



Landbird Monitoring in the Sonoran Desert Network

Annual Report 2007

Natural Resource Data Series NPS/SODN/NRDS—2009/008



ON THE COVER

Ash-throated flycatcher. U.S. Fish and Wildlife Service (D. Menke).

Landbird Monitoring in the Sonoran Desert Network

Annual Report 2007

Natural Resource Data Series NPS/SODN/NRDS—2009/008

Author

Brian F. Powell
USGS Southwest Biological Science Center
Sonoran Desert Research Station
School of Natural Resources
University of Arizona
Tucson, Arizona 85721

Contact information

Andy Hubbard, Network Program Manager
National Park Service
Sonoran Desert Network
7660 E. Broadway Blvd., Suite #303
Tucson, Arizona 85710
520-429-8147

Editing and Design

Alice Wondrak Biel
National Park Service
Sonoran Desert Network
7660 E. Broadway Blvd., Suite #303
Tucson, Arizona 85710

September 2009

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado

The National Park Service, Natural Resource Program Center publishes a range of reports that address natural resource topics of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. This report received informal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data.

Views, statements, findings, conclusions, recommendations, and data in this report are those of the author(s) and do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the National Park Service.

This report is available from the Sonoran Desert Network website, <http://www.nature.nps.gov/im/units/sodn>, as well as at the Natural Resource Publications Management web site, <http://www.nature.nps.gov/publications/NRPM>.

Please cite this publication as:

Powell, B. F. 2009. Landbird monitoring in the Sonoran Desert Network, 2007. Natural Resource Data Series NPS/SODN/NRDS—2009/008. National Park Service, Fort Collins, Colorado.

Contents

- Tables iv
- Acronyms v
- Acknowledgements vi
- Introduction 1
- Methods.....2
 - Spatial sampling design overview.....2
 - Field methods.....2
- Provisional Results.....5
- Total observations 5
 - New species.....5
 - Species in common.....5
 - Breeding activity 5
- Discussion 8
- Literature Cited 9
- Appendices 11
 - Appendix A. UTM coordinates (NAD 83) of bird landpoints at SODN parks, 2007. 11
 - Appendix B. Mean relative abundance of birds observed at each park during the 2007 field season.....14

Tables

Table 1. Description of the landbird monitoring transects surveyed in 2007. 3

Table 2. Dates of the visits to SODN landbird monitoring transects, 2007. 4

Table 3. List of species observed in 2007 that were not on respective park lists, based on
comparison with Appendix A (Powell et al. (2007))..... 5

Table 4. Ten most abundant species at each unit based on relative abundance scores from
Appendix B..... 6

Table 5. Breeding behavior observations observed at Sonoran Desert Network parks, 2007. 7

Acronyms

CAGR	Casa Grande Ruins National Monument
FOBO	Fort Bowie National Historic Site
I&M	Inventory and Monitoring
MOCC	Montezuma Castle National Monument
NHP	national historical park
NHS	national historic site
NM	national monument
NP	national park
NPS	National Park Service
ORPI	Organ Pipe Cactus National Monument
RMD	Rincon Mountain District
SAGE	Saguaro National Park–Rincon Mountain District
SAGW	Saguaro National Park–Tucson Mountain District
SODN	Sonoran Desert Network
TMD	Tucson Mountain District
TUMM	Tumacacori National Historical Park
TUZI	Tuzigoot National Monument

Acknowledgements

Ann Johnson and Theresa Ferraro collected a wealth of data for this project; we are indebted to their efforts, especially given the difficult field conditions. Aaron Flesch also assisted with data collection. Thanks to Sonoran Desert Network park staff for their guidance and assistance during this field season, with special thanks to Mary Kralovec, Tim Tibbitts, and the rest of the natural resource staff at Organ Pipe Cactus National Monument, for helping us to navigate the border-safety issue. Thanks to Andy Hubbard, Kristen Beaupre, Debbie Angell, and the rest of the staff at the Sonoran Desert Network office for their support and assistance, without which the field season would not have been possible. Bill Halvorson, of the USGS Southwest Biological Science Center, Sonoran Desert Research Center, graciously provided a vehicle for our use.

Introduction

The core mission of the National Park Service (NPS) is to protect and preserve natural and cultural resources for future generations. Responding to criticism that it lacked basic knowledge of natural resources within parks, the NPS initiated the Inventory and Monitoring (I&M) Program to detect long-term changes in biological resources (NPS 1992). Parks with significant natural resources were assigned to one of 32 monitoring networks, each based on ecological similarity and geographic proximity. Each network was charged with developing a monitoring program capable of detecting long-term changes in physical and biological resources within each network.

The Sonoran Desert Network (SODN) includes 11 parks in southern Arizona and New Mexico, ranging in size from 356 hectares (Tumacácori National Historical Park) to 133,882 hectares (Organ Pipe Cactus National Monument). Collectively, these parks represent most of the ecological communities present within the greater Sonoran Desert ecoregion (Mau-Crimmins et al. 2005). In 2005, SODN I&M staff completed a monitoring plan that identified vital signs, or parameters, representing a diverse range of natural resources including air, water, climate, soils, plants, invertebrates, and vertebrates (Mau-Crimmins et al.

2005). Landbird population parameters were considered among the most efficient and feasible vertebrate parameters for long-term monitoring because they are a conspicuous component of many ecosystems and can respond quickly to changes in resource conditions. As such, they are considered good indicators of ecosystem health. Relative to other vertebrates, landbirds are also highly detectable and can be efficiently surveyed with the use of numerous standardized methods.

All SODN parks have nearly complete landbird inventories (see Powell et al. 2005a, Powell et al. 2005b, Powell et al. 2005c, Schmidt et al. 2005a, Powell et al. 2005d, Schmidt et al. 2005b, Powell et al. 2006a, Powell et al. 2006b, Schmidt et al. 2006), and the network's initial landbird monitoring protocol was produced in 2007 (Powell et al. 2007). The SODN started monitoring landbirds in spring 2007. See Powell et al. (2007) for a complete overview of the program's background, objectives, and study design, along with detailed standard operating procedures.

This report, which highlights accomplishments of the 2007 field season, provides only a brief summary of results; detailed data analyses will be conducted every 3–5 years. Because the data upon which this report is based were not thoroughly checked for accuracy prior to analysis, these results should be considered provisional.

Methods

Spatial sampling design overview

We surveyed landbirds at seven SODN parks: Casa Grande Ruins National Monument (NM), Fort Bowie National Historic Site (NHS), Organ Pipe Cactus NM, Montezuma Castle NM (Castle and Well units), Saguaro National Park (NP; Rincon Mountain District [RMD] and Tucson Mountain District [TMD]), Tumacácori National Historical Park (NHP), and Tuzigoot NM (Table 1). We surveyed a total of 29 transects (233 points), with the number of transects per park ranging from 1 at Casa Grande Ruins NM and Tumacácori NHP to 6 at Saguaro NP–RMD. Sites in each park were classified as either riparian or upland sites; we assigned these sites differently because of the difference in bird communities and because we wanted to be sure to survey the riparian community (see Powell et al. 2007).

The methods used for establishing landbird monitoring sites are outlined in Powell et al. (2007) and, for most parks, we used the sites outlined in that protocol (see Appendix A for UTM coordinates). Exceptions occurred at Organ Pipe Cactus NM and Saguaro NP. At Organ Pipe Cactus NM, we encountered significant obstacles to employing a random component to the design due to safety concerns related to illegal immigration activities. Through consultation with park managers, it was determined that all sites in the southern and western portions of the park would be excluded from sampling; of the approximately 40 sites submitted for consideration, only eight were acceptable to park managers based on their knowledge of migration routes taken by undocumented immigrants. Field personnel were additionally required to work in pairs, thereby reducing the number of transects that could be surveyed from 10 sites to five.

Field methods

We surveyed each transect four times. Seasonal timing of surveys varied by park. Timing of the first round of surveys was earliest for the lowest-elevation parks (Casa Grande Ruins NM, Organ Pipe Cactus NM, and Saguaro NP–TMD) and later for the higher-elevation parks (Saguaro NP–RMD, Fort Bowie NHS, Tumacácori NHP) and the parks in the Verde Valley (Montezuma Castle NM and Tuzigoot NM). Differences in timing of the first surveys were intended to account for the differences in the onset of breeding for the greatest number of species in each park. We spaced surveys at least 10 days apart, and all surveys were complete by June 28 (Table 2).

We employed the point-transect survey method (Nelson and Fancy 1999; Buckland et al. 2001), the most widespread and accepted method for estimating landbird density (Rosenstock et al. 2002). Details on how to conduct point-transect surveys and for completing data forms are provided in SOP #5 of Powell et al. (2007); a brief introduction is provided here.

We spent eight minutes at each point and estimated the linear distance to individual birds. We recorded all birds, regardless of detection distance from the surveyor, including birds flying over the observer. After counts were completed, observers located successive points with use of a GPS. While walking from one point to the next, observers searched for species not recorded during the previous count period. We deviated from the published protocol at Organ Pipe Cactus NM, because two observers were required to work together. To account for this, both observers conducted simultaneous counts while standing approximately 15 m apart. Observers did not share information and made no attempt to communicate with each other during the surveys.

Table 1. Description of the landbird monitoring transects surveyed in 2007.

Park unit	Transect/ Group name	Transect type	Number of survey points
Casa Grande Ruins NM	U	Upland	9
Fort Bowie NHS	SPN	Riparian	10
	UpE	Upland	8
	UpW	Upland	7
Montezuma Castle NM (Castle Unit)	R1	Riparian	6
	R2	Riparian	6
	Up1	Upland	8
	Up2	Upland	8
Montezuma Castle NM (Well Unit)	R	Riparian	7
	Up	Upland	9
Organ Pipe Cactus NM	R1	Riparian	7
	U1	Upland	9
	U12	Upland	16
	U4	Upland	7
	U5	Upland	7
Saguaro NP (Rincon Mountain District)	008	Upland	7
	009	Upland	7
	112	Upland	7
	115	Upland	8
	139	Upland	8
	LRC	Riparian	8
Saguaro NP (Tucson Mountain District)	204	Upland	7
	212	Upland	6
	213	Upland	8
	238	Upland	6
	239	Upland	8
Tumacácori NHP	Riparian	Riparian	14
Tuzigoot NM	East	Riparian	7
	West	Riparian (predominantly)	8

Table 2. Dates of the visits to SODN landbird monitoring transects, 2007.

Park	Transect	Visit Number			
		1	2	3	4
Casa Grande Ruins NM	U	Apr 20	May 13	May 24	Jun 18
Fort Bowie NHS	SPN	May 2	May 16	Jun 10	Jun 26
	UpE	Apr 19	May 18	Jun 11	Jun 27
	UpW	Apr 19	May 17	Jun 12	Jun 28
Montezuma Castle NM (Castle Unit)	R1	Apr 24	May 8	May 30	Jun 14
	R2	Apr 24	May 8	May 30	Jun 15
	Up1	Apr 27	May 9	May 29	Jun 14
	Up2	Apr 27	May 9	May 30	Jun 15
Montezuma Castle NM (Well Unit)	R	Apr 25	May 11	Jun 1	Jun 19
	Up	Apr 25	May 11	Jun 1	Jun 20
Organ Pipe Cactus NM	R1	Apr 10	Apr 10	May 1	Jun 5
	U1	Apr 13	May 4	May 25	Jun 8
	U12	Apr 11	May 2	May 23	Jun 6
	U4	Apr 12	May 3	May 24	Jun 7
	U5	Apr 12	May 3	May 24	Jun 7
Saguaro NP (Rincon Mountain District)	008	Apr 19	May 14	May 23	Jun 7
	009	Apr 17	Apr 30	May 14	May 21
	112	Apr 17	Apr 30	May 14	May 21
	115	Apr 18	May 8	May 18	Jun 11
	139	Apr 18	May 3	May 17	Jun 5
	LRC	Apr 17	May 10	May 22	Jun 5
Saguaro NP (Tucson Mountain District)	204	Apr 9	Apr 16	May 7	May 28
	212	Apr 9	Apr 23	May 15	Jun 4
	213	Apr 6	Apr 23	May 16	Jun 4
	238	Apr 16	May 7	May 15	Jun 4
	239	Apr 6	Apr 23	May 7	May 28
Tumacácori NHP	R	Apr 25	May 3	May 24	Jun 12
Tuzigoot NM	Est	Apr 26	May 10	May 31	Jun 21
	Wst	Apr 26	May 10	May 31	Jun 22

Provisional Results

Total observations

We recorded a total of 15,755 observations of birds for a total of 154 species (Appendix B). The most observations occurred at Organ Pipe Cactus NM ($n = 3,233$), and the fewest were at Casa Grande Ruins NM ($n = 433$). We observed the most species at Saguaro NP–RMD and Tuzigoot NM ($n = 85$ and 86 species, respectively) and the fewest at Casa Grande Ruins NM ($n = 43$).

New species

The most new species were added to the Casa Grande Ruins NM park list ($n = 7$), and the fewest to the lists for Organ Pipe Cactus NM ($n = 0$) and Saguaro NP, Tuzigoot NM, and Fort Bowie NHS ($n = 1$ for each) (Table 3). Notable new species to park lists were the yellow-billed cuckoo at Fort Bowie NHS and thick-billed kingbird at Tumacácori NHP.

Species in common

Eight species occurred at all parks and units: ash-throated flycatcher, black-throated sparrow, brown-crested flycatcher, brown-headed cowbird, common raven, Gambel’s quail, house finch, and mourning dove (Appendix B). Among the most abundant species at each park (Table 4), the house finch was in the top 10 ranking for all parks and units and the mourning dove occurred in the top 10 ranking in eight of nine parks and units. Other species that were common in multiple parks were the brown-crested and ash-throated flycatchers, Gila woodpecker, verdin, cactus wren, and white-winged dove.

Breeding activity

We made total of 42 observations of breeding activity, with the most observations in Saguaro NP–RMD (Table 5). Notable observations were of nesting black hawks at Montezuma Castle NM–Well unit and zone-tailed hawks at Fort Bowie NHS.

Table 3. List of species observed in 2007 that were not on respective park lists, based on comparison with Appendix A (Powell et al. (2007)).

Species	Casa Grande Ruins NM	Fort Bowie NHS	Montezuma Castle NM	Saguaro NP	Tumacácori NHP	Tuzigoot NM
barn swallow	X			X		
black phoebe	X					
black-tailed gnatcatcher			X			
black-throated sparrow	X					
Brewer’s blackbird	X					
brown-crested flycatcher	X					
Cassin’s kingbird	X					
curve-billed thrasher			X			
Hammond’s flycatcher	X		X			
Hutton’s vireo					X	X
thick-billed kingbird					X	
vesper sparrow					X	
yellow-billed cuckoo		X				
zone-tailed hawk					X	

No new species were found at Organ Pipe Cactus NM. Note that Saguaro NP and Montezuma Castle NM were not separated by unit or district. Summary is based on provisional analysis.

Table 4. Ten most abundant species at each unit based on relative abundance scores from Appendix B.

Relative abundance rank	Park	Relative abundance rank	Park	Relative abundance rank	Park
Casa Grande Ruins NM		Fort Bowie NHS		Montezuma Castle NM (Castle Unit)	
1	mourning dove	1	black-throated sparrow	1	house finch
2	great-tailed grackle	2	Gambel's quail	2	mourning dove
3	Gambel's quail	3	mourning dove	3	Lucy's warbler
4	house finch	4	white-winged dove	4	phainopepla
5	house sparrow	5	house finch	5	lesser goldfinch
6	red-winged blackbird	6	ash-throated flycatcher	6	Bewick's wren
7	European starling	7	cactus wren	7	Gambel's quail
8	burrowing owl	8	Bewick's wren	8	black-throated sparrow
9	ash-throated flycatcher	9	northern cardinal	9	brown-headed cowbird
10	white-winged dove	10	turkey vulture	10	Gila woodpecker
Montezuma Castle NM (Well Unit)		Organ Pipe Cactus NM		Saguaro NP (Rincon Mountain District)	
1	mourning dove	1	white-winged dove	1	white-winged dove
2	house finch	2	Gila woodpecker	2	cactus wren
3	Gambel's quail	3	Gambel's quail	3	Gila woodpecker
4	Gila woodpecker	4	verdin	4	Gambel's quail
5	lesser goldfinch	5	curve-billed thrasher	5	black-throated sparrow
6	Lucy's warbler	6	cactus wren	6	ash-throated flycatcher
7	brown-crested flycatcher	7	house finch	7	curve-billed thrasher
8	ash-throated flycatcher	8	ash-throated flycatcher	8	house finch
9	black-chinned hummingbird	9	black-throated sparrow	9	brown-crested flycatcher
10	Bewick's wren	10	brown-crested flycatcher	10	mourning dove
Saguaro NP (Tucson Mountain District)		Tumacácori NHP		Tuzigoot NM	
1	Gila woodpecker	1	Gila woodpecker	1	red-winged blackbird
2	white-winged dove	2	Lucy's warbler	2	mourning dove
3	cactus wren	3	Bewick's wren	3	house finch
4	house finch	4	brown-crested flycatcher	4	phainopepla
5	Gambel's quail	5	summer tanager	5	Gambel's quail
6	verdin	6	white-winged dove	6	northern rough-winged swallow
7	curve-billed thrasher	7	yellow-breasted chat	7	common yellowthroat
8	ash-throated flycatcher	8	phainopepla	8	lesser goldfinch
9	black-throated sparrow	9	house finch	9	brown-headed cowbird
10	mourning dove	10	northern cardinal	10	Bewick's wren

In parks with both riparian and upland transects, relative abundance scores were averaged.

Table 5. Breeding behavior observations observed at Sonoran Desert Network parks, 2007.

Park	Species	Adults carrying food	Adults carrying nesting material	Adults feeding recently fledged young	Nest with young	Adults occupying nest	Recently fledged young
Casa Grande Ruins NM	great-tailed grackle	1					
	house sparrow					1	
	mourning dove					2	
Fort Bowie NHS	Bewick's wren			1			
	Lucy's warbler			1			
	canyon towhee						1
	zone-tailed hawk					1	
Montezuma Castle NM (Castle Unit)	canyon towhee	1					
	wood duck						1
Montezuma Castle NM (Well Unit)	common black-hawk				1		
Organ Pipe Cactus NM	ash-throated flycatcher		1				
	house finch					1	
Saguaro NP (Rincon Mountain District)	Abert's towhee	1					
	Cassin's kingbird					1	
	Gila woodpecker	1			1		
	Lucy's warbler	1					
	ash-throated flycatcher					1	
	black-throated sparrow			1			2
	brown-crested flycatcher					1	
	cactus wren		1				
	gilded flicker				1	2	
	lesser goldfinch						1
	purple martin					1	
Saguaro NP (Tucson Mountain District)	Gila woodpecker					3	
	purple martin					1	
	red-tailed hawk				1		
Tumacácori NHP	Bewick's wren		1				
	Lucy's warbler						1
	gray hawk	1					
	vermillion flycatcher			1		1	
Tuzigoot NM	phainopepla	1	1				
	wood duck						1

Discussion

Among the parks that had both mesic riparian and upland transects (Saguaro NP-RMD, Fort Bowie NHS, and Montezuma Castle NM [both units]), there were few differences in the total number of species found in each community type. For example, the same number of species was detected at Fort Bowie NHS and Montezuma Castle NM-Well unit. However, the species and relative abundances were often quite different (see Appendix B).

The results of the analyses in this report represent an initial summary of the data collected by field personnel in SODN parks in 2007. This provides an important baseline upon which future changes to the landbird community will be assessed.

Literature Cited

- Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to distance sampling: Estimating abundance of biological populations. Oxford University Press, Oxford, England.
- Mau-Crimmins, T., A. Hubbard, D. Angell, C. Filippone, and K. Kline. 2005. Sonoran Desert Network vital signs monitoring plan. Technical Report NPS/IMR/SODN-003. National Park Service, Denver, CO.
- National Park Service (NPS). 1992. NPS-75: Natural resources inventory and monitoring guidelines. U.S. Department of Interior, Washington, D.C.
- Nelson, J. T., and S. G. Fancy. 1999. A test of the variable circular-plot method where exact density of a bird population was known. *Pacific Conservation Biology* 5:139-143.
- Powell, B. F., A. D. Flesch, T. Mau-Crimmins, D. Angell, K. Beaupre, and W. L. Halvorson. 2007. Landbird monitoring protocol for the Sonoran Desert Network. Version 1.02. Unpublished protocol to the National Park Service, Sonoran Desert Network Inventory and Monitoring Program, Tucson, AZ.
- Powell, B. F., C. A. Schmidt, and W. L. Halvorson. 2005a. Vascular plant and vertebrate inventory of Coronado National Memorial. Unpublished report. USGS Southwest Biological Science Center, Sonoran Desert Research Station, University of Arizona, Tucson, AZ.
- . 2006a. Vascular plant and vertebrate inventory of Saguaro National Park, Rincon Mountain District. USGS OFR 2006-1075. USGS, Southwest Biological Science Center, Sonoran Desert Research Station, University of Arizona, Tucson, AZ.
- Powell, B. F., C. A. Schmidt, W. L. Halvorson, and P. Anning. 2005b. Vascular plant and vertebrate inventory of Fort Bowie National Historic Site. USGS OFR 2005-1167. USGS Southwest Biological Science Center, Sonoran Desert Research Station, University of Arizona, Tucson, AZ.
- Powell, B. F., E. W. Albrecht, C. A. Schmidt, W. L. Halvorson, P. Anning, and K. Docherty. 2006b. Vascular plant and vertebrate inventory of Casa Grande Ruins National Monument. USGS OFR 2005-1185. USGS, Southwest Biological Science Center, Sonoran Desert Research Station, University of Arizona, Tucson, AZ.
- Powell, B. F., E. W. Albrecht, W. L. Halvorson, C. A. Schmidt, K. Docherty, and P. Anning. 2005c. Vascular plant and vertebrate inventory of Gila Cliff Dwellings National Monument. USGS OFR 2005-1187. USGS, Southwest Biological Science Center, Sonoran Desert Research Station, University of Arizona, Tucson, AZ.
- Powell, B. F., E. W. Albrecht, W. L. Halvorson, C. A. Schmidt, P. Anning, and K. Docherty. 2005d. Vascular plant and vertebrate inventory of Tumacácori National Historical Park. USGS OFR 2005-1142. USGS, Southwest Biological Science Center, Sonoran Desert Research Station, University of Arizona, Tucson, AZ.
- Rosenstock, S. S., D. R. Anderson, K. M. Giesen, T. Leukering, and M. F. Carter. 2002. Landbird counting techniques: Current practices and an alternative. *Auk* 119:46-53.
- Schmidt, C., B. F. Powell, and W. L. Halvorson. 2006. Plant and vertebrate inventory of Organ Pipe Cactus National Monument. USGS OFR 2006-1076. USGS Southwest Biological Science Center, Sonoran Desert Research Station, University of Arizona, Tucson, AZ.
- . 2005. Vascular plant and vertebrate inventory of Tuzigoot National Monument. USGS OFR 2005-1347. USGS Southwest Biological Science Center, Sonoran Desert Research Station, University of Arizona, Tucson, AZ.
- Schmidt, C. A., B. F. Powell, W. L. Halvorson, and P. Anning. 2005. Vascular plant and vertebrate inventory of Chiricahua National Monument. Unpublished Report. USGS Southwest Biological Science Center, Sonoran Desert Research Station, University of Arizona, Tucson, AZ.

Appendices

Appendix A. UTM coordinates (NAD 83) of bird landpoints at SODN parks, 2007.

Park and Point Name	X_Coord	Y_Coord	Park and Point Name	X_Coord	Y_Coord
CAGR_Bird_U_1	449799	3650680	MOCC_Bird_R2_6	423278	3830787
CAGR_Bird_U_10	450162	3651310	MOCC_Bird_Up1_17	423550	3829737
CAGR_Bird_U_11	450514	3651311	MOCC_Bird_Up1_18	422418	3829734
CAGR_Bird_U_2	450147	3650681	MOCC_Bird_Up1_2	424023	3829693
CAGR_Bird_U_6	450344	3651009	MOCC_Bird_Up1_25	423318	3829619
CAGR_Bird_U_7	449992	3651027	MOCC_Bird_Up1_26	424020	3829942
CAGR_Bird_U_8	449635	3651016	MOCC_Bird_Up1_28	423777	3829627
CAGR_Bird_U_9	449812	3651310	MOCC_Bird_Up1_5	423081	3829742
FOBO_Bird_SPN_1	647071	3557641	MOCC_Bird_Up1_7	422869	3829900
FOBO_Bird_SPN_2	646823	3557671	MOCC_Bird_Up2_1	423008	3830906
FOBO_Bird_SPN_3	646596	3557774	MOCC_Bird_Up2_11	422480	3830393
FOBO_Bird_SPN_4	646391	3557919	MOCC_Bird_Up2_13	422603	3830612
FOBO_Bird_SPN_5	646372	3558168	MOCC_Bird_Up2_24	422739	3830376
FOBO_Bird_SPN_6	646618	3558226	MOCC_Bird_Up2_27	422785	3830789
FOBO_Bird_SPN_7	646846	3558332	MOCC_Bird_Up2_3	422965	3830521
FOBO_Bird_SPN_8	646893	3558578	MOCC_Bird_Up2_4	423164	3830359
FOBO_Bird_UpE_11	647378	3557403	MOCC_Bird_Up2_9	423585	3830087
FOBO_Bird_UpE_14	645858	3558611	MOWE_Bird_R_1	429733	3833941
FOBO_Bird_UpE_15	646186	3558400	MOWE_Bird_R_2	429948	3834028
FOBO_Bird_UpE_3	646539	3557310	MOWE_Bird_R_3	430200	3834059
FOBO_Bird_UpE_4	647671	3557214	MOWE_Bird_R_4	430439	3834101
FOBO_Bird_UpE_5	646770	3557442	MOWE_Bird_R_5	430697	3834071
FOBO_Bird_UpE_7	646114	3558716	MOWE_Bird_R_6	430927	3834108
FOBO_Bird_UpE_8	647533	3557677	MOWE_Bird_R_7	431129	3834246
FOBO_Bird_UpW_10	643453	3558345	MOWE_Bird_Up_1	430186	3834717
FOBO_Bird_UpW_12	644125	3558261	MOWE_Bird_Up_10	430182	3834454
FOBO_Bird_UpW_16	643138	3558264	MOWE_Bird_Up_2	431198	3834472
FOBO_Bird_UpW_17	645200	3557724	MOWE_Bird_Up_3	430982	3834735
FOBO_Bird_UpW_2	645581	3557939	MOWE_Bird_Up_4	430435	3834425
FOBO_Bird_UpW_6	643851	3558185	MOWE_Bird_Up_5	430619	3834641
FOBO_Bird_UpW_9	645533	3558247	MOWE_Bird_Up_7	430832	3834369
MOCC_Bird_R1_1	422677	3829646	MOWE_Bird_Up_8	431249	3834782
MOCC_Bird_R1_2	422589	3829892	MOWE_Bird_Up_9	430434	3834810
MOCC_Bird_R1_3	422715	3830236	ORPI_Bird_R1_1	335374	3546195
MOCC_Bird_R1_4	423012	3830219	ORPI_Bird_R1_2	335465	3545874
MOCC_Bird_R1_5	423152	3829994	ORPI_Bird_R1_3	335740	3545841
MOCC_Bird_R1_6	423365	3829846	ORPI_Bird_R1_4	336026	3545778
MOCC_Bird_R2_1	423628	3829855	ORPI_Bird_R1_5	336300	3545746
MOCC_Bird_R2_2	423850	3829999	ORPI_Bird_R1_6	336592	3545699
MOCC_Bird_R2_3	423885	3830263	ORPI_Bird_R1_7	336848	3545821
MOCC_Bird_R2_4	423681	3830431	ORPI_Bird_U1_1	330030	3548928
MOCC_Bird_R2_5	423462	3830560	ORPI_Bird_U1_2	330384	3548911

Appendix A. UTM coordinates (NAD 83) of bird landpoints at SODN parks, 2007, cont.

Park and Point Name	X_Coord	Y_Coord	Park and Point Name	X_Coord	Y_Coord
ORPI_Bird_U1_3	330736	3548896	SAGE_Bird_009_4	525762	3559359
ORPI_Bird_U1_4	331088	3548882	SAGE_Bird_009_5	526010	3559402
ORPI_Bird_U1_5	331646	3548821	SAGE_Bird_009_6	526257	3559439
ORPI_Bird_U1_6	331994	3548770	SAGE_Bird_009_7	526506	3559472
ORPI_Bird_U1_7	332341	3548709	SAGE_Bird_112_1	526003	3558474
ORPI_Bird_U12_1	317577	3563115	SAGE_Bird_112_2	526193	3558324
ORPI_Bird_U12_2	317902	3562944	SAGE_Bird_112_3	526372	3558196
ORPI_Bird_U12_3	318192	3562750	SAGE_Bird_112_4	526578	3558024
ORPI_Bird_U12_4	318501	3562580	SAGE_Bird_112_5	526592	3557775
ORPI_Bird_U12_5	318784	3562369	SAGE_Bird_112_6	525808	3558630
ORPI_Bird_U12_6	319089	3562191	SAGE_Bird_112_7	525608	3558781
ORPI_Bird_U12_7	319395	3561998	SAGE_Bird_115_1	527717	3562406
ORPI_Bird_U4_1	330311	3563892	SAGE_Bird_115_2	527597	3562184
ORPI_Bird_U4_2	330664	3563915	SAGE_Bird_115_3	527512	3561964
ORPI_Bird_U4_3	331027	3563955	SAGE_Bird_115_4	527419	3561730
ORPI_Bird_U4_4	331359	3563850	SAGE_Bird_115_5	527318	3561504
ORPI_Bird_U4_5	331701	3563763	SAGE_Bird_115_6	527839	3562623
ORPI_Bird_U4_6	332042	3563676	SAGE_Bird_115_7	527964	3562840
ORPI_Bird_U4_7	332385	3563590	SAGE_Bird_139_1	528894	3563097
ORPI_Bird_U5_1	336188	3558806	SAGE_Bird_139_2	529102	3563242
ORPI_Bird_U5_2	335849	3558889	SAGE_Bird_139_3	529308	3563374
ORPI_Bird_U5_3	335509	3558975	SAGE_Bird_139_4	529517	3563516
ORPI_Bird_U5_4	335164	3559045	SAGE_Bird_139_5	528681	3562968
ORPI_Bird_U5_5	334824	3559131	SAGE_Bird_139_6	529665	3563722
ORPI_Bird_U5_6	334489	3559230	SAGE_Bird_LRC_1	535856	3554747
ORPI_Bird_U5_7	334147	3559315	SAGE_Bird_LRC_2	535608	3554786
SAGE_Bird_008_1	535227	3556784	SAGE_Bird_LRC_3	535347	3554872
SAGE_Bird_008_2	535207	3556534	SAGE_Bird_LRC_4	535090	3554932
SAGE_Bird_008_3	535192	3556286	SAGE_Bird_LRC_5	534861	3555038
SAGE_Bird_008_4	535173	3556038	SAGE_Bird_LRC_6	534632	3555172
SAGE_Bird_008_5	535157	3557888	SAGE_Bird_LRC_7	536100	3554809
SAGE_Bird_008_6	535135	3555542	SAGE_Bird_LRC_8	536345	3554870
SAGE_Bird_008_7	535117	3555295	SAGW_Bird_204_1	483386	3571990
SAGE_Bird_009_1	525016	3559243	SAGW_Bird_204_2	483468	3572224
SAGE_Bird_009_2	525266	3559289	SAGW_Bird_204_3	483544	3572477
SAGE_Bird_009_3	525515	3559324	SAGW_Bird_204_4	483616	3572710

Appendix A. UTM coordinates (NAD 83) of bird landpoints at SODN parks, 2007, cont.

Park and Point Name	X_Coord	Y_Coord	Park and Point Name	X_Coord	Y_Coord
SAGW_Bird_204_5	483310	3571743	SAGW_Bird_239_7	478786	3569666
SAGW_Bird_204_6	483219	3571509	TUMM_Bird_A_1	495418	3492600
SAGW_Bird_204_7	483750	3572931	TUMM_Bird_A_2	495377	3492184
SAGW_Bird_204_8	483948	3573098	TUMM_Bird_M_1	495202	3492565
SAGW_Bird_212_1	484370	3568709	TUMM_Bird_M_2	495187	3493564
SAGW_Bird_212_2	484604	3568640	TUMM_Bird_M_3	495326	3492964
SAGW_Bird_212_3	484862	3568584	TUMM_Bird_M_4	495182	3493199
SAGW_Bird_212_4	485105	3568534	TUMM_Bird_Rp_1	495634	3493003
SAGW_Bird_212_5	484095	3568744	TUMM_Bird_Rp_2	495196	3493960
SAGW_Bird_212_6	485350	3568467	TUMM_Bird_Rp_3	495478	3494018
SAGW_Bird_213_1	480552	3571560	TUMM_Bird_Rp_4	495542	3493577
SAGW_Bird_213_2	480785	3571494	TUMM_Bird_Rp_5	495717	3492430
SAGW_Bird_213_3	481031	3571413	TUMM_Bird_Rp_6	495724	3492711
SAGW_Bird_213_4	481264	3571328	TUMM_Bird_Rp_7	495303	3494204
SAGW_Bird_213_5	481499	3571246	TUMM_Bird_Rp_8	495692	3493808
SAGW_Bird_213_6	480328	3571673	TUZI_Bird_Est_1	406045	3847602
SAGW_Bird_213_7	480113	3571783	TUZI_Bird_Est_2	406225	3847677
SAGW_Bird_238_1	484872	3579208	TUZI_Bird_Est_3	406480	3847612
SAGW_Bird_238_2	485102	3579235	TUZI_Bird_Est_4	406634	3847796
SAGW_Bird_238_3	485358	3579254	TUZI_Bird_Est_5	406662	3848042
SAGW_Bird_238_4	485612	3579287	TUZI_Bird_Est_6	406587	3848289
SAGW_Bird_238_5	484723	3579407	TUZI_Bird_Est_7	406666	3848503
SAGW_Bird_238_6	484465	3579416	TUZI_Bird_Wst_1	406461	3848382
SAGW_Bird_239_1	478263	3570188	TUZI_Bird_Wst_2	406413	3848630
SAGW_Bird_239_2	478131	3570400	TUZI_Bird_Wst_3	406289	3848877
SAGW_Bird_239_3	478003	3570616	TUZI_Bird_Wst_4	406109	3848694
SAGW_Bird_239_4	477873	3570825	TUZI_Bird_Wst_5	406133	3848482
SAGW_Bird_239_5	478396	3569974	TUZI_Bird_Wst_6	406192	3848255
SAGW_Bird_239_6	478555	3569777	TUZI_Bird_Wst_7	406076	3848003

Appendix B. Mean relative abundance of birds observed at each park during the 2007 field season.

Species	Casa Grande Ruins NM	Fort Bowie NHS		Montezuma Castle NM (Castle unit)		Montezuma Castle NM (Well unit)		Organ Pipe Cactus NM		Saguaro NP			Tumacácori NHP	Tuzigoot NM
		R	U	R	U	R	U	R	U	R	U	Tucson Mountain District	R	R
Abert's towhee				0.77	0.05	0.39				0.53			0.33	0.47
American coot														0.04
American kestrel	0.17							0.03	0.09	0.03	0.04			
American robin		0.03		0.06	0.06	0.18	0.03							0.02
Anna's hummingbird	0.46						0.03	0.01			0.02	0.01		
ash-throated flycatcher	0.71	0.94	0.82	0.44	1.03	0.04	1.11	1.64	0.79	1.25	1.06	0.71	0.41	0.51
barn swallow	0.17		0.02					0.02				0.01	0.30	
Bell's vireo		0.16		0.08	0.17	0.07	0.08			0.06			0.56	0.11
belted kingfisher				0.06	0.03									0.11
Bendire's thrasher								0.03						0.02
Bewick's wren		0.75	0.83	1.46	0.48	0.75	0.19			0.75	0.02		1.83	0.67
black phoebe	0.03			0.06	0.02	0.18							0.02	0.04
black vulture													0.06	
black-chinned hummingbird		0.38	0.10	0.46	0.47	0.54	0.58	0.02		0.19	0.03	0.02	0.11	0.25
black-chinned sparrow			0.02											
black-crowned night-heron														0.15
black-headed grosbeak					0.03		0.03	0.03		0.06	0.04		0.07	0.02
black-tailed gnatcatcher	0.03	0.03	0.03		0.02			0.73	0.73	0.03	0.44	0.43		0.02
black-throated gray warbler			0.02								0.01	0.01		0.02
black-throated sparrow	0.03	1.16	1.82	0.02	1.61		2.31	0.88	0.79	0.22	1.26	0.51	0.02	0.15
blue grosbeak		0.13	0.02	0.33	0.06	0.14	0.08			0.44	0.02		0.35	0.24
blue-gray gnatcatcher		0.06	0.03	0.02	0.05	0.04								
Brewer's blackbird	0.14													
Brewer's sparrow			0.30	0.04	0.42		0.31	0.01		1.00	0.47	0.45		0.05
bridled titmouse		0.13	0.05	0.21	0.05	0.07	0.08						0.09	0.02
broad-billed hummingbird										0.09	0.01	0.01	0.52	

Appendix B. Mean relative abundance of birds observed at each park during the 2007 field season, cont.

Species	Casa Grande Ruins NM	Fort Bowie NHS		Montezuma Castle NM (Castle unit)		Montezuma Castle NM (Well unit)		Organ Pipe Cactus NM		Saguaro NP			Tumacácori NHP	Tuzigoot NM
		R	U	R	U	R	U	R	U	R	Mountain District	Tucson Mountain District	R	R
broad-tailed hummingbird	U	0.09										0.01		
bronzed cowbird										0.09			0.02	
brown-crested flycatcher	0.06	0.13	0.08	0.90	0.50	0.96	0.19	0.64	0.96	0.81	0.83	0.34	1.50	0.29
brown-headed cowbird	0.14	0.28	0.05	1.04	0.48	0.57	0.28	0.21	0.28	0.44	0.11	0.12	0.72	0.75
Bullock's oriole	0.03			0.42	0.09	0.46	0.11		0.02	0.13	0.07	0.11	0.11	0.51
burrowing owl	0.74													
bushtit		0.13	0.20		0.22								0.02	0.15
cactus wren	0.09	0.63	1.07					1.30	1.78	0.97	1.92	1.58	0.02	
canyon towhee		0.63	0.63	0.31	0.06		0.25	0.64	0.07	0.44	0.39	0.17	0.04	0.04
canyon wren		0.31	0.15	0.15	0.03	0.14	0.08		0.05	0.06	0.13	0.14		
Cassin's kingbird	0.06	0.38	0.50	0.06	0.19	0.18				0.72			0.56	0.15
cedar waxwing		0.03												
chipping sparrow			0.22	0.73	0.28	0.04				0.13	0.02	0.01	0.91	0.09
cliff swallow	0.17			0.65	0.27	0.03								
common black-hawk				0.08	0.11	0.29								
common ground-dove										0.06			0.13	
common merganser				0.02										
common moorhen														0.02
common poorwill	0.03								0.02		0.01			
common raven	0.17	0.09	0.13	0.25	0.14	0.07	0.31		0.28	0.03	0.06	0.09	0.11	0.15
common yellowthroat				0.06	0.03	0.18							0.02	0.87
Cooper's hawk		0.03	0.02	0.04	0.03					0.03			0.02	0.02
Costa's hummingbird								0.15	0.01		0.02	0.02	0.02	
crissal thrasher		0.34	0.07											0.02
curve-billed thrasher	0.03	0.09	0.03			0.04		1.85	1.25	0.44	0.98	1.00	0.02	
dusky flycatcher											0.01	0.01		
dusky-capped flycatcher													0.52	
eastern meadowlark			0.05											
European starling	0.94			0.17	0.11	0.54	0.03				0.01		0.02	0.04

Appendix B. Mean relative abundance of birds observed at each park during the 2007 field season, cont.

Species	Casa Grande Ruins NM	Fort Bowie NHS			Montezuma Castle NM (Castle unit)			Montezuma Castle NM (Well unit)			Organ Pipe Cactus NM			Saguaro NP			Tumacácori NHP	Tuzigoot NM
		R	U		R	U		R	U		R	U		Rincon Mountain District	Tucson Mountain District	U	R	R
Gambel's quail	1.43	1.66	1.27		0.69	1.02	0.68	1.56	0.68	1.56	2.18	1.28	1.38	1.30	1.17		0.15	1.33
Gila woodpecker	0.03				0.90	0.61	1.57	0.50	2.42	2.39	2.42	2.39	1.75	1.84	2.84		2.04	0.53
gilded flicker	0.09											0.01	0.22	0.38	0.03		0.06	
golden eagle			0.02															
gray flycatcher	0.03		0.03		0.04	0.16		0.03			0.03	0.03	0.06	0.02			0.04	
gray hawk													0.16				0.33	
gray vireo							0.04											
great blue heron					0.04	0.06	0.07	0.06										0.40
great horned owl	0.06	0.03						0.03			0.08	0.16	0.02					
greater roadrunner	0.03	0.03	0.02								0.03	0.09	0.05				0.04	0.04
great-tailed grackle	1.80																0.52	0.44
green heron																		0.11
green-tailed towhee		0.03	0.12			0.08		0.08					0.09	0.04				0.02
Hammond's flycatcher	0.03				0.02	0.02	0.04							0.01				
Harris's hawk											0.02				0.13			
hooded oriole		0.34	0.10		0.15	0.06	0.21	0.06	0.12	0.01				0.01				
horned lark																		
house finch	1.11	0.91	1.13		1.83	2.30	1.18	2.17	1.42	1.48	1.25	0.86	1.34				1.20	1.95
house sparrow	1.11																0.56	
house wren					0.02												0.02	
Hutton's vireo																	0.02	0.02
Inca dove	0.03												0.13	0.01				
indigo bunting					0.06													
juniper titmouse			0.05															
killdeer					0.02													0.04
ladder-backed woodpecker		0.28	0.27		0.25	0.06	0.04	0.36	0.27	0.08			0.69	0.11	0.02		0.33	0.05
lark sparrow						0.39	0.06	0.06					1.19				0.43	0.13
lazuli bunting		0.03												0.03	0.01		0.02	0.02
lesser goldfinch	0.11	0.31	0.03		1.35	0.67	1.43	0.14					1.53	0.20	0.02		0.87	0.80

Appendix B. Mean relative abundance of birds observed at each park during the 2007 field season, cont.

Species	Casa Grande Ruins NM	Fort Bowie NHS			Montezuma Castle NM (Castle unit)			Montezuma Castle NM (Well unit)			Organ Pipe Cactus NM		Saguaro NP			Tumacácori NHP	Tuzigoot NM
		R	U		R	U		R	U		R	U	R	U		R	R
lesser nighthawk	0.14											0.01		0.01	0.02		0.24
Lincoln's sparrow													0.03				
loggerhead shrike			0.02									0.04					0.02
Lucy's warbler		0.53	0.17									0.13		0.16	0.01	1.93	0.56
MacGillivray's warbler						0.05											0.03
mallard					0.50	0.16		0.04						0.01		0.04	0.13
mourning dove	3.94	1.03	1.28		1.73	1.19	2.71	1.61	0.30	0.37	1.41	0.68	0.47			0.74	3.22
northern beardless-tyrannulet																0.06	
northern cardinal		1.00	0.33		0.21	0.08	0.14	0.14	0.18	0.01	1.22	0.19	0.11			0.96	0.55
northern flicker			0.08									0.01					0.02
northern mockingbird	0.11	0.44	0.80			0.06	0.04	0.56			0.06	0.02	0.02			0.15	0.20
northern rough-winged swallow					0.60	0.08	0.19	0.25								0.20	1.04
olive-sided flycatcher										0.02							
orange-crowned warbler			0.02		0.02	0.08	0.11						0.02			0.02	0.07
peregrine falcon													0.02				
phainopepla		0.16	0.03		1.56	0.66	0.25	0.42	0.18	0.15	0.59				0.04	1.24	1.75
plumbeous vireo		0.03	0.02		0.02	0.02											0.04
prairie falcon														0.02			
purple martin									0.09		0.56	0.21	0.16				
pyrrhuloxia		0.03	0.03						0.18	0.03	0.06	0.38	0.28			0.02	
red-tailed hawk	0.03		0.10		0.02	0.03		0.03		0.03	0.06	0.05	0.05				0.11
red-winged blackbird	1.06				0.04	0.09	0.14									0.04	4.78
rock pigeon	0.11																
rock wren		0.25	0.37		0.13	0.30	0.04	0.33	0.12	0.01		0.03	0.03				0.02
ruby-crowned kinglet							0.04									0.02	
rufous-crowned sparrow		0.16	0.13					0.03				0.04					
rufous-winged sparrow											0.41	0.20	0.05			0.15	

Appendix B. Mean relative abundance of birds observed at each park during the 2007 field season, cont.

Species	Casa Grande Ruins NM	Fort Bowie NHS		Montezuma Castle NM (Castle unit)		Montezuma Castle NM (Well unit)		Organ Pipe Cactus NM		Saguaro NP			Tumacácori NHP	Tuzigoot NM
		R	U	R	U	R	U	R	U	R	Mountain District	Tucson Mountain District	R	R
Say's phoebe	0.06	0.06	0.13										0.06	0.18
Scott's oriole		0.19	0.05					0.73	0.68		0.06	0.05		
sharp-shinned hawk														0.02
solitary sandpiper														0.02
song sparrow		0.06		0.02		0.21							0.89	0.36
sora rail														0.07
spotted sandpiper				0.02										
spotted towhee		0.03		0.04	0.02									0.02
summer tanager		0.25		0.60	0.16	0.82	0.06			0.53	0.02		1.44	0.24
thick-billed kingbird													0.02	
Townsend's solitaire		0.03		0.02		0.04								
Townsend's warbler		0.06				0.04		0.06	0.02			0.01		
tree swallow												0.01		0.02
tropical kingbird													0.11	
turkey vulture		1.31	0.02		0.09		0.56		0.03	0.03	0.04	0.07	0.09	0.02
varied bunting										0.03	0.01		0.02	
verdin	0.46	0.81	0.20	0.25	0.11	0.04	0.11	1.73	1.45	0.50	0.59	1.02	0.28	0.13
vermillion flycatcher										0.72			0.44	0.02
vesper sparrow							0.06						0.07	
violet-green swallow				0.50	0.11		0.03		0.01		0.01		0.07	0.07
Virginia rail														0.09
Virginia's warbler														0.02
warbling vireo			0.02	0.02	0.06	0.04	0.06						0.04	
western flycatcher		0.03						0.09	0.02	0.03			0.02	
western kingbird	0.09	0.22	0.05	0.06	0.06	0.11	0.06		0.01	0.44	0.02		0.46	0.22
western meadowlark							0.08							
western screech-owl			0.03											
western scrub-jay		0.19	0.35											
western tanager		0.03							0.02	0.06	0.01	0.01	0.06	0.04

Appendix B. Mean relative abundance of birds observed at each park during the 2007 field season, cont.

Species	Casa Grande Ruins NM	Fort Bowie NHS		Montezuma Castle NM (Castle unit)		Montezuma Castle NM (Well unit)		Organ Pipe Cactus NM		Saguaro NP			Tumacácori NHP	Tuzigoot NM
		R	U	R	U	R	U	R	U	Rincon Mountain District	Tucson Mountain District	R		
western wood-pewee				0.06	0.03	0.25	0.03				0.01		0.06	0.02
white-breasted nuthatch													0.04	
white-crowned sparrow				0.08	0.20		0.50			0.06	0.02		0.04	0.24
white-throated sparrow			0.15											
white-throated swift		0.16		0.06	0.11				0.04	0.14	0.18			
white-winged dove	0.63	1.28	0.78	0.04		0.04	0.03	2.45	4.05	1.28	2.69	2.47	1.33	
Wilson's warbler	0.03			0.02				0.24	0.03	0.06	0.02		0.15	0.05
wood duck				0.27	0.06									0.07
yellow warbler				0.19	0.03	0.64				0.22			0.93	0.27
yellow-billed cuckoo		0.06				0.11							0.04	0.02
yellow-breasted chat				0.21	0.08	0.29	0.03				0.01		1.33	0.55
yellow-rumped warbler			0.02	0.85		0.29	0.03				0.04		0.02	0.04
zone-tailed hawk		0.19											0.02	

R = riparian transect; U = upland transect.

Relative abundance was calculated as the number of observations divided by the total number of survey points and visits.