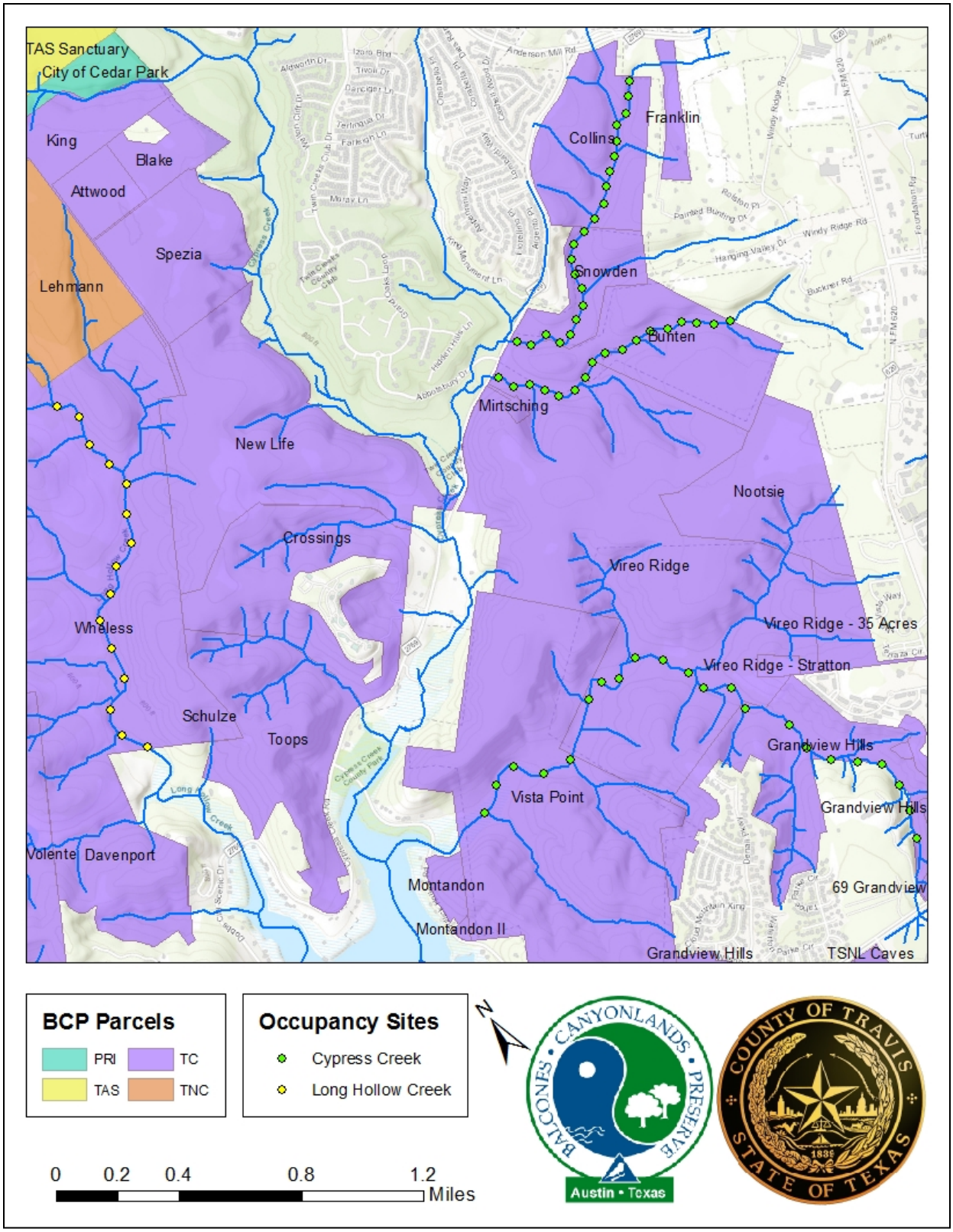

Figure 3. Four tributaries where occupancy surveys were conducted in FY2018.

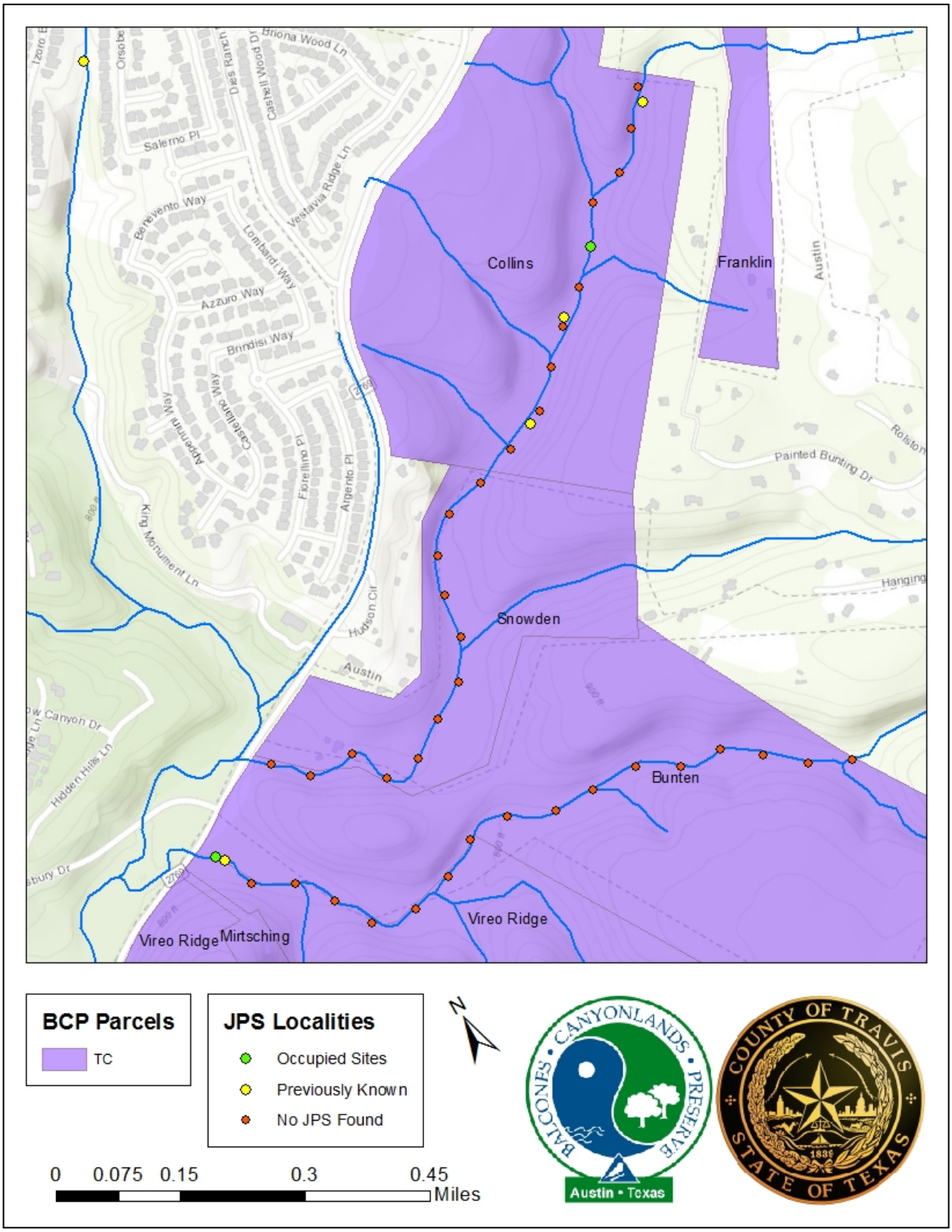

Figure 4. Collins and Bunten tributaries occupancy surveys also showing previously known localities.

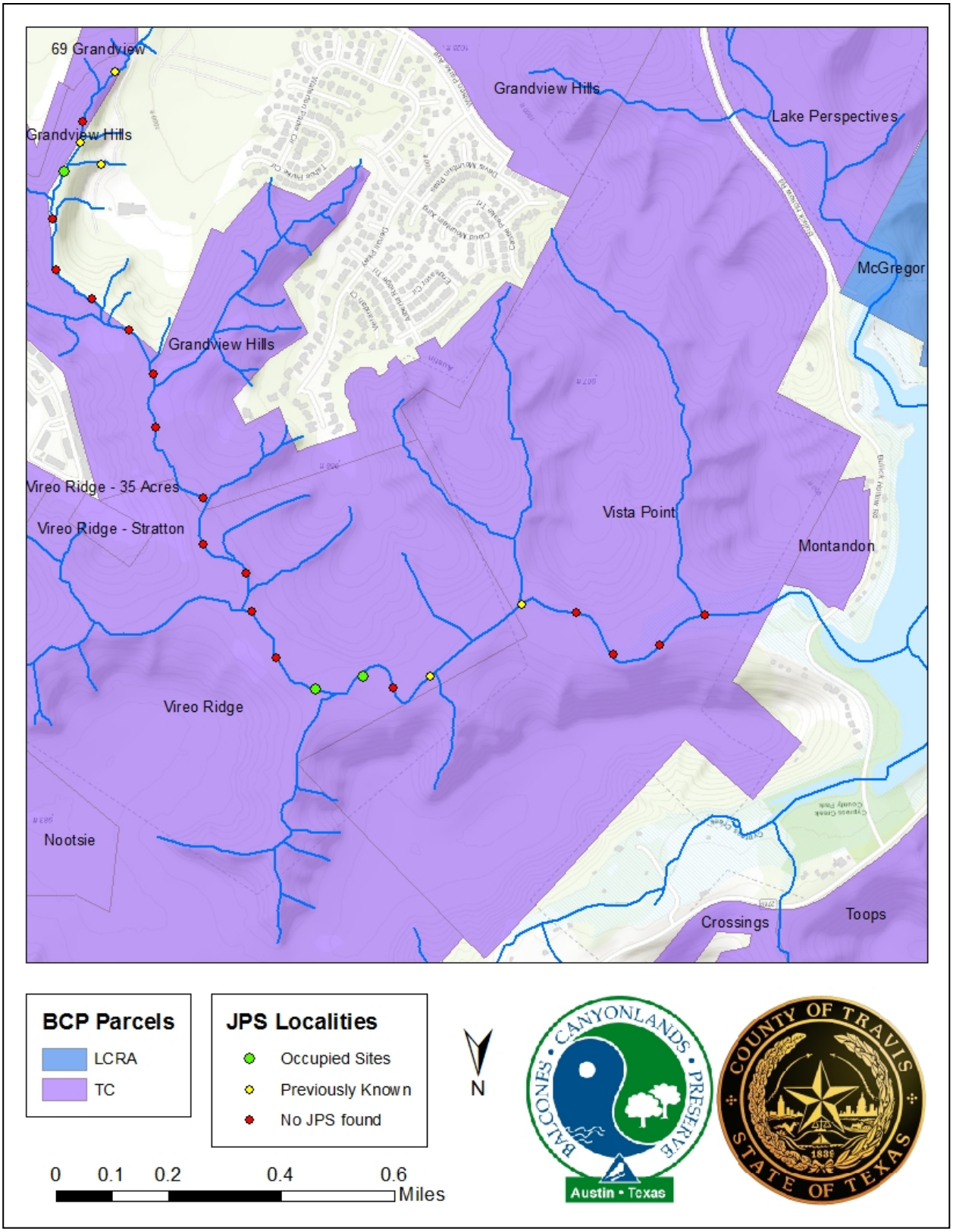

Figure 5. Grandview Hills tributary occupancy survey also showing previously known localities.

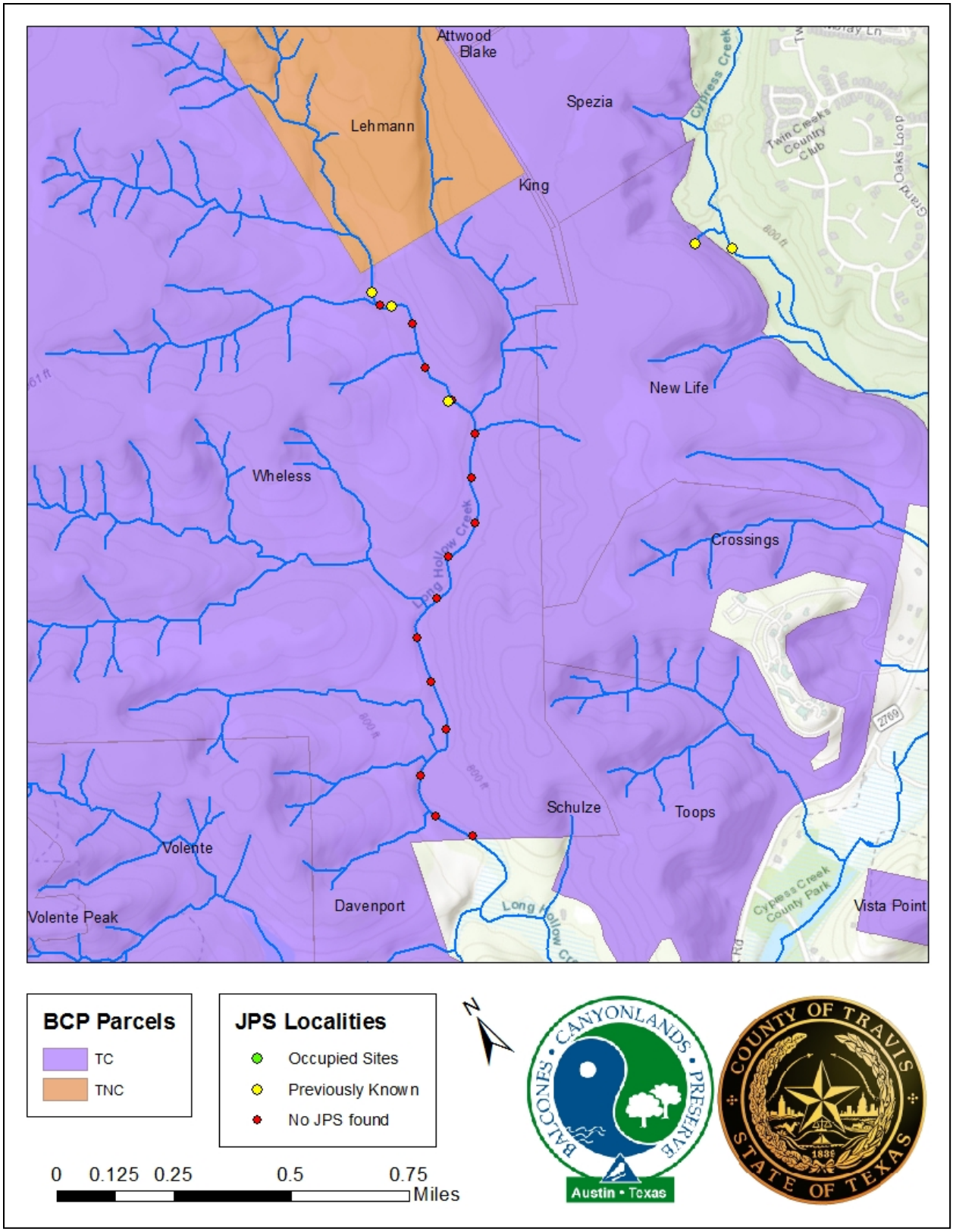

Figure 6. Long Hollow Creek occupancy survey also showing previously known localities.

Table 1. Results of JPS surveys at three BCP sites in 2018.

Site	Date	# Salamanders
Testudo Tube	01/01/2018	25
Lower Ribelin	06/21/2018	129
Upper Ribelin	06/21/2018	172
Testudo Tube	08/31/2018	19

Water Quality

Travis County began routine water quality monitoring of basic parameters in January 2011 in cooperation with the Colorado River Watch Network administered by the Lower Colorado River Authority. As of 2016, however, in collaboration with Travis County Environmental Quality and City of Austin Watershed Protection department, Travis County staff decided to add six BCP-related sites to the current COA Environmental Integrity Index (EII) and take over monitoring of some existing sites. This method will establish a long term monitoring scheme that will compare water quality characteristics, including biological and chemical components, to other sites, streams and watersheds with a numerical score. The new sites will also extend the EII program to the Lake Travis Watershed, while attempting to capture catchments running through the BCP. The new sites have been established and 2019 data will be stored within Travis County and COA WPD databases. All methodology follows City of Austin (2002). References and Results for the other 118 sites can be found in Clamann *et al.* (2015). FY18 data is only preliminary as staff has refined protocols and established purchasing orders with appropriate entities.

Threats

Amphibians are sensitive indicators of environmental degradation (Barinaga 1990, Blaustein et al. 1994, Hartwell and Ollivier 1998). Amphibians with restricted ranges, in or near expanding metro areas, face great risk of extinction. Of the thirteen *Eurycea* salamanders in central Texas, seven are threatened by or completely surrounded by development. Most known localities are at risk from urbanization due to their localized recharge areas (Chippendale *et al.* 2000, Chippendale and Price 2005, USFWS 2012). Prior research has shown that salamander densities are reduced in urbanized stream catchments (Orser and Shure 1972, Willson and Dorcas 2003). Urbanization can cause changes to natural flow regime and degradation of surface and groundwater. These

changes to habitat quality may be the largest threat facing JPS and must be considered in conservation efforts (Bowles *et al.* 2006).

The City of Austin's human population grew 192% from 1970 to 2007 (COA 2007). Bowles *et al.* (2006) found lower JPS density in developed tributaries compared to springs in undeveloped watersheds. Developed tributaries had higher concentrations of chloride, magnesium, nitrate-nitrogen, potassium, sodium, and sulfate (Bowles *et al.* 2006). Four of nine JPS sites monitored by the City of Austin from 1996 to 2007 showed statistically significant declines in salamander abundance over ten years (O'Donnell *et al.* 2006). Analysis of count data from 1996 to 2011 reveal that JPS populations declined in areas with the largest increases in residential development over a 15-year period and furthermore, densities of JPS are negatively correlated with residential development across its range (Bendik *et al*. 2014, Bendik *et al.* 2016).

Future Conservation Efforts

To address the conservation of JPS, Travis County will continue to manage and acquire land to protect endangered species, which will benefit this species and water quality. All streams within Travis County BCP tracts will be protected and if found to host JPS, will be managed to protect this species. Travis County will also collaborate in research efforts to elucidate many of the unknowns in regard to JPS life history, habitat preferences, potential threats, and the mechanics of the northern segment of the Edwards Aquifer. Also, Travis County will continue to contribute long-term monitoring by performing regular JPS surveys and water quality monitoring in creeks occupied by JPS and other BCP sites where appropriate. New occupancy studies will be conducted in FY2019 to better understand occupancy and distribution in drainages where knowledge is lacking. After discovery of additional populations, staff will return on a regular basis to verify JPS presence at these sites.

Literature Cited

Barinaga, M. 1990. Where have all the froggies gone? Science 247: 1033-1044.

Bendik, N. F. and A. G. Gluesenkamp. 2013a. Body length shrinkage in an endangered amphibian is associated with drought. Journal of Zoology 290: 35-41.

Bendik, N. F., B. N. Sissel, J. R. Fields, L. J. O'Donnell, and M. S. Sanders. 2014. Effect of urbanization on abundance of Jollyville Plateau salamanders (Eurycea tonkawae). Herpetological Conservation and Biology.

Bendik, N. F., T. A. Morrison, A. G. Glusenkamp, M. S. Sanders, L. J. O'Donnell. 2013b. Computer-assisted photo identification outperforms visible implant elastomers in an endangered salamander, Eurycea tonkawae. PloS one 8: e59424.

Bendik, N. F., K. D. McEntire, and B. N. Sissel. 2016. Movement, demographics, and occupancy dynamics of a federally-threatened salamander: evaluating the adequacy of critical habitat. PeerJ, 4, e181. http://doi.org/10.7717/peerj.1817.

Bendik, N. F. 2011a. Jollyville Plateau salamander status report. City of Austin, Watershed Protection. SR-11-10

Bendik, N. 2011b. Personal communication. Jollyville Plateau Salamander (*Eurycea tonkawae*). Presentation from City of Austin Watershed Protection to U.S. Fish and Widlife Service. October 5, 2011.

Bendik N. F. 2017. Demographics, reproduction, growth, and abundance of Jollyville Plateau salamanders (*Eurycea tonkawae*). 2017. Ecology and Evolution: 10.1002/ece3.3056.

Blaustein, A. R, P. D. Hoffman, D. G. Hokit, J. M. Kiesecker, S. C. Walls, and J. B. Hays. 1994. UV repair and resistance to solar UV-B in amphibian eggs: a link to population declines? Proc. National Academy of Science 91:1791-1795

Bowles, B. D., M. S. Sanders, and R. S. Hansen. 2006. Ecology of the Jollyville Plateau salamander (*Eurycea tonkawae*: Plethodontidae) with an assessment of the potential effects of urbanization. Hydrobiologia 553:111-120.

Chippendale, P. T., A. H. Price, and D. M. Hillis. 1993. A new species of the perennibrachiate salamander (*Eurycea*; Plethodontidae) from Austin, Texas. Herpetologica 49: 248-259.

Chippendale, P. T., A. H. Price, J. J. Wiens, D. M. Hillis. 2000. Phylogenetic relationships and systematic revision of central Texas hemidactyliine plethodontid salamanders. Herpetol. Monogr. 14, 1-80.

Chippendale, P. T. and A. H. Price. 2005. Conservation of Texas spring and cave salamanders (*Eurycea*). Pages 193-197 in M. Lanoo, editor. Amphibian Declines: The Conservation Status of U. S. species. University of California Press, Berkley, California.

Clamann, A., T. Jackson, R. Clayton, A. Richter. 2015. Environmental Integrity Index: Phase I & II (2013-2014) Watershed Summary Report. City of Austin Watershed Protection. SR-15-08. July 2015.

COA (City of Austin). 2001. Jollyville plateau water quality and salamander assessment. Water Quality Report Series COA-ERM 1999-01. Prepared by City of Austin, Watershed Protection Department, Environmental Resources Management Division, Water Resource Evaluation Section. Austin, Texas, USA, 381 pp.

COA (City of Austin). 2002. Evironmental integrity index methodology. Water Quality Report Series COA-ERM 1999-01. Prepared by City of Austin, Watershed Protection Department, Environmental Resources Management Division, Water Resource Evaluation Section. Austin, Texas, USA, 225 pp.

City of Austin. 2007. Austin area population histories and forecasts. 1p.

Cole, R. A. 1995. A review of status, research and management of taxon viability for three neotenic aquatic salamanders in Travis County, Texas. In A review of the status of current critical biological and ecological information on the *Eurycea* salamanders located in Travis County, Texas. D. E. Bowles ed. Aquatic Biological assessment Team, Resource Protection Division, Texas Parks and Wildlife Department, Austin, Texas (http://www.solsdf.org).

Davis, B., R. Hansen, D. Johns, M. Turner. 2001. Jollyville Plateau water quality and salamander assessment. City of Austin, Austin, Texas.

Devitt, T. J., A. M. Wright, D. C. Cannatella, and D. M. Hillis. 2018. Species delimitation in endangered groundwater salamanders: Implications for aquifer management and biodiversity conservation. PNAS 10.1073. https://doi.org/10.1073/pnas.1815014116.

Dowling, H. G. 1956. Geographic relations of Ozarkian amphibians and reptiles. Southwestern Naturalist 1: 174-189.

Gabor, C. R., K. C. Zabierek, D. S. Kim, L. A. Barbiano, M. J. Mondolli, N. F. Bendik, D. R. Davis. 2016. A non-invasive water-borne assay of stress hormones in aquatic salamanders. Copeia 104: 172-181.

Gillespie, J. H. 2013. Application of stable isotope analysis to study temporal changes in foraging ecology in a highly endangered amphibian. PLoS ONE 8(1): e53041. Doi:10.1371/journal.pone.0053041

Hartwell H. W. Jr. and L. M. Ollivier 1998. Stream Amphibians as indicators of ecosystem stress: a case study from California's redwoods. Ecological Applications 8:1118–1132.

Hillis, D. M., D. A. Chamberlain, T. P. Wilcox, and P. T. Chippendale. 2001. A new species of subterranean blind salamander (Plethodontidae: Hemidactyliini: Eurycea: Typhlomolge) from Austin, Texas, and nomenclature of the major clades of central Texas paedomorphic salamanders. Herpetologica 53: 266-280.

Johns, D. A. 2013. Surprises in groundwater characterization in karst areas of the Jolllyville Plateau, Austin, Texas. National Groundwater Association Summit.

O'Donnell, L., M. Turner, E. Geismar, and M. Sanders. 2005. Summary of Jollyville Plateau salamander data (1997-2006) and status. Water Resource Evaluation. Watershed Protection and Development Review Department. City of Austin. Austin, Texas.

O'Donnell, L., M. Turner, M. Sanders, E. Geismar, S. Heilman, and L. Zebehazy. 2006. Summary of Jollyville Plateau salamander data (1997-2006). Water Resource Evaluation Short Reports SR-07-02. City of Austin. Austin, Texas.

Orser, P. N. and D. J. Shure. 1972. Effects of urbanization on the salamander *Desmognathus fuscus fuscus*. Ecology 53: 1148-1154.

Rudolph, D. C. 1978. Aspects of larval ecology of five plethodontid salamanders of the western Ozarks. American Midland Naturalist 100: 141-159.

Sweet, S. S. 1982. A distributional analysis of epigean populations of *Eurycea neotenes* in central Texas, with comments on the origin of troglobitic populations. Herpetologica 34: 101-108.

Tumilson, R. and G. R. Cline. 1997. Further notes on the habitat of the Oklahoma salamander (*Eurycea tynerensis*). Proceedings of the Oklahoma Academy of Sciences 77: 103-106.

U. S. Fish and Wildlife Service. 1996a. Federal Fish and Wildlife Permit PRT788841.

U. S. Fish and Wildlife Service. 1996b. Final Environmental Impact Statement / Habitat Conservation Plan for Proposed Issuance of a Permit to Allow Incidental Take of the Golden-cheeked Warbler, Black-capped Vireo, and six karst invertebrates in Travis County, Texas.

U. S. Fish and Wildlife Service. 2012. Endangered status for four central Texas salamanders and designation of Critical Habitat; proposed rule. *Federal Register* 77: 163 (22 August 2012) pp. 50769 - 50854.

U. S. Fish and Wildlife Service. 2013. Threatened and endangered wildlife and plants; determination of endangered species status for the Austin blind salamander and threatened status for the Jollyville Plateau salamander throughout their ranges; final rule. *Federal Register* 78: 161 (20 August 2013) pp. 51277 - 51326.

U. S. Fish and Wildlife Service. *in press*. Contaminants in *Eurycea* salamanders and their association with changing land uses in the Texas Edwards Plateau. SSP Project 313-R2-04.

Willson, J. D. and M. E. Dorcas. 2003. Effects of habitat disturbance on stream salamanders. Implications for buffer zones and watershed management. Conservation Biology 17: 763-771.