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Abundance and variety of birds associated with point sources of water in southwestern New Mexico, U. S. A.

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ABSTRACT

Developed waters may improve arid landscapes for birds, but their efficacy requires further study. I counted birds along five 300-m transects originating at point sources of water in a New Mexico grassland, and compared results with those from transects without water. Total birds were nearly three times more abundant on transects with water, but differences were greater in spring and winter than during the wet summer period. Twenty-two of 25 common species trended toward greater abundance on transects with water, eight of these at statistically significant levels, including Gambel's Quail, Mourning Dove, House Finch, and a variety of wintering sparrows. Sixty-four percent of detections along transects with water occurred <50 m from the water sources, at which birds regularly drank. Results suggest 1) that water attracted birds, especially in dry seasons, and 2) that proximity to water may influence the abundance and composition of avian assemblages in arid landscapes.

1. Introduction

Water is a limited and diminishing resource in the desert ecosystems of southwestern North America (Bahr, 1991; Whitford, 2002). One management strategy to enhance southwestern wildlife has been the addition of developed sources of water (Krausman et al., 2006). However, studies of avian responses to developed waters in southwestern ecosystems have been limited and with mixed results (Rosenstock et al., 1999; Simpson et al., 2011). I counted birds along transects associated with point sources of water in southwestern New Mexico, and compared these results with those from paired transects without water. Objectives were to determine the degree to which birds were attracted to water, and how this differed across seasons and among species.

2. Materials and methods

The study area was the 4504-ha Pitchfork Ranch, in Grant County, New Mexico, USA (32° 24′ N, 108° 20′ W). Temperatures range from a mean daily June–July high of 33.1 °C to a mean daily January–February low of −5.3 °C. Average annual precipitation is 26.7 cm, more than half of which occurs during the July–August monsoon. The ranch's dominant feature is a 15 km reach of the Burro Cienega watercourse that dissects the ranch from north to south. Riparian vegetation in the main drainage and its side tributaries includes Gooddings willow (*Salix gooddingi*), velvet ash (*Fraxinus velutina*), Fremont cottonwood (*Populus fremontii*), Arizona walnut (*Juglans major*), and giant sacaton grass (*Sporobolus wrightii*). Upland areas are dominated by a variety of warm-season perennial grasses, mostly tobosa (*Hilaria mutica*) and grama (*Bouteloua*) species, along with scattered Emory oak (*Quercus emoryi*), one-seed juniper (*Juniperus monosperma*), and mesquite (*Prosopus glandulosa*). The ranch was very lightly grazed by an average of about 24 cattle during the years of my study.

I counted birds at and near all the available (five) permanent point sources of water on the property, each in a drainage otherwise lacking surface water: three steel stock tanks fed by windmills that included one or two small feeder tanks within 30 m, one dirt stock tank about 3 m in diameter fed by a solar-powered pump, and one permanent pond about 4 m in diameter fed by precipitation captured through ongoing watershed restoration efforts. The five developments were similar insofar as each provided small and isolated bodies of water that had no apparent impacts on local vegetation.

In May 2008 I established 300-m experimental transects originating at each of these five point sources of water, and paired each with a 300-m control transect in similar vegetation in the same drainage randomly located between 500 and 1000 m from the water source. Each of the 10 300-m transects was at least 500 m

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from its nearest neighbor.

I walked each transect 15 times between May 2008 and August 2014, counting all birds seen or heard within 50 m on either side of the transect lines, and recording instances when I observed a bird drinking from one of the water sources. Because I was interested in the geographic scale at which the water sources might influence bird numbers, I also recorded the point along the transect at which each sighting occurred, and grouped count results into six bands of 50 m each. Counts occurred in the mornings of clear and relatively calm days. I conducted five counts in winter (two in Nov 2008, two in Dec 2009, and one in Dec 2012), five in spring (two in May 2008, one in April 2009, and two in May 2013), and five in summer (two in August 2008, two in August 2011, and one in August 2014). Each count on an experimental transect occurred on the same day as a count on its paired control transect, with both the sequence and direction of walking alternating between visits.

The first six counts on both control and experimental transects were conducted along lines running perpendicular to the drainages, while the second nine counts were conducted along transects originating at the same points but running parallel to the drainages. Average counts of all birds combined did not differ based on transect orientation. Therefore, I combined count results for all further analyses.

I was unable to estimate actual bird densities. Clusters of birds near the transect lines close to water sources violated the assumption of random transect placement relative to bird distribution that is necessary for calculation of distance functions (Buckland et al., 2001). Therefore, I used total numbers counted per transect survey as an index of relative abundance only, and I make no inferences about actual densities. I am confident that numbers of detections of individual species were generally proportional to their actual abundances on experimental versus control plots, 1) because I conducted all the counts personally, therefore eliminating the possibility of differing abilities among observers, and 2) because of the generally similar vegetation on each experimental transect and its paired control. My confidence in the reliability of count results was enhanced by the fact that total bird numbers counted per experimental transect did not differ from control transects except in the immediate vicinity of the water sources, suggesting similarity of landscapes other than presence versus absence of a water source.

I calculated the total numbers of all bird species combined, averaged across all 15 surveys, for each entire transect and for each 50-m transect segment individually, and compared these average counts between treatment and control transects using oneway analyses of variance. Having determined that total numbers of birds averaged much higher on treatment transects (those originating at a water source), I then analyzed data for the 25 most common individual species in two ways, to explore how many and which species contributed to the overall pattern. First, I determined the number of species whose average counts were higher on experimental versus control transects, regardless of the magnitude of the difference, and used the chi-square contingency statistic to compare this result against the null expectation of equal numbers of species in both categories. Second, I compared average counts of each species across treatments using oneway analyses of variance. Mindful of the possibility of Type-I errors with such a large number of comparisons (Zar, 2009), I interpreted the anova results not as tests of individual hypotheses but as a means of exploring the relative contributions of different species to the overall pattern. Finally, I calculated the total numbers of individuals counted per transect, averaged separately for counts within the three sample seasons (n = five surveys each in spring, summer, and winter), and tested for a possible interaction between treatment and seasonal effects using twoway analysis of variance. All statistical tests were performed using Statview 5.0.1 (SAS Institute, 1999), with $p < 0.05$

Table 1

A. Mean (SE) detections per survey of all birds and the 25 most common species on five 300-m transects originating at point sources of water (experimental transects), and on five paired control transects on the Pitchfork Ranch, Grant County, New Mexico. Each transect was counted 15 times between May 2008 and August 2014. Species marked with an asterisk are those also observed drinking at one or more of the water sources.

	Transect type		$F_{1,8}$ (p)
	Exp.	Cont.	
All birds	41.1 (6.4)	14.4 (2.3)	15.3 (0.005)
Gambel's Quail (*Callipepla gambelii*)*	6.1 (1.5)	2.0 (0.5)	6.5 (0.03)
Mourning Dove (*Zenaida macroura*)*	2.3 (0.5)	0.8 (0.1)	8.6 (0.02)
Northern Flicker (*Colaptes auratus*)	0.2 (0.1)	0.1 (0.1)	ns[a]
Western Kingbird (*Tyrannus verticalis*)	0.2 (0.1)	0.2 (0.1)	ns
Mexican Jay (*Aphelocoma wollweberi*)	0.1 (0.1)	0.2 (0.1)	ns
Cactus Wren (*Campylorhynchus brunneicapillus*)	0.2 (0.1)	0.1 (0.1)	ns
Ruby-crowned Kinglet (*Regulus calendula*)	0.1 (0.1)	0.2 (0.1)	ns
Curve-billed Thrasher (*Toxostoma curvirostre*)	0.3 (0.1)	0.2 (0.1)	ns
Northern Mockingbird (*Mimus polyglottos*)*	0.6 (0.1)	0.2 (0.1)	5.6 (0.05)
Wilson's Warbler (*Cardellina pusilla*)*	0.2 (0.1)	0.1 (0.1)	ns
Spotted Towhee (*Pipilo maculatus*)	0.3 (0.2)	0.2 (0.1)	ns
Rufous-crowned Sparrow (*Aimophila ruficeps*)*	0.2 (0.1)	0.1 (0.1)	ns
Canyon Towhee (*Melozone fusca*)	0.9 (0.2)	0.8 (0.2)	ns
Chipping Sparrow (*Spizella passerina*)*	9.4 (1.5)	2.2 (0.7)	18.2 (0.003)
Brewer's Sparrow (*Spizella breweri*)*	1.9 (0.9)	0.3 (0.2)	ns
Vesper Sparrow (*Pooecetes gramineus*)*	1.2 (0.2)	0.2 (0.1)	16.0 (0.004)
Lark Sparrow (*Chondestes grammacus*)*	0.2 (0.1)	0.1 (0.1)	ns
Black-throated Sparrow (*Amphispiza bilineata*)*	1.7 (0.6)	1.3 (0.3)	ns
White-crowned Sparrow (*Zonotrichia leucophrys*)*	4.3 (1.6)	1.5 (0.9)	6.3 (0.04)
Dark-eyed Junco (*Junco hyemalis*)*	1.8 (1.3)	0.3 (0.2)	ns
Northern Cardinal (*Cardinalis cardinalis*)*	0.4 (0.2)	0.2 (0.1)	ns
Blue Grosbeak (*Passerina caerulea*)	0.4 (0.1)	0.3 (0.1)	ns
Brown-headed Cowbird (*Molothrus ater*)	0.3 (0.1)	0	5.2 (0.05)
Bullock's Oriole (*Icterus bullockii*)*	0.3 (0.3)	0.2 (0.1)	ns
House Finch (*Haemorhous mexicanus*)*	3.5 (0.6)	0.6 (0.2)	17.9 (0.003)
Five winter sparrows[b]	18.5 (3.1)	4.5 (1.7)	15.8 (0.004)

[a] ns = $p > 0.10$.
[b] These five species were Chipping Sparrow, Brewer's Sparrow, Vesper Sparrow, White-crowned Sparrow, and Dark-eyed Junco.

considered significant. Values reported in the results section are means + SE.

3. Results

Counts of all birds averaged nearly three times higher on experimental than on control plots across all seasons combined (Table 1). Twenty-five species comprised 89% of all birds counted, 22 of which were detected more frequently on experimental than on control transects ($X^2 = 14.44$, $p < 0.001$). Among these 25 species, those whose counts differed significantly between treatments were among those relatively common in the study area (Table 1): three year-round residents (Gambel's Quail, Mourning Dove, House Finch) and three wintering sparrows (Chipping Sparrow, Vesper Sparrow, and White-crowned Sparrow). Two other winter sparrows (Brewer's Sparrow and Dark-eyed Junco) also were counted much more frequently on experimental transects, although high variances among sites precluded statistical significance. The five winter sparrows combined were more than four times more abundant on transects with water than on those without water (Table 1). I observed 15 of the 25 most abundant species drinking from one or more of the water sources, including all those whose abundances differed significantly between treatments. The birds often arrived in flocks, coming from unknown but considerable distances.

There was a strong interaction between treatment and season (Fig. 1), attributable to the fact that birds were much more abundant on plots with vs. without water in spring and winter than in summer (treatment effect: $F_{1,24} = 30.3$, $p < 0.001$; season effect: $F_{2,24} = 8.9$, $p = 0.001$; interaction: $F_{2,24} = 5.3$, $p = 0.01$). The differences between counts on experimental versus control plots occurred entirely in the first 50 m of the transect origins (Fig. 2; $F_{1,8} = 19.98$, $p = 0.002$), which was the only band in which transect types differed significantly in average numbers of detections. Sixty-four percent of all detections on the experimental transects occurred <50 m from water.

4. Discussion

This study included only five pairs of transects, leaving open the possibility that differences in bird numbers or their detectability between treatments could have been due to minor chance differences in transect vegetation. However, this seems highly unlikely, given that 1) each experimental transect (with water) was placed in the same drainage as its paired control, in a generally similar area, 2) the numbers of detections within 50 m of the transect points of origin averaged more than six times higher on transects where the point of origin began at a water source (Fig. 2), but 3) detections beyond the 50 m limit did not differ between treatments. I conclude that birds were strongly attracted to sources of water on the Pitchfork Ranch, and that they came there to drink.

There are two possible reasons why birds came to water more in spring and winter than in summer (Fig. 1), neither exclusive of the other. First, July–August is the nesting season for most species on the study site (personal observation), when individuals are most likely to be on territories, tied to nests, and therefore less mobile. Second, and a more likely explanation, this also is the period of the summer monsoon, when water is more generally available across the study area (A. T. and L. Cole, unpublished data).

Several studies have quantified the numbers of birds visiting developed waters in western North America, but without comparison to areas lacking water (Gubanich and Panic, 1986; O'Brien et al., 2006; Lynn et al., 2008). Those few studies comparing bird numbers between areas near versus far from developed waters have yielded mixed results. Two reported higher numbers near water (Cutler and Morrison, 1998; Knight et al., 1998), while two others found no differences (Burkett and Thompson, 1994; Lynn et al., 2006).

The preponderance of evidence, including results from this study, indicates that a variety of southwestern birds regularly drink at developed waters in otherwise dry seasons and landscapes. Gambel's Quail, Mourning Doves, and House Finches were strongly attracted to water sources on the Pitchfork Ranch, and all have been shown to depend on free water during dry periods elsewhere in their ranges (see review of this topic in Krausman et al., 2006).

Particularly striking in the present study was the attraction of wintering sparrows to developed waters. Vegetation structure and seed availability have been shown to be key variables determining the abundance and composition of sparrow assemblages wintering in southwestern desert grasslands (Pulliam and Mills, 1977;

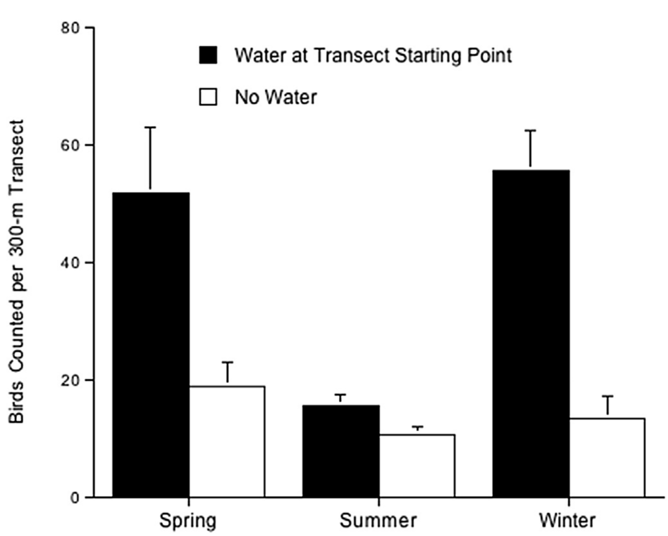

Fig. 1. Mean (SE) detections per survey of all birds on five 300-m transects originating at point sources of water and on five paired control transects in southwestern New Mexico, separated into spring (April–May), summer (Aug.) and winter (Nov.–Dec.) seasons.

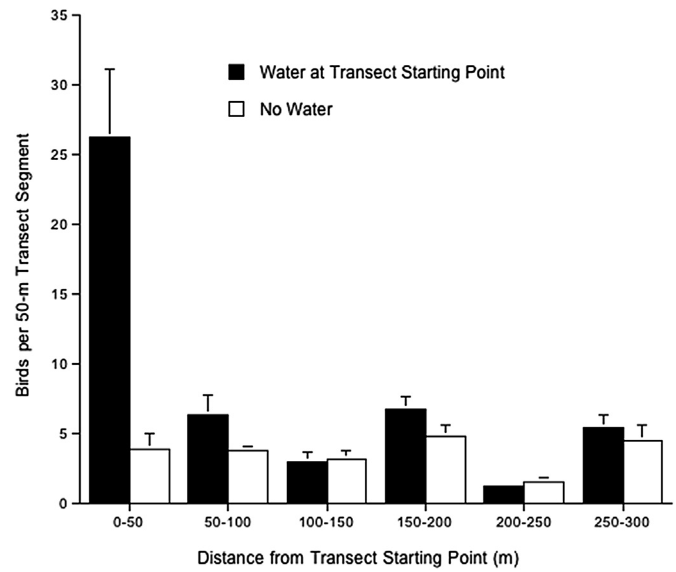

Fig. 2. Mean (SE) detections per survey of all birds on five 300-m transects originating at point sources of water and on five paired control transects in southwestern New Mexico, with each transect divided into 6 50-m segments.

Pulliam, 1985; Pulliam and Dunning, 1987). Results of present study suggest that proximity to water may be a third critical factor operating at the landscape scale.

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