



# City of Austin

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Founded by Congress, Republic of Texas, 1839  
Watershed Protection Department  
P.O. Box 1088. Austin. Texas 78767

December 15, 2015

Ms. Vanessa Martinez  
U.S. Fish and Wildlife Service  
Ecological Services  
PO Box 1306  
Albuquerque, New Mexico 87103  
Ph: 505-248-6665  
Vanessa\_Martinez@fws.gov

Dear Ms. Martinez:

Enclosed is the City of Austin's 2015 annual report for the U.S. Fish and Wildlife Service 10(a)1(A) permit (TE-833851) covering scientific activities affecting *Eurycea sosorum*, *E. waterlooensis*, and *E. tonkawae*.

Please do not hesitate to contact me should you require additional information at 512-974-2652, or Nathan Bendik, Watershed Protection Department Environmental Scientist, at 512-974-2040.

Sincerely,

Mike Personett, Assistant Director  
Watershed Protection Department

2015 Annual Report  
U.S. Fish and Wildlife Service Scientific Permit (TE-833851)

Reporting period: December 2014- November 2015

This report documents the activities associated with the Barton Springs salamander (*Eurycea sosorum*) that are authorized under the above federal endangered species permit for 2015.

Tables and figures are numbered by section.

**TE-833851, Section S., Permit Condition 6: General Annual Reporting Requirements for Barton Springs and Austin Blind Salamanders**

1) Precise locations of previously undocumented surveyed areas

None.

2) Dates of surveys conducted-see 4 below.

3a) Survey methods

Surveys of abundance of *Eurycea sosorum* (Barton Springs Salamander) and *Eurycea waterlooensis* (Austin Blind Salamander) were conducted bi-monthly throughout the year at the three perennial spring sites, Parthenia Spring (= Barton Springs Pool), Eliza Spring, and Zenobia Spring (=Old Mill= Sunken Garden) and at one intermittent spring, Upper Barton Spring, when water was present.

For each survey the date, weather, type of flow (base flow or storm flow) and aquifer discharge are recorded by the U.S. Geological Survey station at Barton Springs. Each site was searched by the drive survey method, which consists of a moving line from downstream do upstream. All substrate was searched for salamanders, rocks are removed and replaced behind the survey line, and aquatic macrophytes and bryophytes are searched without dislodgement. Every individual salamander found was identified to species and categorized by total length, 0–1", 1–2", >2" or measured from photographed (if a mark-recapture survey). For mark-recapture surveys (currently at Eliza and Upper Barton springs), salamanders are captured using small hand-held dip nets, photographed, and returned to the spring within 3–4 hours. The total number of salamanders of each species and size class found were recorded, although we only present the totals below.

3b) Salamander collection methods

Salamanders were captured using small dipnets or net bags and placed into containers with clean groundwater before photographing. Temperature was controlled by keeping containers in the shade or in the spring water. During mark-recapture surveys, most individuals were kept in flow-through mesh boxes within the spring before releasing. Small juveniles were kept separately in rigid containers.

4) Survey results

The number of *E. sosorum* found in the Barton Springs complex during monthly surveys are presented in the table below.

Barton Springs Salamander and Austin Blind Salamander Abundance December 2014–November 2015. Parthenia Spring is located within Barton Springs Pool. Old Mill Spring/Sunken Garden is represented by OMS/SG, and Upper Barton Spring, by UBS.

<i>Eurycea sosorum</i>			<i>Eurycea waterlooensis</i>		
Site	Date	Total	Site	Date	Total
Eliza	2/10/2015	90	Eliza	2/10/2015	0
Eliza	2/11/2015	72	Eliza	2/11/2015	0
Eliza	2/12/2015	53	Eliza	2/12/2015	0
Eliza	8/18/2015	74	Eliza	8/18/2015	0
Eliza	8/19/2015	69	Eliza	8/19/2015	0
Eliza	8/20/2015	50	Eliza	8/20/2015	1
Eliza	11/17/2015	80	Eliza	11/17/2015	0
Eliza	11/18/2015	48	Eliza	11/18/2015	0
Eliza	11/19/2015	41	Eliza	11/19/2015	0
Parthenia	12/18/2014	3	Parthenia	12/18/2014	0
Parthenia	6/11/2015	1	Parthenia	6/11/2015	0
Parthenia	8/27/2015	25	Parthenia	8/27/2015	1
Parthenia	10/22/2015	135	Parthenia	10/22/2015	0
OMS/SG	3/26/2015	0	OMS/SG	3/26/2015	3
OMS/SG	6/4/2015	0	OMS/SG	6/4/2015	1
OMS/SG	8/27/2015	0	OMS/SG	8/27/2015	1
OMS/SG	10/22/2015	1	OMS/SG	10/22/2015	4
UBS	12/10/2014	25	UBS	12/10/2014	0
UBS	2/13/2015	6	UBS	2/13/2015	0
UBS	4/9/2015	22	UBS	4/9/2015	0
UBS	6/11/2015	4	UBS	6/11/2015	0
UBS	8/13/2015	0	UBS	8/13/2015	0
UBS	10/7/2015	1	UBS	10/7/2015	0

5) Results of species identifications

No new species found.

6) Number of salamanders collected from the wild

We collected one small juvenile (15mm TL) *Eurycea waterlooensis* on March 26, 2015 from Old Mill Spring. This salamander was found ventral side up and remained ventral side up when we placed it in a pan for observation. We collected it to preserve for DNA work, in the event that it died. The salamander recovered in captivity and is part of the captive breeding program.

7) Number of salamanders handled and marked with elastomers

None.

8) Observations of abnormal behavior or condition of salamanders handled/ marked;

None.

9) Results of any mark-recapture methods

We conducted robust-design mark-recapture sampling at Eliza Spring using photographic identification methods for three consecutive days in February, August, and November. The scheduled May survey was canceled due to high, turbid water conditions from heavy rains that persisted for weeks.

We performed a closed-population analysis in MARK using the Huggins likelihood formulation. While complete closure within the confines of the concrete surface area of Eliza Spring were likely not achieved, we believe the assumption of closure to permanent migrants to be reasonable. If the absence of closure is due to a “trap-shy” behavioral effect this can be accounted for (and tested) in models with a free parameter  $c$ .

We also photographed individuals at Upper Barton Springs during all surveys for the reporting year, although this did not follow a robust-design. There were not many recaptures, and therefore we did not perform any statistical analyses on these data.

Closed population model results for *E. sosorum* at Eliza Spring. Detection probability =  $p$ ; recapture probability =  $c$ ; (t) indicates time variation and (.) indicates a constant value.

#### February

Model	AICc	Delta AICc	AICc Weights	Model Likelihood	Num. Par	Deviance
$p(t) c(t)$	489.987	0	0.57166	1	4	1022.189
$p(t) = c(t)$	491.6818	1.6948	0.24497	0.4285	3	1025.926
$p(.) c(t)$	492.5707	2.5837	0.15707	0.2748	3	1026.815
$p(.) c(.)$	496.1878	6.2008	0.02574	0.045	2	1032.463
$p(.) = c(.)$	503.8759	13.8889	0.00055	0.001	1	1042.171

#### August

Model	AICc	Delta AICc	AICc Weights	Model Likelihood	Num. Par	Deviance
$p(.) c(t)$	412.9889	0	0.48624	1	3	814.77
$p(t) c(t)$	414.3656	1.3767	0.24429	0.5024	4	814.0963
$p(t) = c(t)$	414.4124	1.4235	0.23864	0.4908	3	816.1934
$p(.) c(.)$	419.1139	6.125	0.02274	0.0468	2	822.9326
$p(.) = c(.)$	421.179	8.1901	0.0081	0.0167	1	827.0227

#### November

Model	AICc	Delta AICc	AICc Weights	Model Likelihood	Num. Par	Deviance
$p(t) = c(t)$	381.5783	0	0.54753	1	3	772.6598
$p(t) c(t)$	383.0631	1.4848	0.26061	0.476	4	772.0923
$p(.) c(.)$	384.7774	3.1991	0.11059	0.202	2	777.898
$p(.) c(t)$	385.3939	3.8156	0.08126	0.1484	3	776.4755
$p(.) = c(.)$	404.6347	23.0564	0.00001	0	1	799.7813

Parameter estimates from the AIC top model for each month. N is the population size estimate.

**February**

Parameter	Estimate	Standard Error	Lower 95% CI	Upper 95% CI
<b>p1</b>	0.48	0.21	0.15	0.82
<b>p2</b>	0.25	0.23	0.03	0.79
<b>c1</b>	0.48	0.05	0.38	0.58
<b>c2</b>	0.31	0.04	0.23	0.40
<b>N</b>	184	78	137	561

**August**

Parameter	Estimate	Standard Error	Lower 95% CI	Upper 95% CI
<b>p</b>	0.64	0.05	0.53	0.74
<b>c1</b>	0.62	0.06	0.51	0.72
<b>c2</b>	0.40	0.05	0.31	0.50
<b>N</b>	113	3.4	110	125

**November**

Parameter	Estimate	Standard Error	Lower 95% CI	Upper 95% CI
<b>p1</b>	0.66	0.05	0.54	0.75
<b>p2</b>	0.40	0.05	0.31	0.50
<b>p3</b>	0.34	0.05	0.26	0.44
<b>N</b>	120	6.1	112	137

10) Results of genetic research conducted as a result of tail-clipping

None.

11) Results of any research of management activities authorized by this permit and approved through the submission of study plans to the CPI Branch of the Austin ESFO

- a. City of Austin monitors water quality in the Barton Springs Complex under this permit to meet the requirements of the Habitat Conservation Plan contained in the USFWS IO(a)(1)(B) permit PRT-839031 and the Texas Pollutant Discharge Elimination System permit WQ0004705000 (EPA NPDES TXS000401). Permitted staff collect water samples from each perennial spring, and Upper Barton Spring when flowing. Samples are analyzed for the following parameters at designated frequencies (GET FROM FSDB). On an approximately biweekly frequency, tested parameters include total suspended solids, volatile suspended solids, N03+N02-N, NH3-N, Ortho-P, temperature, dissolved oxygen, pH, conductivity, and turbidity. Quarterly sampling includes biweekly parameters plus alkalinity, Ca, Na, K, Mg, Cl, S04, F, As, Cu, Fe, Pb, Ni, Zn. TPDES annual sampling includes all of the above plus Hardness, Ag, Cd, Cr, Hg, TOC, oil & grease, total polycyclic aromatic hydrocarbons, bromacil, organophosphate pesticides, chlorinated herbicides, volatiles, and semi-volatiles. Additionally, the City of Austin in cooperation with the United States Geological Survey maintains continuous monitoring for spring discharge and physiochemical parameters at Barton Springs. In this reporting period, City of Austin staff completed an analysis of Barton Springs dissolved oxygen trends in support of the development of a Habitat Conservation Plan by the Barton Springs Edwards Aquifer Conservation District, with the publication available here:

[http://www.austintexas.gov/watershed\\_protection/publications/document.cfm?id=225011](http://www.austintexas.gov/watershed_protection/publications/document.cfm?id=225011)

- b. U.S. Geological Survey deploys and maintains water quality sampling equipment in Parthenia Spring. Equipment was serviced on a monthly basis by USGS dive teams.
- c. The USGS (Barbara Mahler, PI) also collected water samples to examine concentrations of glyphosphate and atrazine. They have reported non-detections on both atrazine and glyphosate at all four spring sites (Upper, Old Mill, Eliza, and Parthenia). Atrazine detection level: 0.1 ug/L Glyphosate detection level: 0.2 ug/L.
- d. City of Austin staff collect sediment samples at Barton Springs for testing to meet requirements of the City's TPDES permit. These samples were collected the following dates: 12/16/2014, 04/01/2015, 07/27/2015, 09/24/2015, 11/30/2015. A report written based on these data is available here:  
[http://www.austintexas.gov/watershed\\_protection/publications/document.cfm?id=230085](http://www.austintexas.gov/watershed_protection/publications/document.cfm?id=230085)
- e. Corticosterone assessments of *E. sosorum* and *E. tonkawae* were performed in collaboration with Texas State University (Caitlin Gabor, PI), some of which we have previously reported on. Results from these studies will be published in a forthcoming issue of the journal *Copeia*, in an article titled "A non-invasive water-borne assay of stress hormones in aquatic salamanders" (Gabor et al., *in press*).

## TE-833851 Permit Condition: Captive Breeding Annual Reporting Requirements

1) The number of *Eurycea sosorum*, *Eurycea waterlooensis*, and *Eurycea tonkawae* held at the captive breeding facility (including the number of wild-caught and captive-bred individuals from each spring site collected).

Table 1. Inventory of Salamanders in Captive Breeding Program

Species	Spring of Origin	No. Wild-Caught	No. Captive-Bred > 6 Months of Age	No. Captive-Bred < 6 Months of Age
<i>Eurycea sosorum</i>	Barton Springs Pool	9	49	1
	Sunken Garden Spring	7	215	0
	Eliza Spring	34	111	0
	Upper Barton Spring	0	17	0
	Dallas Aquarium lineage and other <sup>*1</sup>	0	3	0
Total		50	395	1
<i>Eurycea waterlooensis</i>	Barton Springs Pool	0	NA <sup>*2</sup>	NA <sup>*2</sup>
	Sunken Garden Spring	9	NA <sup>*2</sup>	NA <sup>*2</sup>
	Eliza Spring	1	NA <sup>*2</sup>	NA <sup>*2</sup>
	Upper Barton Spring	0	NA <sup>*2</sup>	NA <sup>*2</sup>
	Total		10	35
<i>Eurycea tonkawae</i>	Bull Creek	8	4	0
	MacDonald Well	0	5	0
	SAS Canyon	6	0	0
	Testudo Tube	2	0	0
	Wheless	5	0	0
Total		21	9	0

<sup>\*1</sup> Founder salamanders for the Dallas Aquarium captive population were collected from more than one spring site (Barton Springs Pool and Sunken Gardens) and mixed together. COA has F2's from Dallas F1's that were used for educational purposes at the Splash! Into the Edwards Aquifer exhibit at Barton Springs in Zilker Park.

<sup>\*2</sup> *E. waterlooensis* are not separated and bred according to spring site of origin due to the fact that the species is primarily aquifer-dwelling.

2) Number of observations of courtship behavior, spermatophores, spermatophore depositions, sperm transfers, and ovipositions.

In 2015, courtship behavior was observed in both wild-caught and captive-bred salamanders. In general, salamanders are not disturbed by City staff during courtship. Because salamanders can store sperm, observed courtship behavior does not necessarily result in immediate egg-laying. Each oviposition with viable offspring represents at least one sperm transfer, and possibly multiple transfers. Oviposition data are presented in Table 2.

Table 2. Ovipositions in Captivity 12/01/14-12/01/15. Tank I.D. indicates spring site of origin, reproductive group, and wild-caught or captive-bred status. Individuals in reproductive groups are recorded in order to follow actual or potential dams and sires. BSP denotes groups from Parthenia Spring, E, groups from Eliza Spring, SG, groups from Sunken Garden Spring, UBS, groups from Upper Barton Spring, and F, captive-bred salamanders.

Estimated Oviposition Date	Tank ID	Clutch Size	No. Hatched
<i>Eurycea sosorum</i>			
12/01/14	SGF1 (C182)	8	NA <sup>*3</sup>
12/13/14	UBSF1 (C53)	3	0
12/17/14	EF2 (C243)	19	NA <sup>*3</sup>
12/17/14	SGF1 (C187)	13	NA <sup>*3</sup>
12/20/14	SGF2 (C184)	13	Disappeared before moved
12/20/14	SGF1 (C176)	15	NA <sup>*3</sup> , 1 later found in tank
01/01/15	BSPF2 (C156)	11	NA <sup>*3</sup>
01/01/15	EF1 (C147)	16	NA <sup>*3</sup>
01/01/15	E (C175)	13	11
01/13/15	UBSF1 (C95)	7	NA <sup>*3</sup>
01/13/15	BSP (C01B)	19	15
01/18/15	SGF1 (C109)	14	NA <sup>*3</sup>
01/20/15	SGF1 (C146A)	17	NA <sup>*3</sup>
01/21/15	EF1 (C242)	13	NA <sup>*3</sup>
01/24/15	SGF1 (C146B)	22	NA <sup>*3</sup>
01/25/15	SGF1 (C164)	7	NA <sup>*3</sup>
01/27/15	EF2 (C236)	14	NA <sup>*3</sup>
01/27/15	BSP (C178)	9	4
01/27/15	SGF1 (C176)	NA (juveniles found in tank)	14
02/02/15	SGF1 (C159)	24	NA <sup>*3</sup>
02/02/15	EF1 (C98)	8	NA <sup>*3</sup>
02/02/15	SGF1 (C93)	14	NA <sup>*3</sup>
02/02/15	UBSF1 (C53)	9	NA <sup>*3</sup>
02/08/15	EF1 (C154)	10	NA <sup>*3</sup>
02/08/15	SGF1 (C86)	3	NA <sup>*3</sup>
02/12/15	EF2 (C243)	26	NA <sup>*3</sup>
02/19/15	EF1 (C177)	8	NA <sup>*3</sup>
02/19/15	SGF1 (C176)	33	NA <sup>*3</sup>
02/21/15	SGF1 (C164)	8	NA <sup>*3</sup>
02/25/15	SGF1 (C187)	15	NA <sup>*3</sup>
02/27/15	BSPF1 (C247)	17	NA <sup>*3</sup>
02/28/15	SGF1 (C164)	10	NA <sup>*3</sup>

03/02/15	EF2 (C237)	14	NA <sup>*3</sup>
03/04/15	SGF1 (C89)	16	NA <sup>*3</sup>
03/04/15	SGF1 (C182)	16	NA <sup>*3</sup>
03/07/15	SGF1 (C148)	14	NA <sup>*3</sup>
03/12/15	SGF1 (C176)	8	NA <sup>*3</sup>
03/12/15	EF2 (C236)	8	NA <sup>*3</sup>
03/12/15	UBSF2 (C155)	9	NA <sup>*3</sup>
03/14/15	SGF2 (C188)	15	NA <sup>*3</sup>
03/15/15	SGF2 (C227)	17	NA <sup>*3</sup>
03/15/15	SGF2 (C184)	21	NA <sup>*3</sup>
03/26/15	UBSF1 (C53)	21	NA <sup>*3</sup>
04/02/15	SGF1 (C176)	14	NA <sup>*3</sup>
04/14/15	BSPF1 (C249)	18	NA <sup>*3</sup>
04/20/15	SGF1 (C176)	27	NA <sup>*3</sup>
04/29/15	SGF1 (C146B)	20	NA <sup>*3</sup>
06/18/15	SGF1 (C176)	30	NA <sup>*3</sup>
07/27/15	SGF1 (C176)	NA (2 eggs found after development started)	NA <sup>*3</sup>
07/30/15	BSP (C01B)	NA	1 juvenile found in tank
10/01/15	SGF1 (C176)	18	NA <sup>*3</sup>
10/26/15	SGF1 (C187)	12	NA <sup>*3</sup>
<i>Eurycea waterlooensis</i>			
02/02/15	WC (CW21)	17	4

<sup>\*3</sup> Eggs preserved to manage the population size and genetic diversity (prevent a disproportionate number of offspring produced from a single reproductive group, or to minimize inbreeding)

3, 4) Information on clutch sizes (range, mean, and standard deviation) and hatching success (range, mean, and standard deviation)

Table 3. Salamander Clutch Size and Hatching Success – 12/01/14-12/01/15

	Range	Mean	Standard Deviation
<i>E. sosorum</i>			
Clutch Size	3-33 (N=49)	14.6	6.5
No. Hatched	0-15 (N=4)	7.5	6.8
% Hatching	0-85 (N=4)	52.0	38.9

5) Salamander Mortalities (including age and cause of death, if known)

Table 4. Salamander Mortalities 12/01/14–12/01/15

Species	Wild-Caught or Captive-Bred	Age (years)	No. Mortalities	Cause of Death (health condition observed)
<i>Eurycea sosorum</i>	WC	9-10 <sup>*4</sup>	5	Senescence (1 with gular displacement)
	WC	10 <sup>*4</sup>	3	Problem with tank aeration
	WC	12 <sup>*4</sup>	4	Senescence

	WC	15 <sup>*4</sup>	1	Senescence
	CB	1-3	14	Unknown
	CB	3-5	12	Unknown
	CB	5-7	4	Unknown
	CB	7-9	16	Senescence
	CB	11	1	Senescence
	CB	13	1	Senescence
<i>Eurycea waterlooensis</i>	WC	9-12 <sup>*4</sup>	2	Senescence
	WC	14 <sup>*4</sup>	1	Senescence
	CB	NA	0	
<i>Eurycea tonkawae</i>	WC	9-11 <sup>*4</sup>	7	Senescence
	CB	0.5-3	2	Unknown

<sup>\*4</sup> Age of wild-caught salamanders is estimated based on size at collection, with a maximum estimated age of 1.5 years for salamanders > 2 inches total length at collection.

#### 6) Information on Obvious Health Conditions or Behavioral Aberrations

Salamanders housed in Display Tank #2 at Splash! Into the Edwards Aquifer Educational Exhibit developed health problems in 2015. These problems include foot loss, scoliosis, gas bubble trauma, stiffness and loss of the tail tip. Most of the problems improved once the tank maintenance regime was changed to include larger water changes and less aeration and disturbance of the water within the tank. This method of tank maintenance is labor intensive, however, given the volume of the tank. Therefore, a new approach using a CO2 system to maintain water chemistry similar to that of the groundwater will be tested. Salamanders in Splash! Display Tank #1 have not exhibited any health problems.

#### 7) Special Projects

The captive breeding program provides support and salamanders for the public display tank at the Splash! Into the Edwards Aquifer Educational Exhibit. WPD staff are working with Splash! staff to adjust display tank maintenance practices.

### **TE-833851, Section T., Permit Condition 6: General Annual Reporting Requirements for Jollyville Plateau Salamanders**

#### *Personnel*

#### **Names of all persons involved in the salamander surveys and their duties.**

All personnel are City of Austin employees unless noted otherwise.

1. Nathan Bendik: study design, analysis, field work supervision
2. Blake Sissel: field assistance, data recording and entry
3. Tom Devitt: field assistance
4. Dee Ann Chamberlain: field assistance
5. Mark Sanders: field assistance
6. Jonny Scalise: field assistance
7. Donelle Robinson: field assistance
8. Jacob Owen: field assistance
9. John Kuhl (Hicks & Company): field assistance

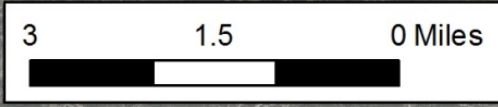
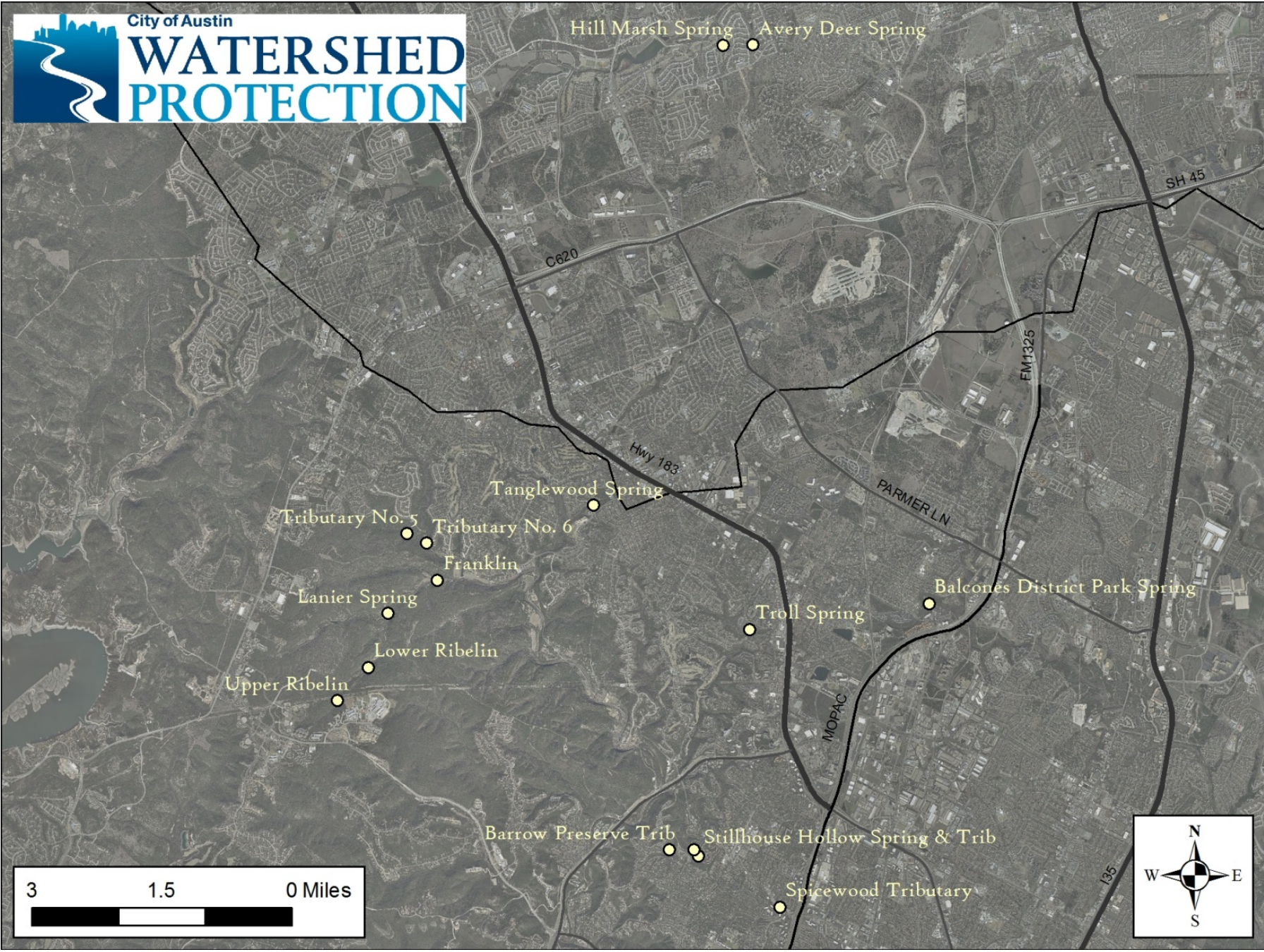
10. Julie LeClair (Hicks & Company): field assistance
11. Elizabeth Hauss (Hicks & Company): field assistance

**Person(s) directly responsible for writing the report**

Nathan Bendik

*Location*

The first map depicts locations of all CMR study sites while the second map depicts the locations of all occupancy survey sites. Note only a subset of CMR sites were sampled during 2015.





## Methods

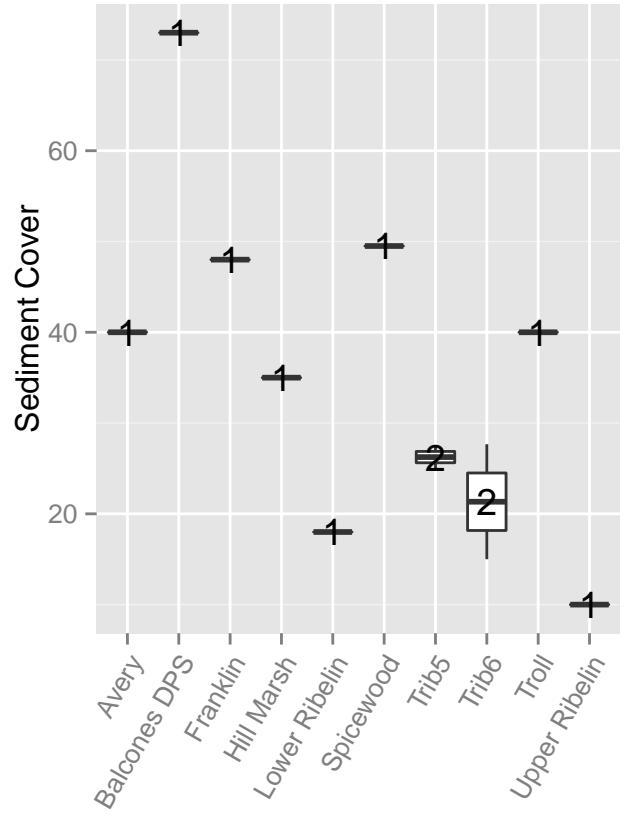
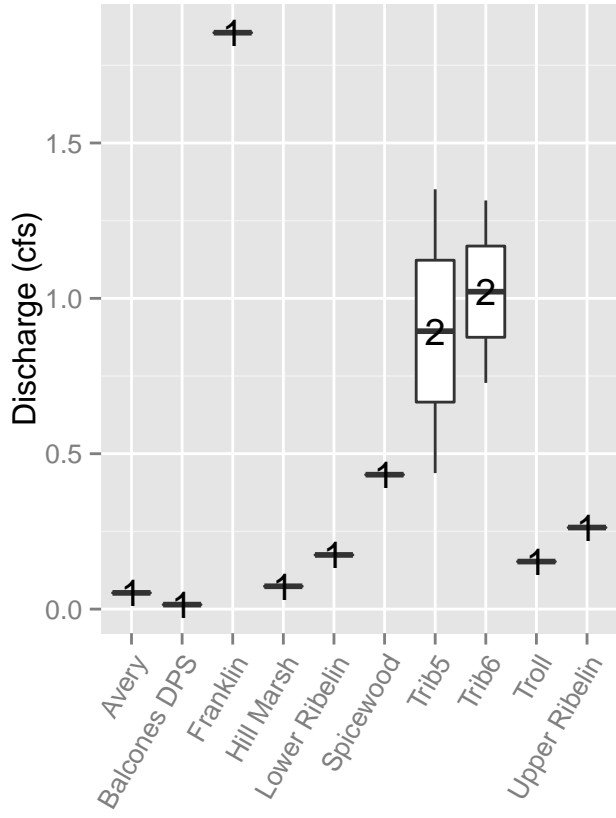
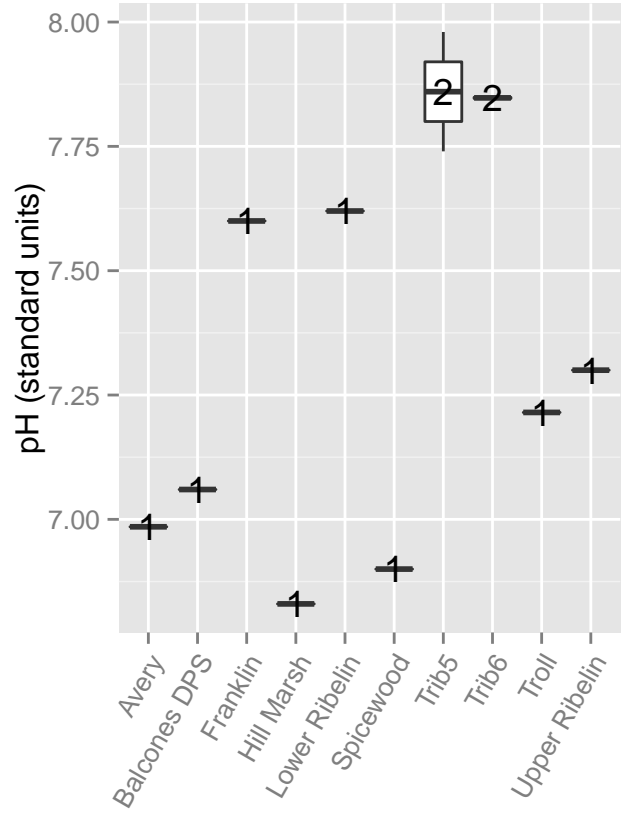
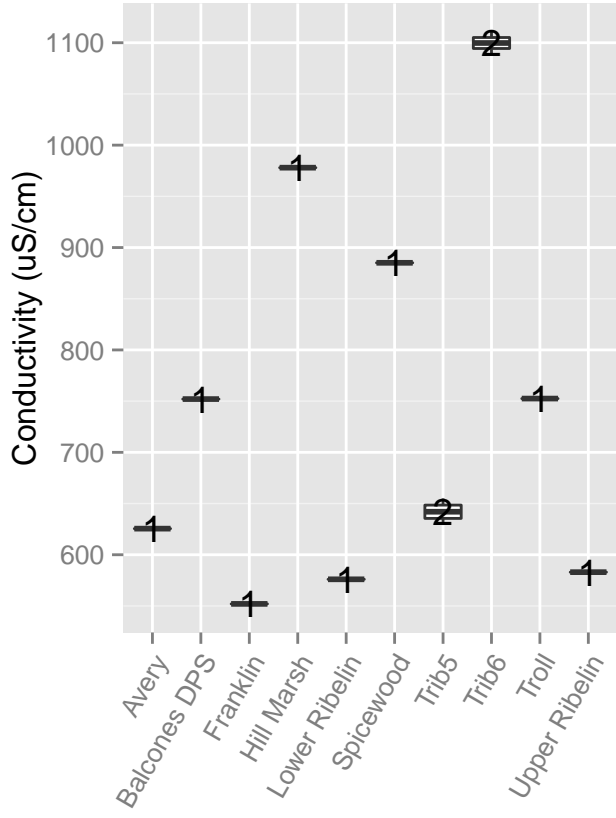
**Capture-recapture surveys:** Observers surveyed each site by exhaustively searching all cover objects on the surface of the stream (e.g., rock cover, leaf litter, woody debris), counting each salamander observed and visually estimating their size (total length: < 25 mm, 25–50 mm,  $\geq$  50 mm). This 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. Salamanders were captured using small hand nets and photographed for later photographic identification. For further detail, please refer to Bendik et al., (2013) and (2014).

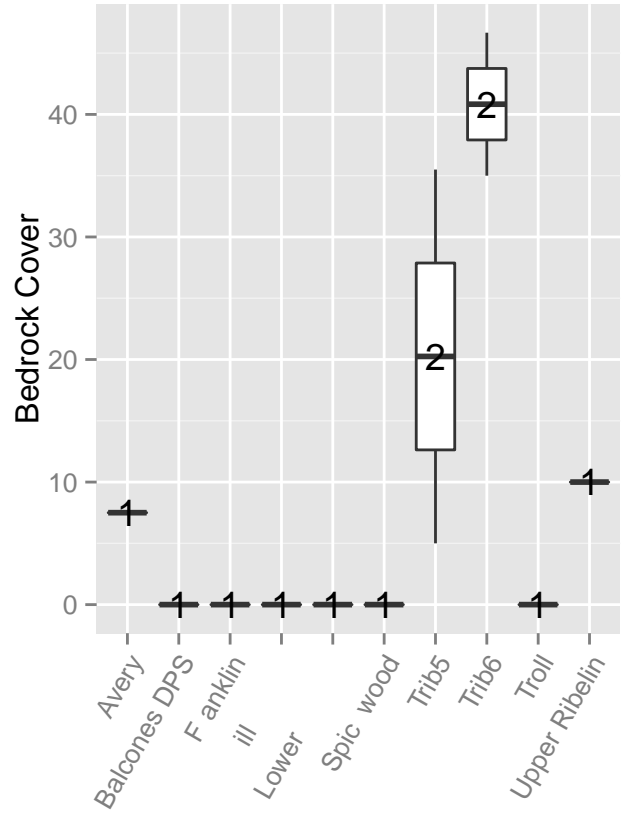
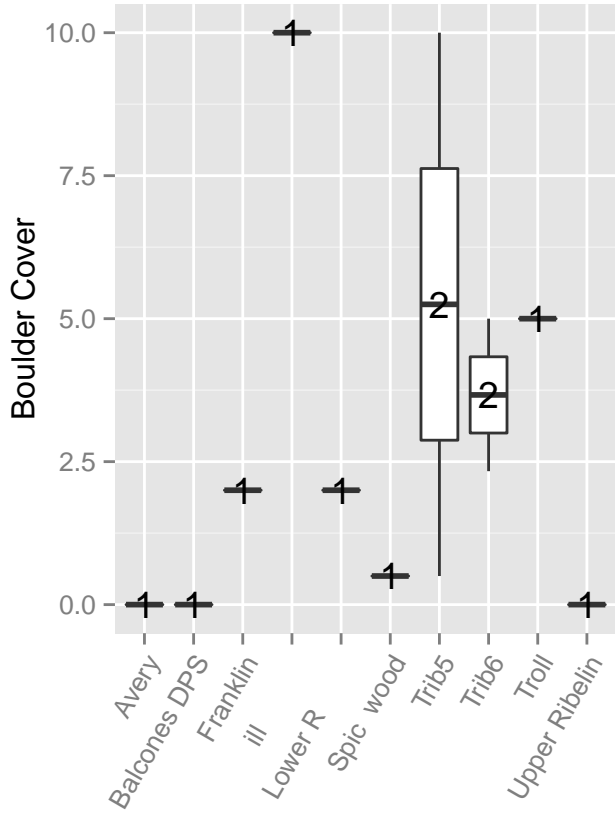
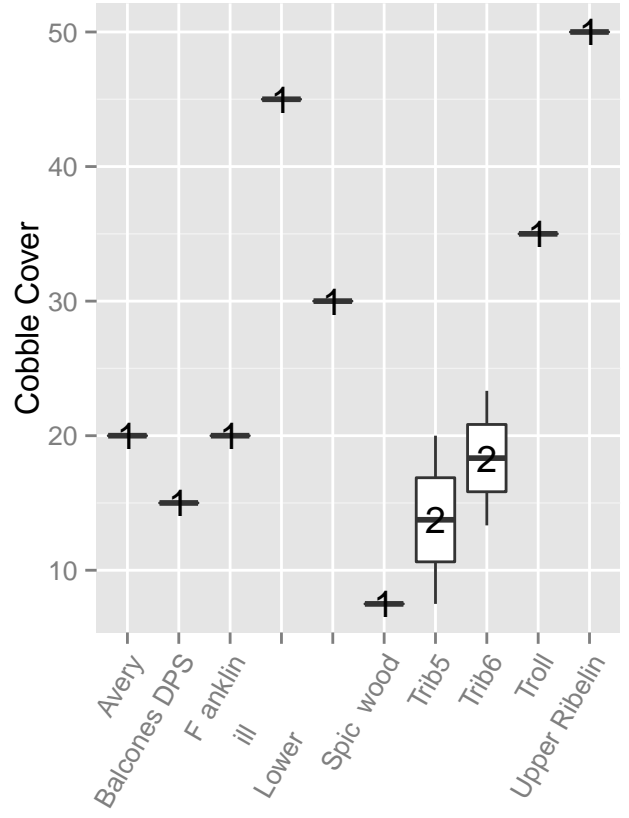
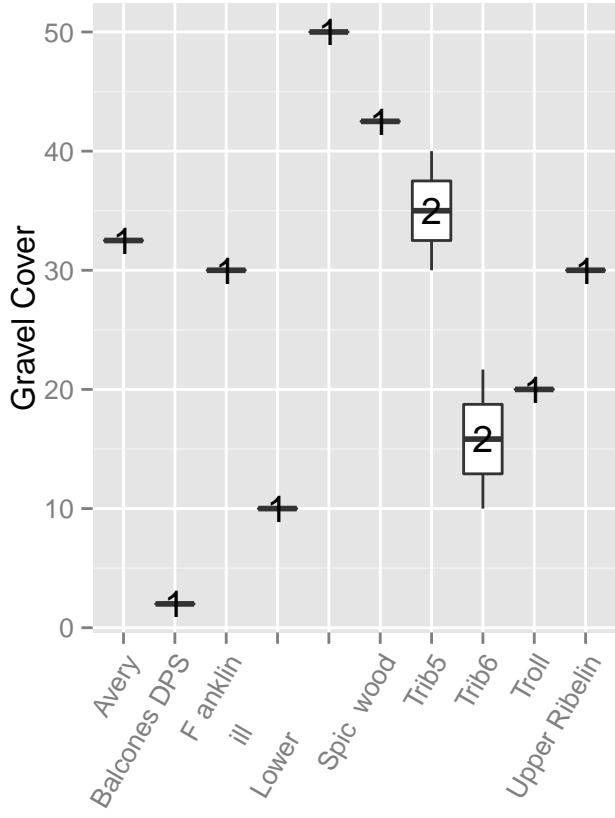
**Occupancy surveys:** Starting at the downstream confluence below the nearest known *E. tonkawae* locality in six tributaries of Bull Creek (see map above), we surveyed 127 sites, 118 of which were wet. We avoided deep pools (> 0.6 m), such as man-made impoundments, during site selection. Otherwise, sites were selected in a systematic, random fashion. Site selection started at a random point 0–100 m from the confluence and proceeded upstream, while maintaining equal distances among sites. Because we were targeting an even distribution of sites among tributaries and urban/non-urban catchments, sites in Barrow Hollow, Trib. 2, Trib. 4 and Trib. 7 were spaced 70 m apart, while those in Mainstem/Trib. 8 were spaced 140 m apart due to the larger size of that tributary. Each site was 10 m in length and spanned the width of the channel. Sites were surveyed from late March through early May (a “season”), from 2013–2015. Two experienced observers simultaneously performed a time-limited search removing cover objects for 5 min at each site, three times during each season, at a minimum interval of one-week.

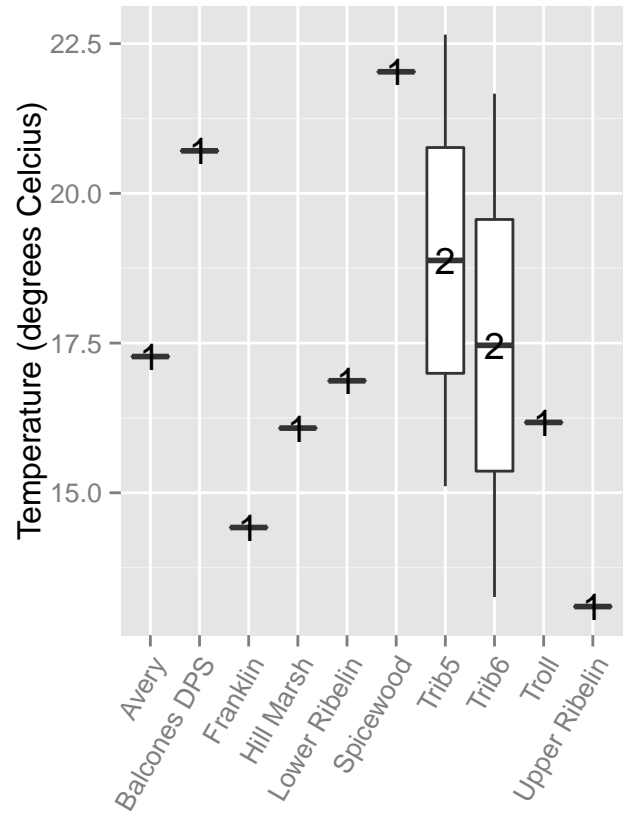
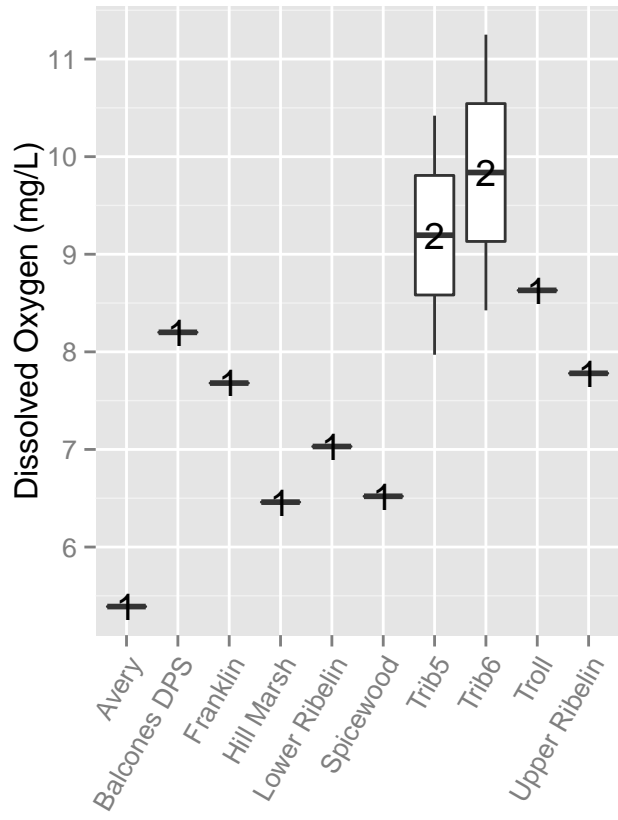
## Survey Results

Here we present the total number of salamanders observed for each capture-recapture survey. These include the total number of salamanders captured and photographed as well as any salamanders that missed capture as reported by the observer. Capture-recapture photographed have not been processed for summary or analysis, although a future report is forthcoming.

Site	Date	Total
Spicewood Spring	6/16/2015	1
Trib 6	6/12/2015	14
Trib 5	6/12/2015	8
Upper Ribelin	3/17/2015	112
Franklin	2/20/2015	89
Trib 6	2/19/2015	92
Trib 5	2/19/2015	22
Hill Marsh Spring	2/18/2015	89
Lower Ribelin	2/17/2015	128
Balcones Park	2/6/2015	2
Avery Deer Spring	2/6/2015	10
Troll Spring	2/6/2015	36
Spicewood Spring	11/23/2015	1
Troll Spring	11/23/2015	28
Hill Marsh Spring	11/24/2015	33
Trib 5	11/25/2015	0
Avery Deer Spring	5/13/2015	33
Trib 6	11/30/2015	17







Below are presented results from occupancy surveys conducted in 2015. We report survey dates and times for each site, and include plots of summary data. All data are available at <https://data.austintexas.gov/>.

Table : Occupancy Survey Dates and Times

Date	Time	Site
2015-04-14	1407	Barrow Trib @ JPS Occupancy Site 029
2015-05-04	1020	Barrow Trib @ JPS Occupancy Site 029
2015-04-01	1021	Barrow Trib @ JPS Occupancy Site 029
2015-04-01	1055	Barrow Trib @ JPS Occupancy Site 030
2015-04-14	1357	Barrow Trib @ JPS Occupancy Site 030
2015-05-04	1031	Barrow Trib @ JPS Occupancy Site 030
2015-04-01	1110	Barrow Trib @ JPS Occupancy Site 031
2015-04-14	1347	Barrow Trib @ JPS Occupancy Site 031
2015-05-04	1042	Barrow Trib @ JPS Occupancy Site 031
2015-04-01	1121	Barrow Trib @ JPS Occupancy Site 032
2015-04-14	1337	Barrow Trib @ JPS Occupancy Site 032
2015-05-04	1056	Barrow Trib @ JPS Occupancy Site 032
2015-05-04	1107	Barrow Trib @ JPS Occupancy Site 033
2015-04-01	1142	Barrow Trib @ JPS Occupancy Site 033
2015-04-14	1329	Barrow Trib @ JPS Occupancy Site 033
2015-04-01	1155	Barrow Trib @ JPS Occupancy Site 034
2015-04-14	1321	Barrow Trib @ JPS Occupancy Site 034
2015-05-04	1115	Barrow Trib @ JPS Occupancy Site 034
2015-04-01	1206	Barrow Trib @ JPS Occupancy Site 035
2015-04-14	1308	Barrow Trib @ JPS Occupancy Site 035
2015-05-04	1122	Barrow Trib @ JPS Occupancy Site 035
2015-04-01	1219	Barrow Trib @ JPS Occupancy Site 036
2015-05-04	1133	Barrow Trib @ JPS Occupancy Site 036
2015-04-14	1257	Barrow Trib @ JPS Occupancy Site 036
2015-04-01	1231	Barrow Trib @ JPS Occupancy Site 037
2015-04-14	1247	Barrow Trib @ JPS Occupancy Site 037
2015-05-04	1143	Barrow Trib @ JPS Occupancy Site 037
2015-04-01	1242	Barrow Trib @ JPS Occupancy Site 038
2015-04-14	1231	Barrow Trib @ JPS Occupancy Site 038
2015-05-04	1152	Barrow Trib @ JPS Occupancy Site 038
2015-04-14	1205	Barrow Trib @ JPS Occupancy Site 039
2015-05-04	1202	Barrow Trib @ JPS Occupancy Site 039
2015-04-01	1253	Barrow Trib @ JPS Occupancy Site 039
2015-04-01	1304	Barrow Trib @ JPS Occupancy Site 040
2015-04-14	1153	Barrow Trib @ JPS Occupancy Site 040
2015-05-04	1213	Barrow Trib @ JPS Occupancy Site 040
2015-04-01	1314	Barrow Trib @ JPS Occupancy Site 041
2015-04-14	1140	Barrow Trib @ JPS Occupancy Site 041
2015-05-04	1231	Barrow Trib @ JPS Occupancy Site 041
2015-04-01	1326	Barrow Trib @ JPS Occupancy Site 042
2015-05-04	1240	Barrow Trib @ JPS Occupancy Site 042
2015-04-14	1130	Barrow Trib @ JPS Occupancy Site 042
2015-04-01	1340	Barrow Trib @ JPS Occupancy Site 043
2015-04-14	1120	Barrow Trib @ JPS Occupancy Site 043

2015-05-04	1258	Barrow Trib @ JPS Occupancy Site 043
2015-04-14	1103	Barrow Trib @ JPS Occupancy Site 044
2015-05-04	1305	Barrow Trib @ JPS Occupancy Site 044
2015-04-01	1356	Barrow Trib @ JPS Occupancy Site 044
2015-04-01	1407	Barrow Trib @ JPS Occupancy Site 045
2015-05-04	1316	Barrow Trib @ JPS Occupancy Site 045
2015-04-14	1052	Barrow Trib @ JPS Occupancy Site 045
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2015-05-04	1336	Barrow Trib @ JPS Occupancy Site 048
2015-04-14	1032	Barrow Trib @ JPS Occupancy Site 048
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2015-04-01	1451	Barrow Trib @ JPS Occupancy Site 049
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2015-04-16	1030	Bull Creek @ JPS Occupancy Site 057
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2015-04-07	1227	Bull Creek @ JPS Occupancy Site 058
2015-04-16	1041	Bull Creek @ JPS Occupancy Site 058
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2015-04-29	1522	Bull Creek @ JPS Occupancy Site 059
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2015-04-07	1715	Bull Creek @ JPS Occupancy Site 129
2015-04-16	1337	Bull Creek @ JPS Occupancy Site 129
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2015-04-29	1210	Bull Creek @ JPS Occupancy Site 131
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2015-04-21	1232	Bull Creek Trib 2 @ JPS Occupancy Site 115
2015-04-30	1346	Bull Creek Trib 2 @ JPS Occupancy Site 115
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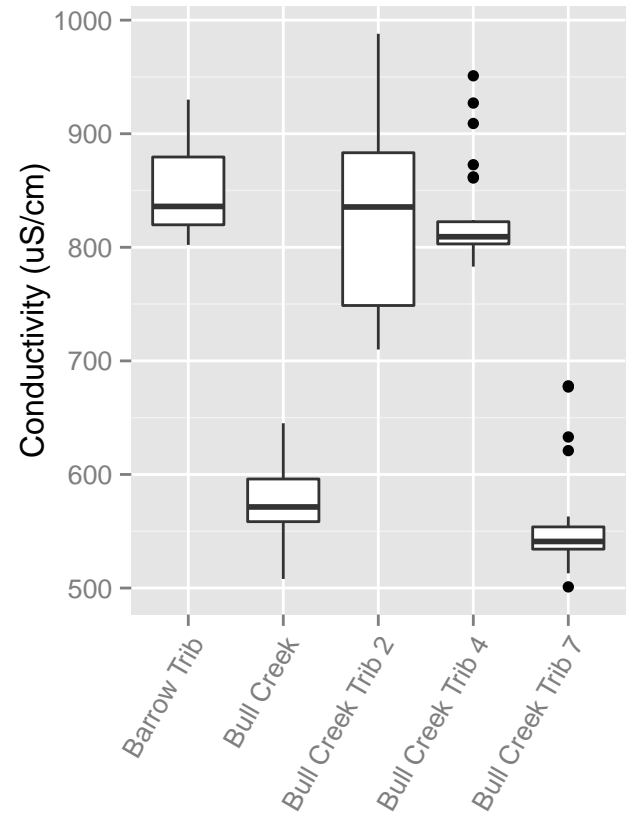
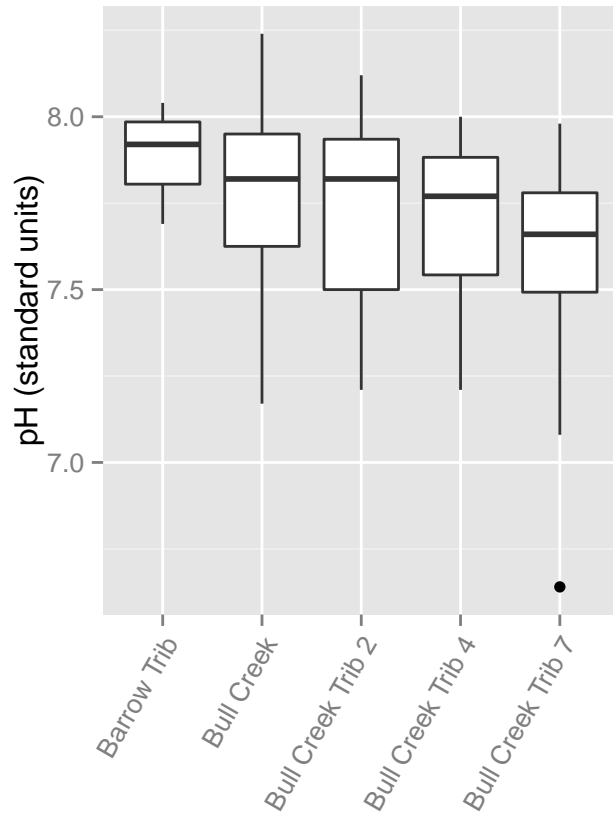
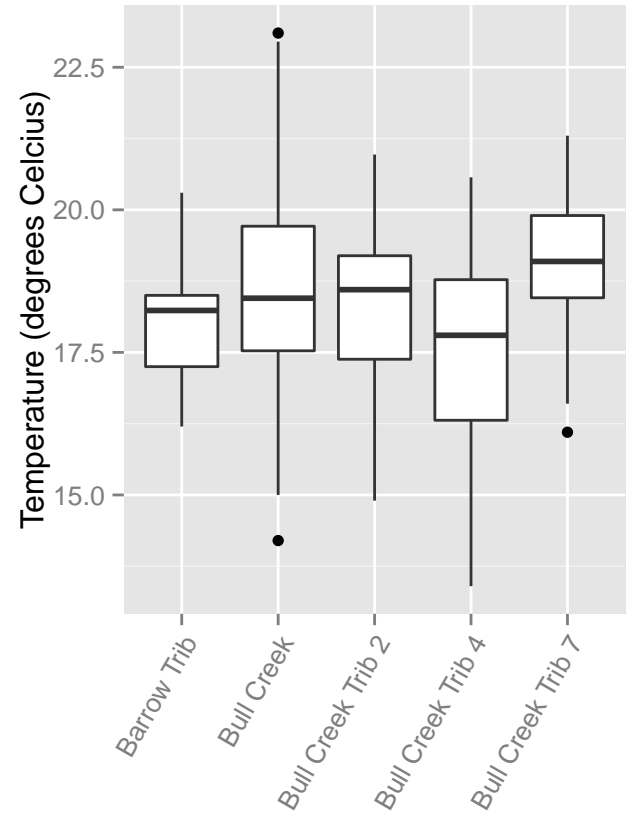
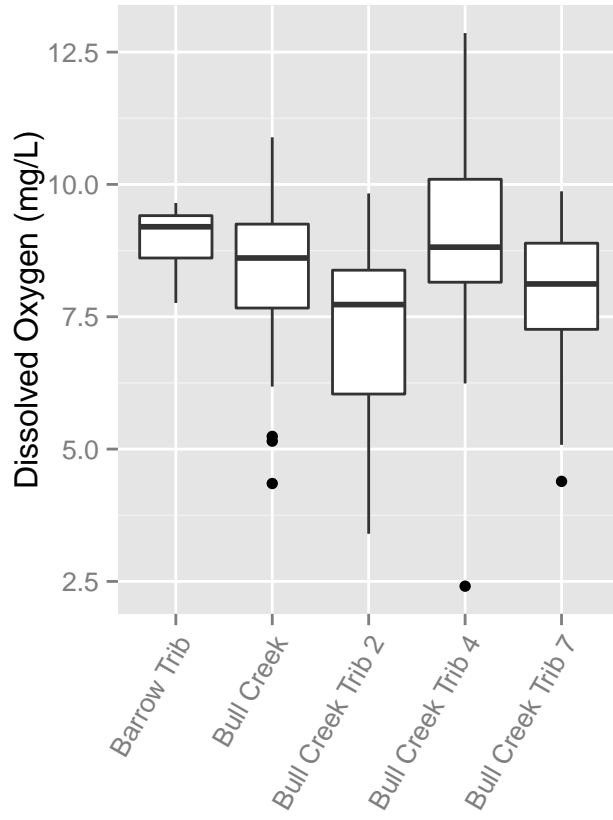
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2015-04-02	1421	Bull Creek Trib 2 @ JPS Occupancy Site 121
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2015-04-02	1442	Bull Creek Trib 2 @ JPS Occupancy Site 122
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2015-04-06	1037	Bull Creek Trib 4 @ JPS Occupancy Site 002
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2015-05-04	1444	Bull Creek Trib 4 @ JPS Occupancy Site 002
2015-04-06	1116	Bull Creek Trib 4 @ JPS Occupancy Site 003
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2015-04-15	1153	Bull Creek Trib 4 @ JPS Occupancy Site 007
2015-04-06	1218	Bull Creek Trib 4 @ JPS Occupancy Site 008
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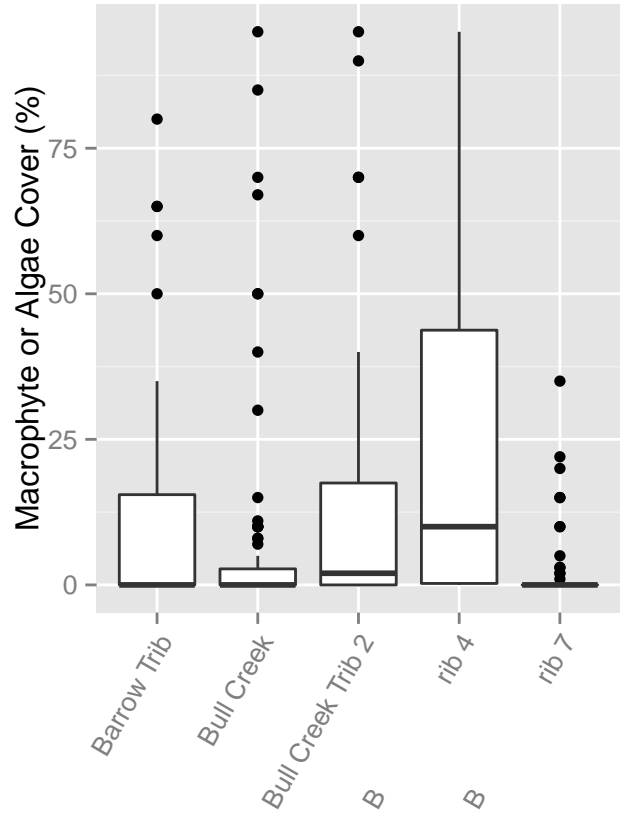
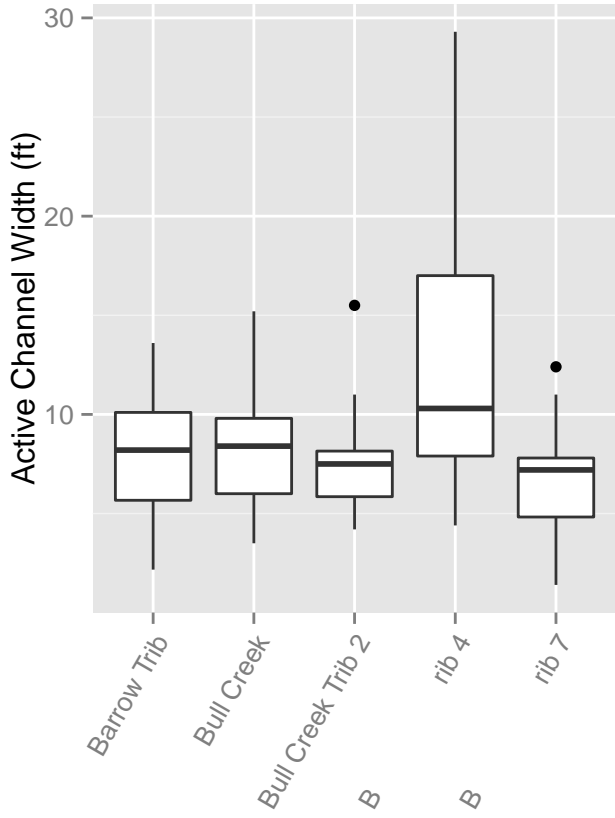
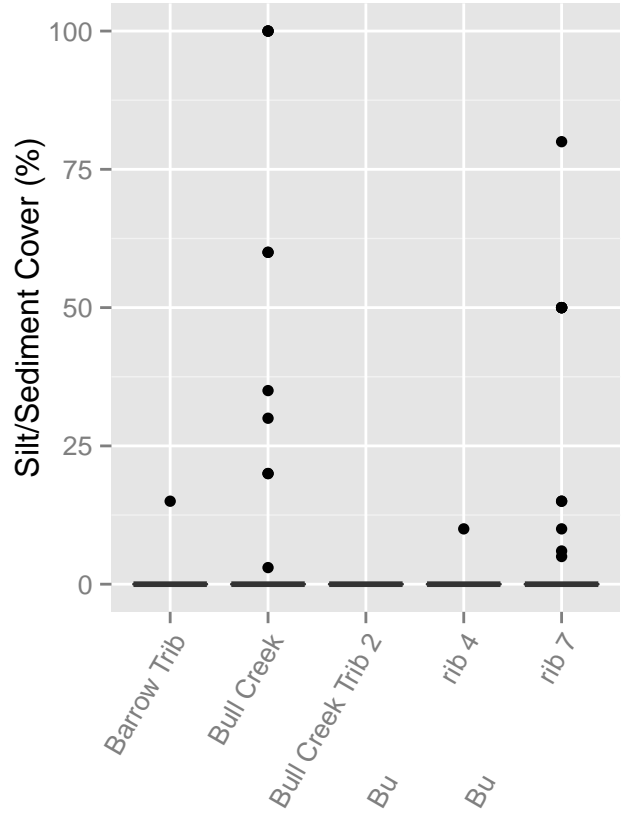
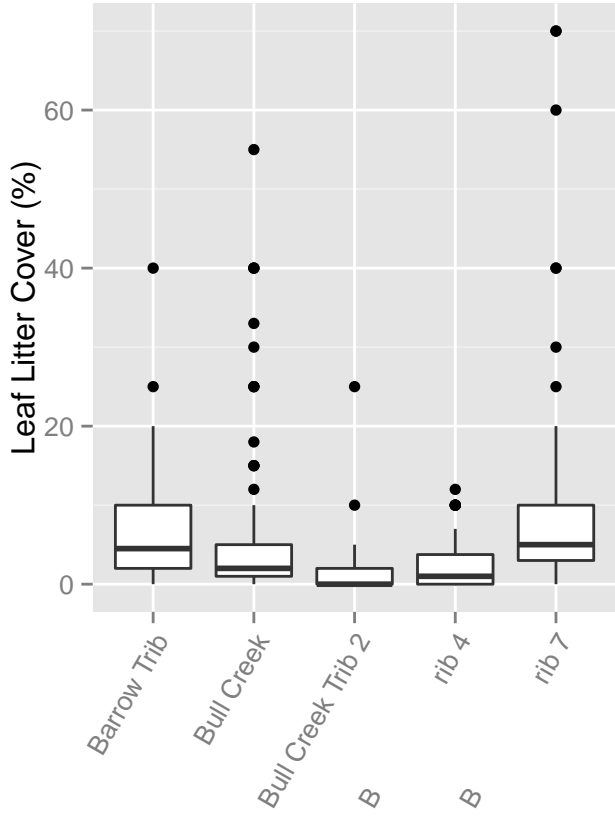
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2015-04-06	1249	Bull Creek Trib 4 @ JPS Occupancy Site 010
2015-04-15	1237	Bull Creek Trib 4 @ JPS Occupancy Site 010
2015-04-28	1438	Bull Creek Trib 4 @ JPS Occupancy Site 010
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2015-04-28	1328	Bull Creek Trib 4 @ JPS Occupancy Site 023
2015-04-06	1439	Bull Creek Trib 4 @ JPS Occupancy Site 023
2015-04-06	1454	Bull Creek Trib 4 @ JPS Occupancy Site 024
2015-04-15	1426	Bull Creek Trib 4 @ JPS Occupancy Site 024
2015-04-28	1315	Bull Creek Trib 4 @ JPS Occupancy Site 024
2015-04-06	1513	Bull Creek Trib 4 @ JPS Occupancy Site 025
2015-04-15	1441	Bull Creek Trib 4 @ JPS Occupancy Site 025
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2015-04-06	1524	Bull Creek Trib 4 @ JPS Occupancy Site 026

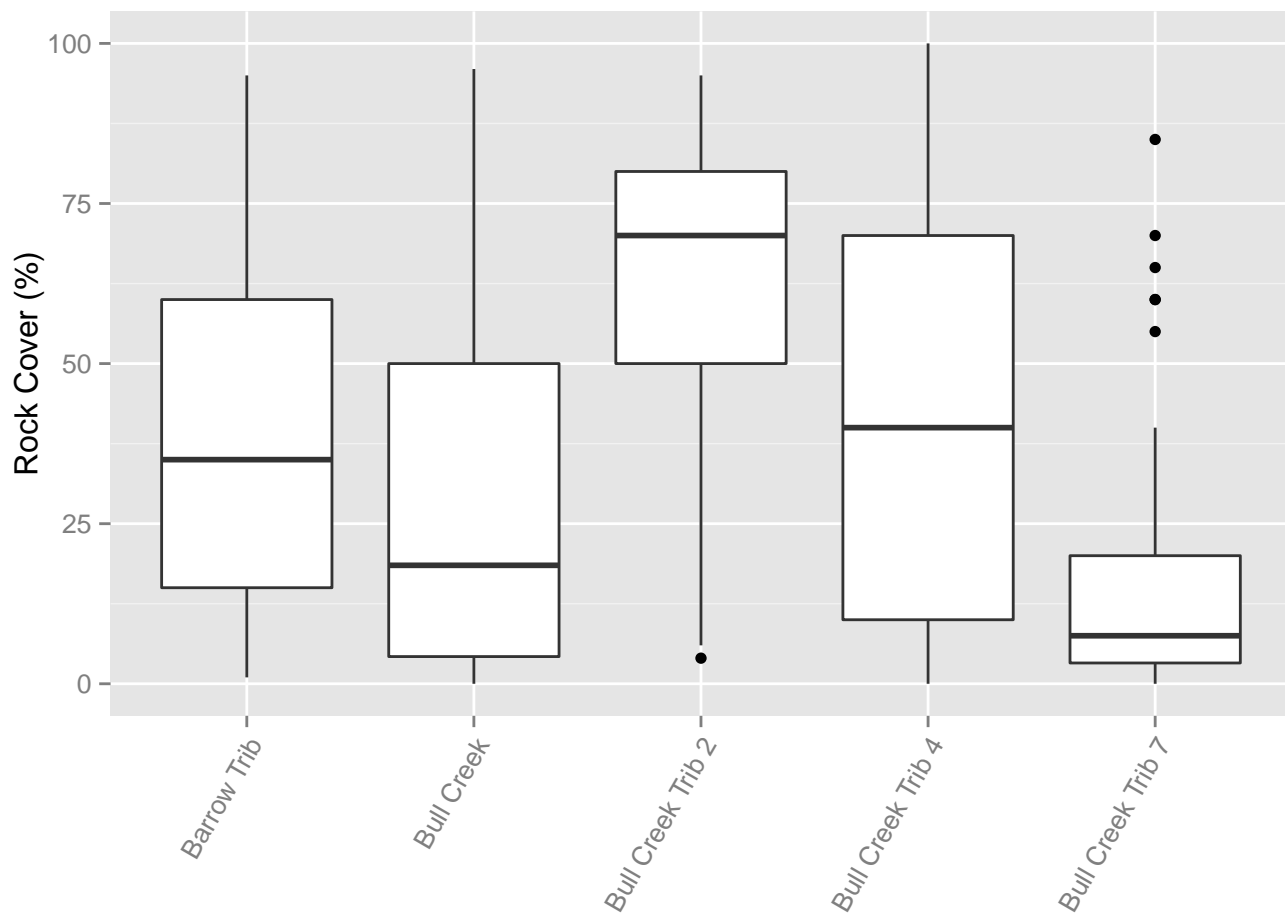
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2015-04-13	1023	Bull Creek Trib 7 @ JPS Occupancy Site 081
2015-04-24	1020	Bull Creek Trib 7 @ JPS Occupancy Site 081
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2015-05-01	1553	Bull Creek Trib 7 @ JPS Occupancy Site 082
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2015-04-24	1046	Bull Creek Trib 7 @ JPS Occupancy Site 083
2015-05-01	1548	Bull Creek Trib 7 @ JPS Occupancy Site 083
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2015-04-13	1130	Bull Creek Trib 7 @ JPS Occupancy Site 085
2015-04-24	1104	Bull Creek Trib 7 @ JPS Occupancy Site 085
2015-05-01	1536	Bull Creek Trib 7 @ JPS Occupancy Site 085
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2015-04-13	1217	Bull Creek Trib 7 @ JPS Occupancy Site 087
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2015-04-24	1211	Bull Creek Trib 7 @ JPS Occupancy Site 091
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2015-04-24	1257	Bull Creek Trib 7 @ JPS Occupancy Site 094
2015-05-01	1346	Bull Creek Trib 7 @ JPS Occupancy Site 094
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2015-04-24	1425	Bull Creek Trib 7 @ JPS Occupancy Site 101
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2015-05-01	1222	Bull Creek Trib 7 @ JPS Occupancy Site 102
2015-04-24	1446	Bull Creek Trib 7 @ JPS Occupancy Site 103
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2015-05-01	1208	Bull Creek Trib 7 @ JPS Occupancy Site 104
2015-04-14	1453	Bull Creek Trib 7 @ JPS Occupancy Site 105
2015-04-24	1455	Bull Creek Trib 7 @ JPS Occupancy Site 105
2015-05-01	1154	Bull Creek Trib 7 @ JPS Occupancy Site 105

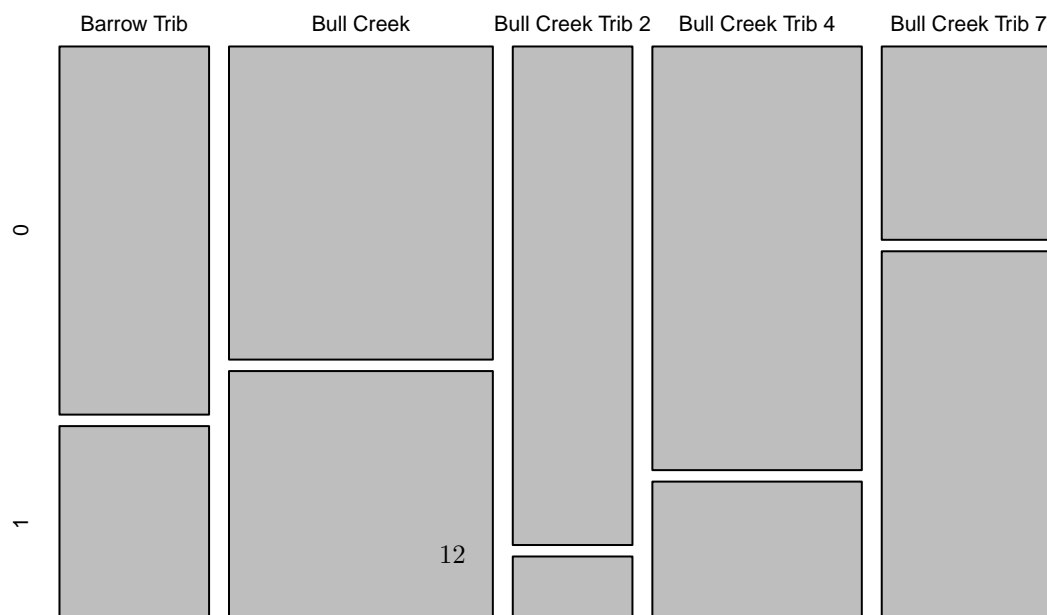
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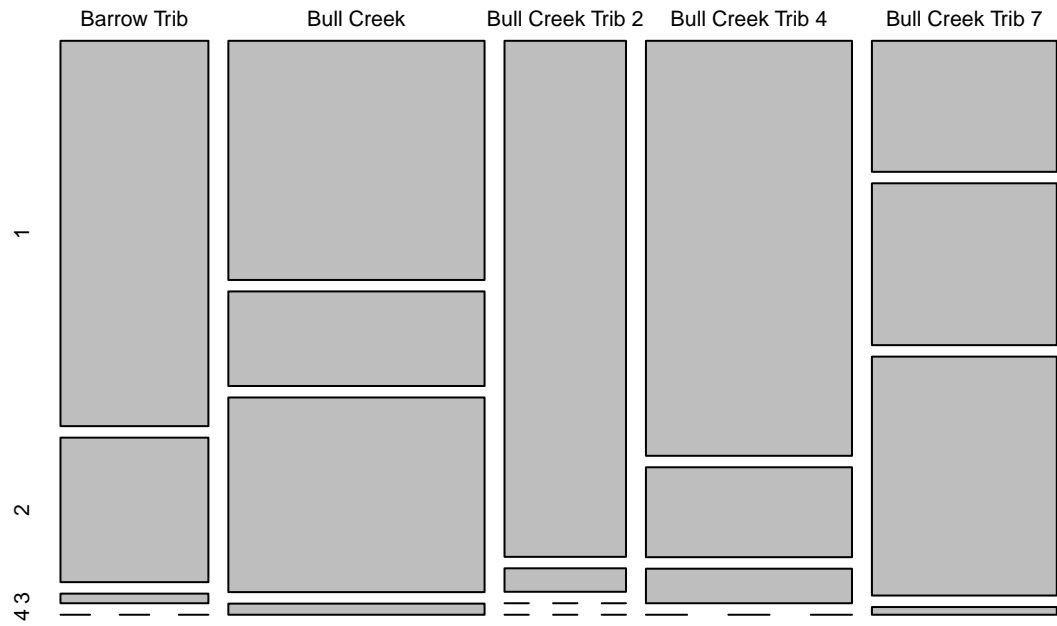




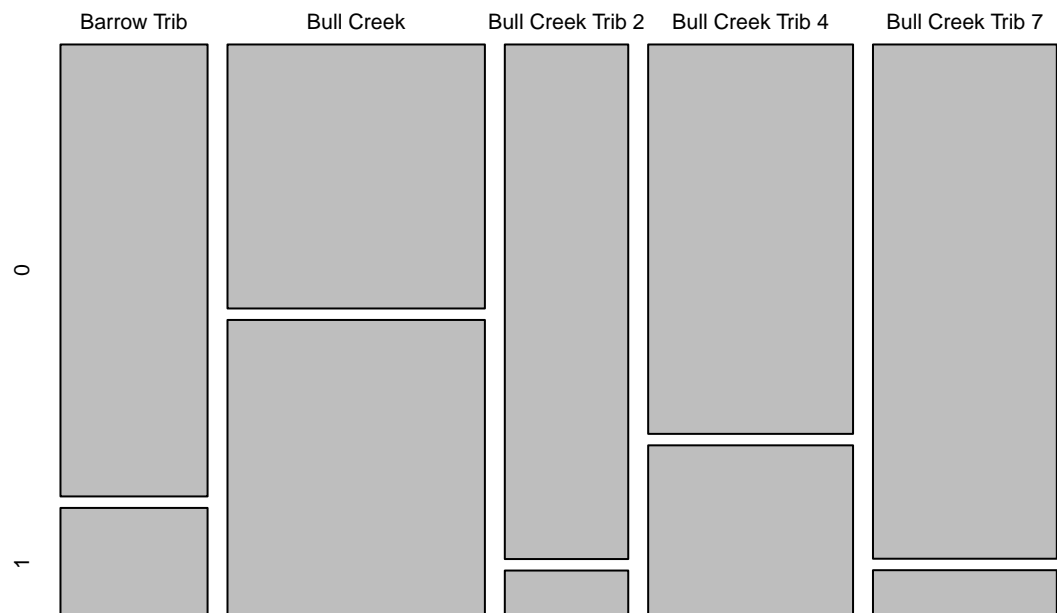
### Maidenhair Fern Presence



## Calcium Carbonate



## Salamander Presence



Species	Site	County	Date	LAT	LONG	Current Disposition
<i>Eurycea tonkawae</i>	box culvert at the junction of 620 and SH 45	Williamson	2015-01-07	30.482	-97.742	TNHC 92952
<i>Eurycea waterlooensis</i>	Eliza Spring	Travis	2015-02-11	30.265	-97.770	TNHC
<i>Eurycea waterlooensis</i>	Old Mill Spring (Sunken Gardens)	Travis	2015-03-26	30.263	-97.768	TNHC
<i>Eurycea sosorum</i>	Upper Barton Spring	Travis	2015-04-09	30.264	-97.774	TNHC

Table : Specimen Collection Log

**TE-833851, Section U., Permit Condition 6: General Annual Reporting Requirements for San Marcos Salamanders**

No research activities were performed on San Marcos Salamanders or within San Marcos Salamander habitat.

## TE-833851, Section V., Permit Condition 6: General Annual Reporting Requirements for Karst Invertebrates

During hydrogeological investigations, City of Austin permitted staff entered several caves that may harbor protected karst invertebrates. These caves, the dates of entry, City personnel, purpose of visit, and relevant observations are presented in the table below.

Date	#Entrants	Cave	Purpose	Individuals
12/2/2014	6	Flint Ridge	retrieve water samples	Justin Shaw, Heather Tucek, Jeff Nichols, Yaz Avila, Don Broussard, Elizabeth Herrer
12/16/2014			went to the end of the cave to dig more material that was washed in after the September 18 heavy rain.	Jeff Nichols, Yazmin Avila and Park Rangers Patrick Chaiken and Jeanette Spears
12/30/2014	4	Flint Ridge	To continue excavation on potential lead beyond Drip Pit.	Guinn McDaid, Bryce Smith, Rich Zarria, Yazmin Avila
1/7/2015	3	Flint Ridge	To remove rocks and dirt from the Drip Pit	Bryce Smith, Yazmin Avila and Park Ranger Julie Webber
1/19/2015	4	Flint Ridge	To enlarge a small passage below Drip Pit	Fernando Hernandez, Lydia Hernandez, Richard Zarria, Yazmin Avila
1/28/2015	7	Flint Ridge	To continue excavation on potential lead beyond Drip Pit.	Fernando Hernandez, Heather Tuček, Jeff Nichols, Vivian Loftin , Lydia Hernandez, Richard Zarria, Yazmin Avila
1/30/2015	4	Flint Ridge	To remove rocks and dirt from Drip Pit	Fernando Hernandez, Lydia Hernandez, Richard Zarria, Yazmin Avila
2/6/2015		Goat/maple Run	CoA educator training	
2/4/2015	7	Flint Ridge	To continue excavation on potential lead beyond Drip Pit.	Jeff Nichols, Fernando Hernandez, Lydia Hernandez, Yazmin Avila and Park Rangers Trisha Porter, Mark D. Cusman, John Nelsen
2/6/2015	4	Flint Ridge	To prepare room above Drip Pit for remove material	Lydia Hernandez, Fernando Hernandez, Jim Kennedy, Yazmin Avila
2/7/2015	9	Flint Ridge	To remove rocks from Dip Pit to an upper room	Lydia Hernandez, Fernando Hernandez, Andy Zenker, Liana Boop, Kris Peña, William Quast, Mimi Alexander, Jonny Scalise, Yazmin Avila
2/9/2015	3	Flint Ridge	Looking for passages above Drip Pit	Fernando Hernandez, Blake Sissel, Yazmin Avila
2/11/2015	3	Flint Ridge		Fernando Hernandez, Justin Shaw, Yazmin Avila
9/10/2015		Whirlpool	TX A&M Galveston Biospeology class	Tom Illife
9/11/2015		Airmans	TX A&M Galveston Biospeology class	
9/13/2015		Goat	TX A&M Galveston Biospeology class	
9/13/2015	11	Maple run	TX A&M Galveston Biospeology class	Justin Shaw, Fernando Hernandez

## References

- Bendik, N.F., Morrison, T.A., Gluesenkamp, A.G., Sanders, M.S., O'Donnell, L.J., 2013. Computer-assisted photo identification outperforms visible implant elastomers in an endangered salamander, *Eurycea tonkawae*. PLoS One 8, e59424. doi:10.1371/journal.pone.0059424
- Bendik, N.F., Sissel, B.N., Fields, J.R., O'Donnell, L.J., Sanders, M.S., 2014. Effect of urbanization on abundance of Jollyville Plateau salamanders (*Eurycea tonkawae*). Herpetol. Conserv. Biol. 9, 206–222. doi:10.1146/annurev.biochem.74.082803.133136
- Gabor, C.R., Zabierek, K.C., Kim, D.S., Alberici Da Barbiano, L., Mondelli, M.J., Bendik, N.F. and Davis, D.R. (*in press*). A non-invasive water-borne assay of stress hormones in aquatic salamanders. Copeia.