



In Cooperation with the University of Arizona, School of Natural Resources

# Vascular Plant and Vertebrate Inventory of Fort Bowie National Historic Site



Southwest Biological Science Center  
Open-File Report 2005-1167  
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U.S. Department of the Interior  
U.S. Geological Survey  
National Park Service







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By Brian F. Powell, Cecilia A. Schmidt , and William L. Halvorson

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**U.S. Department of the Interior  
U.S. Geological Survey  
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## Dedication



**Eric Wells Albrecht  
1970-2004**

This report, as others in this series, is dedicated to Eric's life and work; he was an extraordinary ecologist, community member, father, and partner. Eric was co-coordinator of the University of Arizona (UA) biological inventory and monitoring program from 2002 until his sudden and unexpected death on September 20, 2004. Eric was near completion of his MS degree in Wildlife Conservation from the UA, which was awarded posthumously in November 2004. In his last year, Eric spearheaded projects to investigate the efficiency of current monitoring programs; he was passionate about using the best available information to guide vertebrate monitoring efforts in the region. He is survived by his partner, Kathy Moore, and their two young children, Elizabeth and Zachary. We hope that the lives of his children will be enriched by Eric's hard work on behalf of the national parks in the Sonoran Desert Network.

## Acknowledgements

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We thank a core group of dedicated field biologists who collected a wealth of data at Fort Bowie NHS: James MacAdam, and Meg Quinn (plants); Eric Albrecht, Gabe Martinez, and Janine McCabe (birds); and Patina Thompson (mammals). Barbara Herman-Reese provided Trailmaster data. We are appreciative of the following people, whose work in the office made the field effort more successful: Debbie Angell, Jennifer Brodsky, Brian Cornelius, Taylor Edwards, Carianne Funicelli, Marina Hernandez, Colleen McClain, Heather McClaren, Lindsay Norpel, Ryan Reese, Jill Rubio, Brent Sigafus, Taffy Sterpka, Jenny Treiber, and Alesha Williams.

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## Executive Summary

This report summarizes results of an inventory of plants, birds, and mammals of Fort Bowie National Historic Site (NHS) in southeastern Arizona.

Surveys at the park were part of a larger effort to inventory vascular plants and vertebrates in eight National Park Service (NPS) units in Arizona and New Mexico. Our inventory efforts build on past research for the park; included in this report is the most comprehensive synthesis of species lists from past studies of plants and vertebrates. Though we did not survey specifically for them, we also include a species lists of amphibians and reptiles that have been observed or documented at the park.

For a park of its size (405 ha), Fort Bowie NHS has extraordinary species richness, especially for plants (638 species) and mammals (57 species). This diversity results from its geographic location at the junction of three biogeographical provinces, its diverse geology, and the presence of year-round water from an active spring.

We found 45 new plant and vertebrate species for the park (Table 1) including:

- Plants: two species representing new families and nine species representing new genera, including one new genus (*Euphorbia*) represented by three species;
- Birds: zone-tailed hawk and common ground dove;
- Mammals: domestic dog and hooded skunk.

Based on a review of past studies and our own work, we consider the inventories of plants and vertebrates to be 90% complete. With baseline inventories at Fort Bowie NHS among the most complete of the 11 parks in the Sonoran Desert Network, park staff are now in an excellent position to monitor changes in these resources.

**Table 1. Summary results of plant and vertebrate inventories at Fort Bowie NHS, 2002 to 2004.**

Taxonomic group	UA Effort			Total number of species on park list <sup>b</sup>
	Number of species recorded	Number of non-native species	Number of new species added to park list <sup>a</sup>	
Plants	193	13	33	638
Amphibians and Reptiles	8	0	0	40
Birds	109	0	6	189
Mammals	14	1	2	59
<b>Totals</b>	<b>324</b>	<b>14</b>	<b>41</b>	<b>926</b>

<sup>a</sup>Species that had not been observed or documented by previous studies.

<sup>b</sup>From all sources (see Appendices A-D for complete lists).



# Chapter 1: Introduction to the Biological Inventories

## Project Overview

*Inventory: A point-in-time effort to document the resources present in an area.*

In the early 1990s, responding to criticism that it lacked basic knowledge of natural resources within parks, the National Park Service (NPS) initiated the Inventory and Monitoring Program (NPS 1992). The purpose of the program is to increase scientific research in NPS units and to detect long-term changes in biological resources (NPS 1992). At the time of the program's inception, basic biological information, including lists of plants and animals, were absent or incomplete for many parks (Stohlgren et al. 1995).

Species inventories have both direct and indirect value for management of the park. Species lists facilitate resource interpretation and visitor appreciation of natural resources. Knowledge of which species are present, particularly sensitive species, and where they occur is critical for making management decisions (e.g., locating new facilities). Inventories are also a cornerstone of long-term monitoring. Thorough biological inventories provide a basis for choosing parameters to monitor and can provide initial data (i.e., a baseline) for monitoring ecological populations and communities. Inventories can also test sampling strategies, field methods, data collection protocols, and provide estimates of variation that are essential in prospective power analysis.

## Goals

The purpose of this study was to complete basic inventories for vascular plants, birds, and mammals at Fort Bowie National Historic Site (NHS). This effort was part of a larger biological inventory of eight NPS units in southern Arizona and southwestern New Mexico (Davis and Halvorson 2000, Powell et al. 2003, 2004, 2005a). The results presented in this report supersede those reported by Powell et al. (2003, 2004, and 2005b).

The goals of our biological inventory of Fort Bowie NHS were to:

1. Conduct field surveys to bring the current species lists for vascular plants, birds, and mammals to at least 90% of the species expected to occur at the park.
2. Use repeatable sampling designs and survey methods (when appropriate) that allow estimation of parameters of interest with associated estimates of precision.
3. Compile historic occurrence data for plants and vertebrates (including amphibians and reptiles) from three sources: museum records (specimen vouchers), previous studies, and park records.
4. Create resources useful to park managers, including detailed species lists, maps of study sites, and high-quality digital images for use in resource interpretation and education.

The bulk of our effort addressed goals number 1 and 2. To maximize efficiency (i.e., the number of species recorded by effort) we used field techniques designed to detect multiple species. We did not undertake single-species surveys for threatened or endangered species.

## Administrative History

The original study plan for this project was developed, and an inventory of one Sonoran Desert Network (SDN) park (Tumacácori National Historical Park) was completed, through a cooperative agreement between NPS, UA, and the USGS. This project comprises biological inventories for seven additional parks and was funded through Task Agreements UAZ-03, -05, -06, and -07 (under Colorado Plateau CESU cooperative agreement number 1200-99-009). The National Park Service thereafter obligated additional funds for administration, management, and technical oversight of the biological inventories through the Colorado Plateau CESU (UAZ-07) and the Desert Southwest CESU (cooperative agreement number CA 1248-00-002, reference UAZ39, -77, -87, -97, and 128).

## Report Format and Data Organization

This report includes summaries and analyses of data related to vascular plants, birds, and mammals collected from 2002 to 2004 at Fort Bowie NHS. This report is intended to be useful in internal planning processes and outreach and education, and as such we strive to make it relevant, easy to read, and well organized. We report only common names (listed in phylogenetic sequence) unless the species is not listed later in an appendix; in this case we present both common and scientific names. For each taxonomic group we include an appendix of all species that we recorded at the park (Appendices A, C, and D). Although we did not survey specifically for amphibians and reptiles, we made a few incidental observations and we include a list of species observed or documented by others (Appendix B). Species lists are in phylogenetic sequence and include taxonomic order, family, genus, species, subspecies or varieties (if applicable) and common name. Scientific and common names used throughout this document are current according to accepted authorities for each group: Integrated Taxonomic Information System (ITIS 2004) and the PLANTS database (USDA 2004; including designation of plants as “non-native”) for plants; Stebbins (2003) for amphibians and reptiles; American Ornithologist Union (AOU 1998, 2003) for birds; and Baker et al. (2003) for mammals. To maintain consistency throughout the document, we do not capitalize the first letter of common names unless they are proper names. In this document we use the International System of Units for measurements.

### *Previous Amphibian and Reptile Inventories*

We did not survey for amphibians and reptiles because there have been two thorough inventories for them: the first by Lowe and Johnson (1976) and more recently by Swann et al. (2001). In addition to re-surveying Lowe and Johnson’s line-transects, Swann et al. set up long-term monitoring plots, surveyed road transects, and produced an annotated species list. In total, these studies found one non-native species (American bullfrog), and 31 reptile species (16 lizards, one turtle, and 14 snakes) including Texas horned lizard, a federally listed species of concern. The most notable species is now-extirpated Chiricahua

leopard frog (a federally threatened species; HDMS 2004). In this report, we list the species found by these studies and species that our crews found while conducting surveys for other taxa (Appendix B). We also summarize specimens located in the University of Arizona herpetology collection (Appendix E), and a few photographic vouchers that we took during our course of other field research (Appendix I).

### *Spatial Data*

Most spatial data are geographically referenced to facilitate mapping of study plots and locations of plants or animals. Coordinate storage is the Universal Transverse Mercator (UTM) projection, using North American datum 1983 (NAD 83), Zone 12. We recorded UTM coordinates using hand-held Garmin eMap® Global Positioning System (GPS) units (Garmin International Incorporated, Olathe, KS; horizontal accuracy is about 10–30 m). For each taxon-specific chapter of this document we mapped the location of all plots or stations overlaid on Digital Orthophoto Quarter Quads (DOQQ; produced by the U.S. Geological Survey). All study-site coordinates are stored at the same locations as for data archiving (below).

### *Species Conservation Designations*

We indicate species conservation designations by the following agencies: U.S. Fish and Wildlife Service (responsible for administering the Endangered Species Act), Bureau of Land Management, U.S.D.A. Forest Service, Arizona Game and Fish Department, and Partners in Flight (a partnership of federal, state and local governments, non-governmental organizations, and private industry).

### *Databases and Data Archiving*

We entered field data into taxon-specific databases (Microsoft Access version 97) and checked all data for transcription errors. From these databases we reproduced copies of the original field datasheets using the “Report” function in Access. The output looks similar to the original datasheets but data are easier to read. The databases, printouts, and other data such as digital photographs and GIS layers will be distributed to the park and to the University of Arizona, Special Collections (Main Library, Tucson). Original copies of all datasheets will be given to the NPS SDN I&M program office in



Tucson and may be archived at another location (most likely Western Archaeological Conservation Center, Tucson; Andy Hubbard, *pers. comm.*). This redundancy in data archiving is to ensure that these valuable data are never lost. Along with the archived data we will include copies of the original datasheets and a guide to filling them out. This information, in conjunction with the text of this report, should enable future researchers to repeat our work.

## Verification and Assessment of Results

### Photographic Vouchers

Whenever possible we documented vertebrate species with analog color photographs. Many of these photos show detail on coloration or other characteristics of visual appearance, and they may serve as educational tools for the park staff and visitors. Photographs will be archived with other data as described above.

### Specimen Vouchers

With proper documentation, specimen vouchers are the most indisputable form of evidence of species occurrence. For plants, we searched the University of Arizona Herbarium for existing specimens from Fort Bowie NHS (see Appendix A for results), but we collected herbarium

specimens whenever flowers or fruit were present on plants in the field (Appendix A). All specimens that we collected were accessioned into the University of Arizona Herbarium. Although we did not collect specimen vouchers for vertebrates, we searched for existing vouchers from Fort Bowie NHS in records from 23 natural history museums (Table 1.1 see Appendix E for results).

### Assessing Inventory Completeness

We evaluated inventory completeness by (1) examining the rate at which new species were recorded in successive surveys (i.e., species accumulation curves; Hayek and Buzas 1997) and (2) by comparing the list of species we recorded with a list of species likely to be present based on previous research and/or expert opinion. For all species accumulation curves, we randomized the order of the sampling periods to break up clusters of new detections that resulted from temporal conditions (e.g., monsoon initiation) independent of cumulative effort. We used the computer program Species Richness and Diversity III (Pisces Conservation Ltd., IRC House, Pennington, Lymington, UK) to calculate species accumulation curves where the order of samples was shuffled >10 times and the average is plotted, thereby smoothing the curve.

**Table 1.1. Museums that were queried in 1998 for vertebrate specimen vouchers with “Arizona” and “Fort Bowie National Historic Site” in the collection location.** Collections in bold-faced type had specimens from Fort Bowie NHS. See Appendix E for results.

Collection	Collection cont.
<b>Chicago Academy of Sciences</b>	Peabody Museum, Yale University
Cincinnati Museum of Natural History & Science	Saguaro National Park
Cornell Vertebrate Collections, Cornell University	Strecker Museum, Baylor University, Waco
George Mason University (Fairfax, VA)	Texas Cooperative Wildlife Collection
Marjorie Barrick Museum, University of Nevada-Las Vegas	<b>University of Arizona</b>
Michigan State University Museum (East Lansing)	University of Texas, Arlington
Milwaukee Public Museum	University of Illinois, Champaign-Urbana
Museum of Texas Tech University	<b>University of Colorado Museum</b>
<b>Museum of Vertebrate Zoology, University of California, Berkeley</b>	Walnut Canyon National Monument, Arizona
Museum of Life Sciences, Louisiana State University, Shreveport	Western Archaeological and Conservation Center, Tucson
North Carolina State Museum of Natural Sciences	Wupatki National Monument, Arizona
Oklahoma Museum of Natural History, Norman	

## Technical Concepts

### *Sampling Design*

Sampling design is the process of selecting sample units from a population or area of interest (for a review, see Thompson [1992]). Random samples allow inference to the larger population from which those samples were drawn, and estimate the true value of a parameter. Non-random samples are less likely to be representative of the entire population, because the sample may (intentionally or not) be biased toward a particular characteristic, perhaps of interest or convenience.

We briefly address sampling design in each chapter. Our surveys were not randomly located because we were more interested in detecting the maximum number of species than in providing inference to a larger area. Thus, abundance estimates (relative abundance, useful as an index to true abundance) detailed in this report may be biased because we surveyed in areas likely to have high species richness; however, the nature or extent of that bias is difficult to characterize or quantify. If population estimates were a higher priority, avoiding this potential bias would have greater importance.

### *Estimates of Abundance*

Estimating population size is a common goal of biologists, generally motivated by the desire to reduce (e.g., pest species), increase (e.g., endangered species), maintain (e.g., game species) or monitor (e.g., indicator species) population size. Our surveys at Fort Bowie NHS were generally focused on detecting species rather than estimating population size. In many cases, however, we present estimates of “relative

abundance” by species, which is an index to population size; we calculate it as the number of individuals of a species recorded, scaled by survey effort. Some researchers (particularly plant, marine, and invertebrate ecologists) prefer to scale such frequency counts by the number of observations of other species, which provides a measure of community dominance; abundance relative to other species present. If we completed multiple surveys in comparable areas (e.g., anywhere within Fort Bowie NHS), we included a measure of precision (usually standard error) with the mean of those survey results.

Indices of abundance are presumed to correlate with true population size but do not typically attempt to account for variation in detectability among different species or groups of species under different conditions. Metrics (rather than indices) of abundance do consider variation in detection probability, and these include density (number of individuals per unit area; e.g., two black-throated sparrow per hectare of semi-desert grassland), and absolute abundance (population size; e.g., 28 black-throated sparrow at Fort Bowie NHS). These latter techniques are beyond the scope of our research. While it is true that indices to abundance have often been criticized (and with good reason, c.f. Anderson 2001), the abundance information that we present in this report is used to characterize the commonness of different species rather than to quantify changes in abundance through space (e.g., habitat-use studies) or time (e.g., monitoring). As such, relative abundance estimates are more useful than (1) detectability-adjusted estimates of density for only a few species or (2) raw count data for all species without scaling counts by search effort. For a review of methods used to estimate abundance, see Lancia et al. (1996).

## Chapter 2: Park Overview

### Park Area and History

Fort Bowie National Historic Site (NHS) is located in southeastern Arizona approximately 22 km south of the town of Bowie, Arizona (Fig. 2.1). The park lies in Apache Pass between the Chiricahua Mountains to the south and the Dos Cabezas Mountains to the north.

Fort Bowie NHS was established in 1964 to preserve the historic dwellings of Fort Bowie, a 19th century U.S. military outpost, prehistoric structures associated with Apache Spring, and a portion of the Butterfield Overland Trail and Station (NPS 2001). The park also commemorates the fort's soldiers, the Chiricahua Apaches, and the settlement of the west (NPS 2001). The park, which encompasses 405 ha, is administered by Chiricahua National Monument. Recent annual visitation is approximately 9,500 (NPS 2005).

### Natural Resources Overview

#### *Physiography, Geology and Soils*

Fort Bowie NHS is located in Apache Pass, which separates the San Simon and the Sulphur Springs Valleys. Elevation at the park ranges from 1,400 m to 1,600 m. The park contains three riparian areas: Siphon Canyon, Cutoff Canyon, and Willow Gulch. The geology of the park is characterized by the Apache Pass Fault made of Pennsylvanian and Cretaceous limestone on top of Precambrian granite (Denney and Peacock 2000). In some areas small fan terraces have formed from the granitic alluvium deposited by drainageways. For a complete soil survey, see Denny and Peacock (2000).

#### *Hydrology*

There are no perennial-flowing streams, but two springs, Apache and Mine Tunnel, are found within the park. Three other springs are outside, but near to the boundary of the park: Siphon, Bear, and Goodwin springs. Currently, half of the water flow of Apache Springs can be diverted to adjacent lands for use in cattle tanks, though this is rarely realized (Alan Whalon, *pers. comm.*). Siphon Canyon and Willow Gulch have ephemeral flow during summer (monsoonal) and winter rains (NPS 2001).

#### *Climate*

Fort Bowie NHS experiences an annual bimodal pattern of precipitation that is characterized by heavy summer (monsoon) storms from the Gulf of Mexico, and less intense frontal systems from the Pacific Ocean in the winter. On average, approximately one-half of the annual precipitation falls from July through September (Table 2.1; WRCC 2005). The area's hot season occurs from April through October; maximum temperatures in July can exceed 40°C. Winter temperatures dip below freezing and snow is occasional. Based on data from Bowie, Arizona (the closest climate station), average annual precipitation totals during the course of our study were significantly lower than the long-term mean (27.3 cm) in 2002 (21.5 cm) and 2003 (19.3 cm), but similar for 2004 (29.3 cm through October 2004) (Fig 2.3; WRCC 2005). Average annual temperatures during all years of our survey were above the long-term mean of 17.7°C (17.8°C in 2002, 18.3°C in 2003, and 18.9°C through October 2004).

**Table 2.1. Average monthly climate data for Bowie, Arizona, 1899–2004.** Data from WRCC (2005).

Characteristic	Month												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Maximum temperature (°C)	16.2	18.7	22.2	26.8	31.7	36.8	36.8	35.3	33.2	27.8	20.7	15.7	26.8
Minimum temperature (°C)	-0.7	1.2	3.7	7.0	11.5	16.6	19.7	18.7	15.2	9.0	2.6	-0.5	8.7
Precipitation (cm)	2.1	2.0	1.5	0.7	0.6	0.9	5.2	5.3	2.6	2.2	1.5	2.4	2.3

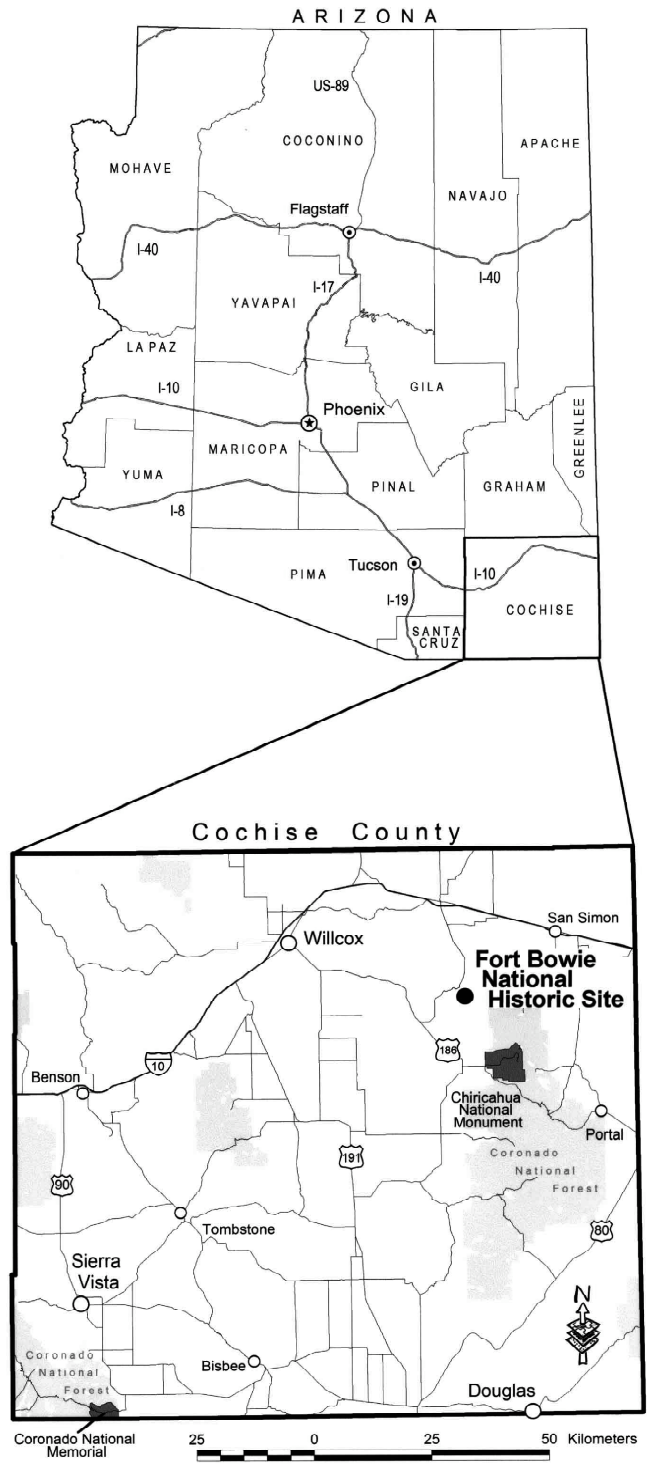


Figure 2.1. Location of Fort Bowie NHS in southern Arizona.

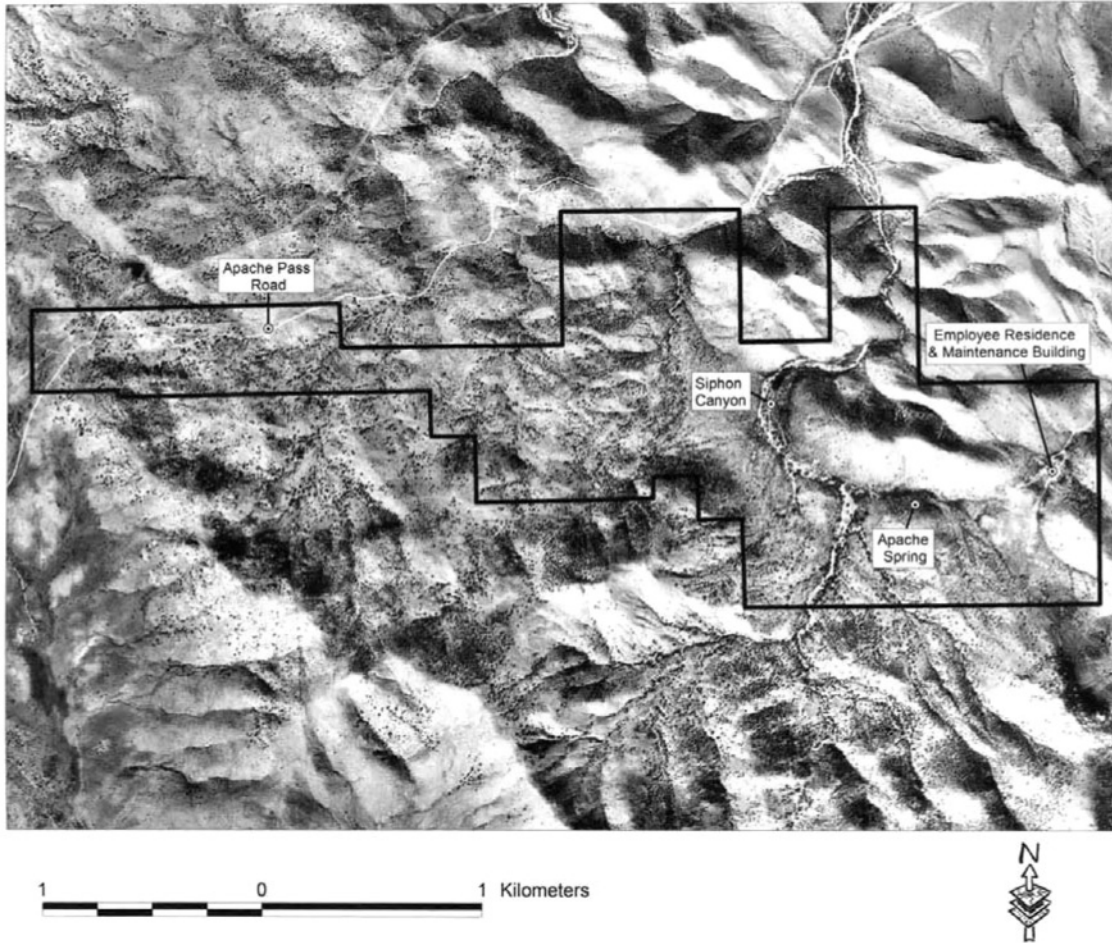


Figure 2.2. Aerial photograph of Fort Bowie NHS showing some of the major features.

### Vegetation

Fort Bowie NHS contains four major vegetation communities (based on Warren et al. [1992]):

- **Madrean Evergreen Forest and Woodland** containing Emory Oak–Point-leaf Manzanita– Beargrass Association, Emory Oak–Turpentine bush–Grama Grass Association, Scrub Oak–Bear Grass–Oneseed Juniper Association and Desert Deerbrush–Alder-leaf Mountain-mohogany–Desert Sumac Association;
- **Semi-desert Grassland** containing Velvet Mesquite–Turpentine bush–Burroweed Association, Turpentine bush–Fairy Duster–Ocotillo Association, Ocotillo–Mariola–Grama Grass Association, Velvet Mesquite–Desert Sumac–Snakeweed Associations and Russian Thistle–Snakeweed–Mixed Grass Association;
- **Chihuahuan Desertscrub** containing Creosote-bush–Velvet Mesquite–Mariola Association; and
- **Interior Southwestern Riparian Deciduous Forest and Woodland** containing Arizona Walnut–Netleaf Hackberry–Gum Bumelia Association.

Historic photographs from the era of settlement show that juniper and oak trees were not abundant in the area near the fort, presumably because the trees had been cut for firewood (Warren et al. 1992). More recently, mesquite trees have invaded the semi-desert grassland areas of the park, most likely as a result of fire suppression and cattle grazing (NPS 2000b). Park personnel have removed many of the large mesquite trees that encroached into the area near the fort ruins. (NPS 2001).

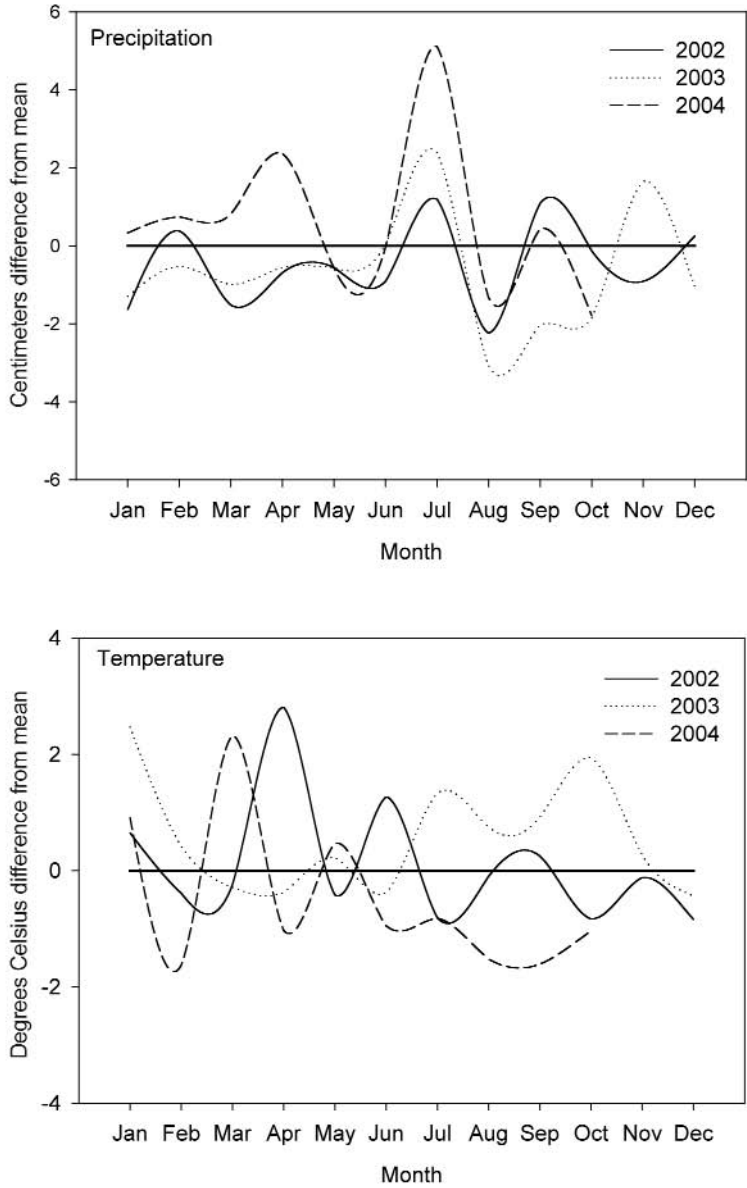


Figure 2.3. Comparison of monthly weather data during the time of the inventory (2002–2004) compared to the long-term mean (1899–2004; thick solid line in both figures), Bowie, Arizona. Data from WRCC (2005).

## Natural Resource Management Issues

### *Cattle Grazing*

Two cattle grazing allotments at the park were recently retired, though trespass of cattle onto the park is common. Livestock grazing has degraded an estimated 80% of streams and riparian ecosystems in the western United States through loss of vegetation, stream-bank erosion, soil compaction, flooding, and water pollution (Bahre

1991, BLM 1994, Fleischner 1994). Livestock grazing can also increase the number and extent of non-native plants (Belsky et al. 1999) and can negatively affect wildlife through habitat modification and competition for resources (Saab et al. 1995). At Fort Bowie, cattle have decreased grass cover, damaged historic artifacts, and helped to spread woody plants, such as mesquite, into what was once predominantly semi-desert grassland (NPS 2001).

### *Non-Native Species*

Lehmann lovegrass and other non-native grasses are the most important non-native species issue at the park. The change in species composition in the semi-desert grassland to a community dominated by Lehmann lovegrass, in particular, can alter the fire regime of the area by supporting higher fire frequencies, thereby leading to other changes in vegetation composition and structure including a loss of species richness (Anable et al. 1992).

The presence of American bullfrogs is another important non-native species management issue. Bullfrogs are native to eastern North America but have been introduced throughout the western U.S. for food production and sport (Stebbins 2003). American bullfrog adults and tadpoles are voracious predators (Kiesecker and Blaustein 1997) and are thought to be partially responsible for the decline of many native reptiles (Schwalbe and Rosen 1988) and amphibians (particularly other Ranid frogs; Hayes and Jennings 1986, Lawler et al. 1999) in the southwest.

### *Undocumented Immigrants*

Approximately 20 undocumented immigrants pass through the park each week (NPS 2003). In addition to compromising visitor safety, border crossers also adversely impact the natural resources; they have created trails (including into the fort ruins), damaged vegetation, and have left trash behind. These impacts affect water quality and wildlife movement patterns, though the extent of these impacts has not been established.

### *Adjacent Land Use*

Due to its small size, the park is easily affected by land management practices (e.g., development, mining, grazing, and hunting) outside its boundaries. Currently there is a Buddhist retreat center being built to the north of the park, but because the remainder of the land surrounding the park is managed by the BLM, ex-urban housing development is unlikely to significantly affect the park's resources.





## Chapter 3: Plant Inventory

### Previous Research

Warren et al. (1992) completed the most thorough inventory of plants at Fort Bowie NHS (Appendix A). Most of the specimen vouchers reported by Warren et al. were collected by Marina Hoy from 1972 to 1977. The collection is comprised of 471 species and subspecies. Warren et al. reported that most of the specimens were located at the park with “duplicates of selected species at the University of Arizona”. However, in a recent search of the UA collections, Halvorson (2003) did not find any specimens from this study. Bennett et al. (1996) compiled a species list for the Chiricahua Mountains and vicinity (including Fort Bowie NHS) from a variety of sources including: complete examination of herbaria at Chiricahua National Monument, Fort Bowie NHS, the Southwestern Research Station, and minimal examination of herbaria at the University of Arizona, Arizona State University, and New Mexico State University. In their annotated species list, Bennett et al. indicated if the plant was found at Fort Bowie NHS. Most of the species attributed to Fort Bowie NHS were from the collections made by Marina Hoy, therefore there is considerable overlap between the Bennett et al. list and that by Warren et al. (1992; Appendix A). Ruyle (2001) assessed range conditions at eight permanently marked transects: six in the park and two outside (but near) the park. He found ten species of plants new to the park though he did not, to our knowledge, collect specimens. His work remains the only plot-based plant research at the park. Halvorson and Guertin (2003) mapped the distribution of 22 non-native plant species in the park from the fall of 1999 to the spring of 2001. There are two other poorly documented plant species lists for the park. NPS (2000a) produced an annotated species list for Fort Bowie NHS. This list appears to be compiled from Warren et al. (1992) and Bennett et al. (1996) but these sources do not entirely make up the list (Appendix A). Finally, Hartman and Rottman (1998) compiled a checklist for the park but again, no documentation exists from their work.

### Methods

To complete the species list for the park, we used “general botanizing” surveys, during which observers walked throughout the park (particularly around the parade grounds and along trails) and opportunistically collected and recorded plants. In addition to our own results, we present here the first synthesis of findings from past studies and collections.

#### *Spatial Sampling Design*

Our survey crews walked throughout the park on each visit. They did not record their search paths, but indicated the location of each collection.

#### *General Botanizing*

##### Field Methods

Whenever possible we collected at least one representative specimen (with reproductive structures) for each plant species that were thought to represent a new species for the park. When we collected a specimen we recorded flower color, associated dominant vegetation, date, collector name(s), and UTM coordinates. We pressed the specimens immediately upon collection. Specimens remained pressed for 2–3 weeks and were frozen for 48 hours to prevent infestation by insects and pathogens. We then mounted the specimens and accessioned them into the University of Arizona Herbarium.

##### Effort

We made nine day-long visits, typically with two observers, on 28 September and 5, 6, 9, 23, 29, and 31 October 2002 and on 6 and 9 May 2003.

### Results and Discussion

We found 193 species and subspecies, including 33 new species for the park (Appendix A). Of these, we found two species representing new families for the park and nine species representing new genera for the park. Of particular note were three species of *Euphorbia*, a new genus for the park. Of the 33 species new for the park, only one was non-native.

Considering all available sources, there have been 638 species and subspecies recorded at the park, of which 38 (6%) are non-native (Appendix A). The percentage of non-native plants in the park's flora is low compared to other sites in southeastern Arizona (e.g., Burgess et al. 1991, Powell et al. 2005a). The number and extent of non-native plants may be buffered by the lack of roads through the park. Roads act as dispersal corridors for non-native plant species, which often thrive in the adjacent disturbed soils. Although the park has a low percentage of non-native species, the percent of area covered by them is greater. Halvorson and Guertin (2003) mapped the distribution of 22 species of non-native plants at the park. Lehmann lovegrass was the most widespread of the non-native species and other non-native species were especially prevalent around the visitor center. Ruyle (2001) established plots and his work remains the only study that is able to quantify the dominance and relative abundance of plants. Yet because of the diversity of vegetation communities and conditions in the park, Ruyle did not survey enough plots to address the dominance of non-native species; he found no non-native species during his surveys, but clearly did not have plots in the semi-desert grasslands west of Siphon Canyon (near the cemetery) where Lehmann lovegrass dominates. In Chapter 6 we make recommendations for more plot-based survey work.

The number of species documented for the park far outnumbers the expected species richness (330), based on size and topographic relief of the park (Warren et al. 1992). The extraordinary species richness that has been found at the park is due to three main factors: geographic location of park, geologic faults separating different rock substrates, and the presence of permanent water.

Fort Bowie NHS lies at the juncture to four major biogeographical provinces: Madrean, Rocky Mountain, and Sonoran and Chihuahuan deserts. The Madrean biogeographic region in particular is well represented in the flora of the park, and this region has the highest plant species richness in

Arizona (Bowers and McLaughlin 1982). Other floristic influences are from the Great Plains and Chihuahuan regions (Warren et al. 1992).

The high species richness at the park is also the result of local influences from two faults that pass through the park: Apache Pass and Fort Bowie faults (Denny and Peacock 2000). These faults separate major geologic substrates including limestone, shale, sandstone, and granitic and metamorphic rock, all of which give rise to conditions that favor certain plant species. For example, Warren et al. (1992) noted that a number of species with primarily Chihuahuan desert distributions are found on limestone outcrops at Fort Bowie NHS.

Finally, the perennial Apache Spring gives rise to the third determinant of high species richness and vegetation communities at the park. The presence of water is responsible for the vegetation structure in the riparian area, which is in stark contrast to upland areas, and also is an important determinant of vertebrate species richness and abundance (see Chapters 4 and 5).

### **Inventory Completeness**

Fort Bowie NHS has one of the most complete inventories for vascular plants in all of the Sonoran Desert Network parks. Based on our work and that by others, we believe that the inventory is likely 90% complete. We found 33 new species, a 5% increase in the number of plants for the park. Additional surveys, particularly during the late spring, will add more species to the park list, but considering our survey effort, we believe the percentage of new species found will not be significant (see Chapter 7 for additional information on more studies). However, of particular concern in all natural areas is the increase in the abundance and distribution of non-native species. This will likely happen if Cochise County paves Apache Pass Road, thereby increasing the number of vehicles in the area (see Chapter 6).

## Chapter 4: Bird Inventory

### Previous Bird Research

The first comprehensive inventory of birds at the park was in 1975 and 1976 by Russell and Johnson (1976) who surveyed five transect routes multiple times in all seasons. They reported abundance of species based on the number of observations per hour of surveys. Although no original data exist from that study (Terry Johnson, *pers. comm.*), the transect routes were similar to those used by our survey crews and we therefore make gross comparisons between our two studies. Many of the observations of rare birds noted in that report are from Marina Hoy. Fischer (2002) compiled a list of bird species at the park based on: (1) field observations made in the early 1990s (Dan Fischer, *pers. comm.*) and (2) review of bird lists and specimens from the region. Typically we do not consider species lists credible forms of evidence of species occurrence in an area; often these lists are not well documented. However, the list by Fischer (2002) is well documented and is mostly based on his field experience. We therefore use it to create the species list for the park (Appendix C). In 2002 and 2003 there was a Monitoring Avian Productivity and Survivorship (MAPS; DeSante and O'Grady 2000) banding station at the park, which was operated by staff from the Southeastern Arizona Bird Observatory. Finally, we found specimen vouchers, representing 20 species, which were collected in 1893 and 1894 (Appendix E).

### Methods

We surveyed for birds at Fort Bowie NHS in 2003 and 2004. We used four field methods: variable circular-plot (VCP) counts for diurnal birds during the breeding season, nocturnal surveys for owls and nightjars, line transects for birds in the non-breeding season, and incidental observations for all birds in all seasons. Although winter bird surveys were not included in the original study proposal (Davis and Halvorson 2000), we felt they were important in our effort to inventory birds at the park because many species that use the area during the fall and winter may not be present during spring and summer (breeding season) surveys. We concentrated most of our survey effort during the

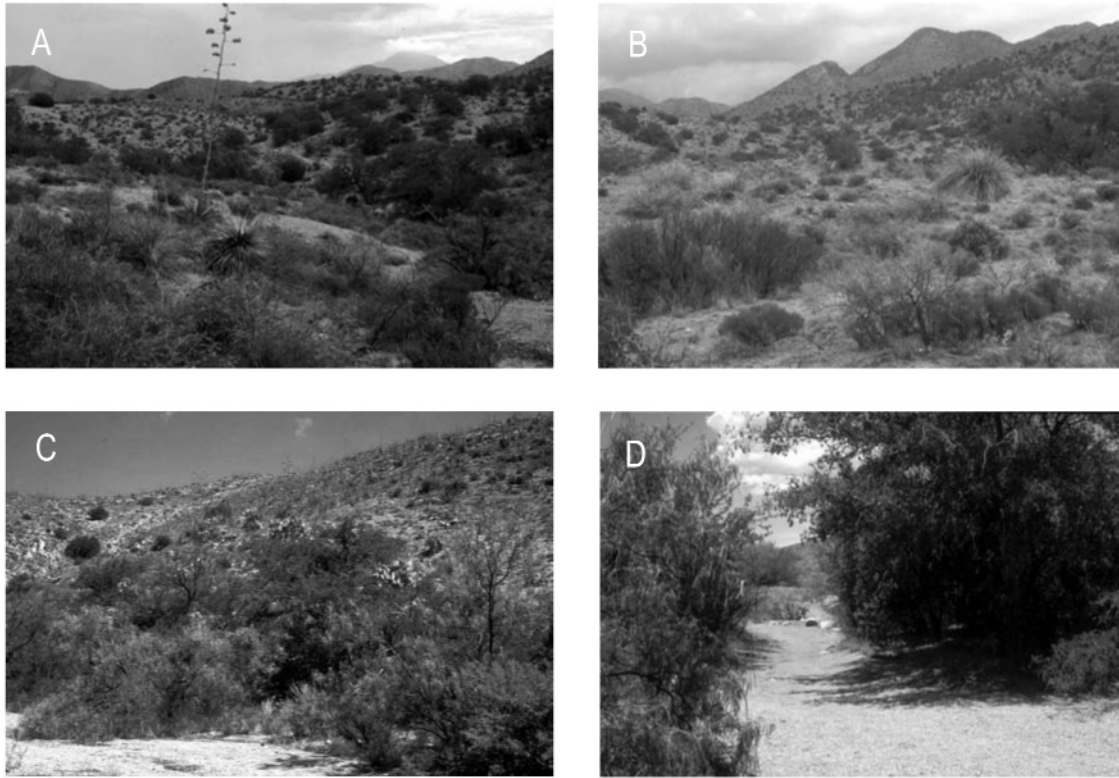
breeding season because bird distribution is relatively uniform at this time (due to territoriality among most landbird species) (Bibby et al. 2000). Therefore, surveying during the breeding season increased our precision in estimating relative abundance and also enabled us to document breeding activity. Our survey period included peak spring migration times for most species, adding many migratory species to our list. We also sampled vegetation in the vicinity of VCP stations. Vegetation structure and plant species composition are important predictors of bird species richness or the presence of particular species (MacArthur and MacArthur 1961, Rice et al. 1984, Strong and Bock 1990, Powell and Steidl 2000).

In most cases we do not report observations that failed to determine species (e.g., “unknown woodpeckers”). Ravens are an exception. Both Chihuahuan and common ravens occur at the park and both species are difficult to differentiate unless they are viewed at a short range under certain conditions or if they are seen flying together (Bednarz and Raitt 2002). We were not able to positively determine the species for any raven sighting and therefore report all observations as “unknown raven.”

### *Spatial Sampling Design and General Vegetation Characteristics*

We subjectively placed the two VCP transects in areas that we believed would have the highest species richness (Siphon Canyon) and would be representative of the dominant vegetation at the park (Butterfield). Some sections of our survey locations correspond to those of Russell and Johnson (1976). The Siphon Canyon transect ran from Apache Spring to where the canyon exits the park (Fig. 4.1). The Butterfield transect began near the junction of the namesake trail and Siphon Canyon and ended near the western boundary of the park (Fig. 4.1; see also Fig. 4.2).

The Butterfield transect follows its namesake trail and it is more xeric than the Siphon Canyon transect. It is dominated by Emory oak and oneseed juniper (Table 4.1) with a wide variety of shrub such as turpentine bush, sotol, manzanita, agave, and yucca (Fig. 4.1). The Siphon Canyon



**Figure 4.1. Photographs taken from bird survey stations, Fort Bowie NHS.** Photographs A and B are looking east from Butterfield transect station numbers 8 and 6, respectively. Photographs C and D are looking north from Siphon Canyon station numbers 6 and 5, respectively. See Fig. 4.2 for location of stations.

transect has some areas of very dense vegetation, including netleaf hackberry, Arizona oak, and Utah juniper near Apache Spring (Table 4.1). Other riparian vegetation, including desert willow and Arizona walnut, is in the bottom of Siphon Canyon (Fig. 4.1). The upslope areas are similar to the Butterfield transect, but with few Emory oak (Table 4.1).

### *VCP Surveys*

#### Field Methods

We used the variable circular-plot method to survey for diurnally active birds during the breeding season (Reynolds et al. 1980, Buckland et al. 2001). Conceptually, these surveys are similar to traditional “point counts” (Ralph et. al 1995), during which an observer spends a standardized length of time at one location (i.e., station) and records all birds seen or heard and the distance to each bird or group of birds.

We surveyed the Siphon Canyon transect in 2003 and 2004 and the Butterfield transect in

2004 (Table 4.2). Each transect consisted of eight stations, each located a minimum of 250 m apart to maintain independence among observations at each station. We surveyed each year from mid April through early July, the period of peak breeding activity for most species in the area.

On each visit to a transect we alternated the order in which we surveyed stations to minimize bias by time of day and direction of travel. We did not survey when wind speed exceeded 15 km/h or when precipitation exceeded an intermittent drizzle. We began bird surveys approximately 30 minutes before sunrise and concluded no later than three hours after sunrise.

We recorded a number of environmental variables at the beginning of each transect: wind speed (Beaufort scale), presence and severity of rain (qualitative assessment), air temperature (°F), relative humidity (%), and cloud cover (%). After arriving at a station, we waited one minute before beginning the count to allow birds to resume their normal activities. We identified to species all birds

seen or heard during an eight-minute “active” period. For each detection we recorded distance in meters from the observer (measured with laser range finder when possible), time of detection (measured in one-minute intervals beginning at the start of the active period), and the sex and/or age class (adult or juvenile), if known. We did not measure distances to birds that were flying overhead, nor did we use techniques to attract birds (e.g., “pishing”). We made an effort to avoid double-counting individuals that had been recorded at previous stations. During the “passive” count

period (between the eight-minute counts), if we observed a species that had not been recorded previously at a station on that visit, we recorded its distance to the nearest station.

#### Effort

We surveyed the eight stations of the Siphon Canyon transect five times in 2003 and the Siphon Canyon and Butterfield transects (also eight stations) six times each in 2004 (Table 4.2). We visited each station for eight minutes on each visit.

**Table 4.1. Mean density (ha) of the most common tree species at each station along the two VCP transects, Fort Bowie NHS, 2004.** Data summarized from Appendix F. Numbers represent the number of individuals observed in the “tree” and “potential cavity-nesting” categories from point-quarter sampling. Species present on >4 stations are included in this summary. See Appendix A for scientific names.

Transect	Station	Species									
		netleaf hackberry	desert willow	Arizona walnut	oneseed juniper	Utah juniper	velvet mesquite	Arizona oak	Emory oak	desert sumac	gum belly
Butterfield	1	0.7		2.4	0.7	0.7	8.7			2.7	
	2	6.9				6.9	20.8		14.4		
	3					1.9	1.8	1.9	25.9		
	4				4.1		10.1	1.7	23.1		
	5				2.8			3.4	7.4		
	6				11.3		3.8		14.0		
	7				3.5		2.6	1.8	11.5		
	8				6.0		1.5	1.6	3.7		
Siphon Canyon	1	5.1		2.2	5.1	6.2	8.1	6.3			12.2
	2	8.6		0.8	6.5		15.5	2.3		4.2	21.0
	3	7.0	11.0	4.4			11.4		1.3	16.7	
	4	46.8	11.2	5.4			19.3			20.9	15.8
	5	6.9	3.1	6.2	1.5		6.9				9.2
	6	8.2	17.0	3.0	2.5		14.0			9.3	0.3
	7	14.4		3.0	3.1	3.4	3.1			15.7	3.1
	8	4.2		1.8			6.3	5.8			15.8

**Table 4.2. Summary of bird survey effort, Fort Bowie NHS, 2002–2004.** Sample size (*n*; number of visits multiplied by number of stations) was used to calculate relative abundance for each transect and year.

Survey type	Transect name	Year(s)	Visits	Stations/ sections	<i>n</i>
VCP	Butterfield	2004	6	8	48
	Siphon Canyon	2003	5	8	40
		2004	6	8	48
Line transect	Coach	2002-2003	4	6	24
	Siphon Canyon	2002-2003	4	5-6	23
Nocturnal survey	Owl	2003	3	5	15
		2004	3	5	15

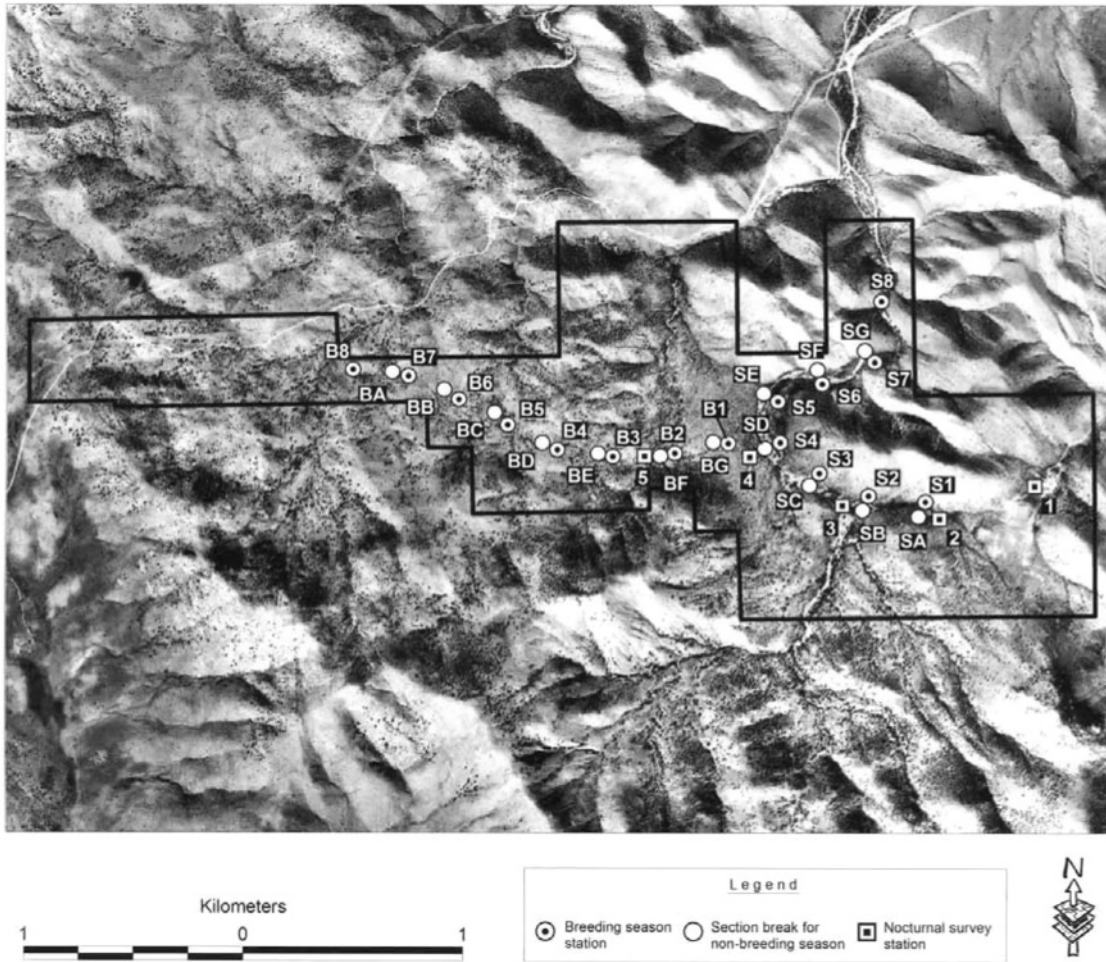


Figure 4.2. Location of bird surveys, Fort Bowie NHS, 2002–2004.

### Analyses

We calculated relative abundance of each species along each transect as the number of detections at all stations and visits (including zero values) divided by effort (sample size: total number of visits multiplied by total number of stations). We reduced our full collection of observations for each VCP station ( $n = 1,986$ : 1,378 and 608 for Siphon Canyon and Butterfield transects, respectively) to a subset of data ( $n = 1,093$ ; 793 and 244 for Siphon Canyon and Butterfield transects, respectively) that was more appropriate for estimating relative abundance. We used only those detections that occurred  $\leq 75$  m from count stations (thereby excluding 344 and 273 observations, respectively) because detectability is influenced by

conspicuousness of birds (i.e., loud, large, or colorful species are more detectable than others) and environmental conditions (dense vegetation can reduce likelihood of some detections). Truncating detections may reduce the influence of these factors (Verner and Ritter 1983; for a review of factors influencing detectability see Anderson 2001, Farnsworth et al. 2002). We also excluded observations of birds that were flying over the station (145 and 71 observations, respectively), birds observed outside of the eight-minute count period (128 and 45 observations, respectively), and unknown species (38 and 7 observations, respectively). Some observations met more than one of these criteria for exclusion from analysis.

## *Line-transect Surveys*

### Field Methods

From 15 October 2002 to 9 January 2003 we surveyed for birds using the line-transect method (Bibby et al. 2002). Line transects differ from VCP transects, in that an observer records birds seen or heard while the observer walks a line, rather than remaining stationary. The transect method is more effective during the non-breeding season because bird vocalizations are less conspicuous and frequent, making birds more difficult to detect (Bibby et al. 2000). This method was once the preferred survey technique for surveys in all seasons and was used by Russell and Johnson (1976) in their surveys of the park.

We established two transects at the park (Fig. 4.2). The transects were broken into sections, with the start and finish locations corresponding to the breeding-season stations. Each section was approximately 250 m in length. As with other survey methods, we alternated direction of travel along transects to reduce biases and did not survey during periods of excessive rain or wind (see breeding-season survey methods for details). We began surveys at sunrise and continued until we completed both transects. As with breeding-season surveys, we recorded weather conditions at the beginning and end of each survey. Prior to beginning a section, we recorded the section name (e.g., "A-B") and the start time.

We timed our travel so that we traversed each section in ten minutes, during which time we assigned all birds seen and/or heard into one of the following distance categories:  $\leq 100$  m,  $> 100$  m, or "flyover." When possible, we noted the sex and age class of birds. We recorded birds observed before or after surveys as "incidentals" (see section below), and we did not use techniques to attract birds (e.g., "pishing").

### Effort

We surveyed all six sections of the Siphon Canyon and Butterfield transects four times each in the fall and winter of 2002 and 2003 (Table 4.2).

### Analysis

We used all observations ( $N = 483$ ), except unknown species, to estimate relative abundance (see Methods section of VCP surveys for more details).

## *Nocturnal Surveys*

### Field Methods

To survey for owls we broadcast commercially available vocalizations using a compact disc player and broadcaster (Colver et al. 1999, Bibby et al. 2002) and recorded other nocturnal species (nighthawks and poorwills) when detected. We established one transect from approximately the visitor center to 600 m west of Siphon Canyon, along the Butterfield Trail (Fig. 4.2). The transect had five stations that were a minimum of 300 m apart. As with other survey methods, we varied direction of travel along transects and did not survey during periods of excessive rain or wind. We began surveys approximately 45 minutes after sunset.

We began surveys at each station with a three-minute "passive" listening period during which time we broadcast no calls. We then broadcast vocalizations for a series of two-minute "active" periods. We used vocalizations of species that we suspected, based on habitat and range, might be present: elf, western screech, whiskered-screech, barn, and (on one occasion) northern pygmy owl. We excluded great horned owl from the broadcast sequence because of its aggressive behavior toward other owls. We broadcast recordings of owls in sequence from smallest to largest size species so that smaller species would not be inhibited by the "presence" of larger predators or competitors (Fuller and Mosher 1987). During active periods, we broadcast owl vocalizations for 30 seconds followed by a 30-second listening period. This pattern was repeated two times for each species. During the count period we used a flashlight to scan nearby vegetation and structures for visual detections. If we observed a bird during the three-minute passive period, we recorded the minute of the passive period in which the bird was first observed, the type of detection (aural, visual or both), and the distance to the bird. If a bird was observed during any of the two-minute active periods, we recorded in which interval(s) it was detected and the type of detection (aural, visual, or both). As with other survey types, we attempted to avoid double-counting individuals recorded at previous stations. We also used multiple observers, alternated direction of travel along transects, and did not survey during inclement weather.

### Effort

We surveyed all five stations on each of the three visits during the breeding season in both 2003 and 2004 (Table 4.2).

### Analysis

Because of the low number of detections, we report only the number of detections and do not calculate relative abundance as for the other survey methods.

### *Incidental and Breeding Observations*

#### Field Methods

When we were not conducting formal surveys and encountered a rare species, a species in an unusual location, or an individual engaged in breeding behavior, we recorded UTM coordinates, time of detection, and (if known) the sex and age class of the bird. We recorded all breeding behavior observations using the standardized classification system (developed by the North American Ornithological Atlas Committee; NAOAC 1990). This system classifies breeding behavior into one of nine categories: adult carrying nesting material, nest building, adult performing distraction display, used nest, fledged young, occupied nest, adult carrying food, adult feeding young, or adult carrying a fecal sac. We made breeding observations during both standardized surveys and incidental observations.

#### Analysis

We report frequency counts of incidental and breeding observations; we cannot calculate relative abundance because we did not standardize survey effort.

### *Vegetation Sampling at VCP Stations*

In 2004 we sampled vegetation associated with each of the breeding-season stations along the Siphon Canyon and Butterfield transects. We sampled vegetation at five subplots located at a modified random direction and distance from each station. Each plot was located within a 72° range of the compass from the station (e.g., Plot 3 was located between 145° and 216°) to reduce clustering of plots. We randomly placed plots within 75 m of the stations to correspond with truncation of data used in estimating relative abundance.

At each plot we used the point-quarter method (Krebs 1998) to sample vegetation by

dividing the plot into four quadrants along cardinal directions. We applied this method to plants in three height categories: sub-shrubs (0.5–1.0 m), shrubs (> 1.0–2.0 m), trees (> 2.0 m), and one size category: potential cavity-bearing vegetation (> 20 cm diameter at breast height). If there was no vegetation in a given category within 25 m of the plot center, we indicated this in the species column. For each individual plant, we recorded its distance from the plot center, species, height, and maximum canopy diameter (including errant branches). Association of a plant to a quadrant was determined by the location of its trunk, regardless of which quadrant the majority of the plant was in; no plant was recorded in more than one quadrant. Standing dead vegetation was only recorded in the “potential cavity-bearing tree” category. On rare occasions when plots overlapped we repeated the selection process for the second plot.

Within a 5-m radius around the center of each plot, we visually estimated (1) percent ground cover by type (bare ground, litter, or rock); and (2) percent aerial cover of vegetation in each quadrant using three height categories: 0–0.5 m, > 0.5–2.0 m, and > 2.0 m. For both estimates we used one of six categories for percent cover: 0 (0%), 10 (1–20%), 30 (21–40%), 50 (41–60%), 70 (61–80%), and 90 (81–100%).

#### Analysis

Using point-quarter data, we calculated mean density (number of stems/ha) for all species in each of the four height/size categories using the computer program “Krebs” (Krebs 1998). We collected these data to quantify vegetation characteristics around survey stations (Appendix F).

### *Comparisons to Surveys by Russell and Johnson (1976)*

We summarized data from Russell and Johnson (1976) and made limited comparisons between their results and ours. To facilitate these comparisons, we used only those data from our surveys that corresponded to the study sites used by Russell and Johnson: their “wash-riparian” corresponds to our VCP stations numbers 1–4 and line transects sections A-B to D-E of our Siphon Canyon transect; their “mesquite-grassland” corresponds to our VCP stations numbers 1–4 and line-transect sections A-B to D-E of our Butterfield



transect; and their “oak-juniper woodland” corresponds to our VCP stations numbers 5–8 and line-transect sections E-F to I-J of our Butterfield transect. We combined relative abundance scores from Russell and Johnson for the spring and summer surveys and compared these data to our VCP surveys. We excluded fall surveys from comparison (they visited the park only twice in the fall of 1975) and made direct comparisons between their “winter” surveys and our line-transect surveys. Because of the different field methods (and therefore inappropriateness of comparing relative abundance estimates), we compared ranks of only the most abundant species.

## Results

We found 109 species during surveys from October 2002 to July 2004 (Appendix C). We found 77 species during VCP surveys, 51 species during line transect surveys, four species during nocturnal surveys, and 72 species by incidental observation during all seasons. We found no non-native species. We found a number of species of high conservation concern including peregrine falcon, loggerhead shrike, and Baird’s sparrow. Based on a review of other studies at the park, there have been 189 species observed at the park (Appendix C).

### *VCP Surveys*

We found three species on the Butterfield transect that we did not find on the Siphon Canyon transect, and 36 species on the Siphon Canyon transect that we did not find on the Butterfield transect (Tables 4.3, 4.4). Among the 36 species found only on the Siphon Canyon transect, some were among the most abundant on the transect: the Cassin’s and western kingbirds, Bell’s vireo, summer tanager, Bullock’s and hooded orioles, and northern cardinal (Table 4.3). Most of these species are riparian obligate species. Among species that we found on both transects, and for which we were able to calculate relative abundance, there were some notable differences among transects: 10 species had higher mean relative abundance on the Butterfield transect, while 12 species had higher mean relative abundance on the Siphon Canyon transect (using the mean relative abundance scores from 2003 and 2004). There were no surprises in

these numbers. Abundant species on the Butterfield transect are known to be associated with drier conditions: the black-throated sparrow, rufous-crowned sparrow, Bewick’s wren, Scott’s oriole, and canyon towhee. Similarly, the Siphon Canyon transect had species that reach their highest abundance in areas of dense vegetation: the white-winged dove, Gambel’s quail, verdin, and Lucy’s warbler. In the Siphon Canyon transect in both 2003 and 2004 the northern cardinal, Gambel’s quail, and white-winged dove were the most abundant (Table 4.3). On the Butterfield transect the mourning dove, black-throated sparrow, and Bewick’s wren were the most abundant (Table 4.4).

We observed 69 species along the Siphon Canyon transect in 2003 and 2004, of which we were able to calculate relative abundance for 47 species (Table 4.3). We found 12 species in each year that we did not find the other year. With the exception of the crissal thrasher, the species not found in the other year were not among the most abundant (Table 4.3). Almost all relative abundance estimates were higher in 2004 (mean  $\pm$  SE =  $0.24 \pm 0.040$ ) than in 2003 ( $0.18 \pm 0.030$ ;  $t = 6.3$ ,  $P < .0001$  on log transformed data). Among the most common species, only ash-throated flycatcher and verdin had much greater relative abundance estimates in 2003 than in 2004. Conversely, many abundant species such as mourning dove, Cassin’s kingbird, Bewick’s wren, and northern mockingbird had much higher relative abundance estimates in 2004 than in 2003.

### *Line-transect Surveys*

We observed 50 species during line-transect surveys in 2002 and 2003, 35 species on the Butterfield transect and 41 species on the Siphon Canyon transect (Table 4.5). Nine species were unique to the Butterfield transect, while 16 species were unique to the Siphon Canyon transect. Excluding sandhill crane (observed only on one occasion flying over the park), Gambel’s quail, chipping sparrow, and white-crowned sparrow were most abundant on the Butterfield transect (Table 4.5). On the Siphon Canyon transect, white-crowned sparrow, Gambel’s quail, American robin, and spotted towhee were the most abundant.

**Table 4.3. Total number of observations (Total obs.) and relative abundance (mean  $\pm$  SE) of birds observed during VCP surveys, Siphon Canyon transect, Fort Bowie NHS, 2003 and 2004.** Total number of observations includes all birds observed during surveys whereas relative abundance estimates exclude birds observed > 75 m from stations, flyovers, and observations made outside of the eight-minute count period. Sum is the number of observations used in calculating relative abundance estimates. See Methods section for additional details on estimation of relative abundance and effort used in those calculations.

Species	Total obs.	Relative abundance by year					
		2003 ( <i>n</i> = 40)			2004 ( <i>n</i> = 48)		
		Sum	Mean	SE	Sum	Mean	SE
Gambel's quail	101	27	0.68	0.169	30	0.63	0.128
turkey vulture	21				2	0.04	0.029
Cooper's hawk	8	5	0.13	0.082	2	0.04	0.029
zone-tailed hawk	1						
red-tailed hawk	4						
golden eagle	1						
white-winged dove	122	22	0.55	0.101	34	0.71	0.126
mourning dove	84	15	0.38	0.117	43	0.90	0.158
white-throated swift	7						
black-chinned hummingbird	8	3	0.08	0.042			
broad-tailed hummingbird	14	1	0.03	0.025	4	0.08	0.040
ladder-backed woodpecker	23	5	0.13	0.053	8	0.17	0.062
greater pewee	1						
western wood-pewee	6	2	0.05	0.035			
gray flycatcher	2				1	0.02	0.021
dusky-capped flycatcher	1						
ash-throated flycatcher	54	25	0.63	0.142	14	0.29	0.079
brown-crested flycatcher	3	1	0.03	0.025			
Cassin's kingbird	61	8	0.20	0.082	33	0.69	0.130
western kingbird	13	3	0.08	0.055	5	0.10	0.054
Bell's vireo	14	5	0.13	0.082	6	0.13	0.048
plumbeous vireo	2				2	0.04	0.029
warbling vireo	3						
curve-billed thrasher	8	1	0.03	0.025	5	0.10	0.054
crissal thrasher	18				11	0.23	0.068
western scrub-jay	22	8	0.20	0.082	12	0.25	0.082
Mexican jay	1						
unknown raven	17						
violet-green swallow	5						
verdin	32	15	0.38	0.078	9	0.19	0.057
bush-tit	5	2	0.05	0.050	11	0.23	0.124
cactus wren	71	19	0.48	0.095	33	0.69	0.130
rock wren	2				1	0.02	0.021
canyon wren	3				1	0.02	0.021
Bewick's wren	57	10	0.25	0.069	28	0.58	0.111
house wren	2	1	0.03	0.025			
ruby-crowned kinglet	13	6	0.15	0.057	6	0.13	0.057
blue-gray gnatcatcher	4	1	0.03	0.025	2	0.04	0.029
American robin	1	1	0.03	0.025			
northern mockingbird	72	14	0.35	0.084	35	0.73	0.139
phainopepla	10				6	0.13	0.048
Lucy's warbler	14	1	0.03	0.025	13	0.27	0.071
yellow-rumped warbler	4	1	0.03	0.025	1	0.02	0.021
black-throated gray warbler	4				3	0.06	0.046
Townsend's warbler	1				1	0.02	0.021
Wilson's warbler	8	2	0.05	0.035	2	0.04	0.029

Species	Relative abundance by year						
	Total obs.	2003 (n = 40)			2004 (n = 48)		
		Sum	Mean	SE	Sum	Mean	SE
summer tanager	31	4	0.10	0.048	13	0.27	0.088
western tanager	7	1	0.03	0.025			
green-tailed towhee	8	6	0.15	0.057	1	0.02	0.021
spotted towhee	7	3	0.08	0.042	3	0.06	0.046
canyon towhee	40	20	0.50	0.139	26	0.54	0.111
Botteri's sparrow	1	1	0.03	0.025			
rufous-crowned sparrow	14	2	0.05	0.035	6	0.13	0.064
chipping sparrow	2	1	0.03	0.025			
Brewer's sparrow	2	4	0.10	0.078			
black-throated sparrow	40	7	0.18	0.071	22	0.46	0.123
Oregon junco	1	1	0.03	0.025			
northern cardinal	112	38	0.95	0.129	56	1.17	0.113
pyrrhuloxia	1	1	0.03	0.025			
black-headed grosbeak	7				1	0.02	0.021
blue grosbeak	2	2	0.05	0.050	1	0.02	0.021
lazuli bunting	1				1	0.02	0.021
bronzed cowbird	1	2	0.05	0.050			
brown-headed cowbird	33	5	0.13	0.053	13	0.27	0.077
hooded oriole	36	15	0.38	0.111	13	0.27	0.083
Bullock's oriole	25	6	0.15	0.067	11	0.23	0.074
Scott's oriole	6	2	0.05	0.035	3	0.06	0.035
house finch	40	8	0.20	0.073	14	0.29	0.079
lesser goldfinch	3				2	0.04	0.029

### Nocturnal Surveys

We recorded four species of nocturnal birds: one observation each of the western screech owl and great-horned owl, three observations of the elf owl, and 12 observations of the common poorwill.

### Incidental and Breeding Observations

We made incidental observations of 72 species, including 12 species that were not detected during any other survey type (Appendix C). These species included: long-eared owl, common ground dove, greater roadrunner, Bendire's thrasher, Baird's sparrow, and grasshopper sparrow. We made 84 observations of breeding behavior, representing 32 species (Table 4.6). We made the most breeding observations of mourning dove (14 observations). We confirmed breeding for Bell's vireo and summer tanager, two riparian-obligate species.

### Inventory Completeness

Based on the results from our surveys and the list by Fischer (2002), the inventory of birds that

regularly use the park is probably close to completion. A look at the species accumulation curve for our work indicates that our effort alone was not sufficient to document all of the species that occur in the park; the cumulative number of new species for this study was not approaching an asymptote (Fig. 4.3). We found 6 species that were new to the park list: Baird's sparrow, Hutton's vireo, common ground-dove, dusky-capped flycatcher, greater pewee, and zone-tailed hawk (Appendix C). Of these species, only Hutton's vireo may nest at the park. Because of the location of the park near to the species-rich Chiricahua Mountains (one of the most popular destinations in the United States for bird watchers), we expect that new species of birds will be added to the list for years to come, but that these species will likely be uncommon or rare at the park. Only through major modification of the vegetation community (either by the use of fire or removal of mesquite) will additional species, such as grassland-associated sparrows (e.g., grasshopper, Cassin's, and Botteri's), nest in the park.

**Table 4.4. Total number of observations (Total obs.) and relative abundance (mean  $\pm$  SE) of birds during VCP surveys, Butterfield transect, Fort Bowie NHS, 2004.** Total number of observations includes all birds observed during surveys whereas relative abundance estimates exclude birds observed > 75 m from stations, flyovers, and observations made outside of the eight-minute count period. Sum is the number of observations used in calculating relative abundance estimates. See Methods section for additional details on estimation of relative abundance and Table 4.2 for sample size.

Species	Total obs.	Relative abundance ( $n = 48$ )		
		Sum	Mean	SE
Gambel's quail	34	7	0.15	0.089
turkey vulture	17	1	0.02	0.021
red-tailed hawk	3			
white-winged dove	38	2	0.04	0.029
mourning dove	71	15	0.31	0.095
black-chinned hummingbird	3			
ladder-backed woodpecker	20	8	0.17	0.069
western wood-pewee	1			
Hammond's flycatcher	1	1	0.02	0.021
ash-throated flycatcher	42	19	0.40	0.093
Cassin's kingbird	6			
western kingbird	1			
crissal thrasher	12	8	0.17	0.062
western scrub-jay	17	5	0.10	0.045
unknown raven	5			
bridled titmouse	1	1	0.02	0.021
juniper titmouse	3	4	0.08	0.065
verdin	2	2	0.04	0.029
bush-tit	4	11	0.23	0.124
cactus wren	39	23	0.48	0.094
rock wren	7	4	0.08	0.050
Bewick's wren	50	32	0.67	0.113
ruby-crowned kinglet	2	2	0.04	0.029
northern mockingbird	28	4	0.08	0.050
phainopepla	4	3	0.06	0.046
Lucy's warbler	3	1	0.02	0.021
green-tailed towhee	1	1	0.02	0.021
canyon towhee	36	31	0.65	0.117
rufous-crowned sparrow	29	17	0.35	0.070
chipping sparrow	1	1	0.02	0.021
black-throated sparrow	67	47	0.98	0.141
northern cardinal	2			
black-headed grosbeak	5			
blue grosbeak	3	3	0.06	0.046
brown-headed cowbird	18	11	0.23	0.068
Scott's oriole	18	10	0.21	0.073
house finch	10	2	0.04	0.029

**Table 4.5. Relative abundance of birds observed during line-transect surveys, Fort Bowie NHS, 2002 and 2003.**

Species	Transect					
	Butterfield (n = 24)			Siphon Canyon (n = 23)		
	Sum	Mean	SE	Sum	Mean	SE
Gambel's quail	80	3.33	2.383	40	1.74	0.796
Montezuma quail	1	0.04	0.042			
Cooper's hawk				1	0.04	0.043
red-tailed hawk	1	0.04	0.042			
sandhill crane <sup>a</sup>	52	2.17	2.167			
red-naped sapsucker				1	0.04	0.043
ladder-backed woodpecker	4	0.17	0.078	7	0.30	0.132
northern flicker	8	0.33	0.098	12	0.52	0.187
loggerhead shrike	1	0.04	0.042			
solitary vireo type <sup>b</sup>				1	0.04	0.043
western scrub-jay	12	0.50	0.170	21	0.91	0.259
unknown raven				2	0.09	0.087
Steller's jay	2	0.08	0.083			
curve-billed thrasher				2	0.09	0.060
crissal thrasher	6	0.25	0.090	10	0.43	0.138
bridled titmouse	10	0.42	0.232	1	0.04	0.043
juniper titmouse	2	0.08	0.083			
verdin	6	0.25	0.090	4	0.17	0.102
bush-tit	28	1.17	0.809			
brown creeper				1	0.04	0.043
cactus wren	6	0.25	0.109	12	0.52	0.165
rock wren				3	0.13	0.072
Bewick's wren	3	0.13	0.092	8	0.35	0.119
ruby-crowned kinglet	11	0.46	0.159	21	0.91	0.188
western bluebird	18	0.75	0.391	9	0.39	0.272
Townsend's solitaire	4	0.17	0.078			
hermit thrush				1	0.04	0.043
American robin	2	0.08	0.058	37	1.61	0.838
northern mockingbird	3	0.13	0.069	7	0.30	0.117
cedar waxwing				12	0.52	0.522
phainopepla	7	0.29	0.127	9	0.39	0.137
yellow-rumped warbler	2	0.08	0.083	1	0.04	0.043
black-throated gray warbler				1	0.04	0.043
green-tailed towhee	6	0.25	0.090	28	1.22	0.259
spotted towhee	15	0.63	0.189	37	1.61	0.249
canyon towhee	13	0.54	0.170	27	1.17	0.249
rufous-crowned sparrow				1	0.04	0.043
chipping sparrow	54	2.25	0.738	29	1.26	0.389
Brewer's sparrow	21	0.88	0.641	30	1.30	0.531
Lincoln's sparrow				6	0.26	0.113
black-chinned sparrow	1	0.04	0.042	4	0.17	0.136
vesper sparrow	4	0.17	0.130	29	1.26	1.171
black-throated sparrow	9	0.38	0.145	3	0.13	0.072
white-crowned sparrow	78	3.25	1.277	56	2.43	0.612
dark-eyed junco	6	0.25	0.090	2	0.09	0.060
northern cardinal				13	0.57	0.197
pyrrhuloxia				1	0.04	0.043
house finch				4	0.17	0.081
pine siskin	1	0.04	0.042			
lesser goldfinch				6	0.26	0.180

<sup>a</sup>All observed flying over the park on one occasion.

<sup>b</sup>Either solitary or cordilleran.

**Table 4.6. Number of observations by breeding behavior for birds, Fort Bowie NHS, 2003 and 2004.** Breeding behaviors follow standards set by NAOAC (1990).

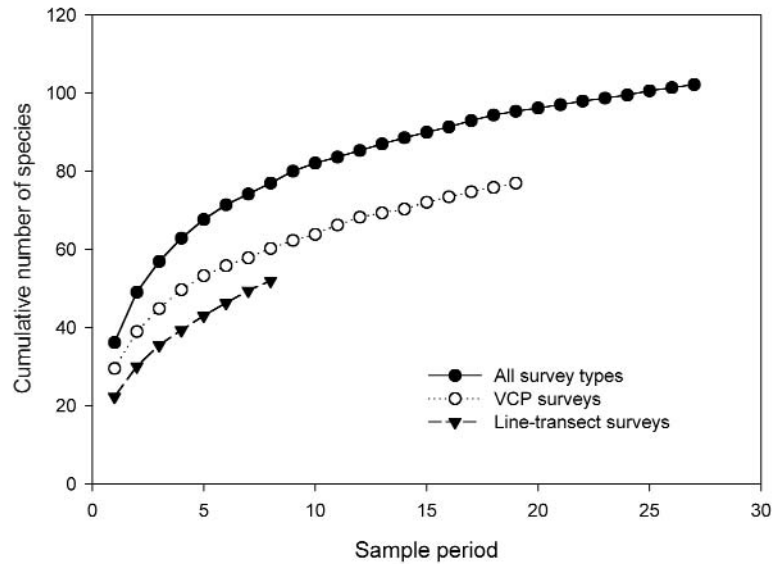
Common name	Nest			Adults carrying		Other			Totals	
	Building	With eggs	With young	Occupied	Food	Nesting material	Distraction displays	Feeding recently fledged young		Recently fledged young
Gambel's quail								1		1
Cooper's hawk				2						2
white-winged dove		1		4						5
mourning dove				14						14
black-chinned hummingbird				1						1
broad-tailed hummingbird	1			3			2			6
ladder-backed woodpecker				1						1
Say's phoebe								2	1	3
brown-crested flycatcher				1						1
Cassin's kingbird	1			2					1	4
western kingbird								1		1
Bell's vireo				1				1		2
western scrub-jay									1	1
barn swallow	1									1
verdin	1									1
cactus wren				1	1			2		4
rock wren					1					1
canyon wren					1			1		2
Bewick's wren					1				1	2
black-tailed gnatcatcher								1		1
northern mockingbird					1			2		3
curve-billed thrasher									1	1
crissal thrasher									1	1
phainopepla				1						1
summer tanager								2		2
canyon towhee				1	2	2		1	1	7
black-throated sparrow			1		1			1		4
northern cardinal				1	1				1	3
brown-headed cowbird									1	1
hooded oriole	1			1		1				3
Bullock's oriole			1	1				1		3
house finch				1						1
<b>Totals</b>	<b>5</b>	<b>1</b>	<b>2</b>	<b>35</b>	<b>10</b>	<b>3</b>	<b>2</b>	<b>16</b>	<b>9</b>	<b>84</b>

## Discussion

Based on our research and that by others, Fort Bowie NHS has a diverse bird community ( $n = 189$  species) for a small area (405 ha) with little topographic relief. Although the pattern of extraordinary species richness that we observed in plants (Chapter 3) was not mirrored in the bird community, the diversity of vegetation communities at the sites clearly plays a role in

determining the bird community. For example, there were notable differences in the bird communities along the two repeat-visit VCP transects where the Siphon Canyon transect had almost twice as many species as the Butterfield transect (Tables 4.3, 4.4).

Many of the species that we found in the Siphon Canyon transect are known to occur primarily in riparian areas or areas of dense vegetation: Bell's vireo, summer tanager, hooded



**Figure 4.3. Species accumulation curves, by survey type, for the UA bird inventory effort, Fort Bowie NHS, 2002–2004.** Each sample period for all survey types represents a randomized ordering of 101 observations ( $N = 2,821$ ; a completely randomized combination of the four survey types). Each sample period for VCP and line-transect surveys represents one survey day.

oriole, and northern cardinal (Powell and Steidl 2000). Although not as species rich as in Siphon Canyon, the bird community along the Butterfield transect had species that are associated with the oak savanna and chaparral including juniper titmouse, Crissal thrasher, and rufous-crowned sparrow. Each bird species is closely tied to gross vegetation characteristics such as (1) vertical structure (MacArthur and MacArthur 1961, Cody 1981), (2) horizontal patchiness (Roth 1976, Kotliar and Weins 1990), and (3) floristics (Rice et al. 1984, Strong and Bock 1990, Powell and Steidl 2002). Given the differences in vegetation structure and composition between the two transects, the differences that we noted in the bird communities were not surprising.

The dense riparian vegetation near Apache Spring plays an important role in providing nesting habitat for Cooper's hawk and summer tanager; they were found nesting in that area. Research in the southwestern U.S. has consistently shown that areas with riparian trees have bird communities that are more diverse than adjacent sites (Carothers et al. 1974, Szaro and Jakle 1985, Strong and Bock 1990), which is due, in part, to the variety of microhabitats that riparian vegetation provides for

nesting (Powell and Steidl 2002), cover, and foraging.

Park managers are interested in the impact that the invasion of the native velvet mesquite is having on the visitors experience in the park (NPS 2000b) because mesquite was not identified in historic photographs of the area. Velvet mesquite has increased in density and distribution in the region since the late 1800s, primarily due to disruption of historical fire regimes and the introduction of cattle grazing (Humphrey 1974, Brown 1994, Van Auken 2000). The conversion of semi-desert grasslands to mesquite woodlands has important implications for the bird community by favoring shrub-associated species such as northern cardinal, verdin, and black-throated sparrow (Lloyd et al. 1998) while not favoring many species of management concern such as Botteri's, Cassin's, and grasshopper sparrows. The loss of native grassland has been identified as a primary factor in population declines of grassland birds as a group (Herkert 1994, Knopf 1994, Peterjohn and Sauer 1999).

#### *Comparisons to Russell and Johnson (1976)*

The research by Russell and Johnson (1976) was the first comprehensive survey of birds at the park.

Unfortunately we can only make very gross comparisons between our two studies because we did not use the same survey methods and exactly the same area. Yet a number of species and communities were quite different between the two studies. We found 14 species that Russell and Johnson did not find and they found 62 species that we did not find (Appendix C). We found black-throated sparrow to be among the most common species in the oak-juniper woodland, but Russell and Johnson did not find them to be very abundant (Appendix G). Conversely, in Siphon Canyon, they found black-chinned hummingbird to be the most common species, whereas it was among the least common species in 2003 and was not found at all in 2004 (Table 4.3). There is little indication of a regional population decline in this species (Sauer et al. 2004), though banding data from Hummingbird

Monitoring Network sites is showing some decline for 2005 (Larry Norris, *pers. comm.*). Nevertheless, the decline that we saw may have been an artifact of different field methods; species such as hummingbirds may be more conspicuous while walking a transect line.

During the non-breeding season the mesquite-grassland vegetation community had the most bird species that did not rank as abundant for the other study (Appendix G). This may have been an artifact of small sample size from both studies. It could also reflect the variability of non-breeding season birds. For example, species such as white-crowned, black-throated, Brewer's, and chipping sparrows can form large, sometimes mixed-species flocks which, if encountered, can radically affect the relative abundance estimates for a transect.



# Chapter 5: Mammal Inventory

## Previous Research

The documented species list of mammals from the park is largely complete. The first inventory of mammals at Fort Bowie was completed by Roth and Cockrum (1976). More recently Petryszyn (1999) and Hermann-Reese (unpublished data) completed surveys for rodents, and Krebs (2005) surveyed for bats from 2001 to 2004. Hermann-Reese also surveyed for medium and large mammals using infrared-triggered cameras and in this report we summarize that work (Appendix H). Swann et al. (2001) noted mammals seen incidentally to their surveys of reptiles and amphibians. In all, there have been 57 species documented (including specimens at the University of Arizona mammal collection) for the park: 12

bats, 30 small mammals (Orders Insectivora, Rodentia, and Lagomorpha), and 15 medium to large mammals (Orders Carnivora and Artiodactyla; Appendix D).

## Methods

Because mammals have been surveyed extensively, we surveyed only for medium and large mammals using infrared-triggered cameras at three sites (Fig. 5.1). For this report our purpose was to (1) augment the infrared-triggered camera effort of Herman-Reese and (2) synthesize species lists from the previously mentioned survey efforts. We refer the reader to the other inventory efforts for more detailed species accounts.

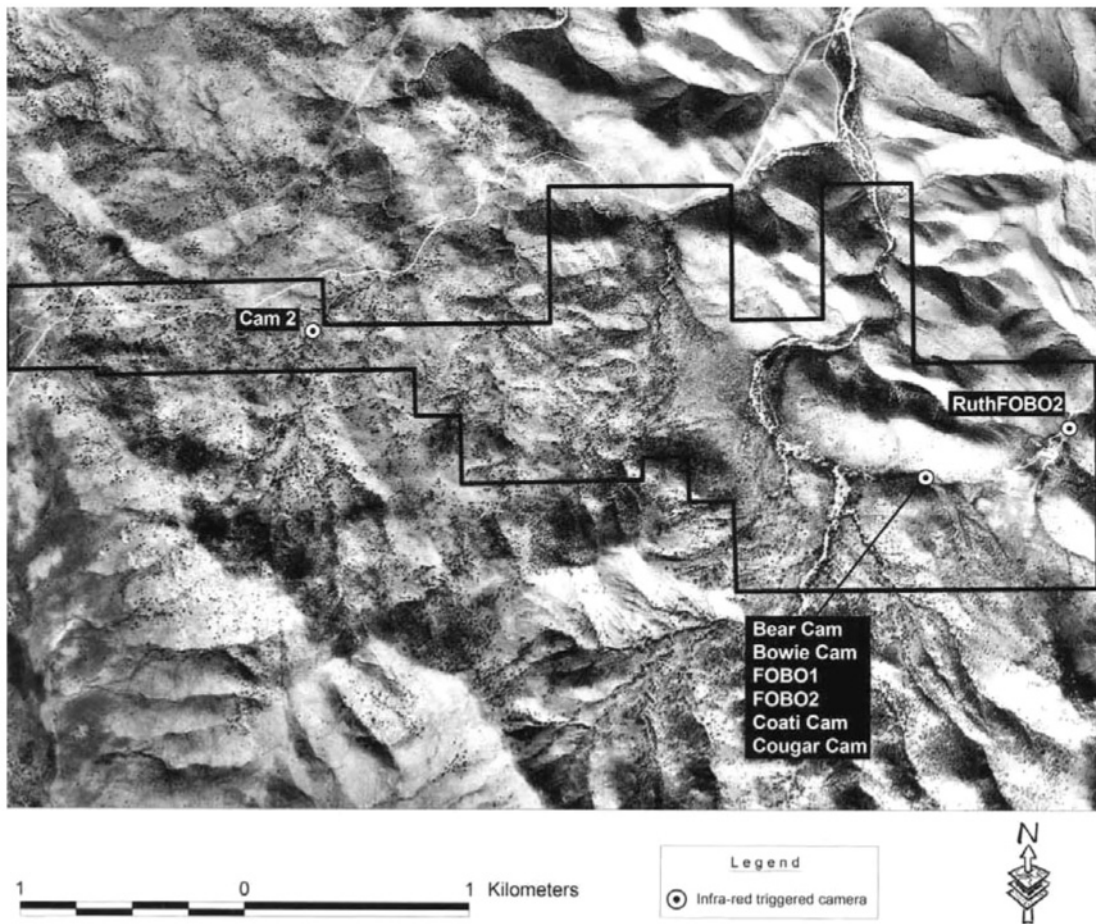
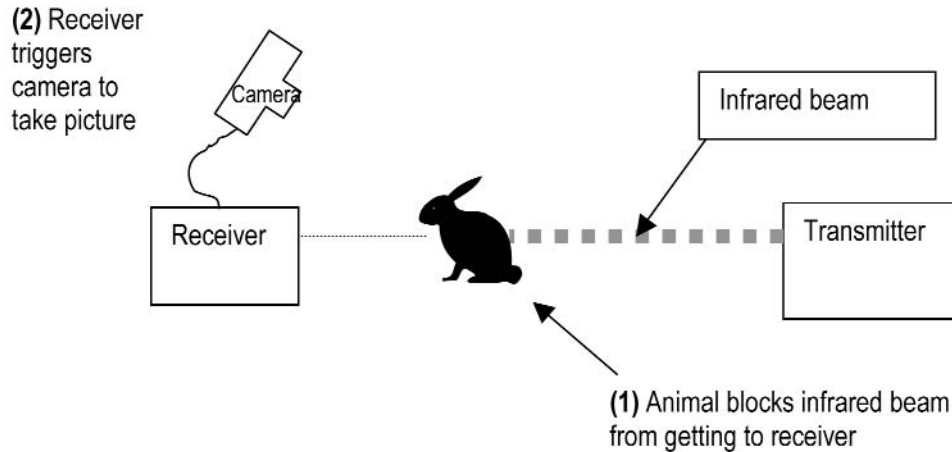


Figure 5.1. Location of Trailmaster camera sites, Fort Bowie NHS, 2002–2003.



**Figure 5.2. Diagram of infrared-triggered camera (Trailmaster) set-up.** Image based on Swann et al. (2004).

### *Trailmaster Cameras*

We used infrared-triggered cameras (herein referred to as “Trailmaster”; Trailmaster®; model 1500, Goodman and Associates, Inc, Lenexa, KS; Kucera and Barrett 1993) to record the presence of medium and large mammals. Trailmasters have three components: receiver, transmitter, and camera (Fig. 5.2). The transmitter sends an infrared beam to the receiver at a specified rate (5 times per second for this study). The receiver then sends a signal (via cable) to a camera mounted on a tripod 6–8 m away. When an animal blocks the infrared beam the camera takes a picture.

We set the receiver and transmitter approximately 8 m apart and 20 cm above the ground so that medium and large mammals were captured on film but smaller animals such as rodents and birds were not. We set cameras to take no more than one photograph every five minutes to reduce the chances of recording the same individual more than once (on the same occasion). We placed cameras in three areas of the park (Fig. 6.1; UTM coordinates for Willow Gulch = 644390 N, 3558289 E; Apache Spring = 647101 N, 3557644 E; Visitor Center Road = 647729 N, 3557866 E) that we thought would record the highest number of species; typically these were in areas of dense vegetation. We baited camera sites with a commercial scent lure (ingredients included synthetic catnip oil, bobcat musk, beaver castorium, and propylene glycol as a preservative) or canned cat food. We checked cameras approximately every two weeks to change film and batteries and to ensure their proper function. We

photographed a placard documenting the date and camera location on the first exposure of every new roll of film.

### Spatial Sampling Design

We selectively placed cameras in areas that we felt would have the most success, primarily near Apache Spring.

### Effort

We operated Trailmaster cameras at three locations from May 2002 to May 2003 for a total of 278 days of camera operation (Table 5.1). Of the three locations, Apache Spring had the most effort (47%), followed by visitor center road (38%) and Willow Gulch (15%).

### Analysis

Trailmaster cameras are the most cost-effective method for recording the presence of medium and large mammal species (Kucera and Barrett 1993, Cutler and Swann 1999). However, one drawback to this method is an inability to differentiate individuals, which precludes any estimates of abundance (i.e., one must be able to determine whether one animal has been photographed repeatedly or whether more than one individual has been photographed). In some cases, size or physical abnormality may differentiate individuals of any species, but this was not evident in our photographs. Also, each species is more or less likely to be attracted to the camera area. Therefore, we report the number of times a species was photographed to indicate species that may be common, based on the number of photographs.

**Table 5.1. Summary of Trailmaster camera effort, Fort Bowie NHS, 2002 and 2003.**

General location	Camera name	Year	Start date	End date	Number of days open
Willow Gulch	Cam 2	2002	6 Oct	19 Oct	13
		2002	19 Oct	17 Nov	29
Apache Spring	Bowie Cam	2002	12 May	25 May	13
	FOBO2	2002	2 Jun	16 Jun	14 <sup>a</sup>
	Coati Cam	2002	30 Jun	7 Jul	7 <sup>a</sup>
	Cougar Cam	2002	14 Jul	21 Jul	7 <sup>a</sup>
		2002	28 Jul	31 Jul	3 <sup>a</sup>
		2002	22 Sep	4 Oct	12
		2002	19 Oct	13 Nov	25
		2002	17 Nov	28 Nov	11
	Bear Cam	2002	25 Aug	21 Sep	27
	FOBO1	2002	6 Oct	18 Oct	12
Visitor Center Road	RuthFOBO2	2002-2003	19 Dec	3 May	105

<sup>a</sup>Due to improper documentation, this number is an estimate of the number of days the camera was available to take photographs.

### *Incidental Observations and Signs*

As with other taxa, we recorded UTM coordinates of mammal sightings made outside of formal surveys. Observers from all field crews (e.g., bird crew) recorded mammal sightings.

### **Results and Discussion**

We documented two birds (common black hawk and American robin) and 11 species of mammals using Trailmaster cameras at Fort Bowie NHS in 2002 and 2003 (Table 5.2). We documented two new species of mammals for the park: hooded

skunk and feral dog (Appendix D). The photo of the dog is the first documentation of a non-native mammal in the park. The most photographs were of the white-nosed coati (Table 5.2). Collared peccary and striped skunk were also in many of the photographs.

As we expected, most of the photos were from Apache Spring (Table 5.2). In general, this was an extremely dry period (Fig. 2.3) and the spring was an important resource, drawing in many animals including an American black bear, which was likely dispersing from the Pinaleno or Chiricahua Mountains. We did not document any animals at the Willow Gulch site.

**Table 5.2. Number of photographs of animals, by Trailmaster camera site, Fort Bowie NHS, 2002 and 2003.** Number in parentheses is the total number of individuals if >1 individual was seen in a picture.

Group	Species	Site		
		Number of photographs	Number of individuals in photographs	Visitor Center Road Number of photographs and individuals
<b>Bird</b>	common black-hawk	1	1	
	American robin			4
<b>Mammal</b>	American black bear	4	4	
	white-nosed coati	29	55	
	striped skunk	18	19	2
	hooded skunk	2	2	
	white-backed hog-nosed skunk			1
	feral dog	1	1	
	common gray fox	6	6	
	mountain lion	11	12	2
	bobcat	6	6	
	collared peccary	15	20	6
	mule deer	9	12	



## Chapter 6: Management Implications

Based on the data from this study and our knowledge of the natural resource issues at the park, we highlight issues that affect the park's natural resources. Coordination with other agencies, non-governmental organizations, and/or adjacent landowners may prove the best route to resolving some of these challenges.

### *Development Adjacent to the Park*

One of the most serious threats to the biological diversity of Fort Bowie NHS may be residential development to the north of the park. The development may lead to an increase in the number and extent of non-native plants (Seabloom et al. 2003) and may disrupt animal movement patterns and result in the loss and/or fragmentation of habitat (Mills et al. 1989, Theobald et al. 1997, Riley et al. 2003), particularly for larger mammals. Also, free-roaming pets, normally associated with development, can negatively impact native vertebrates through harassment and mortality (Coleman and Temple 1993). This may not be a problem because the Buddhist retreat, on which most of the adjacent development is taking place, does not allow pets.

### *Cattle Grazing*

The impact of cattle grazing on the park's natural resources has never been documented. As mentioned in the Park Introduction chapter, cattle grazing can have harmful impacts on the native biota by causing changes in the distribution, abundance, and composition of plant populations as well as soil erosion and compaction. Ruyle (2001) assessed the range condition on eight sites; his results indicate that conditions ranged from fair

to good, but those conditions were only assessed using vegetation measures. We suggest that if grazing were to continue at the park, managers establish more long-term monitoring protocols and sites to determine the impact of grazing on the natural resources of the park, particularly soils, vegetation, and vertebrates.

Perhaps the most damaging practice relating to grazing is the use of water from Apache Spring to supply water to adjacent cattle allotments. Although the allotment of one-half of the water from the spring is rarely realized (Larry Ludwig, *pers. comm.* to Michele Gerard), there is a potential for that amount of water to be diverted. The water from the spring is a vital resource for the park and is responsible for the riparian area that is so valuable for plants and wildlife in the area. A hydrologist could help park managers determine the impact of water diversion on the riparian area.

### *Visitor Impacts*

If the road over Apache Pass is paved, there will likely be increased mortality of reptiles, particularly snakes, which seek out the pavement on hot summer nights to bask (Rosen and Lowe 1994). Increased vehicular volume and speed will also likely increase the modification of animal behavior (Trombulak and Frissell 2000). Modification of behavior probably already takes place at Apache Spring, which is the only source of perennial water for animals, but is also a popular resting spot for hikers. The effect of this conflict has never been quantified, but given the high abundance and species richness of birds and large mammals in that area (see Tables 4.3, 5.2), conflicts are inevitable.



## Chapter 7: Additional Inventories

No inventory is ever truly complete; species distributions expand and contract across boundaries, particularly at smaller parks such as Fort Bowie NHS. In general, we feel that the inventories for vascular plants and vertebrates are nearly complete and that the park is in a good position to monitor changes in species composition. Through the continuous collection of data, such as specimens from road kill, photographs, and through research studies at the park, managers can continue to monitor changes. An additional step would be to coordinate additional inventory-like field efforts with adjacent landowners to increase the spatial scope of the inventory effort. Below we suggest ways to complete the species inventories and/or implement monitoring on the park.

### *Plants*

A number of woody invasive species such as velvet mesquite and burroweed are of concern to park managers (NPS 2000b) and there is currently a program to remove mesquite. We suggest that a more rigorous, plot-based vegetation monitoring program be established at the park (e.g., Powell et al. 2005a), including a number of plots in the area of mesquite removal. This monitoring would inform the park managers of the effectiveness of the program as well as document changes in the plant community concurrent to this removal (of particular concern is the spread of non-native grasses such as Lehmann lovegrass). Repeat inventories for plants, particularly the early detection of non-native plants, should be carried out at least every five years.

Specimen vouchers from the park may be residing in the herbarium collections at Arizona State University and Northern Arizona University. In early 2005 it became possible to access information about these collections. We suggest that these databases be searched for specimens from the park. However, care should be taken in accepting the list of species without confirming the proper identification of species or updating taxonomy (Halvorson 2003).

Many of the specimens cited in the report by Warren et al. (1992) are currently housed at the

park, but because the park does not have a natural resource staff member who is responsible for the proper curation of that collection, it is unlikely that the plant specimens are receiving proper care. Therefore, we recommend removing them to a collection that has proper archival conditions, such as the University of Arizona.

### *Reptiles and Amphibians*

Swann et al. (2001) surveyed for amphibians and reptiles in 1997 and 1998 and their study remains one of the best examples of a biological inventory in the region. Because they designed their study to form the basis for long-term monitoring, we suggest repeating their effort (or some portion) at least every ten years. It will especially important to survey for amphibians and aquatic reptiles because these groups are experiencing sharp declines in distribution and abundance (Wake 1990).

### *Birds*

Additional surveys during the winter season and during the spring and fall migrations will pick up species missed by efforts at other times. It is important to note, however, that bird lists are difficult to complete because birds are highly mobile. Only sites that are visited regularly by avid bird watchers (e.g., Madera Canyon, Ramsey Canyon, and Patagonia-Sonoita Creek Preserve in southern Arizona) have bird lists that can be considered to be “complete.”

### *Mammals*

Herman-Reese did not write up the results of either the small mammal trapping or Trailmaster studies that she undertook. Although we published an appendix of her Trailmaster camera results (Appendix H), this effort is insufficient to properly document and archive data from that project. We encourage park staff to work with her to complete that effort before too much time passes; her field effort was considerable and it would be unfortunate not to have a report to document her effort.

The one group of mammals that may require additional inventory work is bats. Krebbs (2005) netted at the park from 2001-2004 for a total of five nights of netting. It did not appear to

be sufficient for documenting all of the species of insectivorous bats at the park; new species continued to be found. We therefore recommend additional netting at Apache Spring. The use of ultrasonic detectors to identify bat species is increasing, and many researchers are refining the field techniques and improving the technology (e.g., Johnson et al. 2002, Gannon et al. 2003). These technologies may become more useful in the coming years with these refinements.



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**Appendix A. Plant species that were observed or collected at Fort Bowie NHS by the University of Arizona inventory personnel (UA; 2002 and 2003) and other studies: Warren et al. (1992; WEA), Bennett et al. (1996; BEA), Ruyle (1996; RUL), Hartman and Rottman (1998; H&R), NPS (2000; NPS), and Halvorson and Guertin (2003; H&G).<sup>a</sup> Species in bold-faced type are non-native.**

Family	Scientific name	Common name	UA	UA Herb-arium <sup>b</sup>	WEA	BEA	RUL	H&R	NPS	H&G
Acanthaceae	<i>Anisacanthus thurberi</i> (Torr.) Gray	Thurber's desert honeysuckle	X		X	X	X	X	X	
	<i>Carlowrightia arizonica</i> Gray	Arizona wrightwort			X	X		X	X	
Agavaceae	<i>Agave palmeri</i> Engelm.	Palmer's century plant			X	X		X	X	
	<i>Agave parryi</i> Engelm.	Parry's agave	X		X	X		X	X	
	<i>Yucca baccata</i> Torr.	banana yucca	X		X			X	X	
	<i>Yucca baccata</i> var. <i>brevifolia</i> (Schott ex Torr.) L. Benson & Darrow	Spanish dagger				X				
	<i>Yucca elata</i> (Engelm.) Engelm.	soaptree yucca			X	X		X	X	
Aizoaceae	<i>Trianthema portulacastrum</i> L.	desert horsepurslane	X		X	X		X	X	
Amaranthaceae	<i>Amaranthus fimbriatus</i> (Torr.) Benth. ex S. Wats.	fringed amaranth				X			X	
	<i>Amaranthus palmeri</i> S. Wats.	carelessweed			X	X		X	X	
	<i>Froelichia arizonica</i> Thomb. ex Standl.	Arizona snakecotton	X		X	X		X	X	
	<i>Gomphrena caespitosa</i> Torr.	tufted globe amaranth			X	X		X	X	
	<i>Guilleminea densa</i> (Humb. & Bonpl. ex Willd.) Moq.	small matweed	X		X	X			X	
	<i>Guilleminea densa</i> var. <i>densa</i> (Humb. & Bonpl. ex Willd.) Moq.	small matweed				X		X		
	<i>Rhus aromatica</i> Ait.	fragrant sumac	X							
	<i>Rhus microphylla</i> Engelm. ex Gray	littleleaf sumac	X		X	X		X	X	
	<i>Rhus trilobata</i> Nutt.	skunkbush sumac			X			X	X	
	<i>Rhus trilobata</i> var. <i>pilosissima</i> Engelm.	pubescent squawbush				X		X	X	
Anacardiaceae	<i>Rhus virens</i> var. <i>chortophylla</i> (Woot. & Standl.) L. Benson	evergreen sumac			X	X		X	X	
	<i>Toxicodendron radicans</i> (L.) Kuntze	eastern poison ivy			X				X	
	<i>Toxicodendron radicans</i> ssp. <i>divaricatum</i> (Greene) Gillis	eastern poison ivy				X				
	<i>Toxicodendron radicans</i> ssp. <i>radicans</i> (L.) Kuntze	eastern poison ivy	X					X		
	<i>Toxicodendron rydbergii</i> (Small ex Rydb.) Greene	western poison ivy				X				
	<i>Cymopterus multinervatus</i> (Coul. & Rose) Tidestrom	purplenerve springparsley			X	X		X	X	
	<i>Daucus pusillus</i> Michx.	American wild carrot			X	X		X	X	
	<i>Lomatium nevadense</i> (S. Wats.) Coult. & Rose	Nevada biscuitroot			X			X	X	
	<i>Lomatium nevadense</i> var. <i>parishii</i> (Coul. & Rose) Jepson	Parish's biscuitroot				X				
	<i>Pseudocymopterus montanus</i> (Gray) Coult. & Rose	alpine false springparsley			X	X		X	X	
	<i>Spermodopsis echinata</i> (Nutt. ex DC.) Heller	bristly scalseed			X	X		X	X	
	Apocynaceae	<i>Macrosiphonia brachysiphon</i> (Torr.) Gray	Huachuca Mountain rocktrumpet			X	X		X	X
Aristolochiaceae	<i>Aristolochia watsonii</i> Woot. & Standl.	Watson's dutchman's pipe			X	X		X	X	
Asclepiadaceae	<i>Asclepias asperula</i> (Dcne.) Woods.	spider milkweed	X		X			X	X	
	<i>Asclepias asperula</i> (Dcne.) Woods. ssp. <i>asperula</i>	spider milkweed				X				

Family	Scientific name	Common name	UA	UA Herb- arium <sup>b</sup>	WEA	BEA	RUL	H&R	NPS	H&G
Asclepiadaceae	<i>Asclepias asperula</i> ssp. <i>capricornu</i> (Woods.) Woods.	antelopehorns	X							
	<i>Asclepias engelmanniana</i> Woods.	Engelmann's milkweed			X	X		X	X	
	<i>Asclepias macrotis</i> Torr.	longhood milkweed			X	X		X	X	
	<i>Asclepias nyctaginifolia</i> Gray	Mojave milkweed			X	X		X	X	
	<i>Funastrum crispum</i> (Benth.) Schlechter	wavyleaf twinevine	X		X	X		X	X	
	<i>Funastrum cynanchoides</i> ssp. <i>cynanchoides</i> (Dcne.) Schlechter	fringed twinevine						X		
	<i>Funastrum cynanchoides</i> ssp. <i>heterophyllum</i> (Vail) Kartesz, comb. nov. ined.	Hartweg's twinevine			X	X			X	
Asteraceae	<i>Acourtia nana</i> (Gray) Reveal & King	dwarf desertpeony			X	X		X	X	
	<i>Acourtia wrightii</i> (Gray) Reveal & King	brownfoot			X	X		X	X	
	<i>Ambrosia confertiflora</i> DC.	wealeaf burr ragweed			X	X		X	X	
	<i>Artemisia dracunculus</i> L.	tarragon			X			X	X	
	<i>Artemisia dracunculus</i> ssp. <i>dracunculus</i> L.	wormwood				X				
	<i>Artemisia ludoviciana</i> Nutt.	white sagebrush	X		X			X	X	
	<i>Artemisia ludoviciana</i> ssp. <i>mexicana</i> (Willd. ex Spreng.) Keck	white sagebrush				X				
	<i>Baccharis bigelovii</i> Gray	Bigelow's false willow	X		X	X		X	X	
	<i>Baccharis pteronioides</i> DC.	yerba de pasmo			X	X	X	X	X	
	<i>Baccharis salicifolia</i> (Ruiz & Pavón) Pers.	mule's fat			X	X		X	X	
	<i>Baccharis sarothroides</i> Gray	desertbroom	X		X	X		X	X	
	<i>Baccharis sergiioides</i> Gray			X	X					
	<i>Baccharis thesioides</i> Kunth	Arizona baccharis			X	X			X	
	<i>Baccharis wrightii</i> Gray	Wright's baccharis			X	X			X	
	<i>Bahia absinthifolia</i> Benth.	hairyseed bahia	X		X	X		X	X	
	<i>Bahia absinthifolia</i> var. <i>dealbata</i> (Gray) Gray	Dealbata's bahia				X				
	<i>Baileya multiradiata</i> Harvey & Gray ex Gray	desert marigold	X		X	X		X	X	
	<i>Baileya pauciradiata</i> Harvey & Gray ex Gray	laxflower			X			X	X	
	<i>Baileya pleniradiata</i> Harvey & Gray ex Gray	woolly desert marigold			X	X			X	
	<i>Bertandiera lyrata</i> Benth.	lyreleaf greeneyes			X	X		X	X	
	<i>Bidens leptoccephala</i> Sherff	fewflower beggarticks			X	X		X	X	
	<i>Brickellia baccharidea</i> Gray	resinleaf brickellbush			X	X			X	
	<i>Brickellia californica</i> (Torr. & Gray) Gray	California brickellbush			X	X			X	
	<i>Brickellia eupatorioides</i> var. <i>chlorolepis</i> (Woot. & Standl.) B.L. Turner	false boneset			X	X		X	X	
	<i>Brickellia venosa</i> (Woot. & Standl.) B.L. Robins.	veiny brickellbush	X		X	X		X	X	
	<i>Carminatia tenuiflora</i> DC.	plumeweed	X							
	<i>Carpochaete bigelovii</i> Gray	Bigelow's bristlehead			X	X		X	X	
	<i>Chaenactis stevioides</i> Hook. & Arn.	Steve's dustymaiden			X	X		X	X	
	<i>Chaetopappa ericoides</i> (Torr.) Nesom	rose heath			X	X		X	X	



Family	Scientific name	Common name	UA	UA Herb-arium <sup>o</sup>	WEA	BEA	RUL	H&R	NPS	H&G
Asteraceae	<i>Cirsium neomexicanum</i> Gray	New Mexico thistle	X		X	X		X	X	
	<i>Cirsium ochrocentrum</i> Gray	yellowspine thistle			X	X		X	X	
	<i>Conyza canadensis</i> (L.) Cronq.	Canadian horseweed			X			X	X	
	<i>Conyza canadensis</i> (L.) Cronq. var. <i>canadensis</i>	Canadian horseweed			X	X		X	X	
	<i>Ericameria laricifolia</i> (Gray) Shimmers	turpentine bush	X		X	X	X	X	X	
	<i>Ericameria nauseosa</i> (Pallas ex Pursh) Nesom & Baird	rubber rabbitbrush					X			
	<i>Ericameria nauseosa</i> var. <i>latisquamata</i> (Gray) Nesom & Baird	rubber rabbitbrush				X				
	<i>Ericameria nauseosa</i> var. <i>nauseosa</i> (Pallas ex Pursh) Nesom & Baird	rubber rabbitbrush	X		X				X	
	<i>Erigeron colomexicanus</i> A. Nels.	running fleabane			X	X			X	
	<i>Erigeron divergens</i> Torr. & Gray	spreading fleabane			X			X	X	
	<i>Erigeron modestus</i> Gray	plains fleabane						X	X	
	<i>Erigeron oreophilus</i> Greenm.	chapparal fleabane			X	X		X	X	
	<i>Flourensia cernua</i> DC.	American tarwort			X	X		X	X	
	<i>Gaillardia pulchella</i> Foug.	firewheel			X			X	X	
	<i>Gaillardia pulchella</i> Foug. var. <i>pulchella</i>	firewheel				X				
	<i>Gnaphalium</i> sp. L.	cutweed					X			
	<i>Gutierrezia microcephala</i> (DC.) Gray	threadleaf snakeweed			X	X		X	X	
	<i>Gutierrezia sarothrae</i> (Pursh) Britt. & Rusby	broom snakeweed		X	X	X		X	X	
	<i>Gymnosperma glutinosum</i> (Spreng.) Less.	gunhead		X						
	<i>Helianthus annuus</i> L.	common sunflower			X	X		X	X	
<i>Helianthus petiolaris</i> Nutt.	prairie sunflower				X					
<i>Heliomeris multiflora</i> var. <i>multiflora</i> Nutt.	showy goldeneye			X	X		X	X		
<i>Heterosperma pinnatum</i> Cav.	wingpetal		X	X	X		X	X		
<i>Heterotheca subaxillaris</i> (Lam.) Britt. & Rusby	camphorweed								X	
<i>Hymenoclea monogyra</i> Torr. & Gray ex Gray	singlewhorl burrobush			X	X		X	X		
<i>Hymenothrix wisizeni</i> Gray	TransPecos thimblehead			X	X		X	X		
<i>Hymenothrix wrightii</i> Gray	Wright's thimblehead				X					
<i>Hymenoxys microcephala</i> (Gray) Biemer	Apache Passe rubberweed			X	X		X	X		
<i>Isocoma coronopifolia</i> (Gray) Greene	common goldenbush			X	X					
<i>Isocoma tenuisecta</i> Greene	burroweed		X		X	X	X	X		
<i>Iva ambrosiifolia</i> (Gray) Gray	ragged marshelder			X	X		X	X		
<i>Iva dealbata</i> Gray	woolly marshelder			X	X		X	X		
<b>Lactuca serriola</b> L.	<b>prickly lettuce</b>			X	X		X	X	X	
<i>Laennecia coulteri</i> (Gray) Nesom	conyza			X	X				X	
<i>Lasthenia californica</i> DC. ex Lindl.	California goldfields				X					
<i>Machaeranthera canescens</i> var. <i>incana</i> (Lindl.) Gray	hoary tansyaster			X	X		X	X	X	

Family	Scientific name	Common name	UA	UA Herb- arium <sup>b</sup>	WEA	BEA	RUL	H&R	NPS	H&G
Asteraceae	<i>Machaeranthera gracilis</i> (Nutt.) Shimmers	slender goldenweed			X					
	<i>Machaeranthera pinnatifida</i> (Hook.) Shimmers	lacy tansyaster			X				X	
	<i>Machaeranthera pinnatifida</i> ssp. <i>gooddingii</i> (A. Nels.) B.L.	Goodding's tansyaster			X					
	<i>Machaeranthera pinnatifida</i> var. <i>pinnatifida</i> (Hook.) Shimmers	lacy tansyaster			X			X		
	<i>Machaeranthera tagetina</i> Greene	mesa tansyaster			X			X	X	
	<i>Malacothrix fendleri</i> Gray	Fendler's desertdandelion			X			X	X	
	<i>Packera neomexicana</i> var. <i>neomexicana</i> (Gray) W.A. Weber & A. Löve	New Mexico groundsel			X			X	X	
	<i>Packera quercetorum</i> (Greene) C. Jeffrey	Oak Creek ragwort			X			X	X	
	<i>Parthenium incanum</i> Kunth	marola	X		X		X	X	X	
	<i>Pectis filipes</i> Harvey & Gray	fivebract cinchweed			X			X	X	
	<i>Pectis filipes</i> var. <i>subnuda</i> Fern.	fivebract cinchweed				X				
	<i>Pectis longipes</i> Gray	longstalk cinchweed			X			X	X	
	<i>Pectis prostrata</i> Cav.	spreading cinchweed			X			X	X	
	<i>Pseudognaphalium canescens</i> ssp. <i>canescens</i> (DC.) W.A. Weber	Wright's cudweed	X		X			X	X	
	<i>Psilostrophe cooperi</i> (Gray) Greene	whitestem paperflower			X		X		X	
	<i>Psilostrophe sparsiflora</i> (Gray) A. Nels.	greenstem paperflower			X			X	X	
	<i>Psilostrophe tagetina</i> (Nutt.) Greene	woolly paperflower	X		X			X	X	
	<i>Psilostrophe tagetina</i> (Nutt.) Greene var. <i>tagetina</i>	woolly paperflower			X					
	<i>Rafinesquia neomexicana</i> Gray	New Mexico plumseed			X				X	
	<i>Ratibida columnifera</i> (Nutt.) Woot. & Standl.	upright prairie coneflower			X			X	X	
	<i>Sanvitalia abertii</i> Gray	Albert's creeping zinnia	X		X			X	X	
	<i>Schkuhria wisizenii</i> Gray		X							
	<i>Senecio flaccidus</i> var. <i>douglasii</i> (DC.) B.L. Turner & T.M. Barkl.	Douglas' ragwort	X			X				
	<i>Senecio flaccidus</i> var. <i>flaccidus</i> Less.	threadleaf ragwort			X			X	X	
	<i>Senecio flaccidus</i> var. <i>monoensis</i> (Greene) B.L. Turner & T.M. Barkl.	Mono ragwort			X			X	X	
	<i>Senecio spartioides</i> var. <i>multicapitatus</i> (Greenm. ex Rydb.) Welsh	broomlike ragwort	X		X			X	X	
	<i>Solidago velutina</i> DC.	threeneve goldenrod			X			X	X	
	<b>Sonchus oleraceus</b> L.	<b>common sowthistle</b>			X				X	
	<i>Stephanomeria pauciflora</i> (Torr.) A. Nels.	brownplume wirelettuce	X		X			X	X	
	<i>Tagetes micrantha</i> Cav.	licorice marigold	X							
	<i>Thelesperma longipes</i> Gray	longstalk greenthread			X			X	X	
	<i>Thelesperma megapotaemicum</i> (Spreng.) Kuntze	Hopi tea greenthread	X		X			X	X	
	<i>Thymophylla acerosa</i> (DC.) Strother	pricklyleaf dogweed			X			X	X	
	<i>Thymophylla pentachaeta</i> var. <i>pentachaeta</i> (DC.) Small	fiveneedle pricklyleaf			X			X	X	
	<i>Trixis californica</i> Kellogg	American threefold			X			X	X	
	<i>Uropappus lindleyi</i> (DC.) Nutt.	Lindley's silverpuffs			X			X	X	

Family	Scientific name	Common name	UA	UA Herb- arium*	WEA	BEA	RUL	H&R	NPS	H&G	
Asteraceae	<i>Verbesina encelioides</i> (Cav.) Benth. & Hook. f. ex Gray	golden crownbeard			X	X		X	X		
	<i>Verbesina rothrockii</i> Robins. & Greene	Rothrock's crownbeard	X	X	X	X		X	X		
	<i>Viguiera deltoidea</i> Gray	Parish's goldeneye			X				X		
	<i>Viguiera dentata</i> (Cav.) Spreng.	toothleaf goldeneye			X	X		X	X		
	<i>Viguiera parishii</i> Greene	Parish's goldeneye			X	X		X			
	<i>Zinnia acerosa</i> (DC.) Gray	desert zinnia	X		X	X		X	X		
	<i>Zinnia grandiflora</i> Nutt.	Rocky Mountain zinnia			X	X		X	X		
	<i>Chilopsis linearis</i> (Cav.) Sweet	desert willow	X		X		X	X	X		
	<i>Chilopsis linearis</i> (Cav.) Sweet ssp. <i>linearis</i>	desert willow				X					
	<i>Amsinckia menziesii</i> var. <i>intermedia</i> (Fisch & C.A. Mey.) Ganders	common fiddleneck			X	X		X	X		
Boraginaceae	<i>Cryptantha crassisejala</i> (Torr. & Gray) Greene	thicksepal cryptantha			X	X		X	X		
	<i>Cryptantha micrantha</i> (Torr.) I.M. Johnston	redroot cryptantha			X	X		X	X		
	<i>Cryptantha pterocarya</i> (Torr.) Greene	wingnut cryptantha	X								
	<i>Lappula occidentalis</i> (S. Wats.) Greene	fatspine stickseed	X								
	<i>Lappula occidentalis</i> var. <i>cupulata</i> (Gray) Higgins	fatspine stickseed			X			X	X		
	<i>Lappula occidentalis</i> var. <i>occidentalis</i> (S. Wats.) Greene	fatspine stickseed			X	X		X	X		
	<i>Lithospermum cobrense</i> Greene	smooththroat stoneseed			X	X		X	X		
	<i>Lithospermum incisum</i> Lehm.	narrowleaf stoneseed				X					
	<i>Pectocarya platycarpa</i> (Munz & Johnston) Munz & Johnston	broadfruit combseed				X					
	<i>Pectocarya recurvata</i> I.M. Johnston	curvenut combseed			X	X		X	X		
Brassicaceae	<i>Plagiobothrys arizonicus</i> (Gray) Greene ex Gray	Arizona popcornflower			X	X		X	X		
	<i>Tiquilia canescens</i> (DC.) A. Richards.	woody crinklemat			X			X	X		
	<i>Tiquilia canescens</i> (DC.) A. Richards. var. <i>canescens</i>	woody crinklemat				X					
	<i>Arabis perennans</i> S. Wats.	perennial rockcress		X	X	X		X	X		
	<i>Descurainia pinnata</i> (Walt.) Britt.	western fansymustard		X	X			X	X		
	<i>Descurainia pinnata</i> ssp. <i>glabra</i> (Woot. & Standl.) Detling	western fansymustard				X					
	<b><i>Descurainia sophia</i> (L.) Webb ex Prantl</b>	<b>herb sophia</b>			<b>X</b>	<b>X</b>		<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
	<i>Draba cuneifolia</i> Nutt. ex Torr. & Gray	wedgeleaf draba			X			X	X		
	<i>Draba cuneifolia</i> Nutt. ex Torr. & Gray var. <i>cuneifolia</i>	wedgeleaf draba				X					
	<i>Draba standleyi</i> J.F. Macbr. & Payson	Standley's draba				X					
<i>Lepidium lasiocarpum</i> Nutt.	shaggyfruit pepperweed			X			X	X			
<i>Lepidium lasiocarpum</i> Nutt. var. <i>lasiocarpum</i>	shaggyfruit pepperweed				X						
<i>Lepidium thurberi</i> Woot.	Thurber's pepperweed				X		X	X			
<i>Lepidium virginicum</i> var. <i>medium</i> (Greene) C.L. Hitchc.	medium pepperweed			X	X		X	X			
<i>Lesquerella fendleri</i> (Gray) S. Wats.	Fendler's bladderpod			X	X		X	X			
<i>Lesquerella gordonii</i> (Gray) S. Wats.	Gordon's bladderpod			X	X		X	X			

Family	Scientific name	Common name	UA	UA Herb-arium <sup>o</sup>	WEA	BEA	RUL	H&R	NPS	H&G
Brassicaceae	<i>Lesquerella tenella</i> A. Nels.	Moapa bladderpod	X							
	<i>Pennellia longifolia</i> (Benth.) Rollins	longleaf mock thelypody			X			X	X	
	<i>Schoenocrambe linearifolia</i> (Gray) Rollins	silfleaf plainsmustard			X			X	X	
	<i>Schoenocrambe limifolia</i> (Nutt.) Greene	flaxleaf plainsmustard	X							
	<b><i>Sisymbrium irio</i> L.</b>	<b>London rocket</b>	<b>X</b>		<b>X</b>			<b>X</b>	<b>X</b>	<b>X</b>
	<i>Streptanthella longirostris</i> (S. Wats.) Rydb.	longbeak streptanthella			X			X	X	
	<i>Streptanthus carinatus</i> ssp. <i>arizonicus</i> (S. Wats.) Kruckeberg, Rodman & Worthington	lyreleaf jewelflower			X			X	X	
	<i>Thelypodium wrightii</i> Gray	Wright's thelypody			X			X	X	
	<i>Thelypodium wrightii</i> Gray ssp. <i>wrightii</i>	Wright's thelypody				X				
Cactaceae	<i>Echinocereus coccineus</i> Engelm. var. <i>coccineus</i>	scarlet hedgehog cactus							X	
	<i>Echinocereus fendleri</i> (Engelm.) F. Seitz	pinkflower hedgehog cactus	X					X	X	
	<i>Echinocereus fendleri</i> var. <i>fasciculatus</i> (Engelm. ex B.D. Jackson) N.P. Taylor	pinkflower hedgehog cactus							X	
	<i>Echinocereus fendleri</i> var. <i>ledingii</i> (Peebles) N.P. Taylor	Leding's hedgehog cactus			X				X	
	<i>Echinocereus fendleri</i> var. <i>rectispinus</i> (Peebles) L. Benson	pinkflower hedgehog cactus			X			X	X	
	<i>Echinocereus pectinatus</i> (Scheidw.) Engelm.	rainbow cactus				X				
	<i>Echinocereus rigidissimus</i> (Engelm.) Haage f.	rainbow hedgehog cactus			X			X	X	
	<i>Echinocereus triglochidiatus</i> Engelm.	kingcup cactus							X	
	<i>Escobaria vivipara</i> var. <i>bisbeeana</i> (Orcutt) D.R. Hunt	Bisbee spiny star			X				X	
	<i>Escobaria vivipara</i> var. <i>vivipara</i> (Nutt.) Buxbaum	spiny star	X					X		
	<i>Ferocactus wislizeni</i> (Engelm.) Britt. & Rose	candy barrel cactus	X		X		X	X	X	
	<i>Mammillaria grahamii</i> var. <i>grahamii</i> Engelm.	Graham's nipple cactus			X			X	X	
	<i>Mammillaria grahamii</i> var. <i>oliviae</i> (Orcutt) L. Benson	Graham's nipple cactus				X			X	
	<i>Mammillaria heyderi</i> var. <i>macdougallii</i> (Rose) L. Benson	Macdougall's nipple cactus			X			X	X	
	<i>Opuntia chlorotica</i> Engelm. & Bigelow	dollarjoint pricklypear			X			X	X	
	<i>Opuntia engelmannii</i> Salm-Dyck	cactus apple	X						X	
	<i>Opuntia engelmannii</i> Salm-Dyck var. <i>engelmannii</i>	cactus apple			X			X	X	
	<i>Opuntia kleiniae</i> DC.	candle cholla			X				X	
	<i>Opuntia leptocaulis</i> DC.	Christmas cactus			X			X	X	
	<i>Opuntia macrocentra</i> Engelm.	purple pricklypear							X	
	<i>Opuntia macrocentra</i> var. <i>macrocentra</i> Engelm.	purple pricklypear	X		X			X	X	
	<i>Opuntia martiniana</i> (L. Benson) Parfitt	seashore cactus							X	
	<i>Opuntia phaeacantha</i> var. <i>major</i> Engelm.	Mojave pricklypear	X		X			X	X	
	<i>Opuntia santa-rita</i> (Griffiths & Hare) Rose	Santa Rita pricklypear			X				X	
	<i>Opuntia spinosior</i> (Engelm.) Toumey	walkingstick cactus	X		X			X	X	
	<i>Opuntia ?tetracantha</i> Toumey (pro sp.)	[acanthocarpa ? leptocaulis]			X			X	X	
	<i>Peniocereus greggii</i> var. <i>greggii</i> (Engelm.) Britt. & Rose	nightblooming cereus			X			X	X	

Family	Scientific name	Common name	UA	UA Herb- arium*	WEA	BEA	RUL	H&R	NPS	H&G
Cactaceae	<i>Peniocereus greggii</i> var. <i>greggii</i> (Engelm.) Britt. & Rose	nightblooming cereus			X	X		X	X	
Campanulaceae	<i>Nemacladus glanduliferus</i> Jepson	glandular threadplant	X							
	<i>Triodanis perfoliata</i> (L.) Nieuwl.	clasping Venus' looking-glass			X			X	X	
	<i>Triodanis perfoliata</i> var. <i>perfoliata</i> (L.) Nieuwl.	clasping Venus' looking-glass				X				
Capparaceae	<i>Polanisia dodecandra</i> (L.) DC.	redwhisker clammyweed			X				X	
	<i>Polanisia dodecandra</i> ssp. <i>trachysperma</i> (Torr. & Gray) Iltis	sandyseed clammyweed				X		X		
Caryophyllaceae	<i>Silene antirrhina</i> L.	sleepy silene	X							
Chenopodiaceae	<i>Atriplex canescens</i> (Pursh) Nutt.	fourwing saltbush			X	X		X	X	
	<i>Atriplex elegans</i> (Moq.) D. Dietr.	wheelscale saltbush			X			X	X	
	<i>Atriplex elegans</i> (Moq.) D. Dietr. var. <i>elegans</i>	wheelscale saltbush				X				
	<i>Chenopodium desiccatum</i> A. Nels.	aridland goosefoot			X				X	
	<i>Chenopodium fremontii</i> S. Wats.	Fremont's goosefoot			X			X	X	
	<i>Chenopodium fremontii</i> S. Wats. var. <i>fremontii</i>	Fremont's goosefoot				X				
	<i>Chenopodium leptophyllum</i> (Moq.) Nutt. ex S. Wats.	narrowleaf goosefoot				X				
	<b>Chenopodium murale</b> L.	<b>nettleleaf goosefoot</b>				<b>X</b>			<b>X</b>	
	<i>Chenopodium pratericola</i> Rydb.	desert goosefoot	X					X		
	<i>Chenopodium watsonii</i> A. Nels.	Watson's goosefoot			X	X		X	X	
	<i>Krascheninnikovia lanata</i> (Pursh) A.D.J. Meese & Smit	winterfat	X		X	X	X	X	X	
	<b>Salsola kali</b> L.	<b>Russian thistle</b>	<b>X</b>			<b>X</b>				
	<b>Salsola tragus</b> L.	<b>prickly Russian thistle</b>			<b>X</b>			<b>X</b>	<b>X</b>	
Commelinaceae	<i>Commelina dianthifolia</i> Delle	birdbill dayflower			X	X		X	X	
Convolvulaceae	<b>Convolvulus arvensis</b> L.	<b>field bindweed</b>	<b>X</b>		<b>X</b>	<b>X</b>		<b>X</b>	<b>X</b>	
	<i>Convolvulus equitans</i> Benth.	Texas bindweed						X	X	
	<i>Evolvulus nuttallianus</i> J.A. Schultes	shaggy dwarf morning-glory	X					X	X	
	<i>Evolvulus sericeus</i> Sw.	silver dwarf morning-glory			X			X	X	
	<i>Evolvulus sericeus</i> var. <i>sericeus</i> Sw.	silver dwarf morning-glory				X				
	<i>Ipomoea barbatisepala</i> Gray	canyon morning-glory			X	X		X	X	
	<b>Ipomoea coccinea</b> L.	<b>redstar</b>			<b>X</b>			<b>X</b>	<b>X</b>	
	<b>Ipomoea hederacea</b> Jacq.	<b>ivyleaf morning-glory</b>						<b>X</b>		
	<i>Ipomoea hederifolia</i> L.	scarletcreeper				X		X		
	<b>Ipomoea purpurea</b> (L.) Roth	<b>tall morning-glory</b>			<b>X</b>	<b>X</b>		<b>X</b>	<b>X</b>	<b>X</b>
Crassulaceae	<i>Sedum cockerellii</i> Britt.	Cockerell's stonecrop			X	X		X	X	
Cucurbitaceae	<i>Apodanthera undulata</i> Gray	melon loco			X	X		X	X	
	<i>Cucurbita digitata</i> Gray	fingerleaf gourd			X	X		X	X	
	<i>Cucurbita foetidissima</i> Kunth	Missouri gourd			X	X		X	X	

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Cucurbitaceae	<i>Marah glifensis</i> Greene	Gila manroot		X	X	X		X	X	
Cupressaceae	<i>Juniperus coahuilensis</i> (Martinez) Gausson ex R.P. Adams	redberry juniper			X	X			X	
	<i>Juniperus deppeana</i> Steud.	alligator juniper			X	X		X	X	
	<i>Juniperus monosperma</i> (Engelm.) Sarg.	oneseed juniper	X				X	X		
Cyperaceae	<i>Carex</i> sp. L.	sedge					X			
	<b><i>Cyperus esculentus</i> L.</b>	<b>chufa flatsedge</b>			<b>X</b>	<b>X</b>		<b>X</b>	<b>X</b>	<b>X</b>
	<i>Cyperus sphaerolepis</i> Boeckl.	Rusby's flatsedge			X	X		X	X	
	<i>Cyperus squarrosus</i> L.	bearded flatsedge			X	X		X	X	
Dryopteridaceae	<i>Woodsia mexicana</i> Fée	phanerophlebia			X			X	X	
Ephedraceae	<i>Ephedra tritunca</i> Torr. ex S. Wats.	longleaf jointfir			X	X		X	X	
Ericaceae	<i>Arctostaphylos pringlei</i> Parry	Pringle manzanita				X			X	
	<i>Arctostaphylos pungens</i> Kunth	pointleaf manzanita	X		X	X		X	X	
Euphorbiaceae	<i>Acalypha neomexicana</i> Muell.-Arg.	New Mexico copperleaf	X		X	X		X	X	
	<i>Chamaesyce albomarginata</i> (Torr. & Gray) Small	whitemargin sandmat	X		X	X		X	X	
	<i>Chamaesyce hyssopifolia</i> (L.) Small	hyssopleaf sandmat			X	X		X	X	
	<i>Chamaesyce revoluta</i> (Engelm.) Small	threadstem sandmat	X		X	X		X	X	
	<i>Chamaesyce serpyllifolia</i> ssp. <i>serpyllifolia</i> (Pers.) Small	thymeleaf sandmat	X							
	<i>Chamaesyce serrula</i> (Engelm.) Woot. & Standl.	sawtooth sandmat	X							
	<i>Chamaesyce stictospora</i> (Engelm.) Small	slimseed sandmat			X	X		X	X	
	<i>Croton pottii</i> var. <i>pottii</i> (Klotzsch) Muell.-Arg.	leatherweed	X		X	X		X	X	
	<i>Euphorbia bilobata</i> Engelm.	blackseed spurge	X							
	<i>Euphorbia exstipulata</i> Engelm.	squareseed spurge	X							
	<i>Euphorbia heterophylla</i> L.	Mexican fireplant	X							
	<i>Tragia nepetifolia</i> Cav.	catnip noseburn			X				X	
	<i>Tragia ramosa</i> Torr.	branched noseburn	X		X	X		X	X	
Fabaceae	<i>Acacia angustissima</i> (P. Mill.) Kuntze	prairie acacia			X			X	X	
	<i>Acacia angustissima</i> var. <i>suffrutescens</i> (Rose) Isely	prairie acacia			X					
	<i>Acacia constricta</i> Benth.	whitehorn acacia			X	X		X	X	
	<i>Acacia greggii</i> Gray	catclaw acacia			X	X		X	X	
	<i>Amorpha fruticosa</i> L.	desert false indigo			X	X		X	X	
	<i>Astragalus allochrous</i> Gray	halfmoon milkvetch			X	X		X	X	
	<i>Astragalus allochrous</i> var. <i>playanus</i> Isely	halfmoon milkvetch			X	X		X	X	
	<i>Astragalus arizonicus</i> Gray	Arizona milkvetch			X	X		X	X	
	<i>Astragalus calycosus</i> Torr. ex S. Wats.	Torrey's milkvetch			X			X	X	
	<i>Astragalus calycosus</i> Torr. ex S. Wats. var. <i>calycosus</i>	Torrey's milkvetch			X			X	X	
	<i>Astragalus nothoxys</i> Gray	sheep milkvetch			X	X		X	X	

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Fabaceae	<i>Astragalus nuttallianus</i> DC.	smallflowered milkvetch		X				X	X	
	<i>Astragalus nuttallianus</i> var. <i>austrinus</i> (Small) Barneby	smallflowered milkvetch			X					
	<i>Astragalus tephrodes</i> Gray	ashen milkvetch			X	X		X	X	
	<i>Astragalus thurberi</i> Gray	Thurber's milkvetch			X	X		X	X	
	<i>Caesalpinia drepanocarpa</i> (Gray) Fisher	sicklepod holdback			X	X		X	X	
	<i>Calliandra eriophylla</i> Benth.	fairyduster		X	X	X	X	X	X	
	<i>Calliandra humilis</i> Benth.	dwarf stickpea						X		
	<i>Calliandra humilis</i> Benth. var. <i>humilis</i>	dwarf stickpea			X	X			X	
	<i>Calliandra humilis</i> var. <i>reticulata</i> (Gray) L. Benson	dwarf stickpea			X	X		X	X	
	<i>Chamaecrista nictitans</i> (L.) Moench	partridge pea		X						
	<i>Crotalaria pumila</i> Ortega	low rattlebox		X						
	<i>Dalea albiflora</i> Gray	whiteflower prairie clover			X	X		X	X	
	<i>Dalea candida</i> var. <i>oligophylla</i> (Torr.) Shinnars	white prairie clover		X						
	<i>Dalea formosa</i> Torr.	featherplume		X	X	X	X	X	X	X
	<i>Dalea nana</i> Torr. ex Gray	dwarf prairie clover			X			X	X	X
	<i>Dalea nana</i> var. <i>camescens</i> Kearney & Peebles	dwarf prairie clover				X				
	<i>Dalea nana</i> Torr. ex Gray var. <i>nana</i>	dwarf prairie clover		X						
	<i>Dalea pogonathera</i> Gray	bearded prairie clover			X	X		X	X	X
	<i>Dalea pringlei</i> Gray	Pringle's prairie clover		X						
	<i>Dalea versicolor</i> Zucc.	oakwoods prairie clover			X					X
	<i>Dalea versicolor</i> var. <i>sessilis</i> (Gray) Barneby	oakwoods prairie clover		X		X		X	X	
	<i>Dalea wrightii</i> Gray	Wright's prairie clover		X	X	X		X	X	X
	<i>Desmanthus cooleyi</i> (Eat.) Trel.	Cooley's bundleflower		X	X	X		X	X	X
	<i>Desmanthus virgatus</i> (L.) Willd.	wild tantan								X
	<i>Desmanthus virgatus</i> var. <i>depressus</i> (Humb. & Bonpl. ex Willd.) B.L. Turner	wild tantan					X			
	<i>Desmodium neomexicanum</i> Gray	New Mexico ticktrefoil		X						
<i>Desmodium procumbens</i> (P. Mill.) A.S. Hitchc.	western trailing ticktrefoil			X				X	X	
<i>Desmodium procumbens</i> var. <i>exiguum</i> (Gray) Schub.	western trailing ticktrefoil				X					
<i>Erythrina flabelliformis</i> Kearney	coralbean					X	X			
<i>Galactia wrightii</i> Gray	Wright's milkpea			X	X		X	X	X	
<i>Galactia wrightii</i> var. <i>mollissima</i> Kearney & Peebles					X					
<i>Hoffmannseggia glauca</i> (Ortega) Eifert	Indian rushpea			X	X		X	X	X	
<i>Lotus greenii</i> Ottley ex Kearney & Peebles	Greene's bird's-foot trefoil			X	X		X	X	X	
<i>Lotus humistratus</i> Greene	foothill deerveatch			X	X				X	
<i>Lotus plebeius</i> (Brand) Barneby	New Mexico bird's-foot trefoil			X	X		X	X	X	
<i>Lotus rigidus</i> (Benth.) Greene	shrubby deerveatch			X	X		X	X	X	

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Fabaceae	<i>Lotus wrightii</i> (Gray) Greene	Wright's deerfatch			X	X		X	X	
	<i>Lupinus brevicaulis</i> S. Wats.	shortstem lupine			X	X		X	X	
	<i>Lupinus concinnus</i> J.G. Agardh	scarlet lupine			X	X		X	X	
	<i>Lupinus sparsiflorus</i> Benth.	Mojave lupine			X	X		X	X	
	<b><i>Macroptilium gibbosifolium</i> (Ortega) A. Delgado</b>	<b>variableleaf bushbean</b>	<b>X</b>		<b>X</b>	<b>X</b>		<b>X</b>	<b>X</b>	
	<i>Marina calycosa</i> (Gray) Barneby	San Pedro false prairie-clover			X	X		X	X	
	<i>Mimosa aculeaticarpa</i> Ortega	catclaw mimosa	X							
	<i>Mimosa aculeaticarpa</i> var. <i>biuncifera</i> (Benth.) Barneby	catclaw mimosa			X	X	X	X	X	
	<i>Phaseolus acutifolius</i> Gray	teparty bean	X		X			X	X	
	<i>Phaseolus acutifolius</i> var. <i>tenuifolius</i> Gray	teparty bean				X				
	<i>Prosopis glandulosa</i> Torr.	honey mesquite	X					X		
	<i>Prosopis glandulosa</i> var. <i>torreyana</i> (L. Benson) M.C. Johnston	western honey mesquite			X	X			X	
	<i>Prosopis velutina</i> Woot.	velvet mesquite			X	X	X	X	X	
	<i>Rhynchosia senna</i> var. <i>texana</i> (Torr. & Gray) M.C. Johnston	Texas snoutbean			X	X		X	X	
	<i>Robinia neomexicana</i> Gray	New Mexico locust			X			X	X	
	<i>Robinia neomexicana</i> Gray var. <i>neomexicana</i>	New Mexico locust				X				
	<i>Senna baubinioides</i> (Gray) Irwin & Barneby	twinleaf senna			X	X		X	X	
	<i>Senna covesii</i> (Gray) Irwin & Barneby	Coves' cassia			X				X	
	<i>Vicia ludoviciana</i> ssp. <i>ludoviciana</i> Nutt.	Louisiana vetch			X	X		X	X	
	<i>Vicia pulchella</i> Kunth	sweetclover vetch			X	X		X	X	
Fagaceae	<i>Quercus arizonica</i> Sarg.	Arizona white oak	X		X	X		X	X	
	<i>Quercus dunii</i> Kellogg	Palmer oak			X	X		X	X	
	<i>Quercus emoryi</i> Torr.	Emory oak	X		X	X	X	X	X	
	<i>Quercus grisea</i> Liebm.	gray oak	X		X	X		X	X	
	<i>Quercus hypoleucooides</i> A. Camus	silverleaf oak			X	X		X	X	
	<i>Quercus pungens</i> Liebm.	pungent oak	X		X	X		X	X	
	<i>Quercus rugosa</i> Née	netleaf oak			X	X		X	X	
	<i>Quercus toumeyii</i> Sarg.	Toumey oak			X	X		X	X	
	<i>Quercus turbinella</i> Greene	Sonoran scrub oak			X	X		X	X	
Fouquieriaceae	<i>Fouquieria splendens</i> Engelm.	ocotillo	X		X	X	X	X	X	
Fumariaceae	<i>Corydalis aurea</i> Willd.	scrambled eggs	X		X			X	X	
	<i>Corydalis curvisiliqua</i> ssp. <i>occidentalis</i> (Engelm. ex Gray) W.A. Weber	curvepod fumewort			X				X	
Garryaceae	<i>Garrya flavescens</i> S. Wats.	ashy silktassel			X	X			X	
	<i>Garrya wrightii</i> Torr.	Wright's silktassel	X		X	X		X	X	
Geraniaceae	<i>Erodium cicutarium</i> (L.) L'Hér. ex Ait.	redstem stork's bill	X		X			X	X	
	<i>Erodium cicutarium</i> ssp. <i>jacquinianum</i> (Fisch., C.A. Mey. & Avé-Lall.) Briq.	redstem stork's bill			X			X	X	X



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Geraniaceae	<i>Erodium texanum</i> Gray	Texas stork's bill		X	X	X		X	X	
Hydrangeaceae	<i>Fendlera rupicola</i> Gray	cliff fenderbush			X	X		X	X	
Hydrophyllaceae	<i>Nama hispidum</i> Gray	bristly nama			X	X		X	X	
	<i>Phacelia arizonica</i> Gray	Arizona phacelia			X	X		X	X	
	<i>Phacelia congesta</i> Hook.	caterpillars			X	X			X	
	<i>Phacelia crenulata</i> Torr. ex S. Wats.	clefleaf wildheliotrope	X		X	X		X	X	
	<i>Phacelia rupestris</i> Greene	rock phacelia						X	X	
Juglandaceae	<i>Juglans major</i> (Torr.) Heller	Arizona walnut	X		X	X	X	X	X	
Juncaceae	<i>Juncus bufonius</i> L.	toad rush						X	X	
	<i>Juncus drummondii</i> E. Mey.	Drummond's rush			X	X			X	
	<i>Juncus saximontanus</i> A. Nels.	Rocky Mountain rush			X	X		X	X	
	<i>Juncus tenuis</i> Willd.	poverty rush			X			X	X	
Krameriaceae	<i>Krameria erecta</i> Willd. ex J.A. Schultes	littleleaf ratany					X			
	<i>Krameria lanceolata</i> Torr.	trailing krameria			X			X	X	
Lamiaceae	<i>Hedeoma drummondii</i> Benth.	Drummond's false pennyroyal			X	X		X	X	
	<i>Hedeoma hyssopifolia</i> Gray	aromatic false pennyroyal				X		X	X	
	<i>Hedeoma nana</i> (Torr.) Briq. ssp. <i>nana</i>	dwarf false pennyroyal				X				
	<i>Hedeoma nanum</i> (Torrey) Briq.				X			X	X	
	<i>Hedeoma oblongifolia</i> (Gray) Heller	oblongleaf false pennyroyal	X							
Lamiaceae	<b><i>Lamium amplexicaule</i> L.</b>	<b>henbit deadnettle</b>			X	X		X	X	
	<b><i>Marrubium vulgare</i> L.</b>	<b>horehound</b>	X		X	X		X	X	X
	<i>Salvia columbariae</i> Benth.	chia	X		X	X		X	X	
	<i>Salvia henryi</i> Gray	crimson sage			X	X		X	X	
	<i>Salvia lemmonii</i> Gray	Lenmon's sage			X	X		X	X	
	<i>Salvia subincisa</i> Benth.	sawtooth sage	X		X	X		X	X	
	<i>Stachys coccinea</i> Ortega	scarlet hedgenettle			X	X		X	X	
	<i>Trichostema arizonicum</i> Gray	Arizona bluecurfs	X		X	X		X	X	
Liliaceae	<i>Allium acuminatum</i> Hook.	tapertip onion				X			X	
	<i>Allium macropetalum</i> Rydb.	largeflower onion			X	X		X	X	
	<i>Calochortus ambiguus</i> (M.E. Jones) Ownbey	doubling mariposa lily			X	X		X	X	
	<i>Dasylirion wheeleri</i> S. Wats.	common sotol	X		X	X	X	X	X	
	<i>Dichelostemma capitatum</i> (Benth.) Wood ssp. <i>capitatum</i>	wild hyacinth			X	X		X	X	
	<i>Echeandia flavescens</i> (J.A. & J.H. Schultes) Cruden	Torrey's craglily			X	X		X	X	
	<i>Nolina microcarpa</i> S. Wats.	sacahuista	X		X	X	X	X	X	
	<i>Zephyranthes longifolia</i> Hemsl.	copper zephyrtilly			X	X		X	X	

Family	Scientific name	Common name	UA	UA Herb- arium <sup>o</sup>	WEA	BEA	RUL	H&R	NPS	H&G
Linaceae	<i>Linum lewisii</i> Pursh	prairie flax		X				X	X	
	<i>Linum lewisii</i> Pursh var. <i>lewisii</i>	prairie flax				X				
	<i>Linum puberulum</i> (Engelm.) Heller	plains flax			X			X	X	
	<b><i>Linum ustatissimum</i> L.</b>	<b>common flax</b>			<b>X</b>			<b>X</b>	<b>X</b>	
Loasaceae	<i>Cevallia sinuata</i> Lag.	singing serpent	X		X			X	X	
	<i>Mentzelia albicaulis</i> (Dougl. ex Hook.) Dougl. ex Torr. & Gray	whitestem blazingstar	X		X			X	X	
	<i>Mentzelia multiflora</i> (Nutt.) Gray	Adonis blazingstar	X		X				X	
	<i>Mentzelia multiflora</i> var. <i>integra</i> M.E. Jones	Adonis blazingstar				X				
	<i>Mentzelia pumila</i> Nutt. ex Torr. & Gray	dwarf mentzelia					X			
Malpighiaceae	<i>Janusia gracilis</i> Gray	slender janusia			X		X	X	X	
Malvaceae	<i>Abutilon parvulum</i> Gray	dwarf Indian mallow			X			X	X	
	<i>Gossypium thurberi</i> Todaro	Thurber's cotton					X			
	<i>Malvella lepidota</i> (Gray) Fryxell	scurfymallow			X			X	X	
	<i>Rhynchosida physocalyx</i> (Gray) Fryxell	buffpetal			X			X	X	
	<b><i>Sida abutilifolia</i> P. Mill.</b>	<b>spreading fanpetals</b>	<b>X</b>		<b>X</b>			<b>X</b>	<b>X</b>	
	<i>Sphaeraalcea hastulata</i> Gray	spear globemallow			X			X	X	
	<i>Sphaeraalcea laxa</i> Woot. & Standl.	caliche globemallow	X		X			X	X	
	<i>Sphaeraalcea wrightii</i> Gray	Wright's globemallow				X			X	
Moraceae	<i>Morus microphylla</i> Buckl.	Texas mulberry	X	X	X			X	X	
Nyctaginaceae	<i>Allionia incarnata</i> L.	trailing windmills	X		X			X	X	
	<i>Boerhavia coccinea</i> P. Mill.	scarlet spiderling						X		X
	<i>Boerhavia coulteri</i> (Hook. f.) S. Wats.	Coulter's spiderling				X				
	<i>Boerhavia diffusa</i> L.	red spiderling			X				X	
	<i>Boerhavia erecta</i> L.	erect spiderling						X	X	
	<i>Boerhavia intermedia</i> M.E. Jones	fivewing spiderling			X				X	
	<i>Boerhavia purpurascens</i> Gray	purple spiderling	X		X			X	X	
	<i>Boerhavia spicata</i> Choisy	creeping spiderling	X		X			X	X	
	<i>Mirabilis albida</i> (Walt.) Heimerl	white four o'clock	X		X			X	X	
	<i>Mirabilis bigelovii</i> Gray	wishbone-bush			X			X	X	
	<i>Mirabilis bigelovii</i> Gray var. <i>bigelovii</i>	wishbone-bush			X					
	<i>Mirabilis coccinea</i> (Torr.) Benth. & Hook. f.	scarlet four o'clock			X			X	X	
	<i>Mirabilis comata</i> (Small) Standl.	hairy-tuft four o'clock					X			
	<i>Mirabilis linearis</i> (Pursh) Heimerl	narrowleaf four o'clock	X		X			X	X	
	<i>Mirabilis longiflora</i> L.	sweet four o'clock			X			X	X	
	<i>Mirabilis multiflora</i> (Torr.) Gray	Colorado four o'clock			X			X	X	
	<i>Mirabilis multiflora</i> (Torr.) Gray var. <i>multiflora</i>	Colorado four o'clock			X			X	X	

Family	Scientific name	Common name	UA	UA Herb-anium*	BEA	RUL	H&R	NPS	H&G
Nyctaginaceae	<i>Mirabilis pumila</i> (Standl.) Standl.	dwarf four o'clock		X	X		X	X	
Oleaceae	<i>Fraxinus velutina</i> Torr.	velvet ash	X		X	X	X	X	
	<i>Menodora scabra</i> Gray	rough menodora			X		X	X	
Onagraceae	<i>Calylophus hartwegii</i> (Benth.) Raven	Hartweg's sundrops		X			X	X	
	<i>Calylophus hartwegii</i> ssp. <i>pubescens</i> (Gray) Towner & Raven	Hartweg's sundrops			X		X	X	
	<i>Camissonia californica</i> (Nutt. ex Torr. & Gray) Raven	California suncup		X			X	X	
	<i>Camissonia contorta</i> (Dougl. ex Lehm.) Keamey	plains evening-primrose		X			X	X	
	<i>Epilobium canum</i> ssp. <i>latifolium</i> (Hook.) Raven	hummingbird trumpet		X			X	X	
	<i>Epilobium ciliatum</i> ssp. <i>ciliatum</i> Raf.	fringed willowherb	X						
	<i>Gaura hexandra</i> ssp. <i>gracilis</i> (Woot. & Standl.) Raven & Gregory	harlequinbush		X	X		X	X	
	<i>Oenothera brachycarpa</i> Gray	shortfruit evening-primrose	X		X		X	X	
	<i>Oenothera caespitosa</i> Nutt.	tufted evening-primrose		X			X	X	
	<i>Oenothera caespitosa</i> ssp. <i>caespitosa</i> Nutt.	tufted evening-primrose			X				
	<i>Oenothera elata</i> ssp. <i>hirsutissima</i> (Gray ex S. Wats.) W. Dietr.	Hooker's evening-primrose			X				
	<i>Oenothera elata</i> ssp. <i>hookeri</i> (Torr. & Gray) W. Dietr. & W.L. Wagner	Hooker's evening-primrose		X	X		X	X	
	<i>Oenothera pallida</i> ssp. <i>runcinata</i> (Engelm.) Munz & W. Klein	pale evening-primrose		X	X		X	X	
	<i>Oenothera primiveris</i> Gray	desert evening-primrose			X			X	
Orobanchaceae	<i>Orobanche cooperi</i> (Gray) Heller	desert broomrape		X	X			X	
	<i>Orobanche ludoviciana</i> Nutt.	Louisiana broomrape					X		
Papaveraceae	<i>Argemone pleiacantha</i> Greene	southwestern pricklypoppy					X		
	<i>Argemone pleiacantha</i> ssp. <i>pinnatisecta</i> G.B. Ownbey	southwestern pricklypoppy		X				X	
	<i>Argemone pleiacantha</i> Greene ssp. <i>pleiacantha</i>	southwestern pricklypoppy			X			X	
	<i>Argemone pleiacantha</i> Greene ssp. <i>mexicana</i> (Greene) C. Clark	California poppy	X		X		X	X	
Pedaliaceae	<i>Proboscidea parviflora</i> (Woot.) Woot. & Standl.	doubleclaw		X	X		X	X	
Pinaceae	<i>Pinus cembroides</i> Zucc.	Mexican pinyon					X		
	<i>Pinus discolor</i> D.K. Bailey & Hawksworth	border pinyon		X	X		X	X	
	<i>Pinus edulis</i> Engelm.	twoneedle pinyon	X	X	X		X	X	
	<i>Pinus monophylla</i> Torr. & Frém.	singleleaf pinyon		X				X	
	<i>Pinus monophylla</i> var. <i>fallax</i> (Little) Silba	singleleaf pinyon			X			X	
Plantaginaceae	<i>Plantago patagonica</i> Jacq.	woolly plantain	X		X		X	X	
Platanaceae	<i>Platanus wrightii</i> S. Wats.	Arizona sycamore			X	X		X	
Poaceae	<i>Aristida adscensionis</i> L.	sixweeks threeawn	X		X		X	X	
	<i>Aristida pansa</i> Woot. & Standl.	Wooton's threeawn		X				X	
	<i>Aristida purpurea</i> Nutt.	purple threeawn				X		X	
	<i>Aristida purpurea</i> var. <i>longiseta</i> (Steud.) Vasey	Fendler threeawn			X		X	X	
	<i>Aristida purpurea</i> var. <i>nealleyi</i> (Vasey) Allred	blue threeawn		X	X		X	X	

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Poaceae	<i>Aristida purpurea</i> var. <i>purpurea</i> Nutt.	purple threeawn			X					
	<i>Aristida terripes</i> var. <i>gentilis</i> (Hendr.) Allred	spidegrass			X	X		X	X	
	<i>Aristida terripes</i> Cav.	spidegrass			X			X	X	
	<i>Aristida terripes</i> Cav. var. <i>terripes</i>	spidegrass	X							
	<i>Avena fatua</i> L.	oat								X
	<i>Bothriochloa barbinodis</i> (Lag.) Herter	cane bluestem	X		X	X	X	X	X	
	<i>Bothriochloa sacharoides</i> (Sw.) Rydb.	silver bluestem			X			X	X	
	<i>Bouteloua aristoides</i> (Kunth) Griseb.	needle grama			X	X		X	X	
	<i>Bouteloua barbata</i> Lag.	sixweeks grama			X	X	X	X	X	
	<i>Bouteloua chondrosioides</i> (Kunth) Benth. ex S. Wats.	sprucetop grama		X	X	X	X	X	X	
	<i>Bouteloua curtipendula</i> (Torr.) Torr.	sidecoat grama	X		X	X	X	X	X	
	<i>Bouteloua eriopoda</i> (Torr.) Torr.	black grama	X		X	X	X	X	X	
	<i>Bouteloua gracilis</i> (Willd. ex Kunth) Lag. ex Griffiths	blue grama	X		X	X	X	X	X	
	<i>Bouteloua hirsuta</i> Lag.	hairy grama	X		X		X	X	X	
	<i>Bouteloua hirsuta</i> Lag. var. <i>hirsuta</i>	hairy grama				X				
	<i>Bouteloua repens</i> (Kunth) Scribn. & Merr.	slender grama	X	X	X	X	X	X	X	
	<i>Bromus carinatus</i> Hook. & Arn.	California brome								X
	<b>Bromus rubens</b> L.	red brome	X							X
	<b>Bromus tectorum</b> L.	cheatgrass			X	X		X	X	
	<i>Cenchrus spinifex</i> Cav.	coastal sandbur			X			X	X	
	<i>Chloris virgata</i> Sw.	feather fingergrass	X		X	X		X	X	X
	<b>Cynodon dactylon</b> (L.) Pers.	Bermudagrass			X	X		X	X	X
	<i>Dasyochloa pulchella</i> (Kunth) Willd. ex Rydb.	low woollygrass	X		X	X		X	X	
	<i>Digitaria californica</i> (Benth.) Henr.	Arizona cottontop	X		X	X	X	X	X	
	<i>Digitaria cognata</i> (J.A. Schultes) Pilger	Carolina crabgrass			X	X			X	
	<i>Digitaria cognata</i> (J.A. Schultes) Pilger var. <i>cognata</i>	Carolina crabgrass				X	X	X	X	
	<i>Digitaria sanguinalis</i> (L.) Scop.	hairy crabgrass			X	X		X	X	
	<b>Echinochloa colona</b> (L.) Link	jungle rice	X		X	X		X	X	X
	<b>Echinochloa crus-galli</b> (L.) Beauv.	barnyardgrass			X	X		X	X	
	<i>Elymus elymoides</i> (Raf.) Swezey	squirreltail	X		X					
	<i>Elymus elymoides</i> ssp. <i>elymoides</i> (Raf.) Swezey	squirreltail			X			X	X	
	<i>Enneapogon desvauxii</i> Desv. ex Beauv.	nineawn pappusgrass	X		X	X		X	X	
	<b>Eragrostis cilianensis</b> (All.) Vign. ex Janchen	stinkgrass	X		X	X		X	X	X
	<b>Eragrostis curvula</b> (Schrad.) Nees	weeping lovegrass	X	X						X
	<i>Eragrostis intermedia</i> A.S. Hitchc.	plains lovegrass	X		X	X	X	X	X	X

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Poaceae	<b>Eragrostis lehmanniana</b> Nees	<b>Lehmann lovegrass</b>	X		X	X		X	X	X
	<i>Eragrostis pectinacea</i> (Michx.) Nees ex Steud.	tufted lovegrass			X				X	
	<i>Eragrostis pectinacea</i> var. <i>miserima</i> (Fourn.) J. Reeder	desert lovegrass			X	X		X	X	
	<i>Eragrostis pectinacea</i> (Michx.) Nees ex Steud. var. <i>pectinacea</i>	tufted lovegrass						X		
	<i>Eriochloa acuminata</i> (J. Presl) Kunth	tapertip cupgrass	X	X						
	<i>Eriochloa lemmonii</i> Vasey & Scribn.	canyon cupgrass			X	X		X	X	
	<i>Erioneuron avenaceum</i> (Kunth) Tateoka	shortleaf woollygrass	X	X	X			X	X	
	<i>Hesperostipa neomexicana</i> (Thurb. ex Coult.) Barkworth	New Mexico feathergrass			X	X		X	X	
	<i>Heteropogon contortus</i> (L.) Beauv. ex Roemer & J.A. Schultes	tanglehead	X	X	X	X		X	X	
	<i>Hilaria belangeri</i> (Steud.) Nash	curly-mesquite			X		X	X	X	
	<i>Hilaria belangeri</i> (Steud.) Nash var. <i>belangeri</i>	curly-mesquite				X				
	<b><i>Hordeum murinum</i> ssp. <i>leporinum</i> (Link) Arcang.</b>	<b>leporinum barley</b>			X	X		X	X	
	<i>Koeleria macrantha</i> (Ledeb.) J.A. Schultes	prairie Junegrass			X	X	X	X	X	
	<i>Leptochloa dubia</i> (Kunth) Nees	green sprangletop	X		X	X	X	X	X	
	<i>Lycurus phleoides</i> Kunth	common wolfstail			X		X	X	X	
	<i>Lycurus setosus</i> (Nutt.) C.G. Reeder	bristly wolfstail	X			X				
	<i>Muhlenbergia arenacea</i> (Buckl.) A.S. Hitchc.	ear muhly			X	X		X	X	
	<i>Muhlenbergia arenicola</i> Buckl.	sand muhly	X		X	X		X	X	
	<i>Muhlenbergia emersleyi</i> Vasey	bullgrass	X		X	X		X	X	
	<i>Muhlenbergia fragilis</i> Swallen	delicate muhly	X							
	<i>Muhlenbergia porteri</i> Scribn. ex Beal	bush muhly	X		X	X	X	X	X	
	<i>Muhlenbergia repens</i> (J. Presl) A.S. Hitchc.	creeping muhly			X	X		X	X	
	<i>Muhlenbergia rigens</i> (Benth.) A.S. Hitchc.	deergrass	X			X			X	
	<i>Panicum capillare</i> L.	witchgrass			X	X		X	X	
	<i>Panicum hallii</i> Vasey	Hall's panicgrass			X		X	X	X	
	<i>Panicum hallii</i> Vasey var. <i>hallii</i>	Hall's panicgrass				X				
	<i>Panicum hirticaule</i> J. Presl	Mexican panicgrass	X							
	<i>Panicum obtusum</i> Kunth	vine mesquite	X		X	X		X	X	
	<i>Phalaris</i> sp. L.	canarygrass								X
	<i>Pleuraphis mutica</i> Buckl.	tobosagrass			X	X		X	X	
	<b><i>Poa annua</i> L.</b>	<b>annual bluegrass</b>			X	X		X	X	
	<b><i>Polygonum viridis</i> (Gouan) Breistr.</b>	<b>beardless rabbitsfoot grass</b>			X	X			X	
	<i>Schizachyrium cirratum</i> (Hack.) Woot. & Standl.	Texas bluestem			X			X	X	
	<i>Scleropogon brevifolius</i> Phil.	burrograss			X			X	X	
	<i>Setaria grisebachii</i> Fourn.	Grisebach's bristlegrass	X		X			X	X	
	<i>Setaria leucopila</i> (Scribn. & Merr.) K. Schum.	streambed bristlegrass	X			X				

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Poaceae	<i>Setaria vulpiseta</i> (Lam.) Roemer & J.A. Schultes	plains bristleglass			X	X	X	X	X	
	<b><i>Sorghum halepense</i> (L.) Pers.</b>	<b>Johnsongrass</b>								X
	<i>Sporobolus airoides</i> (Torr.) Torr.	alkali sacaton	X			X				
	<i>Sporobolus contractus</i> A.S. Hitchc.	spike dropseed	X		X	X	X	X	X	
	<i>Sporobolus cryptandrus</i> (Torr.) Gray	sand dropseed	X		X	X	X	X	X	
	<i>Sporobolus wrightii</i> Munro ex Scribn.	big sacaton			X			X	X	
	<i>Stipa</i> L.	needlegrass				X				
	<i>Trachypogon spicatus</i> (L.) Kuntze	spiked crinkleawn				X				
	<i>Tragus berteronianus</i> J.A. Schultes	spiked burr grass			X	X	X	X	X	
	<i>Tridens muticus</i> (Torr.) Nash	slim tridens	X	X	X		X	X	X	
	<i>Tridens muticus</i> var. <i>muticus</i> (Torr.) Nash	slim tridens				X				
	<i>Urochloa arizonica</i> (Scribn. & Merr.) O. Morrone & F. Zuloaga	Arizona signalgrass	X	X						
	<i>Vulpia octoflora</i> (Walt.) Rydb.	sixweeks fescue	X		X		X	X	X	
	<i>Vulpia octoflora</i> var. <i>octoflora</i> (Walt.) Rydb.	sixweeks fescue				X			X	
Polemoniaceae	<i>Allophylullum gillioides</i> (Benth.) A. & V. Grant	dense false gilyflower			X				X	
	<i>Allophylullum gillioides</i> (Benth.) A. & V. Grant ssp. <i>gillioides</i>	dense false gilyflower				X		X		
	<i>Eriastrum diffusum</i> (Gray) Mason	miniature woollystar	X		X	X		X	X	
	<i>Gilia mexicana</i> A. & V. Grant	El Paso gilia	X							
	<i>Gilia ophthalmoides</i> Brand	eyed gilia			X	X			X	
	<i>Gilia sinuata</i> Dougl. ex Benth.	rosy gilia			X	X		X	X	
	<i>Ipomopsis longiflora</i> (Torr.) V. Grant	flaxflowered ipomopsis			X		X	X	X	
	<i>Ipomopsis longiflora</i> (Torr.) V. Grant ssp. <i>longiflora</i>	flaxflowered ipomopsis				X				
	<i>Ipomopsis multiflora</i> (Nutt.) V. Grant	manyflowered ipomopsis			X	X		X	X	
	<i>Linanthus aureus</i> (Nutt.) Greene	golden linanthus	X		X	X		X	X	
	<i>Phlox austromontana</i> Coville	mountain phlox			X		X	X	X	
	<i>Phlox austromontana</i> Coville ssp. <i>austromontana</i>	mountain phlox				X				
	<i>Phlox gracilis</i> ssp. <i>gracilis</i> (Hook.) Greene	slender phlox			X	X		X	X	
	<i>Phlox nana</i> Nutt.	Santa Fe phlox			X				X	
	<i>Phlox triovulata</i> ex Torr.	threeseed phlox				X		X		
Polygalaceae	<i>Polygala barbeyana</i> Chod.	blue milkwort			X	X		X	X	
	<i>Polygala barbeyana</i> Chod. ssp. <i>barbeyana</i>		X							
	<i>Polygala macradenia</i> Gray	glandleaf milkwort			X	X		X	X	
	<i>Eriogonum aberitanum</i> Torr.	Abert's buckwheat			X			X	X	
	<i>Eriogonum aberitanum</i> Torr. var. <i>aberitanum</i>	Abert's buckwheat			X					
	<i>Eriogonum deflexum</i> Torr.	flatcrown buckwheat			X			X	X	
	<i>Eriogonum deflexum</i> Torr. var. <i>deflexum</i>	flatcrown buckwheat				X				

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Polygonaceae	<i>Eriogonum jamesii</i> Benth.	James' buckwheat						X	X	
	<i>Eriogonum jamesii</i> var. <i>undulatum</i> (Benth.) S. Stokes ex M.E. Jones	James' buckwheat				X				
	<i>Eriogonum polycladon</i> Benth.	sorrel buckwheat	X	X	X	X		X	X	
	<i>Eriogonum wrightii</i> Torr. ex Benth.	bastardsage	X	X	X	X		X	X	
	<i>Eriogonum wrightii</i> var. <i>wrightii</i> Torr. ex Benth.	bastardsage			X					
	<b><i>Polygonum convolvulus</i> L.</b>	<b>black bindweed</b>			<b>X</b>			<b>X</b>	<b>X</b>	
	<b><i>Rumex crispus</i> L.</b>	<b>curly dock</b>			<b>X</b>	<b>X</b>		<b>X</b>	<b>X</b>	
	<i>Rumex hymenosepalus</i> Torr.	canaigre dock			X	X		X	X	
Portulacaceae	<i>Portulaca halimoides</i> L.	silkcotton purslane			X	X		X	X	
	<i>Portulaca oleracea</i> L.	little hogweed			X	X		X	X	
	<i>Portulaca suffrutescens</i> Engelm.	shrubby purslane			X	X		X	X	
	<i>Portulaca umbraticola</i> Kunth	wingpod purslane	X							
	<i>Talinum aurantiacum</i> Engelm.	orange faneflower	X		X	X		X	X	
	<i>Talinum parviflorum</i> Nutt.	sunbright			X	X		X	X	
Primulaceae	<i>Androsace occidentalis</i> Pursh	western rockjasmine				X				
Pteridaceae	<i>Argyrochosma limitanea</i> ssp. <i>limitanea</i> (Maxon) Windham	southwestern false cloakfern			X	X		X	X	
	<i>Astrolepis sinuata</i> (Lag. ex Sw.) Benham & Windham ssp. <i>sinuata</i>	wavy scaly cloakfern			X	X		X	X	
	<i>Bommeria hispida</i> (Mett. ex Kuhn) Underwood	copper fern			X	X		X	X	
	<i>Cheilanthes eatonii</i> Baker	Eaton's lipfern	X	X	X	X		X	X	
	<i>Cheilanthes lindheimeri</i> Hook.	fairyswords			X	X		X	X	
	<i>Cheilanthes wootonii</i> Maxon	beaded lipfern			X	X		X	X	
	<i>Cheilanthes wrightii</i> Hook.	Wright's lipfern			X	X		X	X	
	<i>Notholaena standleyi</i> Maxon	star cloak fern			X	X		X	X	
	<i>Pellaea truncata</i> Goodding	spiny cliffbrake			X	X		X	X	
Ranunculaceae	<i>Anemone tuberosa</i> Rydb.	desert anemone			X	X		X	X	
	<i>Clematis drummondii</i> Torr. & Gray	Drummond's clematis			X	X		X	X	
	<i>Delphinium carolinianum</i> ssp. <i>virescens</i> (Nutt.) Brooks	Carolina larkspur			X	X		X	X	
	<i>Delphinium wootonii</i> Rydb.	Organ Mountain larkspur			X					
Rhamnaceae	<i>Ceanothus fendleri</i> Gray	Fendler's ceanothus					X			
	<i>Ceanothus greggii</i> Gray	desert ceanothus			X			X	X	
	<i>Ceanothus greggii</i> var. <i>vestitus</i> (Greene) McMilln	Mojave ceanothus			X					
	<i>Condalia spathulata</i> Gray	squawbush			X			X		
	<i>Condalia wamockii</i> M.C. Johnston	Wamock's snakewood	X							
	<i>Condalia wamockii</i> var. <i>keameyana</i> M.C. Johnston	Kearney's snakewood			X				X	
	<i>Frangula californica</i> ssp. <i>californica</i> (Eschsch.) Gray	California buckthorn			X			X	X	
	<i>Frangula californica</i> ssp. <i>ursina</i> (Greene) Kartesz & Gandhi	California buckthorn			X					

Family	Scientific name	Common name	UA	UA Herb- arium <sup>b</sup>	WEA	BEA	RUL	H&R	NPS	H&G
Rhamnaceae	<i>Ziziphus obtusifolia</i> (Hook. ex Torr. & Gray) Gray	lobebush	X		X		X		X	
	<i>Ziziphus obtusifolia</i> var. <i>canescens</i> (Gray) M.C. Johnston	lobebush				X				
	<i>Ziziphus obtusifolia</i> var. <i>obtusifolia</i> (Hook. ex Torr. & Gray) Gray	lobebush						X		
Rosaceae	<i>Cercocarpus montanus</i> Raf.	alderleaf mountain mahogany	X							
	<i>Cercocarpus montanus</i> var. <i>argenteus</i> (Rydb.) F.L. Martin	silver mountain mahogany			X				X	
	<i>Cercocarpus montanus</i> var. <i>glaber</i> (S. Wats.) F.L. Martin	birchleaf mountain mahogany				X			X	
	<i>Cercocarpus montanus</i> var. <i>paucidentatus</i> (S. Wats.) F.L. Martin	hairy mountain mahogany			X			X	X	
	<i>Fallugia paradoxa</i> (D. Don) Endl. ex Torr.	Apache plume			X		X	X	X	
	<i>Purshia mexicana</i> (D. Don) Henrickson	Mexican cliffrose				X				
Rubiaceae	<i>Bouvardia ternifolia</i> (Cav.) Schlecht.	firecrackerbush			X			X	X	
	<i>Diodia teres</i> Walt.	poorjoe	X		X			X	X	
	<i>Diodia teres</i> var. <i>angustata</i> Gray	poorjoe				X				
	<i>Galium proliferum</i> Gray	limestone bedstraw	X		X			X	X	
	<i>Galium stellatum</i> Kellogg	starry bedstraw	X							
	<i>Galium wrightii</i> Gray	Wright's bedstraw	X		X			X	X	
	<i>Houstonia rubra</i> Cav.	red bluet			X			X		
Rutaceae	<i>Ptelea trifoliata</i> L.	common hoptree	X		X				X	
	<i>Ptelea trifoliata</i> ssp. <i>angustifolia</i> (Benth.) V. Bailey	common hoptree				X		X		
	<i>Thamnosma texana</i> (Gray) Torr.	Texas rue	X		X			X	X	
Salicaceae	<i>Populus fremontii</i> S. Wats.	Fremont cottonwood			X		X	X	X	
	<i>Populus fremontii</i> S. Wats. ssp. <i>fremontii</i>	Fremont cottonwood			X					
	<i>Salix bonplandiana</i> Kunth	Bonpland willow							X	
	<i>Salix exigua</i> Nutt.	narrowleaf willow			X		X	X	X	
	<i>Salix gooddingii</i> Ball	Goodding's willow			X		X	X	X	
Santalaceae	<i>Comandra umbellata</i> ssp. <i>pallida</i> (A. DC.) Pichi	pale bastard toadflax			X			X	X	
Sapindaceae	<i>Sapindus saponaria</i> L.	wingleaf soapberry	X					X		
	<i>Sapindus saponaria</i> var. <i>drummondii</i> (Hook. & Arn.) L. Benson	western soapberry			X		X		X	
Sapotaceae	<i>Sideroxylon lanuginosum</i> Michx.	gum bully	X	X						
	<i>Sideroxylon lanuginosum</i> ssp. <i>rigidum</i> (Gray) T.D. Pennington	gum bully			X		X	X	X	
Saxifragaceae	<i>Heuchera sanguinea</i> Engelm.	coralbelles			X		X	X	X	
Scrophulariaceae	<i>Castilleja austromontana</i> Standl. & Blumer	Rincon Mountain Indian paintbrush			X		X	X	X	
	<i>Castilleja integra</i> Gray	wholeleaf Indian paintbrush			X			X	X	
	<i>Castilleja integra</i> var. <i>gloriosa</i> (Britt.) Cockerell	wholeleaf Indian paintbrush				X				
	<i>Castilleja lanata</i> Gray	Sierra woolly Indian paintbrush	X		X		X	X	X	
	<i>Castilleja sessiliflora</i> Pursh	downy paintedcup			X		X	X	X	
	<i>Castilleja tenuiflora</i> Benth.	Santa Catalina Indian paintbrush			X		X			



Family	Scientific name	Common name	UA	UA Herb- arium*	WEA	BEA	RUL	H&R	NPS	H&G
Scrophulariaceae	<i>Linaria dalmatica</i> (L.) P. Mill.	Dalmatian toadflax			X	X		X		
	<i>Linaria genistifolia</i> (L.) P. Mill.	broomleaf toadflax			X				X	
	<i>Maurandella antirrhiniflora</i> (Humb. & Bonpl. ex Willd.) Rothm.	roving sailor	X		X	X		X	X	
	<i>Mimulus guttatus</i> DC.	seep monkeyflower	X		X	X		X	X	
	<i>Mimulus rubellus</i> Gray	little redstem monkeyflower			X	X		X	X	
	<i>Pedicularis procera</i> Gray	giant lousewort			X	X		X	X	
	<i>Penstemon barbatus</i> (Cav.) Roth	beardlip penstemon			X	X		X	X	
	<i>Penstemon barbatus</i> ssp. <i>torreyi</i> (Benth.) Keck	Torrey's penstemon			X	X				
	<i>Penstemon linarioides</i> Gray	toadflax penstemon	X		X			X	X	
	<i>Penstemon linarioides</i> Gray ssp. <i>linarioides</i>	toadflax beardtongue			X	X				
	<i>Penstemon ramosus</i> Crosswhite	lanceleaf beardtongue			X	X		X	X	
	<b><i>Verbascum virgatum</i> Stokes</b>	<b>wand mullein</b>	<b>X</b>							
	<i>Veronica peregrina</i> L.	neckweed			X			X	X	
	<i>Veronica peregrina</i> ssp. <i>xalapensis</i> (Kunth) Pennell	hairy purslane speedwell			X	X		X	X	
Solanaceae	<i>Chamaesaracha coronopus</i> (Dunal) Gray	greenleaf five eyes			X	X		X	X	
	<i>Chamaesaracha sordida</i> (Dunal) Gray	hairy five eyes	X		X	X		X	X	
	<b><i>Datura innoxia</i> P. Mill.</b>	<b>pricklyburr</b>			<b>X</b>				<b>X</b>	
	<i>Datura wrightii</i> Regel	sacred thorn-apple	X			X		X		
	<i>Lycium fremontii</i> Gray	Fremont's desert-thorn			X	X		X	X	
	<i>Lycium pallidum</i> Miers	pale desert-thorn			X	X		X	X	
	<i>Margaranthus solanaceus</i> Schlecht.	netted globecherry	X							
	<i>Nicotiana obtusifolia</i> Mertens & Galeotti	desert tobacco	X							
	<i>Nicotiana obtusifolia</i> var. <i>obtusifolia</i> Mertens & Galeotti	desert tobacco			X	X		X	X	
	<i>Physalis acutifolia</i> (Miers) Sandw.	sharpleaf groundcherry			X	X		X	X	
	<i>Physalis hederifolia</i> var. <i>fendleri</i> (Gray) Cronq.	Fendler's groundcherry			X	X		X	X	
	<i>Physalis longifolia</i> Nutt. var. <i>longifolia</i>	longleaf groundcherry			X	X		X	X	
	<i>Solanum americanum</i> P. Mill.	American black nightshade			X	X		X	X	
	<i>Solanum elaeagnifolium</i> Cav.	silverleaf nightshade			X	X		X	X	
Sterculiaceae	<i>Ayenia filiformis</i> S. Wats.	TransPecos ayenia	X							
Tamaricaceae	<i>Tamarix</i> sp. L.	tamarisk								X
Ulmaceae	<i>Celtis laevigata</i> var. <i>reticulata</i> (Torr.) L. Benson	netleaf hackberry	X		X	X		X	X	
	<i>Celtis pallida</i> Torr.	spiny hackberry				X				
Verbenaceae	<i>Aloysia wrightii</i> Heller ex Abrams	Wright's beebush	X		X	X		X	X	
	<i>Glandularia bipinnatifida</i> (Nutt.) Nutt.	Dakota mock vervain			X	X		X	X	
	<i>Glandularia bipinnatifida</i> var. <i>bipinnatifida</i> (Nutt.) Nutt.	Dakota mock vervain			X	X		X	X	
	<i>Glandularia wrightii</i> (Gray) Umber	Davis Mountain mock vervain	X		X	X		X	X	

Family	Scientific name	Common name	UA	UA Herb- arium <sup>b</sup>	WEA	BEA	RUL	H&R	NPS	H&G
Verbenaceae	<i>Tetradlea coulteri</i> Gray	Coulter's wrinklefruit			X	X		X	X	
Violaceae	<i>Verbena gracilis</i> Desf.	Fort Huachuca vervain			X	X		X	X	
	<i>Hybanthus verticillatus</i> (Ortega) Baill.	babysippers			X			X	X	
	<i>Hybanthus verticillatus</i> (Ortega) Baill. var. <i>verticillatus</i>	babysippers				X				
Viscaceae	<i>Phoradendron bolleanum</i> (Seem.) Eichl.	Bollean mistletoe						X	X	
	<i>Phoradendron californicum</i> Nutt.	mesquite mistletoe			X	X		X	X	
	<i>Phoradendron capitellatum</i> Torr. ex Trel.	downy mistletoe			X	X			X	
	<i>Phoradendron coryae</i> Trel.	Cory's mistletoe			X	X		X	X	
	<i>Phoradendron pauciflorum</i> Torr.	fir mistletoe				X				
Vitaceae	<i>Vitis arizonica</i> Engelm.	canyon grape	X		X	X	X	X	X	
Zygophyllaceae	<i>Kallstroemia grandiflora</i> Torr. ex Gray	Arizona poppy			X	X		X	X	
	<i>Kallstroemia parviflora</i> J.B.S. Norton	warty catclaw			X	X		X	X	
	<i>Larrea tridentata</i> (Sessé & Moc. ex DC.) Coville	creosote bush			X			X	X	
	<i>Larrea tridentata</i> var. <i>tridentata</i> (Sessé & Moc. ex DC.) Coville	creosote bush	X			X				
	<b><i>Tribulus terrestris</i> L.</b>	<b>puncturevine</b>			<b>X</b>	<b>X</b>		<b>X</b>	<b>X</b>	<b>X</b>

<sup>a</sup> This list includes many species ( $n = 54$ ) for which we included separate lines for specimens that were identified to species only and specimens that were identified to its nominate species (e.g., *Guilleminea densa* and *Guilleminea densa* var. *densa*). In these cases we do not determine these to be separate species in the tally of the number of species for the park or number of new species.

<sup>b</sup> Specimens at the University of Arizona Herbarium. Specimens date from 1902–1994.

**Appendix B. Amphibians and reptiles observed or documented at Fort Bowie NHS by University of Arizona (UA) personnel, Swann et al. (2001; Swann), Lowe and Johnson (1976; L&J), and from voucher specimens reported in Appendix E (AE). “Possible” species have not been observed or documented in the park, but may occur based on habitat and range (reported in Swann et al. [2001]).**

Order	Family	Scientific name	Common name	Observed or documented				
				UA	Swann	L&J	AE	Possible
<b>Caudata</b>	Ambystomatidae	<i>Ambystoma tigrinum mavortium</i>	barred tiger salamander					X
<b>Anura</b>	Pelobatidae	<i>Scaphiopus couchii</i>	Couch's spadefoot		X	X		
		<i>Spea bombifrons</i>	plains spadefoot			X		X
		<i>Spea multiplicata</i>	Mexican spadefoot		X	X		
	Bufonidae	<i>Bufo punctatus</i>	red-spotted toad		X	X		
		<i>Bufo cognatus</i>	Great Plains toad		X	X		
		<i>Bufo alvarius</i>	Sonoran desert toad					X
		<i>Bufo woodhousii</i>	Woodhouse's toad					X
			<i>Bufo debilis</i>	Green toad			X	
	Hylidae	<i>Hyla arenicolor</i>	canyon treefrog		X	X		
	Ranidae	<i>Rana catesbeiana</i>	American bullfrog					X
<i>Rana chiricahuensis</i> <sup>a</sup>		Chiricahua leopard frog		X	X			
<i>Rana blairi</i>		plains leopard frog					X	
<b>Testudines</b>	Kinosternidae	<i>Kinosternon flavescens</i>	yellow mud turtle					X
		<i>Kinosternon sonoriense</i>	Sonoran mud turtle					X
	Emydidae	<i>Terrapene ornata</i>	western box turtle			X		X
	Testudinidae	<i>Gopherus agassizii sonoran</i> <sup>b</sup>	Sonoran desert tortoise					X
<b>Squamata</b>	Eublepharidae	<i>Coleonyx variegatus</i>	western banded gecko		X	X		
	Crotaphytidae	<i>Crotaphytus collaris</i>	eastern collared lizard		X	X	X	
		<i>Gambelia wislizenii</i>	long-nosed leopard lizard					X
	Phrynosomatidae	<i>Holbrookia maculata</i>	lesser earless lizard	X				
		<i>Cophosaurus texanus</i>	greater earless lizard	X	X	X		
		<i>Callisaurus draconoides</i>	zebra-tailed lizard					X
		<i>Sceloporus clarkii</i>	Clark's spiny lizard		X		X	
		<i>Sceloporus virgatus</i>	striped plateau lizard	X				
		<i>Sceloporus slevini</i>	Slevin's bunchgrass lizard					X
		<i>Sceloporus jarrovii</i>	mountain spiny lizard					X
		<i>Sceloporus magister</i>	desert spiny lizard					X
		<i>Sceloporus undulatus</i>	eastern fence lizard					X
		<i>Urosaurus ornatus</i>	ornate tree lizard	X	X	X	X	
		<i>Uta stansburiana</i>	common side-blotched lizard					X
		<i>Phrynosoma cornutum</i>	Texas horned lizard		X	X		
		<i>Phrynosoma douglasii</i>	pygmy short-horned lizard		X	X		
	<i>Phrynosoma modestum</i>	round-tailed horned lizard		X	X			
	<i>Phrynosoma solare</i>	regal horned lizard					X	
	Scincidae	<i>Eumeces obsoletus</i>	Great Plains skink		X	X		
	Teiidae	<i>Cnemidophorus uniparens</i>	desert grassland whiptail		X	X		
<i>Cnemidophorus exsanguis</i>		Chihuahuan spotted whiptail		X		X		
<i>Cnemidophorus sonorae</i>		Sonoran spotted whiptail		X	X			
<i>Cnemidophorus tigris</i>		western whiptail (tiger whiptail)		X	X			
<i>Cnemidophorus burti</i>		canyon spotted whiptail					X	

Order	Family	Scientific name	Common name	Observed or documented				
				UA	Swann	L&J	AE	Possible
<b>Squamata</b>	Teiidae	<i>Cnemidophorus inornatus</i>	little striped whiptail					X
	Anguidae	<i>Elgaria kingii</i>	Madrean alligator lizard		X	X		
	Helodermatidae	<i>Heloderma suspectum</i>	Gila monster	X	X	X		
		<i>Leptotyphlops humilis</i>	western blind snake					X
		<i>Leptotyphlops dulcis</i>	Texas blind snake					X
	Colubridae	<i>Diadophis punctatus</i>	ring-necked snake			X		
		<i>Heterodon nasicus</i>	western hog-nosed snake					X
	Colubridae	<i>Masticophis flagellum</i>	coachwhip		X	X		
		<i>Masticophis bilineatus</i>	Sonoran whipsnake	X	X	X		
		<i>Salvadora hexalepis deserticola</i>	Big Bend patch-nosed snake		X	X		
		<i>Salvadora grahamiae</i>	mountain patch-nosed snake		X	X		
		<i>Senticolis triaspis</i>	green rat snake	X	X	X		
		<i>Pituophis catenifer</i>	gopher snake	X	X	X		
		<i>Arizona elegans</i>	western glossy snake					X
		<i>Lampropeltis getula</i>	common kingsnake					X
		<i>Lampropeltis pyromelana</i>	Sonoran mountain kingsnake					X
		<i>Lampropeltis triangulum</i>	milk snake					X
		<i>Rhinocheilus lecontei</i>	long-nosed snake					X
		<i>Thamnophis cyrtopsis</i>	black-necked garter snake		X	X		
		<i>Thamnophis marcianus</i>	checkered garter snake					X
		<i>Sonora semiannulata</i>	western ground snake					X
		<i>Gyalopion canum</i>	Chihuahuan hook-nosed snake					X
		<i>Tantilla yaquia</i>	Yaqui black-headed snake		X	X		
		<i>Tantilla hobartsmithi</i>	southwestern black-headed snake					X
		<i>Tantilla nigriceps</i>	plains black-headed snake					X
		<i>Trimorphodon biscutatus</i>	western lyre snake			X		
		<i>Hypsiglena torquata</i>	night snake		X			
	Elapidae	<i>Micruroides euryxanthus</i>	Sonoran coral snake		X			
	Viperidae	<i>Sistrurus catenatus</i>	massasauga					X
		<i>Crotalus lepidus</i>	rock rattlesnake					X
		<i>Crotalus viridis cerberus</i>	Arizona black rattlesnake					X
		<i>Crotalus scutulatus</i>	Mojave rattlesnake					X
		<i>Crotalus pricei</i>	twin-spotted rattlesnake					X
		<i>Crotalus atrox</i>	western diamond-backed rattlesnake		X	X	X	
		<i>Crotalus molossus</i>	black-tailed rattlesnake		X	X		

<sup>a</sup> Now extirpated from the park. Listed as "Threatened" under the Endangered Species Act, "Sensitive" by the U.S.D.A. Forest Service, and "Wildlife of Special Concern" by the Arizona Game and Fish Department (HDMS 2004).

<sup>b</sup> "Species of Concern" by U.S. Fish and Wildlife Service, and "Wildlife of Special Concern" by the Arizona Game and Fish Department (HDMS 2004).

**Appendix C. Number of observations of bird species, by detection type, at Fort Bowie NHS by University of Arizona (UA) inventory personnel, 2002–2004.** Numbers of individuals recorded are not scaled by search effort and should not be used for comparison among species. List also includes species reported as seen by Russell and Johnson (1976; R&J), Fisher (2002; FI), and specimen vouchers reported in Appendix E (AE). Underlined species are Neotropical migrants (Rappole 1995). Species in bold-faced type are non-native.

Order	Family	Scientific name	Common name	UA survey method				Observed or documented				Conservation designation					
				VCP	Line transect	Noc-turnal	Incid-ental	R&J	FI	AE	ESA <sup>a</sup>	USFS <sup>b</sup>	AZ <sup>c</sup>	AZ PIF <sup>d</sup>	U.S. FWS <sup>e</sup>		
<b>Anseriformes</b>	Anatidae	<i>Branta canadensis</i>	Canada goose					X									
<b>Galliformes</b>	Odontophoridae	<i>Callipepla squamata</i>	scaled quail														
		<i>Callipepla gambelii</i>	Gambel's quail	146	120		1	X	X								
		<i>Cyrtonyx montezumae</i>	Montezuma quail		1			X	X								
<b>Ciconiiformes</b>	Ardeidae	<i>Ardea herodias</i>	great blue heron						X								
		<i>Butorides virescens</i>	green heron					X									
	Cathartidae	<i>Coragyps atratus</i>	black vulture					X									
		<i>Cathartes aura</i>	turkey vulture	38			1	X	X								
<b>Falconiformes</b>	Accipitridae	<i>Pandion haliaetus</i>	osprey						X								
		<i>Haliaeetus leucocephalus</i>	bald eagle						X								
		<i>Circus cyaneus</i>	northern harrier				1	X	X								
		<i>Accipiter striatus</i>	sharp-shinned hawk					X	X					X			
		<i>Accipiter cooperii</i>	Cooper's hawk	9	1		5	X	X								
		<i>Buteogallus anthracinus</i>	common black-hawk					1	X	X				X	X	X	
		<i>Buteo swainsoni</i>	Swainson's hawk					X	X	X							
		<i>Buteo albonotatus</i>	zone-tailed hawk	1			1										
		<i>Buteo jamaicensis</i>	red-tailed hawk	8	1		2	X	X	X							
		<i>Buteo regalis</i>	ferruginous hawk						X								
		<i>Buteo lagopus</i>	rough-legged hawk						X								
		<i>Aquila chrysaetos</i>	golden eagle	1				X	X								
	Falconidae	<i>Falco sparverius</i>	American kestrel					X	X								
		<i>Falco columbarius</i>	merlin					X	X								
		<i>Falco peregrinus</i>	peregrine falcon	1					X	X			SC	X			X
		<i>Falco mexicanus</i>	prairie falcon					X	X								
<b>Gruiformes</b>	Gruidae	<i>Grus canadensis</i>	sandhill crane		52				X								
<b>Charadriiformes</b>	Charadriidae	<i>Charadrius vociferus</i>	killdeer					X	X								
	Scolopacidae	<i>Tringa flavipes</i>	lesser yellowlegs					X									

Order	Family	Scientific name	Common name	UA survey method				Observed or documented				Conservation designation					
				VCP	Line transect	Noc-turnal	Incid-ental	R&J	FI	AE	ESA <sup>a</sup>	USFS <sup>b</sup>	AZ <sup>c</sup>	AZ PIP <sup>d</sup>	U.S. FWS <sup>e</sup>		
<b>Charadriiformes</b>	Scolopacidae	<i>Actitis macularia</i>	spotted sandpiper					X									
<b>Columbiformes</b>	Columbidae	<i>Patagioenas fasciata</i>	band-tailed pigeon					X									
		<i>Zenaida asiatica</i>	white-winged dove	180			8	X									
		<i>Zenaida macroura</i>	mourning dove	168			16	X									
		<i>Columbina passerina</i>	common ground-dove				2										
<b>Cuculiformes</b>	Cuculidae	<i>Geococcyx californianus</i>	greater roadrunner				3	X									
<b>Strigiformes</b>	Tytonidae	<i>Tyto alba</i>	barn owl					X									
<b>Strigiformes</b>	Strigidae	<i>Megascops kennicottii</i>	western screech-owl			1		X									
		<i>Bubo virginianus</i>	great horned owl			1		X									
		<i>Micrathene whitneyi</i>	elf owl			3		X									X
		<i>Strix occidentalis lucida</i>	Mexican spotted owl					X									
		<i>Asio otus</i>	long-eared owl					X									
<b>Caprimulgiformes</b>	Caprimulgidae	<i>Chordeiles aculipennis</i>	lesser nighthawk				2	X									
		<i>Chordeiles minor</i>	common nighthawk					X									
		<i>Phalaenoptilus nuttallii</i>	common poorwill			12	2	X									
		<i>Caprimulgus vociferus</i>	whip-poor-will					X									
<b>Apodiformes</b>	Apodidae	<i>Chaetura vauxi</i>	Vaux's swift					X									
		<i>Aeronautes saxatalis</i>	white-throated swift	8				X									
	Trochilidae	<i>Cyananthus latirostris</i>	broad-billed hummingbird														
		<i>Eugenes fulgens</i>	magnificent hummingbird					X									
		<i>Calothorax lucifer</i>	Lucifer hummingbird					X									
		<i>Archilochus alexandri</i>	black-chinned hummingbird	14			2	X									
		<i>Calypte anna</i>	Anna's hummingbird					X									
		<i>Calypte costae</i>	Costa's hummingbird					X									X
		<i>Stellula calliope</i>	calliope hummingbird					X									
		<i>Selasphorus platycercus</i>	broad-tailed hummingbird	14			4	X									
		<i>Selasphorus rufus</i>	rufous hummingbird					X									
<b>Coraciiformes</b>	Alcedinidae	<i>Ceryle alcyon</i>	belted kingfisher					X									X
<b>Piciformes</b>	Picidae	<i>Melanerpes lewis</i>	Lewis's woodpecker					X									
		<i>Melanerpes formicivorus</i>	acorn woodpecker					X									

Order	Family	Scientific name	Common name	UA survey method				Observed or documented				Conservation designation					
				VCP	Line transect	Noc-turnal	Incid-ental	R&J	FI	AE	ESA <sup>a</sup>	USFS <sup>b</sup>	AZ <sup>c</sup>	AZ <sup>d</sup>	U.S. FWS <sup>e</sup>		
<b>Piciformes</b>	Picidae	<i>Melanerpes uropygialis</i>	Gila woodpecker					X	X							X	
		<i>Sphyrapicus thyroideus</i>	Williamson's sapsucker					X	X								
		<i>Sphyrapicus nuchalis</i>	red-naped sapsucker	1				X									
		<i>Sphyrapicus varius</i>	yellow-bellied sapsucker					X									
		<i>Picoides scalaris</i>	ladder-backed woodpecker	48	11		1	X	X								
<b>Passeriformes</b>	Vireonidae	<i>Colaptes auratus</i>	northern flicker	20				X	X								
		<i>Vireo bellii</i>	Bell's vireo	14			5	X	X		X						X
		<i>Contopus cooperi</i>	olive-sided flycatcher					X				SC					
		<i>Contopus pertinax</i>	greater pewee	1				X									
		<i>Contopus sordidulus</i>	western wood-pewee	7				X	X								
<b>Passeriformes</b>	Tyrannidae	<i>Empidonax traillii</i>	willow flycatcher						X								
		<i>Empidonax hammondi</i>	Hammond's flycatcher	1			3	X	X								
		<i>Empidonax wrightii</i>	gray flycatcher	2			2	X	X								
		<i>Empidonax oberholseri</i>	dusky flycatcher						X								
		<i>Empidonax occidentalis</i> or <i>difficilis</i>	western flycatcher					X									
		<i>Sayornis nigricans</i>	black phoebe					X	X								
		<i>Sayornis saya</i>	Say's phoebe	1			4	X	X		X						
		<i>Myiarchus tuberculifer</i>	dusky-capped flycatcher	1					X	X							
		<i>Myiarchus cinerascens</i>	ash-throated flycatcher	101					X	X		X					
		<i>Myiarchus tyrannulus</i>	brown-crested flycatcher	3			5	X	X								
<b>Passeriformes</b>	Tyrannidae	<i>Tyrannus vociferans</i>	Cassin's kingbird	75			5	X	X								
		<i>Tyrannus verticalis</i>	western kingbird	14			1	X	X								
		<i>Lanius ludovicianus</i>	loggerhead shrike	1				X	X		X		SC		X		
		<i>Vireo vicinior</i>	gray vireo					X	X								
		<i>Vireo plumbeus</i>	plumbeous vireo	2			2	X									
<b>Corvidae</b>	Corvidae	<i>Vireo huttoni</i>	Hutton's vireo	3			1	X									
		<i>Vireo gilvus</i>	warbling vireo	3			4	X	X								
		<i>Cyanocitta stelleri</i>	Steller's jay		2			X									
		<i>Aphelocoma californica</i>	western scrub-jay	48	33		1	X	X		X						
		<i>Aphelocoma ultramarina</i>	Mexican jay	1				X	X		X						
		<i>Gymnorhinus cyanocephalus</i>	pinyon jay				X	X									

Order	Family	Scientific name	Common name	UA survey method				Observed or documented				Conservation designation					
				VCP	Line transect	Nocturnal	Incidental	R&J	FI	AE	ESA <sup>a</sup>	USFS <sup>b</sup>	AZ <sup>c</sup>	AZ PIF <sup>d</sup>	U.S. FWS <sup>e</sup>		
Passeriformes	Corvidae	<i>Nucifraga columbiana</i>	Clark's nutcracker					X									
		<i>Corvus cryptoleucus</i>	Chihuahuan raven					X	X	X							
		<i>Corvus corax</i>	common raven					X	X								
Alaudidae	Corvus sp.	unknown raven	unknown raven	11	2		1										
		<i>Eremophila alpestris</i>	horned lark						X	X							
Hirundinidae	<i>Tachycineta thalassina</i>	violet-green swallow	violet-green swallow	5				X									
		<i>Stelgidopteryx serripennis</i>	northern rough-winged swallow					X	X								
Paridae	<i>Petrochelidon pyrrhonota</i>	cliff swallow	cliff swallow					X	X								
		<i>Hirundo rustica</i>	barn swallow				2	X									
		<i>Baeolophus wollweberi</i>	bridled titmouse	1	11			X	X								
Remizidae	<i>Baeolophus ridgwayi</i>	juniper titmouse	juniper titmouse	3	2		1	X	X								
		<i>Auriparus flaviceps</i>	verdin	40	10		1	X	X								
Aegithalidae	<i>Psaltriparus minimus</i>	bush-tit	bush-tit	11	28			X	X	X							
		<i>Sitta carolinensis</i>	white-breasted nuthatch					X	X								
Certhiidae	<i>Certhia americana</i>	brown creeper	brown creeper		1			X									
		<i>Campylorhynchus brunneicapillus</i>	cactus wren	120	18		4	X	X	X							
Troglodytidae	<i>Salpinctes obsoletus</i>	rock wren	rock wren	9	3		1	X	X								
		<i>Catherpes mexicanus</i>	canyon wren	7			2	X	X								
Troglodytidae	<i>Thryomanes bewickii</i>	Bewick's wren	Bewick's wren	118	11		2	X	X								
		<i>Troglodytes aedon</i>	house wren	2				X									
Regulidae	<i>Regulus calendula</i>	ruby-crowned kinglet	ruby-crowned kinglet	15	32		1	X	X								
		<i>Poliopitula caerulea</i>	blue-gray gnatcatcher	4			1	X	X								
Turdidae	<i>Poliopitula melanura</i>	black-tailed gnatcatcher	black-tailed gnatcatcher	1			1	X	X	X							
		<i>Sialia mexicana</i>	western bluebird		27		1	X	X								
Turdidae	<i>Sialia currucoides</i>	mountain bluebird	mountain bluebird					X	X								
		<i>Myadestes townsendi</i>	Townsend's solitaire		4		1	X	X								
Mimidae	<i>Catharus ustulatus</i>	Swainson's thrush	Swainson's thrush					X									
		<i>Catharus guttatus</i>	hermit thrush		1		4	X	X								
Mimidae	<i>Turdus migratorius</i>	American robin	American robin	1	39		1	X									
		<i>Mimus polyglottos</i>	northern mockingbird	116	10		2	X	X								
Mimidae	<i>Oreoscoptes montanus</i>	sage thrasher	sage thrasher					X	X								



Order	Family	Scientific name	Common name	UA survey method				Observed or documented				Conservation designation						
				VCP	Line transect	Noc-turnal	Incid-ental	R&J	FI	AE	ESA <sup>a</sup>	USFS <sup>b</sup>	AZ <sup>c</sup>	AZ PIF <sup>d</sup>	U.S. FWS <sup>e</sup>			
Passeriformes	Mimidae	<i>Toxostoma bendirei</i>	Bendire's thrasher				1	X	X	X								
		<i>Toxostoma curvirostre</i>	curve-billed thrasher	9	2		1	X	X	X								
		<i>Toxostoma crissale</i>	crissal thrasher	33	16	1	4	X	X	X								X
	Sturnidae	<i>Sturnus vulgaris</i>	European starling					X										
	Motacillidae	<i>Anthus rubescens</i>	American pipit						X									
	Bombycillidae	<i>Bombycilla cedrorum</i>	cedar waxwing		12			X	X									
	Ptilonotidae	<i>Phainopepla nitens</i>	phainopepla	17	16		2	X	X									
	Parulidae	<i>Vermivora celata</i>	orange-crowned warbler				3	X	X									
		<i>Vermivora ruficapilla</i>	Nashville warbler					X	X									
		<i>Vermivora virginiae</i>	Virginia's warbler					X										
		<i>Vermivora luciae</i>	Lucy's warbler	17			1	X	X								X	
		<i>Dendroica petechia</i>	yellow warbler						X									
		<i>Dendroica coronata</i>	yellow-rumped warbler	4	3			X	X									
		<i>Dendroica nigrescens</i>	black-throated gray warbler	4	1			X	X									
		<i>Dendroica townsendi</i>	Townsend's warbler	1				X	X									
		<i>Dendroica occidentalis</i>	hermit warbler						X									
		<i>Seiurus noveboracensis</i>	northern waterthrush					X										
		<i>Oporornis tolmiei</i>	MacGillivray's warbler					X	X									
		<i>Geothlypis trichas</i>	common yellowthroat					X										
		<i>Wilsonia pusilla</i>	Wilson's warbler	8			5	X	X									
Parulidae		<i>Icteria virens</i>	yellow-breasted chat					X										
Thraupidae		<i>Piranga rubra</i>	summer tanager	34			2	X	X									
		<i>Piranga ludoviciana</i>	western tanager	7			3	X	X									
Emberizidae		<i>Pipilo chlorurus</i>	green-tailed towhee	9	34		1	X	X									
		<i>Pipilo maculatus</i>	spotted towhee	7	52			X										
		<i>Pipilo fuscus</i>	canyon towhee	86	40		7	X	X	X								
		<i>Aimophila cassinii</i>	Cassin's sparrow						X									
		<i>Aimophila texana or botterii</i>	Botteri's sparrow	1				X										
		<i>Aimophila ruficeps</i>	rufous-crowned sparrow	49	1			X	X									
		<i>Spizella passerina</i>	chipping sparrow	3	83			X	X									
		<i>Spizella breweri</i>	Brewer's sparrow	2	51		3	X	X									

Order	Family	Scientific name	Common name	UA survey method				Observed or documented				Conservation designation						
				VCP	Line transect	Noc-turnal	Incid-ental	R&J	FI	AE	ESA <sup>a</sup>	USFS <sup>b</sup>	AZ <sup>c</sup>	AZ PIF <sup>d</sup>	U.S. FWS <sup>e</sup>			
Passeriformes	Emberizidae	<i>Spizella atrogularis</i>	black-chinned sparrow	2	5		1	X	X									
		<i>Passerculus sandwichensis</i>	savannah sparrow					X	X									
		<i>Poocetes gramineus</i>	vesper sparrow		33		2	X	X									
		<i>Melospiza lincolni</i>	Lincoln's sparrow		6		1	X	X									
		<i>Chondestes grammacus</i>	lark sparrow					X	X									
		<i>Amphispiza bilineata</i>	black-throated sparrow	115	12	1	6	X	X	X								
		<i>Calamospiza melanocorys</i>	lark bunting					X	X									
		<i>Ammodramus savannarum</i>	grasshopper sparrow				3		X									
		<i>Ammodramus bairdii</i>	Baird's sparrow				1				X					X		
		<i>Passerella iliaca</i>	fox sparrow					X	X									
	<i>Melospiza melodia</i>	song sparrow					X	X										
	<i>Zonotrichia albicollis</i>	white-throated sparrow					X											
	<i>Zonotrichia leucophrys</i>	white-crowned sparrow		134		2	X	X	X									
	<i>Junco hyemalis</i>	dark-eyed junco	X	X			X	X										
	<i>Junco hyemalis mearnsi</i>	pink-sided junco <sup>f</sup>	1	2														
	<i>Junco hyemalis dorsalis</i>	gray-headed junco <sup>f</sup>		2			X											
	<i>Junco hyemalis oregonus</i>	Oregon junco <sup>f</sup>		4														
	<i>Junco phaeonotus</i>	yellow-eyed junco					X											
Cardinalidae	<i>Cardinalis cardinalis</i>	northern cardinal	124	13	1	4	X	X	X									
	<i>Cardinalis sinuatus</i>	pyrrhuloxia	1	1			X	X										
	<i>Pheucticus ludovicianus</i>	rose-breasted grosbeak					X	X										
	<i>Pheucticus melanocephalus</i>	black-headed grosbeak	12			1	X		X						X			
	<i>Passerina caerulea</i>	blue grosbeak	6			1	X	X										
	<i>Passerina amoena</i>	lazuli bunting	1				X	X										
	<i>Passerina ciris</i>	painted bunting					X	X										
Icteridae	<i>Sturnella magna lillianae</i>	eastern meadowlark				1	X	X										
	<i>Sturnella neglecta</i>	western meadowlark					X	X										
	<i>Euphagus cyanocephalus</i>	Brewer's blackbird						X										
	<i>Quiscalus mexicanus</i>	great-tailed grackle						X										
	<i>Molothrus aeneus</i>	bronzed cowbird	1			1	X	X										
	<i>Molothrus ater</i>	brown-headed cowbird	56			2	X	X										

Order	Family	Scientific name	Common name	UA survey method				Observed or documented				Conservation designation					
				VCP	Line transect	Nocturnal	Incidental	R&J	FI	AE	ESA <sup>a</sup>	USFS <sup>b</sup>	AZ <sup>c</sup>	AZ PIF <sup>d</sup>	U.S. FWS <sup>e</sup>		
Passeriformes	Icteridae	<i>Icterus cucullatus</i>	hooded oriole	44			5	X	X	X							
		<i>Icterus bullockii</i>	Bullock's oriole	26			2	X									
		<i>Icterus parisorum</i>	Scott's oriole	26					X	X							
Fringillidae	Carpodacus mexicanus	house finch	54	4		2	X	X									
		pine siskin		1			X	X									
		lesser goldfinch	3	6		1	X	X									
		<i>Coccothraustes vespertinus</i>	evening grosbeak														
	Passeridae	<i>Passer domesticus</i>	house sparrow														

<sup>a</sup> "SC" = "Species of Concern"; "C" = Candidate for listing under the Endangered Species Act, U.S. Fish and Wildlife Service. (in HDMS 2004)

<sup>b</sup> "Sensitive Species"; U.S.D.A. Forest Service (HDMS 2004).

<sup>c</sup> "Wildlife of Special Concern"; Arizona Game and Fish Department (HDMS 2004).

<sup>d</sup> "Priority species"; Arizona Partners in Flight (Latta et al. 1999).

<sup>e</sup> "Species of Conservation Concern"; U.S. Fish and Wildlife Service (HDMS 2004).

<sup>f</sup> We include observations of these subspecies in the appendix because field crew members occasionally made the distinction.

**Appendix D. Mammals recorded at Fort Bowie NHS by University of Arizona inventory personnel (UA) and/or documented/observed by other researchers: Roth (1976; ROH), Petryszyn (1999; PZN), Herman-Reese (unpublished data; HR), Swann et al. (2001; SEA), Krebs (2005; KRB), or specimens located in the UA mammal collection (UAMC). Species in bold-faced type is non-native.**

Order	Family	Scientific name	Common name	UA	UAMC	ROH	PZN	HR	SEA	KRB
<b>Insectivora</b>										
	Soricidae	<i>Notiosorex crawfordi</i>	Crawford's desert shrew			X				
<b>Chiroptera</b>										
	Phyllostomidae	<i>Choeronycteris mexicana</i>	Mexican long-tongued bat		X	X				
		<i>Leptonycteris curasoae yerbabuena</i>	lesser long-nosed bat		X	X				
	Vespertilionidae	<i>Myotis occultus</i>	Arizona myotis							X
		<i>Myotis auricolus</i>	southwestern myotis							X
		<i>Myotis velifer</i>	cave myotis		X	X				X
		<i>Myotis thysanodes</i>	fringed myotis		X	X				X
		<i>Myotis californicus</i>	California myotis							X
		<i>Myotis volans</i>	long-legged myotis							X
		<i>Myotis ciliolabrum</i>	western small-footed myotis							X
		<i>Pipistrellus hesperus</i>	western pipistrelle		X	X				
		<i>Eptesicus fuscus</i>	big brown bat		X					
		<i>Antrozous pallidus</i>	pallid bat		X	X				
<b>Carnivora</b>										
	Ursidae	<i>Ursus americanus</i>	American black bear	X				X		
	Procyonidae	<i>Procyon lotor</i>	northern raccoon			X				
		<i>Nasua narica</i>	white-nosed coati	X		X		X		
		<i>Bassariscus astutus</i>	ringtail			X		X		
	Mustelidae	<i>Taxidea taxus</i>	American badger			X			X	
		<i>Mephitis macroura</i>	hooded skunk	X						
		<i>Spilogale gracilis</i>	western spotted skunk			X				
		<i>Mephitis mephitis</i>	striped skunk	X		X		X		
		<i>Conepatus mesoleucus</i>	white-backed hog-nosed skunk	X		X				
	Canidae	<b><i>Canis familiaris</i></b>	<b>feral dog</b>	X						
		<i>Canis latrans</i>	coyote	X		X		X	X	
		<i>Urocyon cinereoargenteus</i>	common gray fox	X		X		X	X	
	Felidae	<i>Lynx rufus</i>	bobcat	X		X		X	X	
		<i>Puma concolor</i>	mountain lion	X				X	X	
<b>Rodentia</b>										
	Sciuridae	<i>Spermophilus variegatus</i>	rock squirrel	X		X		X	X	
		<i>Spermophilus tereticaudus</i>	round-tailed ground squirrel		X					
		<i>Ammospermophilus harrisi</i>	Harris' antelope squirrel		X	X			X	
		<i>Neotamias dorsalis</i>	cliff chipmunk		X	X			X	
	Geomyidae	<i>Thomomys bottae</i>	Botta's pocket gopher		X	X				
	Heteromyidae	<i>Perognathus flavus flavus</i>	silky pocket mouse		X	X		X		
		<i>Perognathus amplus</i>	Arizona pocket mouse					X		
		<i>Chaetodipus penicillatus</i>	Sonoran Desert pocket mouse		X	X	X	X		
		<i>Chaetodipus intermedius</i>	rock pocket mouse		X	X		X		
		<i>Chaetodipus baileyi</i>	Bailey's pocket mouse		X	X		X		
		<i>Chaetodipus hispidus</i>	hispid pocket mouse		X	X		X		
		<i>Dipodomys spectabilis</i>	banner-tailed kangaroo rat		X	X				
		<i>Dipodomys ordii</i>	Ord's kangaroo rat		X	X		X		
		<i>Dipodomys merriami</i>	Merriam's kangaroo rat			X	X	X		

Order	Family	Scientific name	Common name	UA	UAMC	ROH	PZN	HR	SEA	KRB
<b>Rodentia</b>										
	Heteromyidae	<i>Reithrodontomys megalotis megalotis</i>	western harvest mouse					X		
		<i>Reithrodontomys fulvescens</i>	fulvous harvest mouse		X	X				
		<i>Peromyscus eremicus</i>	cactus mouse		X	X		X		
	Muridae	<i>Peromyscus maniculatus</i>	deer mouse		X	X		X		
		<i>Peromyscus leucopus</i>	white-footed mouse		X					
		<i>Peromyscus boylii</i>	brush mouse		X	X		X		
		<i>Baiomys taylori</i>	northern pygmy mouse					X		
		<i>Onychomys leucogaster</i>	northern grasshopper mouse		X	X		X		
		<i>Onychomys torridus</i>	southern grasshopper mouse		X	X	X	X		
		<i>Neotoma albigula</i>	western white-throated woodrat		X	X	X	X	X	
		<i>Sigmodon hispidus</i>	hispid cotton rat		X	X		X		
	Erethizontidae	<i>Erethizon dorsatum</i>	North American porcupine							X
<b>Lagomorpha</b>										
	Leporidae	<i>Lepus alleni</i>	antelope jackrabbit		X	X				
		<i>Lepus californicus</i>	black-tailed jackrabbit	X	X	X				X
		<i>Sylvilagus audubonii</i>	desert cottontail			X				X
<b>Artiodactyla</b>										
	Tayassuidae	<i>Pecari tajacu</i>	collared peccary	X		X		X	X	
	Cervidae	<i>Odocoileus hemionus</i>	mule deer	X		X		X	X	
		<i>Odocoileus virginianus</i>	white-tailed deer			X			X	

**Appendix E. List of voucher specimens collected from Fort Bowie NHS.** See Table 1.1 for list of collections that were queried for specimens.

Group	Common name	Field collection numbers	Collection <sup>a</sup>	Date	Primary Collector	
<b>Reptile</b>	eastern collared lizard	12578, 12579	CAS	08/02/1950	H. K. Gloyd	
		022207	USNM	05/22/1894	A. K. Fisher	
		12578-16024, 12579-16025	CAS	08/02/1950	H. K. Gloyd	
	Clark's spiny lizard	12586, 12587, 125867-160323	CAS	08/02/1950	H. K. Gloyd	
	ornate tree lizard	12636-16082	CAS	08/02/1950	H. K. Gloyd	
	Chihuahuan spotted whiptail	40890	UCO	07/22/1970	R. L. Holland	
	western diamond-backed rattlesnake	022194	USNM	UNKN	A. K. Fisher	
<b>Bird</b>	Swainson's hawk	3366, 3367, 3368	UCB	05/25/1894	F. H. Fowler	
		68829	UCB	05/18/1936	A. H. Miller	
	red-tailed hawk	3359, 3360, 3361, 3362	UCB	04/17/1893	F. H. Fowler	
	greater roadrunner	3388, 3389, 3390, 3391	UCB	04/10/1893	F. H. Fowler	
	Say's phoebe	3425, 3426	UCB	04/11/1893	F. H. Fowler	
	ash-throated flycatcher	78819	UCB	05/22/1894	F. H. Fowler	
	loggerhead shrike	3500, 3501, 3502, 3503, 3504, 3505, 3506	UCB	04/01/1893	F. H. Fowler	
	western scrub-jay	3441, 3442, 3443, 3444	UCB	04/05/1893	F. H. Fowler	
	Chihuahuan raven	3457, 3458, 3459	UCB	05/11/1893	F. H. Fowler	
	horned lark	3435, 3436, 3437, 3438, 3439, 3440	UCB	04/22/1893	F. H. Fowler	
	bush-tit	3461	UCB	05/03/1894	F. H. Fowler	
	cactus wren	3463, 3464, 3465, 3466, 3467, 3468, 3469, 3471, 3472, 3473, 3474, 3475	UCB	04/01/1893	F. H. Fowler	
	black-tailed gnatcatcher	78882	UCB	04/13/1894	F. H. Fowler	
	Bendire's thrasher	3489	UCB	04/15/1894	F. H. Fowler	
	curve-billed thrasher	12573, 12573	UA	UNKN	UNKN	
	crissal thrasher	3483, 3484, 3486	UCB	04/05/1893	F. H. Fowler	
	canyon towhee	3534, 3535, 3536	UCB	04/13/1893	F. H. Fowler	
	black-throated sparrow	3544, 3545	UCB	04/21/1893	F. H. Fowler	
	white-crowned sparrow	78975	UCB	05/15/1894	F. H. Fowler	
	black-headed grosbeak	78931	UCB	05/15/1894	F. H. Fowler	
	hooded oriole	3519	UCB	05/28/1894	F. H. Fowler	
	<b>Mammal</b>	Sandborn's long-nosed bat	23523	UA	09/22/1976	E. L. Roth
		Mexican long-tongued bat	23506	UA	09/22/1976	E. L. Roth
		cave myotis	23503, 23504	UA	08/08/1976	E. L. Roth
			23621, 23622, 23623	UA	08/08/1976	T. & P. Vaughan
		fringed myotis	23522	UA	09/22/1976	E. L. Roth
		western pipistrelle	23502	UA	08/08/1976	E. L. Roth
big brown bat		23505	UA	09/22/1976	E. L. Roth	
pallid bat		23501	UA	08/08/1976	E. L. Roth	
round-tailed ground squirrel		23461, 23462	UA	09/23/1976	E. L. Roth	
Harris' antelope squirrel		23241, 23493, 23498	UA	10/18/1975	E. L. Roth	
cliff chipmunk		23475, 23485, 23520, 23643	UA	10/18/1975	E. L. Roth	
Botta's pocket gopher		23472, 23478, 23473	UA	09/24/1976	E. L. Roth	
Sonoran Desert pocket mouse		23242, 23243, 23244, 23245, 23246, 23247, 23248, 23481, 23482, 23484, 23490, 23508, 23514, 23518, 23524, 23525	UA	10/18/1975	E. L. Roth	
		rock pocket mouse	23249, 23480, 23495, 23497, 24065	UA	10/18/1975	E. L. Roth
			23641	UA	11/01/1975	P. L. Dods
			23732	UA	08/29/1976	G. S. Mills
		24041	UA	08/07/1976	T. P. Vaughan	
Bailey's pocket mouse		23463, 23499, 23513, 23730	UA	09/23/1976	E. L. Roth	
hispid pocket mouse		23466, 23469, 23470	UA	09/24/1976	E. L. Roth	

Group	Common name	Field collection numbers	Collection <sup>a</sup>	Date	Primary Collector
Mammal	banner-tailed kangaroo rat	23456, 23457	UA	09/23/1976	E. L. Roth
	Ord's kangaroo rat	23458, 23459	UA	09/23/1976	E. L. Roth
	Merriam's kangaroo rat	23228—23240, 23460, 23474, 23483, 23489, 23507, 23512, 23731	UA	10/18/1975	E. L. Roth
	fulvous harvest mouse	23467	UA	09/24/1976	E. L. Roth
	cactus mouse	23258—23266, 23476, 23477, 23491, 23496, 23500, 23509, 23515, 24064	UA	10/18/1975	E. L. Roth
	deer mouse	23521, 23527	UA	10/31/1975	E. L. Roth
	white-footed mouse	23486, 23526	UA	11/02/1975	E. L. Roth
	brush mouse	23267, 23479, 23511, 23517, 23642, 23743, 23744	UA	10/18/1975	E. L. Roth
	northern grasshopper mouse	23464	UA	09/23/1976	E. L. Roth
	southern grasshopper mouse	23250—23257, 23468, 23488, 23510	UA	10/31/1975	E. L. Roth
	western white-throated woodrat	23487, 23492, 23494, 23516, 23519, 23639, 23640, 23644, 24042, 24043, 24043	UA	11/02/1975	E. L. Roth
	hispid cotton rat	23471	UA	09/24/1976	E. L. Roth
	antelope jackrabbit	23465	UA	09/23/1976	E. L. Roth
	black-tailed jackrabbit	23439	UA	10/19/1975	E. L. Roth

<sup>a</sup> CAS = Chicago Academy of Sciences; USNM = U.S. National Museum; UCO = University of Colorado;  
UCB = University of California, Berkeley; UA = University of Arizona

**Appendix F. Summary of vegetation characteristics measured at bird survey stations, Fort Bowie NHS, 2004.** See Appendix A for list of common names of plants.

Transect				
Station	Category	Species	Mean density	
<b>Butterfield 1</b>	Subshrub	<i>Gutierrezia sarothrae</i>	33.69	
		<i>Haplopappus laricifolius</i>	67.39	
		<i>Isocoma tenuisecta</i>	89.85	
		<i>Prosopis velutina</i>	11.23	
		<i>Sideroxylon lanuginosum</i>	22.46	
	Shrub	<i>Rhus microphylla</i>	5.19	
		<i>Haplopappus laricifolius</i>	5.19	
		<i>Opuntia spinosior</i>	5.19	
		<i>Prosopis velutina</i>	23.36	
		<i>Dasyllirion wheeleri</i>	2.60	
		<i>Nolina microcarpa</i>	2.60	
		<i>Sideroxylon lanuginosum</i>	7.79	
		<i>Rhus microphylla</i>	2.69	
	Tree	<i>Juniperus monosperma</i>	0.67	
		<i>Juniperus osteosperma</i>	0.67	
		<i>Prosopis velutina</i>	8.75	
		<i>Celtis reticulata</i>	0.67	
		<i>Juglans major</i>	2.38	
	Cavity	<i>Celtis reticulata</i>	0.79	
	2	Subshrub	<i>Yucca baccata</i>	121.36
			<i>Gutierrezia sarothrae</i>	40.45
			<i>Haplopappus laricifolius</i>	121.36
<i>Isocoma tenuisecta</i>			161.82	
<i>Opuntia spinosior</i>			80.91	
<i>Arctostaphylos pungens</i>			121.36	
<i>Mimosa biuncifera</i>			80.91	
<i>Nolina microcarpa</i>			40.45	
Shrub			<i>Yucca baccata</i>	22.40
			<i>Haplopappus laricifolius</i>	22.40
		<i>Juniperus monosperma</i>	22.40	
		<i>Arctostaphylos pungens</i>	89.60	
		<i>Mimosa biuncifera</i>	22.40	
Tree		<i>Prosopis velutina</i>	201.60	
		<i>Quercus emoryi</i>	44.80	
		<i>Dasyllirion wheeleri</i>	22.40	
		<i>Juniperus deppeana</i>	3.46	
		<i>Juniperus osteosperma</i>	6.93	
		<i>Prosopis velutina</i>	20.78	
		<i>Quercus emoryi</i>	24.24	
		<i>Pinus edulis</i>	6.93	
		<i>Celtis reticulata</i>	6.93	
		Cavity	<i>Juniperus deppeana</i>	1.96
	<i>Quercus emoryi</i>		4.58	
	<i>Pinus edulis</i>		3.27	
	3	Subshrub	<i>Agave palmeri</i>	39.66
<i>Yucca baccata</i>			39.66	
<i>Haplopappus laricifolius</i>			79.32	
<i>Isocoma tenuisecta</i>			19.83	
<i>Opuntia engelmannii</i>			19.83	

Transect				
Station	Category	Species	Mean density	
3	Subshrub	<i>Opuntia spinosior</i>	19.83	
		<i>Arctostaphylos pungens</i>	118.98	
		<i>Dasyllirion wheeleri</i>	19.83	
	Shrub	<i>Nolina microcarpa</i>	39.66	
		<i>Arctostaphylos pungens</i>	153.35	
		<i>Mimosa biuncifera</i>	19.17	
		<i>Prosopis velutina</i>	57.51	
		<i>Quercus arizonica</i>	19.17	
		<i>Quercus emoryi</i>	57.51	
		<i>Quercus sp.</i>	19.17	
		<i>Nolina microcarpa</i>	57.51	
	Tree	<i>Juniperus osteosperma</i>	1.85	
		<i>Arctostaphylos pungens</i>	1.85	
		<i>Prosopis velutina</i>	1.85	
		<i>Quercus arizonica</i>	1.85	
		<i>Quercus emoryi</i>	27.67	
	Cavity	<i>Pinus edulis</i>	1.85	
		<i>Juniperus osteosperma</i>	2.01	
		<i>Quercus arizonica</i>	2.01	
		<i>Quercus emoryi</i>	24.13	
	4	Subshrub	<i>Quercus sp.</i>	2.01
			<i>Agave palmeri</i>	31.66
			<i>Yucca baccata</i>	63.33
<i>Haplopappus laricifolius</i>			348.31	
<i>Arctostaphylos pungens</i>			63.33	
<i>Prosopis velutina</i>			94.99	
Shrub		<i>Dasyllirion wheeleri</i>	31.66	
		<i>Yucca baccata</i>	9.91	
		<i>Arctostaphylos pungens</i>	39.63	
		<i>Prosopis velutina</i>	59.44	
		<i>Quercus emoryi</i>	19.81	
Tree		<i>Dasyllirion wheeleri</i>	9.91	
		<i>Nolina microcarpa</i>	59.44	
		<i>Juniperus monosperma</i>	4.05	
		<i>Prosopis velutina</i>	10.13	
Cavity	<i>Quercus emoryi</i>	26.34		
	<i>Quercus arizonica</i>	1.66		
	<i>Quercus emoryi</i>	19.90		
5	Subshrub	<i>Gutierrezia sarothrae</i>	88.61	
		<i>Haplopappus laricifolius</i>	443.07	
		<i>Arctostaphylos pungens</i>	88.61	
		<i>Dasyllirion wheeleri</i>	132.92	
		<i>Nolina microcarpa</i>	132.92	
	Shrub	<i>Yucca baccata</i>	16.80	
		<i>Juniperus deppeana</i>	16.80	
		<i>Juniperus monosperma</i>	16.80	
		<i>Arctostaphylos pungens</i>	100.80	
		<i>Prosopis velutina</i>	16.80	
		<i>Quercus arizonica</i>	16.80	
	<i>Quercus emoryi</i>	16.80		



Transect				
Station	Category	Species	Mean density	
5	Shrub	<i>Dasyllirion wheeleri</i>	117.60	
		<i>Nolina microcarpa</i>	16.80	
	Tree	<i>Juniperus monosperma</i>	4.92	
		<i>Quercus arizonica</i>	4.92	
		<i>Quercus emoryi</i>	7.87	
		<i>Garrya flavescens</i>	1.97	
	Cavity	<i>Juniperus monosperma</i>	0.63	
		<i>Quercus arizonica</i>	1.90	
		<i>Quercus emoryi</i>	6.96	
		<i>Quercus sp.</i>	1.90	
6	Subshrub	<i>Yucca baccata</i>	2.85	
		<i>Haplopappus laricifolius</i>	14.23	
		<i>Opuntia spinosior</i>	1.42	
		<i>Arctostaphylos pungens</i>	1.42	
		<i>Mimosa biuncifera</i>	1.42	
	Shrub	<i>Quercus emoryi</i>	4.27	
		<i>Nolina microcarpa</i>	2.85	
		<i>Agave palmeri</i>	14.56	
		<i>Arctostaphylos pungens</i>	58.22	
		<i>Mimosa biuncifera</i>	29.11	
		<i>Prosopis velutina</i>	72.78	
		<i>Quercus emoryi</i>	14.56	
		<i>Nolina microcarpa</i>	101.89	
	Tree	<i>Juniperus monosperma</i>	11.25	
		<i>Prosopis velutina</i>	3.75	
		<i>Quercus emoryi</i>	22.50	
	Cavity	<i>Quercus emoryi</i>	5.54	
		<i>Quercus sp.</i>	0.40	
	7	Subshrub	<i>Yucca baccata</i>	139.84
			<i>Baccharis sarothroides</i>	69.92
<i>Haplopappus laricifolius</i>			559.34	
<i>Opuntia spinosior</i>			139.84	
<i>Arctostaphylos pungens</i>			209.75	
<i>Mimosa biuncifera</i>			69.92	
<i>Nolina microcarpa</i>			209.75	
Shrub			<i>Yucca baccata</i>	14.99
		<i>Juniperus monosperma</i>	14.99	
		<i>Arctostaphylos pungens</i>	44.97	
		<i>Mimosa biuncifera</i>	14.99	
		<i>Prosopis velutina</i>	29.98	
		<i>Nolina microcarpa</i>	179.86	
Tree		<i>Juniperus monosperma</i>	6.49	
		<i>Prosopis velutina</i>	2.60	
		<i>Quercus emoryi</i>	16.87	
Cavity		<i>Juniperus monosperma</i>	0.61	
		<i>Quercus arizonica</i>	1.82	
		<i>Quercus emoryi</i>	6.06	
		<i>Quercus sp.</i>	0.61	
8	Subshrub	<i>Agave palmeri</i>	123.43	
		<i>Haplopappus laricifolius</i>	617.13	
		<i>Mimosa biuncifera</i>	431.99	
		<i>Dasyllirion wheeleri</i>	61.71	
	Shrub	<i>Agave palmeri</i>	1.46	
		<i>Juniperus monosperma</i>	2.91	

Transect				
Station	Category	Species	Mean density	
8	Shrub	<i>Mimosa biuncifera</i>	10.19	
		<i>Prosopis velutina</i>	4.37	
		<i>Dasyllirion wheeleri</i>	2.91	
	Tree	<i>Nolina microcarpa</i>	7.28	
		<i>Juniperus monosperma</i>	6.00	
		<i>Prosopis velutina</i>	1.50	
		<i>Quercus arizonica</i>	2.25	
		<i>Quercus emoryi</i>	4.50	
		<i>Garrya flavescens</i>	0.75	
		<i>Juniperus deppeana</i>	0.24	
Cavity	<i>Quercus arizonica</i>	0.94		
	<i>Quercus emoryi</i>	2.83		
<b>Siphon Canyon</b>				
1	Subshrub	<i>Agave palmeri</i>	172.80	
		<i>Yucca baccata</i>	691.19	
		<i>Chrysothamnus nauseosus</i>	172.80	
		<i>Gutierrezia sarothrae</i>	345.59	
		<i>Haplopappus laricifolius</i>	518.39	
		<i>Parthenium incanum</i>	518.39	
		<i>Juniperus osteosperma</i>	172.80	
		<i>Mimosa biuncifera</i>	172.80	
		<i>Garrya flavescens</i>	172.80	
		<i>Nolina microcarpa</i>	172.80	
		<i>Sideroxylon lanuginosum</i>	345.59	
		Shrub	<i>Rhus microphylla</i>	170.36
			<i>Haplopappus laricifolius</i>	56.79
	<i>Juniperus osteosperma</i>		56.79	
	<i>Mimosa biuncifera</i>		113.58	
	<i>Prosopis velutina</i>		56.79	
	<i>Quercus arizonica</i>		113.58	
	<i>Quercus turbinella</i>		170.36	
	Tree	<i>Garrya flavescens</i>	113.58	
		<i>Sapindus saponaria</i>	56.79	
<i>Sideroxylon lanuginosum</i>		170.36		
<i>Celtis reticulata</i>		56.79		
<i>Juniperus monosperma</i>		8.13		
<i>Juniperus osteosperma</i>		8.13		
<i>Prosopis velutina</i>		8.13		
<i>Quercus arizonica</i>		4.07		
<i>Quercus turbinella</i>		8.13		
<i>Fouquieria splendens</i>		8.13		
Cavity	<i>Garrya flavescens</i>	12.20		
	<i>Sapindus saponaria</i>	4.07		
	<i>Sideroxylon lanuginosum</i>	12.20		
	<i>Celtis reticulata</i>	8.13		
	<i>Juniperus monosperma</i>	2.15		
	<i>Juniperus osteosperma</i>	4.31		
	<i>Quercus arizonica</i>	8.62		
	<i>Quercus sp.</i>	2.15		
	<i>Juglans major</i>	2.15		
	<i>Fraxinus velutina</i>	10.77		
2	Subshrub	<i>Celtis reticulata</i>	2.15	
		<i>Unknown species</i>	81.73	
		<i>Gutierrezia sarothrae</i>	81.73	

Transect				
Station	Category	Species	Mean density	
2	Subshrub	<i>Haplopappus laricifolius</i>	163.46	
		<i>Isocoma tenuisecta</i>	245.19	
		<i>Opuntia engelmannii</i>	81.73	
		<i>Opuntia spinosior</i>	163.46	
		<i>Prosopis velutina</i>	81.73	
		<i>Sideroxylon lanuginosum</i>	572.10	
		<i>Celtis reticulata</i>	163.46	
	Shrub	<i>Rhus microphylla</i>	237.17	
		<i>Baccharis sarothroides</i>	79.06	
		<i>Opuntia engelmannii</i>	158.12	
		<i>Prosopis velutina</i>	474.34	
		<i>Sideroxylon lanuginosum</i>	474.34	
		<i>Celtis reticulata</i>	158.12	
		Tree	<i>Rhus microphylla</i>	4.19
	<i>Juniperus monosperma</i>		8.39	
	<i>Prosopis velutina</i>		29.36	
	<i>Fouquieria splendens</i>		8.39	
	<i>Sideroxylon lanuginosum</i>		20.97	
	<i>Celtis reticulata</i>		12.58	
	Cavity		<i>Juniperus monosperma</i>	4.66
<i>Prosopis velutina</i>		1.55		
<i>Quercus arizonica</i>		2.33		
<i>Juglans major</i>		0.78		
<i>Celtis reticulata</i>		4.66		
3		Subshrub	<i>Rhus microphylla</i>	29.36
			<i>Brickellia sp.</i>	88.08
	<i>Gutierrezia sarothrae</i>		117.44	
	<i>Haplopappus laricifolius</i>		29.36	
	<i>Isocoma tenuisecta</i>		117.44	
	<i>Opuntia engelmannii</i>		58.72	
	<i>Opuntia spinosior</i>		58.72	
	<i>Datura meteloides</i>		58.72	
	<i>Celtis reticulata</i>		29.36	
	Shrub		<i>Unknown species</i>	6.01
		<i>Rhus microphylla</i>	6.01	
		<i>Haplopappus laricifolius</i>	18.02	
		<i>Chilopsis linearis</i>	24.02	
		<i>Opuntia spinosior</i>	12.01	
		<i>Prosopis velutina</i>	18.02	
		<i>Sideroxylon lanuginosum</i>	6.01	
	Tree	<i>Lycium pallidum</i>	6.01	
		<i>Celtis reticulata</i>	24.02	
		<i>Rhus microphylla</i>	16.68	
		<i>Chilopsis linearis</i>	16.68	
<i>Prosopis velutina</i>		20.02		
<i>Juglans major</i>		3.34		
<i>Celtis reticulata</i>		10.01		
Cavity	<i>Chilopsis linearis</i>	5.38		
	<i>Prosopis velutina</i>	2.69		
	<i>Quercus emoryi</i>	1.35		
	<i>Juglans major</i>	5.38		
3	Cavity	<i>Celtis reticulata</i>	4.04	
4	Subshrub	<i>Brickellia sp.</i>	41.67	
		<i>Gutierrezia sarothrae</i>	20.84	

Transect			
Station	Category	Species	Mean density
4	Subshrub	<i>Haplopappus laricifolius</i>	31.26
		<i>Opuntia spinosior</i>	20.84
		<i>Ephedra sp.</i>	10.42
		<i>Sideroxylon lanuginosum</i>	83.35
	Shrub	<i>Rhus microphylla</i>	105.49
		<i>Brickellia sp.</i>	70.32
		<i>Prosopis velutina</i>	35.16
		<i>Sideroxylon lanuginosum</i>	140.65
	Tree	<i>Rhus microphylla</i>	20.93
		<i>Prosopis velutina</i>	34.88
		<i>Juglans major</i>	6.98
		<i>Sideroxylon lanuginosum</i>	27.90
	Cavity	<i>Celtis reticulata</i>	48.83
		<i>Chilopsis linearis</i>	11.21
		<i>Prosopis velutina</i>	3.74
		<i>Juglans major</i>	3.74
		<i>Sideroxylon lanuginosum</i>	3.74
		<i>Celtis reticulata</i>	44.86
5	Subshrub	<i>Anisacanthus thurberi</i>	15.71
		<i>Rhus microphylla</i>	31.42
		<i>Brickellia sp.</i>	47.13
		<i>Chrysothamnus nauseosus</i>	15.71
		<i>Gutierrezia sarothrae</i>	15.71
		<i>Isocoma tenuisecta</i>	47.13
		<i>Parthenium incanum</i>	31.42
		<i>Prosopis velutina</i>	47.13
		<i>Garrya flavescens</i>	15.71
		<i>Sideroxylon lanuginosum</i>	31.42
	Shrub	<i>Lycium pallidum</i>	15.71
		<i>Rhus microphylla</i>	4.43
		<i>Brickellia sp.</i>	2.22
		<i>Chilopsis linearis</i>	2.22
		<i>Prosopis velutina</i>	13.30
		<i>Sideroxylon lanuginosum</i>	15.52
	Tree	<i>Celtis reticulata</i>	4.43
		<i>Larrea tridentata</i>	2.22
<i>Chilopsis linearis</i>		3.07	
<i>Juniperus monosperma</i>		1.54	
<i>Prosopis velutina</i>		10.75	
<i>Fouquieria splendens</i>		3.07	
Cavity	<i>Sideroxylon lanuginosum</i>	9.22	
	<i>Celtis reticulata</i>	3.07	
	<i>Chilopsis linearis</i>	3.08	
	<i>Prosopis velutina</i>	3.08	
	<i>Juglans major</i>	6.16	
	<i>Celtis reticulata</i>	10.78	
6	Subshrub	<i>Brickellia sp.</i>	34.33
		<i>Chrysothamnus nauseosus</i>	45.77
		<i>Parthenium incanum</i>	22.89
		<i>Opuntia engelmannii</i>	34.33
		<i>Opuntia spinosior</i>	22.89
	Tree	<i>Juglans major</i>	11.44
		<i>Sideroxylon lanuginosum</i>	45.77
		<i>Lycium pallidum</i>	11.44

Transect				
Station	Category	Species	Mean density	
6	Shrub	<i>Rhus microphylla</i>	15.12	
		<i>Chrysothamnus nauseosus</i>	90.72	
		<i>Chilopsis linearis</i>	30.24	
		<i>Atriplex canescens</i>	45.36	
		<i>Prosopis velutina</i>	15.12	
		<i>Nolina microcarpa</i>	15.12	
		<i>Sideroxylon lanuginosum</i>	75.60	
		<i>Lycium pallidum</i>	15.12	
		Tree	<i>Rhus microphylla</i>	9.33
			<i>Chilopsis linearis</i>	32.65
	<i>Juniperus monosperma</i>		4.67	
	<i>Prosopis velutina</i>		13.99	
	<i>Fouquieria splendens</i>		9.33	
	<i>Juglans major</i>		4.67	
	<i>Condalia warnockii</i>		4.67	
	<i>Celtis reticulata</i>		13.99	
	Cavity		<i>Chilopsis linearis</i>	1.39
			<i>Juniperus monosperma</i>	0.35
		<i>Juglans major</i>	1.39	
		<i>Pinus edulis</i>	0.35	
<i>Sideroxylon lanuginosum</i>		0.35		
<i>Celtis reticulata</i>		2.44		
7	Subshrub	<i>Rhus microphylla</i>	41.00	
		<i>Baccharis sarothroides</i>	20.50	
		<i>Brickellia sp.</i>	20.50	
		<i>Haplopappus laricifolius</i>	20.50	
		<i>Opuntia engelmannii</i>	20.50	
		<i>Juniperus osteosperma</i>	20.50	
		<i>Acacia greggii</i>	61.50	
		<i>Morus microphylla</i>	41.00	
		<i>Ziziphus obtusifolia</i>	20.50	
		<i>Ptelea trifoliata</i>	20.50	
		<i>Sideroxylon lanuginosum</i>	41.00	
		<i>Lycium pallidum</i>	20.50	
		<i>Celtis reticulata</i>	61.50	
		Shrub	<i>Rhus microphylla</i>	88.51
	<i>Baccharis sarothroides</i>		59.00	
	<i>Acacia greggii</i>		118.01	
	<i>Ziziphus obtusifolia</i>		88.51	
	<i>Sideroxylon lanuginosum</i>		118.01	
	<i>Celtis reticulata</i>		118.01	
	Tree	<i>Rhus microphylla</i>	15.73	
<i>Juniperus monosperma</i>		3.15		
<i>Fouquieria splendens</i>		3.15		
<i>Morus microphylla</i>		3.15		
<i>Sideroxylon lanuginosum</i>		3.15		
<i>Celtis reticulata</i>		25.17		
7	Tree	<i>Juniperus osteosperma</i>	0.60	
		<i>Juglans major</i>	2.97	
		<i>Fraxinus velutina</i>	1.19	
		<i>Populus fremontii</i>	1.19	
		<i>Celtis reticulata</i>	3.57	

Transect				
Station	Category	Species	Mean density	
8	Subshrub	<i>Brickellia sp.</i>	20.16	
		<i>Gutierrezia sarothrae</i>	20.16	
		<i>Haplopappus laricifolius</i>	120.96	
		<i>Opuntia engelmannii</i>	120.96	
		<i>Acacia greggii</i>	20.16	
		<i>Mimosa biuncifera</i>	20.16	
		<i>Prosopis velutina</i>	20.16	
		<i>Fouquieria splendens</i>	20.16	
		<i>Sideroxylon lanuginosum</i>	40.32	
		Shrub	<i>Unknown species</i>	12.77
			<i>Agave palmeri</i>	12.77
			<i>Brickellia sp.</i>	12.77
			<i>Opuntia engelmannii</i>	25.55
			<i>Acacia greggii</i>	51.09
	<i>Mimosa biuncifera</i>		25.55	
	<i>Prosopis velutina</i>		12.77	
	<i>Quercus arizonica</i>		12.77	
	<i>Fouquieria splendens</i>		12.77	
	<i>Nolina microcarpa</i>		12.77	
	Tree	<i>Sideroxylon lanuginosum</i>	63.86	
		<i>Acacia greggii</i>	3.17	
		<i>Prosopis velutina</i>	6.34	
		<i>Quercus arizonica</i>	6.34	
		<i>Quercus turbinella</i>	3.17	
		<i>Fouquieria splendens</i>	25.34	
		<i>Sideroxylon lanuginosum</i>	15.84	
		<i>Celtis reticulata</i>	3.17	
		Cavity	<i>Quercus arizonica</i>	5.27
			<i>Juglans major</i>	1.76
	<i>Fraxinus velutina</i>		8.79	
	<i>Celtis reticulata</i>		5.27	

### Appendix F, part 2

Transect	Litter		Bare Ground		Rock		
	Mean	SD	Mean	SD	Mean	SD	
Butterfield	30	18.4	68	18.2	1	3.1	
	50	29.0	51	30.1	4	5.0	
	36	23.5	55	22.4	11	15.0	
	35	15.7	61	16.5	7	9.2	
	29	22.0	43	18.7	27	14.9	
	29	12.1	64	18.5	6	9.4	
	52	23.3	47	22.7	3	4.7	
	22	16.4	76	16.0	6	7.6	
	Siphon Canyon	55	24.2	33	19.2	9	8.8
		52	27.5	41	24.6	7	12.3
59		27.4	38	20.9	4	7.5	
40		32.6	60	32.1	1	3.1	
60		34.3	37	31.2	5	11.0	
28		22.7	62	24.6	8	10.7	
	58	32.1	25	24.8	16	25.0	
	29	26.2	49	33.4	22	18.2	

**Appendix G. Most abundant bird species at each transect and season based on data published in Russell and Johnson (1976) and the UA inventory.** Relative abundance (RA) estimates from Russell and Johnson are number of individuals per transect kilometer whereas RA estimates for the UA effort are the mean number of individuals per transect station or section, including flyovers and birds seen > 75 m or > 100 m from stations or sections, respectively. See methods section for community descriptions. Species in bold-faced type are species that are not found on the corresponding list of the most common species by season. Relative abundance estimates are for showing abundance ranks and cannot be compared between studies because of different methods of data collection.

Community	Season	Study			
		Russell and Johnson		UA	
		Species	RA	Species	RA
Mesquite-grasslands	Breeding	Gambel's quail	4.3	mourning dove	1.9
		black-throated sparrow	2.7	black-throated sparrow	1.8
		canyon towhee	1.7	<b>turkey vulture</b>	1.7
		cactus wren	1.3	canyon towhee	1.3
		mourning dove	0.8	Gambel's quail	1.1
		<b>Mexican jay</b>	<b>0.6</b>	<b>white-winged dove</b>	1.1
		<b>violet-green swallow</b>	0.6	ash-throated flycatcher	1.1
		<b>verdin</b>	0.5	cactus wren	1.1
		<b>Wilson's warbler</b>	0.5	<b>Bewick's wren</b>	1.0
		<b>western tanager</b>	0.4	<b>northern mockingbird</b>	0.6
	ash-throated flycatcher.	0.4	<b>rufous-crowned sparrow</b>	0.6	
	Non-breeding	chipping sparrow	11.0	<b>bushtit</b>	1.2
		<b>Brewer's sparrow</b>	9.9	chipping sparrow	1.0
		<b>black-throated sparrow</b>	6.0	<b>western bluebird</b>	0.8
		white-crowned sparrow	3.7	white-crowned sparrow	0.7
		<b>Gambel's quail</b>	2.6	<b>bridled titmouse</b>	0.4
		canyon towhee	2.4	canyon towhee	0.4
		<b>dark-eyed junco</b>	2.4	<b>phainopepla</b>	0.3
		<b>cactus wren</b>	0.7	<b>western scrub-jay</b>	0.3
		<b>ladder-backed woodpecker</b>	0.7	<b>ruby-crowned kinglet</b>	0.3
Oak-juniper woodland		Breeding	Gambel's quail	5.1	mourning dove
	<b>Mexican jay</b>		1.7	<b>black-throated sparrow</b>	1.5
	<b>western scrub-jay</b>		1.5	Bewick's wren	1.2
	mourning dove		1.5	ash-throated flycatcher	0.8
	cactus wren		0.7	<b>canyon towhee</b>	0.7
	rufous-crowned sparrow.		0.7	Gambel's quail	0.7
	Bewick's wren		0.6	<b>brown-headed cowbird</b>	0.6
	<b>violet-green swallow</b>		0.6	<b>northern mockingbird</b>	0.6
	<b>northern cardinal</b>		0.5	rufous-crowned sparrow	0.6
	<b>black-chinned hummingbird</b>		0.5	cactus wren	0.5
	ash-throated flycatcher	0.4	<b>white-winged dove</b>	0.5	
	Non-breeding	Gambel's quail	5.4	Gambel's quail	3.3
		chipping sparrow	4.2	white-crowned sparrow	2.6
		white-crowned sparrow	4.2	chipping sparrow	1.2
		<b>dark-eyed junco</b>	4.2	Brewer's sparrow	0.7
		Brewer's sparrow	1.5	spotted towhee	0.4
		western scrub-jay	1.5	<b>black-throated sparrow</b>	0.2
		<b>mourning dove</b>	1.0	ruby-crowned kinglet	0.2
		canyon towhee	0.8	western scrub-jay	0.2
		cactus wren	0.8	cactus wren	0.2
ruby-crowned kinglet		0.8	canyon towhee	0.2	
spotted towhee	0.6	<b>crissal thrasher</b>	0.2		
<b>Bewick's wren</b>	0.6	<b>northern flicker</b>	0.2		
Wash-riparian	Breeding	<b>black-chinned hummingbird</b>	5.8	Gambel's quail	1.9
		northern cardinal	4.6	white-winged dove	1.4

Community	Season	Study			
		Russell and Johnson		UA	
		Species	RA	Species	RA
Wash-riparian	Breeding	mourning dove	3.6	northern cardinal	1.2
		white-winged dove	2.8	mourning dove	1.1
		cactus wren	2.7	<b>Cassin's kingbird</b>	0.9
		Gambel's quail	2.1	cactus wren	0.9
		canyon towhee	2.0	<b>Bewick's wren</b>	0.8
		<b>verdin</b>	1.8	<b>northern mockingbird</b>	0.8
		<b>hooded oriole</b>	1.8	canyon towhee	0.8
		<b>northern cardinal</b>	6.6	white-crowned sparrow	3.0
		chipping sparrow	6.0	<b>American robin</b>	1.8
		white-crowned sparrow	5.8	<b>vesper sparrow</b>	1.8
Non-breeding		<b>dark-eyed junco</b>	5.3	spotted towhee	1.8
		canyon towhee	3.9	Brewer's sparrow	1.7
		spotted towhee	3.7	chipping sparrow	1.3
		Brewer's sparrow	3.5	canyon towhee	1.1
		Gambel's quail	3.1	Gambel's quail	1.1
		<b>cactus wren</b>	2.9	<b>green-tailed towhee</b>	1.1
		<b>curved-bill thrasher</b>	2.0	<b>western scrub-jay</b>	1.1

**Appendix H. Number of Trailmaster photos and total number of individuals of each species.** Data from Herman-Reese (unpublished data), Fort Bowie NHS, 2000–2001.

Group	Common name	Number of photographs	Total number of individuals photographed	
<b>Reptile</b>	western diamond-backed rattlesnake	1	2	
<b>Bird</b>	white-winged dove	1	2	
	mourning dove	3	3	
	greater roadrunner	1	3	
	Mexican jay	1	1	
	northern mockingbird	1	1	
	lark sparrow	28	>55	
	northern cardinal	1	1	
	pyrrhuloxia	3	3	
	Bullock's oriole	2	4	
<b>Mammal</b>	American black bear	36	37	
	white-nosed coati	8	9	
	ringtail		3	3
	striped skunk	2	2	
	coyote		3	3
	common gray fox	41	43	
	mountain lion	1	1	
	bobcat		2	2
	rock squirrel	1	1	
	mule deer		17	40

**Appendix I. Photographic vouchers taken by University of Arizona inventory personnel, Fort Bowie NHS, 2002–2004.**

Group	Common name
<b>Reptile</b>	greater earless lizard
	Gila monster
	green rat snake
<b>Bird</b>	common black-hawk
	mourning dove
	Bell's vireo
	canyon towhee
<b>Mammal</b>	American black bear
	white-nosed coati
	striped skunk
	hooded skunk
	feral dog
	common gray fox
	mountain lion
	bobcat
	collared peccary
	mule deer