Effects of Drought on Birds, Vegetation, and Surface Flow in a Desert Riparian Woodland

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Introduction

Global climate change is predicted to reduce water availability in southwest North America within the next 100 years and may already be causing a shift to a more arid climate. The reductions in available water from a changing environment, coupled with increasing demand by growing human populations, may pose a substantial threat to desert riparian woodlands in future years. Riparian woodlands in the desert southwest provide habitat for many species of wintering, breeding, and migratory birds. Over 50% of breeding bird species in the southwest U.S. are estimated to be dependent upon riparian woodlands even though these areas account for <1% of the landscape. Understanding the role of surface water and depth to groundwater for maintaining the ecosystem services provided by riparian woodlands is important for the preservation of regional biodiversity in the face of future changes in climate.

Methods

We conducted a study of a drought-stricken riparian woodland in southeastern Arizona from 2006-2010 to determine how a riparian bird community responds to (and recovers from) decreased surface water, ground water, and degraded riparian vegetation. We surveyed birds and monitored nests while simultaneously measuring riparian vegetation, surface water, and ground water to track the changes in these variables resulting from a temporary drought.

Results

Fig. 1 Surface Water from 2006-2010

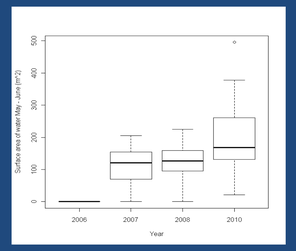
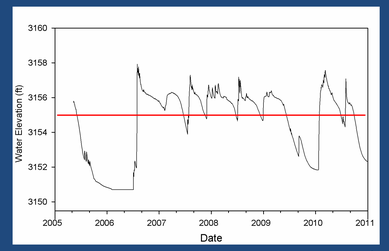


Fig. 2 Ground water elevation 2006-2010



Surface water was completely absent from the site during the avian breeding season (May through June) in 2006 (fig. 1). Groundwater was also extremely low (below the bottom of the monitoring wells) (fig. 2). Normal hydrologic regime was restored in 2007 with a pattern of peak flow in the spring followed by gradual decline throughout the breeding season.

Fig. 3 Repeat Photography

Summer 2006 | Summer 2007 | Summer 2008 | Summer 2011

Effects on Vegetation

Few trees produced leaves during the summer of 2006 and their recovery from the 2006 drought took several years once normal hydrologic regime was restored (fig. 3). Total live vegetation volume increased each year from 2006-2010 (t=10.7, p<0.001; Fig. 4). Total live vegetation volume for the low height class increased more than three-fold (t=12.2, p<0.001), the middle height class more than doubled (t=4.1, p<0.001), but total live vegetation for the highest height class did not show a significant trend across years (t = 0.2, p=0.872). In contrast, total dead vegetation decreased each year from 2006-2010 (t=3.8, p<0.001). Dead vegetation decreased at both the middle (t=4.9, p<0.001) and high (t=2.8, p=0.009) height classes, but not at the low height class (t=1.4, p=0.171).

Fig. 4 Vegetation volume from 2006-2010

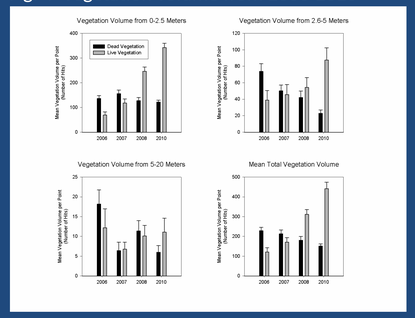


Fig. 5 Species that were less abundant during drought

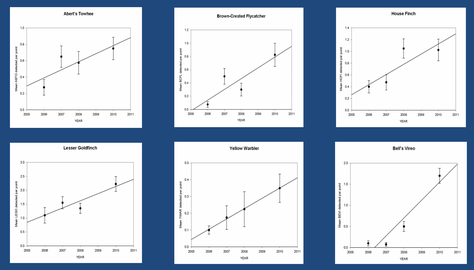


Fig. 6 Species that were more abundant during drought

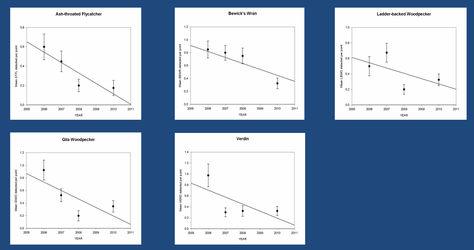


Table 1 Nesting attempts from 2006 -2010

Year	Bell's Vireo	Northern Cardinal	Yellow Warbler	Yellow-billed Cuckoo	Varied Bunting
2006	1	1	0	0	0
2007	0	0	0	0	0
2008	8	4	1	0	0
2010	22	10	1	1	1

Effects on Birds

Of the 20 most common species, we detected 6 with an increasing trend (fig 5) from 2006 to 2010 and 5 with a decreasing trend (fig. 6). We detected a marginally significant positive trend in 2 other species, brown-crested flycatcher (*Myiarchus tyrannulus*) and house finch (*Carpodacus mexicanus*), as well as one species with a marginally significant negative trend, ladder-backed woodpecker (*Picoides scalaris*). Of the 6 species for which we detected a positive trend from 2006 to 2010, 4 are riparian obligates and 2 are in need of conservation action (USGS 2006). Of the 6 species for which we detected a negative trend, 4 species nest in tree cavities and are likely to be associated with dead vegetation. The 2 other species typically breed in the surrounding upland.

Surface water was the most important variable for explaining the relative abundance of 9 species and overall species richness. Surface water had a significant and positive effect on overall species richness as well as the abundance of both lesser goldfinch (*Spinus psaltria*) and vermillion flycatcher (*Pyrocephalus rubinus*). Water also appeared to be an important variable for both brown-crested flycatcher and yellow warbler (*Dendroica petechial*). Surface water had a negative effect on just one species, verdin (*Auriparus flaviceps*). The proportion of live to dead vegetation from the low height class was the most important variable for 6 species. The proportion of live to dead vegetation from the middle height class was the most important variable for 3 species; house finch (tied with the lowest height class), Lucy's warbler (*Vermivora luciae*), and mourning dove (*Zenaida macroura*).

Our nest monitoring efforts support the results from our survey data (table 1). We found increases in the number of nests initiated by 3 of the 4 focal species we monitored from 2006 to 2010, suggesting increased use of the riparian woodland by riparian obligate species in years with surface water. In contrast, we found 3 times more verdin nests in 2006 compared to the subsequent 3 years, suggesting that verdins were more common in the riparian woodland during the drought year (2006).

Note:

Although the reduction in surface water we documented was due to drought, similar effects on water availability can be produced with groundwater pumping for human use (Lite and Stromberg 2005). The transition of the southwest U.S. to a more arid climate and the increase in groundwater withdrawal to support a growing human population will provide a double threat to riparian woodlands. Maintaining an adequate supply of water to southwest riparian woodlands will only become more important, and more difficult, in future years.

Conclusions

Predicted changes in climate and the subsequent shift in drought regime will likely alter riparian woodlands and their associated bird communities. Our data demonstrate how the reduction in available ground water and loss of surface water can result in a direct loss of suitable riparian habitat for several species of riparian birds. The quick recovery of both riparian vegetation and birds we documented may reflect that drought is a part of the natural disturbance regime for southwest riparian woodlands. Climate change has the potential to shift the drought regime outside of the naturally occurring cycle through a combination of decreased winter precipitation, increased temperatures, and increased frequency, size, and duration of drought. Additional information is needed to understand how riparian-obligate birds cope with disturbance caused by drought or increased groundwater withdrawal. Understanding these mechanisms will help mitigate the effects of climate-induced drought conditions in the future.

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