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AVIAN USE OF DESERT WILDLIFE WATER DEVELOPMENTS AS DETERMINED BY REMOTE VIDEOGRAPHY

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ABSTRACT.—In the desert Southwest, migrating birds have been documented using upland habitat and xeroriparian washes as well as riparian areas. Yet aside from the river corridors, natural water sources (e.g., natural rock tanks [tinajas], springs, and ephemeral washes) in upland areas are scarce. Because of this scarcity, state and federal resource managers augmented water sources throughout the Southwest by constructing permanent wildlife water developments with the intention of enhancing game populations. However, despite these increases in free-standing water, there is a paucity of information on the use of water by birds during migration. Our objectives were to document use of these wildlife water developments by resident and migratory songbirds and assess the effectiveness of monitoring these species using remote color videography. We placed color video cameras at 2 wildlife water developments in southwestern Arizona during the spring and fall of 2004. Although we observed more use by migrants during spring than fall, overall use by migratory birds was low. However, the wildlife water developments were frequently used by resident birds. Remote videography provided continuous information on daily and seasonal patterns of bird use at wildlife water catchments with negligible disturbance by observers, yet for passerines, we felt that the benefits of remote videography did not justify the high cost of equipment purchase, installation, maintenance, and data processing.

Key words: Arizona, neotropical migratory birds, resident birds, Sonoran Desert, water developments, xeroriparian washes, video cameras.

In the desert Southwest, riparian areas are important stopover habitats for migrating birds (Johnson et al. 1977, Skagen et al. 1998, Kelly and Hutto 2005, Ecton et al. 2007); however, use of upland habitat and xeroriparian washes has also been documented (Kelly and Hutto 2005, Lynn et al. 2006). Yet aside from the river corridors, natural water sources (e.g., natural rock tanks [tinajas], springs, and ephemeral washes) in upland areas are scarce. Thus, stopover habitat that provides both food and water for migratory bird species beyond these corridors is limiting. Floodplains of the Colorado, Salt, and Gila rivers and their tributaries have been converted from native riparian vegetation to large-scale agricultural production and altered by water diversion and groundwater pumping for flood control, agricultural production, and community development (Sheridan and Nabhan 1978, Nabhan and Holdsworth 1999). These alterations have lowered water tables and decreased available freestanding water and riparian areas used by insectivorous migratory passerines (Johnson et al. 1977). Because naturally occurring desert waters are scarce, state and federal resource managers have augmented water sources throughout the Southwest by constructing permanent wildlife water developments with the intention of enhancing game populations (deVos and Clarkson 1990). As a result, >840 developed waters have been added in Arizona since the 1940s (Rosenstock et al. 1999). However, despite these increases in freestanding water, there is a paucity of information on the use of water by birds during migration (Cutler and Morrison 1998, O'Brien et al. 2006).

Previous studies that used imaging technology in the Southwest used triggered still cameras (Cutler and Swann 1999) and black-and-white remote video cameras (O'Brien et al. 2006) to capture wildlife use of water developments, yet neither method was well suited for identifying small songbirds (e.g., the location and image quality did not permit reliable identification to species). Thus, our objectives were to document use of water developments by resident and migratory songbirds and assess the effectiveness of monitoring these species using remote color videography. Remote color

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TABLE 1. Birds recorded drinking from 2 wildlife water developments in southwestern Arizona, as determined by remote videography during spring (April–May) and fall (August–November) 2004. Recordings in spring were conducted for 60 days (864 hours) and in fall for 118 days (1517 hours).

		Number of individuals	
Common name	Scientific name	Spring	Fall
Migrants			
Lazuli Bunting	*Passerina amoena*	32	0
Yellow-rumped Warbler	*Dendroica coronata*	5	4
Black-headed Grosbeak	*Pheucticus melanocephalus*	3	4
Bullock's Oriole	*Icterus bullockii*	3	0
Western Tanager	*Piranga ludoviciana*	3	0
Western Kingbird	*Tyrannus verticalis*	0	2
Unknown flycatcher	*Empidonax* sp.	0	2
Brewer's Blackbird	*Euphagus cyanocephalus*	0	1
TOTAL		46	13
Residents			
Mourning Dove	*Zenaida macroura*	2857	4673
House Finch	*Carpodacus mexicanus*	6308	810
White-winged Dove	*Zenaida asiatica*	3051	757
Gila Woodpecker	*Melanerpes uropygialis*	491	704
Gambel's Quail	*Callipepla gambelii*	165	281
Turkey Vulture	*Cathartes aura*	369	88
Lesser Goldfinch	*Carduelis psaltria*	0	385
Black-throated Sparrow	*Amphispiza bilineata*	0	205
Common Raven	*Geothlypis trichas*	119	15
Loggerhead Shrike	*Lanius ludovicianus*	37	75
Say's Phoebe	*Sayornis saya*	53	55
Ash-throated Flycatcher	*Myiarchus cinerascens*	74	0
Scott's Oriole	*Icterus parisorum*	35	0
Phainopepla	*Phainopepla nitens*	24	0
Red-tailed Hawk	*Buteo jamaicensis*	2	22
Brown-headed Cowbird	*Molothrus ater*	4	11
American Kestrel	*Falco sparverius*	0	8
Northern Mockingbird	*Mimus polyglottos*	0	8
Great Horned Owl	*Bubo virginianus*	1	4
Cactus Wren	*Campylorhynchus brunneicapillus*	0	4
Elf Owl	*Micrathene whitneyi*	4	0
Great-tailed Grackle	*Quiscalus mexicanus*	4	0
Black-tailed Gnatcatcher	*Polioptila melanura*	3	0
TOTAL		13,601	8105
Winter residents			
Bewick's Wren	*Thryomanes bewickii*	0	7
Cooper's Hawk	*Accipiter cooperii*	0	7
White-crowned Sparrow	*Zonotrichia leucophrys*	0	2
TOTAL		0	16
Unknown		89	2271
Unknown hummingbird	*Trochilidae*	11	1
GRAND TOTAL		13,747	10,406

videography was 1 of 5 methods used during a larger study on the use of wildlife water developments by birds in southwestern Arizona (Lynn et al. 2006).

We conducted our study in southwestern Arizona at 2 wildlife water developments during the spring and fall of 2004. Elevations for the sites were 547 m and 530 m, and latitudes and longitudes were 33°14′51″N, 114°17′50″W and 33°18′46″N, 114°18′46″W. The study area, classified as Sonoran desertscrub, Lower Colorado River subdivision (Turner and Brown 1982), was dominated by palo verde (*Cercidium floridum* and *C. microphyllum*), ironwood (*Olneya tesota*), creosotebush (*Larrea tridentata*), and brittlebush (*Encilia farinose*). During our study,

Fig. 1. Solar-powered color video cameras placed 1.5 m from the access ramp recorded bird use at a wildlife water development in southwestern Arizona.

temperatures ranged from 5.5° to 38.8°C and winter precipitation (December–February) was 1.8 cm in 2003–2004 and 11.2 cm in fall (August–November) of 2004 (data available from: http://cdo.ncdc.noaa.gov/dly/DLY).

We selected water developments that were used in a previous remote videography study (O'Brien et al. 2006). Black-and-white videography documented hundreds of small passerines using these water developments; however, species were unidentifiable because of the proximity of cameras to the water catchment (≤4 m) and the lack of color video images. Direct observations of migratory birds foraging within the nearby xeroriparian washes also provided evidence of their presence at the site during spring and fall. The water developments we studied captured rainwater from corrugated metal apron catchment surfaces that drained into aboveground storage tanks and provided water via access ramps leading into an aboveground concrete trough (ca. 1 × 1.5 m in size). All water developments were fully contained and did not supply water to surrounding vegetation. One water development was located within 30 m of a narrow (i.e., 50–100 m) xeroriparian wash of scattered trees and shrubs abruptly bordered by desert upland. The 2nd was 300 m from a much wider (i.e., 500 m), complex braided wash, but immediate surrounding vegetation was sparse.

We placed color video cameras (model #CC02, Opticom Technologies, Ltd., Vancouver, BC, Canada) 1.5 m from the edge of the access ramp at each trough, effectively capturing a 1 × 1.5-m area around the water surface and allowing a frontal view of birds on the ramp and a profile of birds perched on the side of the box (Fig. 1). Camera systems included solar panel arrays and a shaded belowground vault that housed 12-volt, 90-amp-hour, deep-cycle gel batteries, a charging system, a power supply, a VHS 168-hour time-lapse video recorder (model #SVT168, Sony Corporation of America, New York), and associated electronics (O'Brien et al. 2006). Cameras began recording 1 hour before sunrise and continued until 1 hour after sunset for 5 consecutive days each week during spring migration (5 April–14 May) and for 4 consecutive days each week during fall migration (2 August– 18 November). Each VCR recorded 1 frame per second and videotapes were changed every 2 weeks. During video transcription, we recorded the species, frequency, and type (drinking, bathing) of use; time of day; and behavioral observations

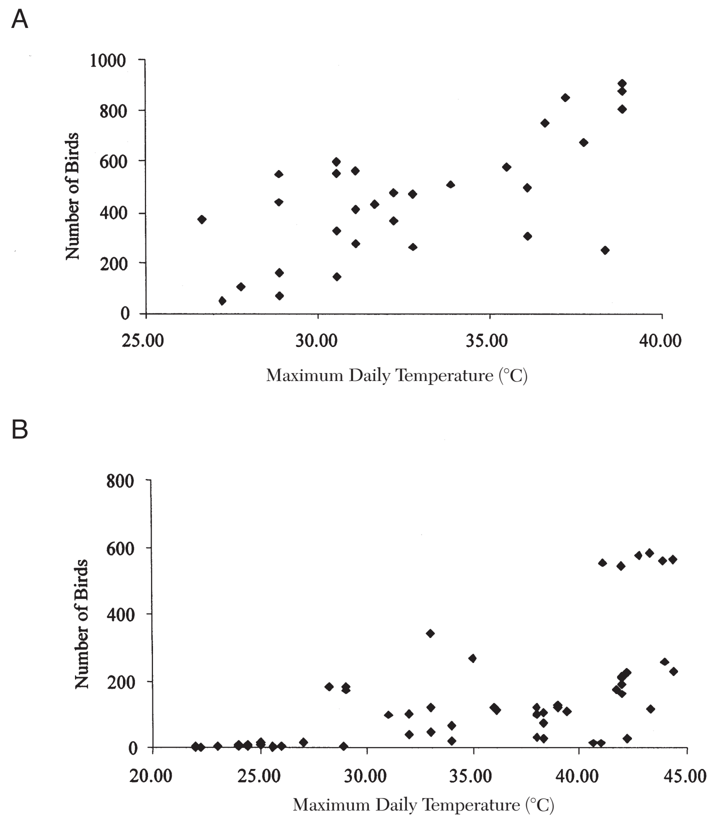

Fig. 2. Number of resident bird species recorded drinking at 2 wildlife water developments in southwestern Arizona, as determined by remote videography in spring 2004 (A) and fall 2004 (B).

such as inter- and intraspecific interactions. We obtained daily temperature data from the National Weather Service stations in Quartzite and at the U.S. Marine Corps Air Station, Arizona (data available from: http://cdo.ncdc.noaa.gov/dly/DYL). Migrants were defined as those species that did not breed within our study area, and winter residents were defined as those that overwintered within our study area but migrated north to breed (Corman and Wise-Gervais 2005). Bartholomew and Cade (1956) found a direct relationship between water consumption and ambient temperature in House Finches (*Carpodacus mexicanus*); therefore, we used linear regression to determine relationships between maximum daily temperatures and water use (Zar 1999).

During 2381 hours we recorded 24,153 birds using waters. We recorded higher numbers of individual migrants drinking at waters in spring ($n = 46$) than in fall ($n = 13$), despite greater observational effort in the fall (864 hours over 60 days in spring versus 1517 hours over 118 days in fall; Table 1). Species richness for migrants was equal for both seasons ($n = 5$). The Black-headed Grosbeak (*Pheucticus melanocephalus*) and the Yellow-rumped Warbler (*Dendroica coronata*) were the only migrant species recorded during spring and fall (Table 1). For residents, we recorded higher water use (13,601 versus 8105 visits) and species richness (19 versus 17 species) in spring (Table 1). Eleven resident species were recorded drinking during both seasons. Six species (Ash-throated Flycatcher, Scott's Oriole, Phainopepla, Great-tailed Grackle, and Black-tailed Gnatcatcher) were recorded in spring but were not observed during fall.

Migrant use occurred during all but the hottest hours of the day (12:00–15:00). In contrast, visitation by resident species increased with increasing temperatures, and we found a positive relationship between visitation and maximum daily temperatures during spring ($r = 0.69$, $P < 0.001$) and fall ($r = 0.61$, $P < 0.001$; Fig. 2). However, birds may have been responding to other variables such as time of day; thus, this relationship should be interpreted with caution. With the start of winter rains, visitation by migrants and residents in October decreased dramatically from an average frequency of 160 visits during the first 2 weeks to an average of 6 visits during the last 2 weeks of the month.

Although we observed more use by migrants in spring than in fall, overall use by migratory birds of the 2 wildlife water developments in our study was low. The few migrant species that did visit and appeared to drink at water catchments have also been documented drinking in 2 previous studies at desert waters (Smyth and Coulombe 1971, Cutler and Morrison 1998). However, the wildlife water developments were frequently used by resident birds. Several residents such as Gambel's Quail (*Callipepla gambelii*), Gila Woodpecker (*Melanerpes uropygialis*), House Finch, Mourning Dove (*Zenaida macroura*), and White-winged Dove (*Zeniada asiatica*) used these waters throughout the year, while Lesser Goldfinch and Black-throated Sparrow visited waters more frequently in spring (Table 1).

The rate of water use by residents in spring was more than double the rate in fall (15.9 versus 6.9 individual visits per hour). Our spring 2004 data, collected during a drought year, differed from observations made during a wetter year by Lynn et al. (2006), who did not find a relationship between temperature and water use of resident species at nearby water catchments. The variation in seasonal water use may be in response to the change in diet and water content found in food resources (Bartholomew and Cade 1956) or the greater need for water during the breeding season.

Most notable was the high frequency of water use by the Black-throated Sparrow (*Amphispiza bilineata*). Although we did not record this species drinking in spring 2004, we observed 205 visits over 118 days of observation in fall 2004 (Table 1). The birds we observed appeared to drink and did not forage or bathe at waters. We recorded the highest frequency of water use ($\bar{x} = 25$ visits $\cdot$ day^{-1}) between 2 August and 16 August, when maximum daily temperatures ranged from 41°–44°C. Lower use was recorded during 11–20 October, when temperatures ranged from 28°–35°C. Although the Black-throated Sparrow is the only North American resident bird species known to survive without exogenous water (Smyth and Bartholomew 1966), Coe and Rotenberry (2003) demonstrated experimentally in a laboratory study that water availability affects reproduction in this species; pairs provided with supplemental water produced significantly larger clutches.

Remote videography provided continuous information on daily and seasonal patterns of bird use at wildlife water catchments with negligible disturbance by observers. Several species, such as the Turkey Vulture (*Cathartes aura*), Red-tailed Hawk (*Buteo jamaicensis*), Gambel's Quail, and Gila Woodpecker, were recorded drinking from catchments via remote videography, but they were not observed drinking or drank less frequently at catchments monitored by human observers (Lynn et al. 2006). Thus, some species may be more sensitive to disturbance, and remote videography may be more suitable than direct observation for these species. For passerines, we felt that the benefits of remote videography did not justify the high cost of equipment purchase, installation, maintenance, and data processing. Transcription of observations from videotapes was labor intensive, and identification of species was subject to difficulty because of image quality and camera resolution. For example, image quality during the midmorning and noon hours was poor because of glare both from the concrete of the water catchment and from the water surface. In fall 2004, we experienced technical difficulties that reduced image quality and made it difficult to distinguish migrants, such as the Lazuli Bunting (*Passerina amoena*) and several warbler species, from resident House Finches. This difficulty resulted in a larger percentage of unidentified birds in fall than in spring (23% and 1%, respectively). Video monitoring systems with higher resolution than we used could circumvent some of these problems.

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