Linking anuran acoustic detections to environmental variables in Verde River Wilderness Areas

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Background & Objectives

Amphibians are declining globally, and anurans (frogs and toads) are one of the most threatened taxonomic groups worldwide (Luedtke et al., 2023). To determine how breeding habitat elements relate to the detection of anurans, I compared riparian sites occupied versus unoccupied by two native and one non-native anuran species.

H_0 Means of environmental variables from sites with anuran species detected vs. not detected do not differ. H_1 Riparian areas with anuran species detected vs. not detected will differ in environmental characteristics. I predict that differences will be species dependent due to varying natural histories and breeding habitat preferences.

Methods

- Detected anurans with 29 acoustic loggers recording overnight in spring 2021 and 2022
- Measured canopy cover, flow width, elevation, percent cover of pool/riffle/run/side-channel, and substrate in May-June 2022
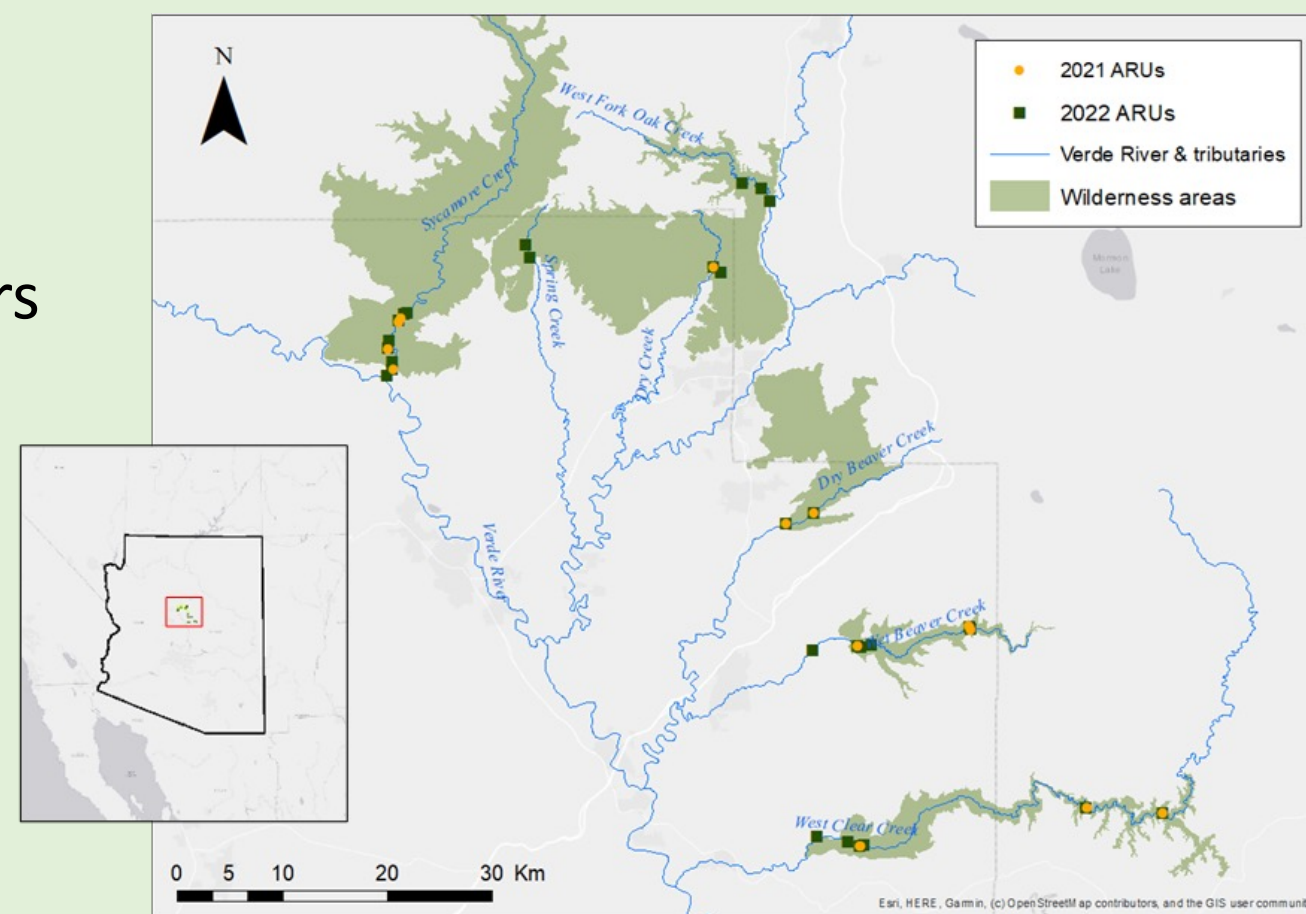- Conducted two-sample t-tests, non-parametric Mann-Whitney U, or Welch's t-tests in R software v4.3.0

Figure 1. Geographic distribution of the study sites across five Wilderness Areas.

WILDLIFE ACOUSTICS

Figure 2. A: Red-spotted toad (*Anaxyrus punctatus*). B: canyon treefrog (*Hyla arenicolor*). Both anuran species are native and relatively wide-spread throughout Arizona.

Results

Red-spotted toad: Sites with red-spotted toad had significantly lower mean flow width, flow width variance, riffle, and pool compared to non-detection sites (Table 1).

Canyon treefrog: Sites with canyon treefrog (n=22) had significantly higher NDVI variance (Welch's t=2.6, p=0.01) and marginally higher percent pool (Mann-Whitney U=112.5, p=0.07) compared to non-detection sites (n=7).

American bullfrog: Sites with American bullfrog had significantly higher mean flow width, sand, and pool and lower mean elevation, boulder, cobble, silt, and NDVI compared to non-detection sites (Table 1).

Table 1. Means and standard errors (SE) of environmental variables at sites occupied (n=3) and unoccupied (n=26) by red-spotted toad (*Anaxyrus punctatus*) and American bullfrog (*Lithobates catesbeianus*). Values in bold represent statistically different means at an alpha = 0.05.

	Red-spotted toad					American bullfrog			
Mean detected	SE	Mean not detected	SE	Variable		Mean detected	SE	Mean not detected	SE
1311.67	135.18	1323.27	240.77	Elevation		**1102.67**	**11.41**	**1347.38**	**45.14**
0.00	**0.00**	**8.35**	**5.27**	Flow width		**12.57**	**0.72**	**6.90**	**1.10**
0.00	**0.00**	**17.17**	**31.94**	Flow width variance		30.77	18.95	13.62	5.99
51.67	46.68	24.42	21.41	Boulder		**0.00**	**0.00**	**30.38**	**4.86**
38.97	34.00	18.00	14.56	Cobble		**3.87**	**1.93**	**22.05**	**3.48**
25.30	16.36	50.15	32.79	Sand		**89.73**	**6.19**	**42.72**	**5.94**
56.37	35.97	25.32	28.91	Silt		**0.00**	**0.00**	**31.83**	**5.99**
0.00	**0.00**	**0.24**	**0.20**	Riffle		0.13	0.08	0.22	0.04
0.00	**0.00**	**0.41**	**0.33**	Pool		**0.84**	**0.11**	**0.31**	**0.06**
0.40	0.05	0.39	0.08	NDVI		**0.32**	**0.01**	**0.40**	**0.02**

American bullfrog: a threat to native amphibians

- American bullfrog has been implicated in the decline of Chiricahua and lowland leopard frogs and federally threatened Mexican gartersnakes (*Thamnophis eques*) (Schwalbe & Rosen, 1988)
- Ranavirus and chytrid fungus are more likely to occur at bullfrog occupied sites, increasing risk of disease spread in native amphibians (Hossack et al., 2023)

Figure 3. American bullfrog (*Lithobates catesbeianus*), an invasive species in the Southwest USA.

Implications & Future Directions

Canyon treefrog is one of the most climate vulnerable amphibian species in the Southwest USA, while invasive American bullfrog is one the least vulnerable (Griffis-Kyle et al., 2018). Overlaps in breeding habitat use between native and non-native species have implications for management, particularly in the contexts of disease and climate change.

Acknowledgements & Literature Cited

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