



Quantifying impacts of groundwater withdrawal on avian communities in desert riparian woodlands of the southwestern U.S.

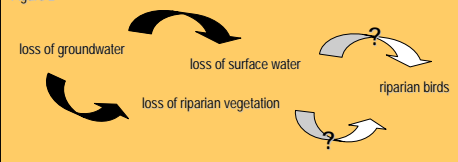
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INTRODUCTION

Desert riparian woodlands in the southwestern U.S. are an extremely important resource because they constitute <1% of the desert landscape, yet typically support >50% of the breeding birds. Desert riparian woodlands also provide shelter and critical food resources for dozens of species of long-distance, neotropical migratory birds that alight in these woodlands during their spring and fall migrations. Groundwater withdrawal (and subsequent loss of surface water) to support urban developments in the southwestern U.S. has the potential to degrade or eliminate desert riparian woodlands throughout the region, including desert riparian woodlands along the Upper San Pedro River adjacent to Fort Huachuca Military Reservation, Arizona (Fig. 1). Rapid lowering of groundwater tables is known to negatively affect the health of riparian vegetation and reduce or eliminate surface water flows in riparian systems (Fig. 2). What's less clear is how reductions in surface water and declines in the long-term health of riparian vegetation will affect populations of riparian bird species in the region (Fig. 2). Military readiness could be jeopardized if limited resources are diverted from the military's mission at Fort Huachuca (and at other military installations throughout the southwestern U.S.) to deal with the recovery of potentially dozens of declining populations of birds.

Figure 2.



OBJECTIVES

- Examine connections between ground water, surface water, and the health and persistence of riparian bird communities in the southwestern U.S.
- Examine underlying ecological processes (e.g., availability of potential food resources such as aerial arthropods) that may influence these connections.
- Develop models so that resource managers on military lands (and elsewhere) can predict how future changes in surface-water and ground-water levels will affect riparian bird communities.

STATISTICAL HYPOTHESES TESTED

- Surface water in 50-m radius of bird survey points is positively correlated with bird species richness and relative abundance.
- Dead or dormant riparian vegetation in 50-m radius of bird survey points is negatively correlated with bird species richness and relative abundance.
- Dry biomass of aerial arthropods is greater in desert riparian woodlands that have surface water.

METHODS

- With the aid of a GIS, we identified ~30 potential study sites that were broadly similar in terms of their elevation, stream order, topography, and vegetation type.
- Of these ~30 sites, we selected 17 sites (Fig. 1) that varied in terms of the amount of surface water and the health of riparian vegetation present.
- From April-June 2006, we estimated bird relative abundance and species richness by conducting 4 bird surveys along point-count survey routes at each site.
- We estimated the surface area of standing pools of water and flowing segments of water at each study site following each replicate bird survey.
- We estimated the volume of both live and dead or dormant vegetation within a 50-m radius of bird survey points using the point-line intercept method.
- We sampled aerial arthropod biomass at a subset of 3 "wet" and 3 "dry" study sites using sticky traps hung from riparian trees at each bird survey point.

STATISTICAL ANALYSES

- We used stepwise multiple linear regression to model the relative influence of our explanatory variables (surface water, vegetation volume, etc.) on our response variables (bird species richness, total relative abundance, and relative abundance by species).
- We used one-way ANOVAs to compare means in dry biomass of aerial arthropods between "wet" and "dry" study sites.

PRELIMINARY RESULTS (YEAR 1 OF 3-YEAR STUDY)

- At the community level, we were unable to detect associations between bird species richness or total bird relative abundance and the presence of surface water or the health of riparian vegetation.
- At the species level, we detected positive associations between surface water (i.e., interactions between surface water and vegetation volume) and bird relative abundance for 3 species (yellow-rumped warbler, Wilson's warbler, and black phoebe) in our final linear regression models (Fig. 3).
- We found that dry biomass of aerial arthropods in 3 arthropod orders (Diptera, Mecoptera, and Trichoptera) was greater on sticky traps at "wet" compared to "dry" study sites (e.g., dry biomass of Dipterans was 3 times greater at "wet" study sites; Table 1).

Figure 1. Map of southeastern Arizona showing locations of 17 study sites, including 2 study sites situated along the San Pedro River (see inset photo) adjacent to Fort Huachuca Military Reservation (bounded by red line).

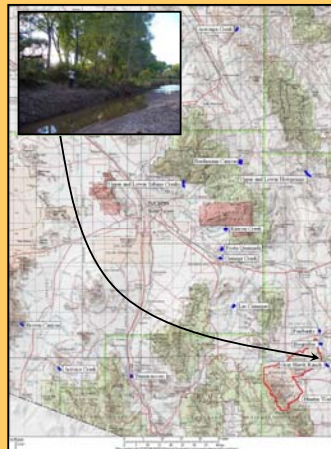


Fig. 3. Three bird species whose relative abundance was positively associated with surface water in riparian woodlands of southeastern Arizona.



DISCUSSION AND CONCLUSIONS

- The presence and extent of surface water in desert riparian woodlands appears to have a positive influence on the relative abundance of some riparian bird species, including both breeding and long-distance migrant species.
- Avian food resources such as Dipterans appear to be more abundant in desert riparian woodlands that have surface water.
- Previous research has shown that Dipterans comprise a relatively large portion of the arthropod diet for many bird species, including black phoebes, yellow-rumped warblers, and Wilson's warblers (Wolf 1997, Hunt and Flaspohler 1998, Ammon and Gibert 1999).
- Depletion of surface water resulting from ground-water pumping and/or drought has the potential to negatively impact populations of riparian bird species in the southwestern U.S.
- Resource managers on military lands (and elsewhere) should consider the implications of continued ground-water pumping (and subsequent surface-water depletion) on the health and persistence of riparian bird communities in the region.

Table 1. Dry biomass (mg) of aerial arthropods at "wet" vs. "dry" study sites.

Order	"Wet" sites (n=3)		"Dry" sites (n=3)		F _{1,4}	P
	Mean	SE	Mean	SE		
Coleoptera	7.9	1.6	5.6	1.9	0.5	0.53
Diptera	15.5	3.5	5.0	1.6	11.9	0.03
Ephemeroptera	0.0	0.0	0.1	0.0	0.4	0.55
Hemiptera	2.4	0.9	2.2	0.9	0.0	0.91
Homoptera	4.8	1.4	3.3	1.1	0.5	0.52
Hymenoptera	22.8	3.8	18.7	4.4	0.2	0.67
Lepidoptera	0.2	0.1	1.2	0.7	1.7	0.26
Mecoptera	0.5	0.1	0.1	0.0	13.0	0.02
Trichoptera	0.4	0.3	0.1	0.0	3.9	0.12
All Orders	73.4	10.0	57.5	10.0	0.3	0.62

FUTURE WORK (2007-2008)

Additional funding from the DOD Legacy Resource Management Program will allow us to:

- 1) Increase our sample size of replicate study sites, especially study sites that have experienced degradation of riparian vegetation.
- 2) Continue collecting data at 10 of our 17 original study sites so that we can track changes in bird parameters through time as surface water conditions change from one year to the next.
- 3) Incorporate ground-water data from each study site into our linear regression models.
- 4) Monitor bird nests and compare reproductive data at a subset of "wet" and "dry" study sites.