USGS
science for a changing world

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

Vascular Plant and Vertebrate Inventory of Chiricahua National Monument

Open-File Report 2008-1023

U.S. Department of the Interior
U.S. Geological Survey
National Park Service

SONORAN DESERT NETWORK
Inventory and Monitoring Program

This page left intentionally blank.

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

Vascular Plant and Vertebrate Inventory of Chiricahua National Monument

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

Open-File Report 2008-1023

U.S. Geological Survey
Southwest Biological Science Center
Sonoran Desert Research Station
University of Arizona
School of Natural Resources
125 Biological Sciences East
Tucson, Arizona 85721

U.S. Department of the Interior
U.S. Geological Survey
National Park Service

U.S. Department of the Interior
DIRK KEMPTHORNE, Secretary

U.S. Geological Survey
Mark Myers, Director

U.S. Geological Survey, Reston, Virginia: 2008

For product and ordering information:
World Wide Web: http://www.usgs.gov/pubprod
Telephone: 1-888-ASK-USGS

For more information on the USGS-the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment:
World Wide Web:http://www.usgs.gov
Telephone: 1-888-ASK-USGS

Suggested Citation
Powell, B.F., Schmidt, C.A., Halvorson, W.L., and Anning, Pamela, 2008, Vascular plant and vertebrate inventory of Chiricahua National Monument: U.S. Geological Survey Open-File Report 2008-1023, 104 p. [http://pubs.usgs.gov/of/2008/1023/].

Cover photo: Chiricahua National Monument. Photograph by National Park Service.

Note: This report supersedes Schmidt et al. (2005).

Authors

Brian F. Powell and Cecilia A. Schmidt
School of Natural Resources
125 Biological Sciences East, Building 43
The University of Arizona
Tucson, AZ 85721

Pamela Anning
National Park Service

William L. Halvorson, US Geological Survey
SBSC Sonoran Desert Research Station
125 Biological Sciences East, Building 43
The University of Arizona
Tucson, AZ 85721

US Geological Survey, Southwest Biological Science Center, Sonoran Desert Research Station Personnel

Charles van Riper III, Station Leader
William L. Halvorson, Research Ecologist
Cecil R. Schwalbe, Ecologist
Michael R. Kunzmann, Ecologist (Emeritus)
Kathryn Thomas, Ecologist
Pamela Nagler, Physical Scientist
Phil Rosen, Ecologist

Program and Expertise Areas of USGS and UA Personnel

Administration & Outreach
Laura Opalka
Wendy Parrish
Emily Sherbrooke
Charles van Riper III

Avian Ecology
Claire Crow
Glenn Johnson
Chris O'Brien
Brian Powell
Charles van Riper III

Data Management
Brent Sigafus

Ecology of Amphibians & Reptiles
Kevin Baker
Cristina Jones
Dave Prival
Phil Rosen
Cecil Schwalbe
Brent Sigafus

Fire Management
Dennis Suhre
Cori Dolan
Bill Halvorson

Invasive Species Research
Patricia Guertin
Jim Malusa
Phil Rosen
Cecil Schwalbe
Brent Sigafus
Dennis Suhre
Kathryn Thomas

Inventory & Monitoring
Patricia Guertin
Bill Halvorson
Pamela Nagler
Brian Powell
Cecilia Schmidt

Vegetation Mapping & Ecology
Patricia Guertin
Bill Halvorson
Kathryn Thomas

USGS Southwest Biological Science Center http://sbsc.wr.usgs.gov
USGS Southwest Biological Science Center, Sonoran Desert Research Station http://sbsc.wr.usgs.gov/sdrs

This page left intentionally blank.

Table of Contents

List of Tables

List of Figures

List of Appendices

This page left intentionally blank.

Acknowledgements

Thanks to the current Superintendent Brian Carey, former Superintendent Alan Whalon and all the staff at Chiricahua National Monument for their administrative support of our program. Special thanks to Ruth Olsen who assisted with field work (herpetofauna and mammal surveys) and Carrie Dennett, former Chief of Resources, for their extraordinary willingness to assist with logistics and general communication. This project was funded by the National Park Service (NPS) Inventory and Monitoring program (I&M) and resulted from the collaboration of many people at the University of Arizona (UA), NPS, and U.S. Geological Survey (USGS). Administration of the project was facilitated by the Desert Southwest and Colorado Plateau Cooperative Ecosystem Studies Units (CESUs). The Southern Arizona Office of the NPS facilitated development of the original study plan that led directly to initiation of this project. Andy Hubbard at the Sonoran Desert Network Inventory and Monitoring (I&M) program has been a strong and convincing advocate for continuing the role of the USGS/UA Inventory program in the I&M program. Kathy Davis at Tuzigoot and Montezuma Castle national monuments played an instrumental role in this project by providing important early initiative. Larry Norris at the Desert Southwest CESU has provided strong support for our program and spent considerable time and effort providing clear and timely administrative assistance. Matt Goode, Don Swann, and Dale Turner provided much of the early planning for this project; we are indebted to their vision and work. Eric Albrecht was an outstanding spokesperson and leader of the program; he was an invaluable member of the team and his contributions are sorely missed.

We thank a core group of dedicated field biologists who collected a wealth of data at Chiricahua NM: James MacAdam, and Meg Quinn (plants); Dan Bell and Kevin Bonine (amphibians and reptiles); Eric Albrecht, Gabe Martinez, and Janine McCabe (birds); and Neil Perry (mammals). We are appreciative of the following people, many of whom never ventured into the field, but 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, Zuleika Valdez, and Alesha Williams. Eric Stitt assisted with writing the amphibian and reptile chapter.

Additional administrative support was provided by Emily Sherbrooke, Wendy Parrish, and Valery Catt at the USGS Sonoran Desert Research Station and Terri Rice, Andy Honaman, Jenny Ferry, and especially Cecily Westphal of the School of Natural Resources at the UA. Special thanks to Lisa Carder and Kathleen Docherty for their years of hard work on all aspects of the project.

Technical support was graciously given by the following experts: Dan Austin, Michael Chamberland, Phil Jenkins, and Charlotte and John Reeder at the UA Herbarium; Tom Huels of the UA ornithology collection; George Bradley of the UA herpetology collection; and Yar Petryszyn and Melanie Bucci of the UA mammal collection. Thanks to Sharon Megdal and Peter Wierenga, the current and former directors, respectively, of the UA Water Resources Research Center, and all their staff.

We received helpful reviews of earlier versions of this report from: Carrie Dennett, Larry Norris, Ruth Olsen, and Eric Stitt (amphibians and reptiles). All mistakes or omissions are the responsibility of the authors.

This page left intentionally blank.

Executive Summary

This report summarizes the results of the first comprehensive inventory of vascular plants and vertebrates at Chiricahua National Monument (NM) in Arizona. This project was part of a larger effort to inventory vascular plants and vertebrates in eight National Park Service units in the Sonoran Desert Network of parks in Arizona and New Mexico. In 2002, 2003, and 2004 we surveyed for plants and vertebrates (amphibians, reptiles, birds, and mammals) at Chiricahua NM to document the presence of species within the boundaries of the monument. Because we used repeatable study designs and standardized field methods, these inventories can serve as the first step in a biological monitoring program for the monument. This report is also the first summary of previous research from the monument and therefore it provides an important overview of survey efforts to date. We used data from our inventory and previous research to compile complete species lists for the monument and to assess inventory completeness.

We recorded a total of 424 species, including 37 not previously found at the monument (Table 1). We found 10 species of non-native plants and one non-native mammal. Most non-native plants were found along the western boundary of the monument. Based on a review of our inventory and past research at the monument, there have been a total of 1,137 species of plants and vertebrates found at the monument. We believe the inventories of vascular plants and vertebrates are nearly complete and that the monument has one of the most complete inventories of any unit in the Sonoran Desert Network.

The mammal community at the monument had the highest species richness (69 species) and the amphibian and reptile community was among the lowest species richness (33 species) of any park in the Sonoran Desert Network. Species richness of the plant and bird communities was intermediate. Among the important determinants of species richness for all groups is the geographic location of the monument at the intergrades between the Chihuahuan and Sonoran deserts with influences from the Great Plains and Madrean ecological provinces. The diversity of plants results from a wide variety of soil types and aspects (from cool, moist canyons to semi-desert grasslands to pine forests). In turn, the vertebrate communities respond to this diversity of vegetation, topography, and microsites. For example, for each taxonomic group we found that some species were only associated with a single community type, most often the riparian areas or semi-desert grasslands. The area of highest species richness for most groups was the western-most portion of Bonita Canyon. The low species richness observed in the amphibian and reptile community was likely because the monument is at the elevational edge of the more species-rich semi-desert grasslands.

This report includes management implications from our work and suggestions for how the monument staff might better maintain or enhance the unique biological resources of the monument. We suggest additional inventory, monitoring, and research studies and we identify components of our effort that could be improved upon, either through the application of new techniques (e.g., establishment of vegetation monitoring plots) or by extending the temporal and/or spatial scope of our work.

Table 1. Summary of vascular plant and vertebrate inventories at Chiricahua NM, 2002–2004.

Taxonomic group	UA inventory			Total number of species on monument list
	Number of species recorded	Number of non-native species	Number of new species added to monument list	
Plants	222	10	19	845
Amphibians and Reptiles	27	0	2	33
Birds	141	0	14	190
Mammals	34	1	2	69
Totals	**424**	**11**	**37**	**1,137**

This page left intentionally blank.

Chapter 1: Introduction to the 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 (I&M) to detect long-term changes in biological resources (NPS 1992). At the time of the program's inception, basic information, including lists of plants and animals, was absent or incomplete for most park units (Stohlgren et al. 1995).

Species inventories have both direct and indirect value for management of the park and are an important first step in long-term monitoring. Species lists are not only useful in resource interpretation and facilitating visitor appreciation of natural resources, but are also critical for making management decisions. Knowledge of which species are present, particularly sensitive species, and where they occur provides for informed planning and decision-making (e.g., locating new facilities). Thorough biological inventories provide a basis for choosing parameters to monitor and can provide baseline data for monitoring ecological populations and communities. Inventories can also test sampling designs, field methods, and 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 and vertebrates at Chiricahua National Monument (NM). This effort was part of a larger biological inventory of eight NPS units in southern Arizona and southwestern New Mexico (Davis and Halvorson 2000; e.g., Powell et al. 2004, 2005a, b). Our goals were to:

1. Conduct field surveys to document at least 90% of all species of vascular plants and vertebrates expected to occur at the monument.
2. Use repeatable sampling designs and survey methods that allow estimation of parameters of interest (e.g., relative abundance).
3. Compile historic occurrence data for all species of plants and vertebrates from three sources: museum records (specimen vouchers), previous studies, and monument records.
4. Create resources useful to monument 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 the first two goals. 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.

Report Format and Data Organization

This report is intended to be useful for internal planning, outreach, and education. We report only common names in the text unless we reference a species that 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 in the monument (Appendices A–D), and amphibian, reptile, and mammal species that were likely present historically or that we suspect are currently present and may be recorded with additional survey effort (Appendices E, F). Species lists are in phylogenetic sequence and, where appropriate, include taxonomic order, family, genus, species, subspecies or variety (if applicable), and common name. Scientific and common names used throughout this document are current according to accepted authorities for each taxonomic group: Integrated Taxonomic Information System (ITIS 2005) and the PLANTS database (USDA 2005) for plants; Stebbins (2003) for amphibians and reptiles; American Ornithologists' Union (AOU 1998,

2003) for birds; and Baker et al. (2003) for mammals. We recognize that the designation of a plant as "non-native" using the aforementioned lists may lead to the misclassification of some species, because these lists indicate only species status in North America as a whole, not regions with the continent. Therefore, our flora underestimates the number of non-native species, but because no authoritative list of non-native species exists for the region, we believe that use of these lists is justified.

Spatial Data

Most spatial data are geographically referenced to facilitate mapping of study plots and locations of plants or animals. Coordinates were stored in the Universal Transverse Mercator (UTM) projection (Zone 12), using the North American Datum of 1983 (NAD 83). We recorded UTM coordinates using hand-held Garmin E-Map® Global Positioning System (GPS) units (Garmin International Incorporated, Olathe, KS; horizontal accuracy approximately 10–30 m). Although we map the locations of study plots, stations, or transects on Digital Orthophoto Quarter Quads (DOQQ; produced by the USGS), the exact UTM coordinates will remain with the park and NPS Sonoran Desert Network I&M office in Tucson.

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), USDA Forest Service, Arizona Game and Fish Department, and Partners in Flight (a partnership of dozens 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 of field data, and other data such as digital photographs will be distributed to park staff and to Special Collections at the University of Arizona. Original copies of all datasheets currently reside at the I&M office in Tucson and may be permanently archived at another location. 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 photographs show coloration or other characteristics of visual appearance in detail, and they may serve as educational tools for the monument staff and visitors. Photographs will be archived with other data as described above.

Specimen Vouchers

Specimen vouchers are an indisputable form of evidence of species occurrence. For plants, we searched the University of Arizona Herbarium for existing specimens from the monument (see Appendix A for results), but we collected herbarium specimens whenever flowers or fruit were present on plants in the field. All specimens that we collected were accessioned into the University of Arizona Herbarium. We searched for existing vertebrate vouchers in records from 29 natural history museums (Table 1.1; see Appendices A, B, D, E, and H for results).

Assessing Inventory Completeness

Inventory completeness can most easily be assessed 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 (unless indicated otherwise), 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 the maximum number of times and the average was plotted, thereby smoothing the curve.

Sampling Design

Sampling design is the process of selecting sample units from a population or area of interest. Unbiased random samples allow inference to the larger population from which those samples were drawn, and enable one to estimate the true value of a parameter. The precision of these estimates, based on sample variance, increases with the number of samples taken; theoretically, random samples can be taken until all possible samples have been selected and precision is exact – a census has been taken and the true value is known. 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 one of interest or convenience.

We briefly address sampling design in each taxon-specific chapter. In general, our survey plots were not randomly located because we were more interested in detecting the maximum number of species than in maintaining 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 abundance; however, the nature or extent of that bias is difficult to characterize or quantify. If population estimates were a higher priority in this inventory effort, avoiding this potential bias would have greater importance. For a thorough review of issues related to sampling design, see Thompson (1992).

Estimates of Abundance

Estimating population size is a common goal of biologists, frequently motivated by the desire to reduce (pest species), increase (endangered species), maintain (game species), or monitor (indicator species) population size. Our surveys at Chiricahua NM were generally focused on detecting species rather than estimating population size. In many cases, however, we present estimates of "relative abundance" by species to provide information on areas in which species might be more or less common. Relative abundance 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 ecologists) prefer to scale such frequency counts by the number of observations of other species, which provides a measure of community dominance (i.e., abundance relative to other species present). If we completed multiple surveys in comparable areas (i.e., anywhere within Chiricahua NM), 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 ecologists do not typically attempt to account for variation in detectability among different species or groups of species under different circumstances. Metrics (rather than indices) of abundance do consider variation in detection probability, and these include density (number of individuals per unit area; e.g., one black-tailed rattlesnake per hectare in Newton Canyon) and absolute abundance (population size; e.g., 10 black-tailed rattlesnakes at Chiricahua NM). These estimates are beyond the scope of our inventory. 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 over time (i.e., monitoring). As such, relative abundance estimates are more useful than (1) detectability-adjusted estimates of abundance for only a few species or (2) raw count data for all species without scaling counts by search effort.

Table 1.1. Museums that were queried in 1998 for vertebrate specimen vouchers with "Arizona" and "Chiricahua National Monument" in the collection location. Collections in bold-faced type had specimens from the monument.

Brigham Young University	Oklahoma Museum of Natural History, Norman
Chicago Academy of Sciences	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
Illinois Natural History Survey	**Tulane Museum of Natural History**
Marjorie Barrick Museum, University of Nevada-Las Vegas	**University of Arizona**
Michigan State University Museum (East Lansing)	University of Texas, Arlington
Milwaukee Public Museum	**University of Illinois, Champaign-Urbana**
Museum of Natural History, University of Kansas	University of Colorado Museum
Museum of Texas Tech University	**United States National Museum**
Museum of Vertebrate Zoology, University of California, Berkeley	Walnut Canyon National Monument, Arizona
Museum of Life Sciences, Louisiana State University, Shreveport	**Western Archaeological and Conservation Center, Tucson**
Natural History Museum of Los Angeles County	Wupatki National Monument, Flagstaff
North Carolina State Museum of Natural Sciences	

Chapter 2: Monument Overview

Monument Area and History

Chiricahua National Monument (NM) is located approximately 50 km southeast of Willcox, Arizona (Fig. 2.1) and was established in 1924 to preserve unique volcanic rock structures occurring there (NPS 1996). Although created to preserve geologic resources, the monument also contains historic and prehistoric Native American sites, a historic military encampment (Camp Bonita), early settlement structures (Faraway Ranch and Stafford Cabin), Civilian Conservation Corps (CCC) built structures (visitor center, headquarters, residences, and maintenance facilities), and important natural resources. The monument is bounded by USDA Forest Service land to the north, south and east; and by private land to the west. The monument encompasses 4,850 ha, 86% of which is designated as wilderness. There is one small (1 ha) private inholding within the monument boundaries that contains a section of the King of Lead Mine. Annual visitation to the monument averages approximately 80,000 (NPS 2005).

Natural Resources Overview

Physiography, Geology, and Soils

Located within the Mexican Highland portion of the Basin and Range Physiographic Province, the monument is situated in the northwest portion of the Chiricahua Mountains, one of the region's "sky island" mountain ranges. Topography varies from steep rocky canyons to flat meadows and ranges in elevation from 1,562 m in Bonita Creek at the west boundary to 2,385 m at the northern boundary of the monument. Geology of the monument is a result of a cataclysmic eruption of the Turkey Creek Caldera during the middle Tertiary period and later volcanic eruptions (Denny and Peacock 2000). The soils at the monument were derived from residuum, aeolian material, alluvium and colluvium (see Denny and Peacock 2000).

Hydrology

There are no perennial flowing streams in the monument; however there are six springs or seeps that flow all year, most notably: Shake, Headquarters, Silver Spur, and Superintendent's springs (Sprouse et al. 2002). The two major drainages in the monument, Bonita and Rhyolite creeks, flow intermittently, usually only during periods of heavy rains.

Climate

Chiricahua NM experiences an annual bimodal pattern of precipitation which is characterized by heavy summer (monsoon) storms brought about by moisture coming from the Gulf of Mexico, and less intense frontal systems coming from the Pacific Ocean in the winter. On average, more than one-half of the annual precipitation falls from July through September (Table 2.1; WRCC 2005). The monument's hot season occurs from April through October when maximum temperatures can exceed 40 ^{o}C. Winter temperatures dip below freezing and snow is common. Average annual precipitation totals during the course of our study ranged from slightly above to substantially below the long-term mean of 48.7 cm (42.2 cm in 2002, 19.5 cm in 2003, and 48.9 cm in 2004; Fig. 2.3; WRCC 2005). Average annual temperatures during the three years of our study were above the long-term mean of 14.7 ^{o}C (15.3 ^{o}C in 2002, 15.8 ^{o}C in 2003, and 14.9 ^{o}C; Fig. 2.3; WRCC 2005).

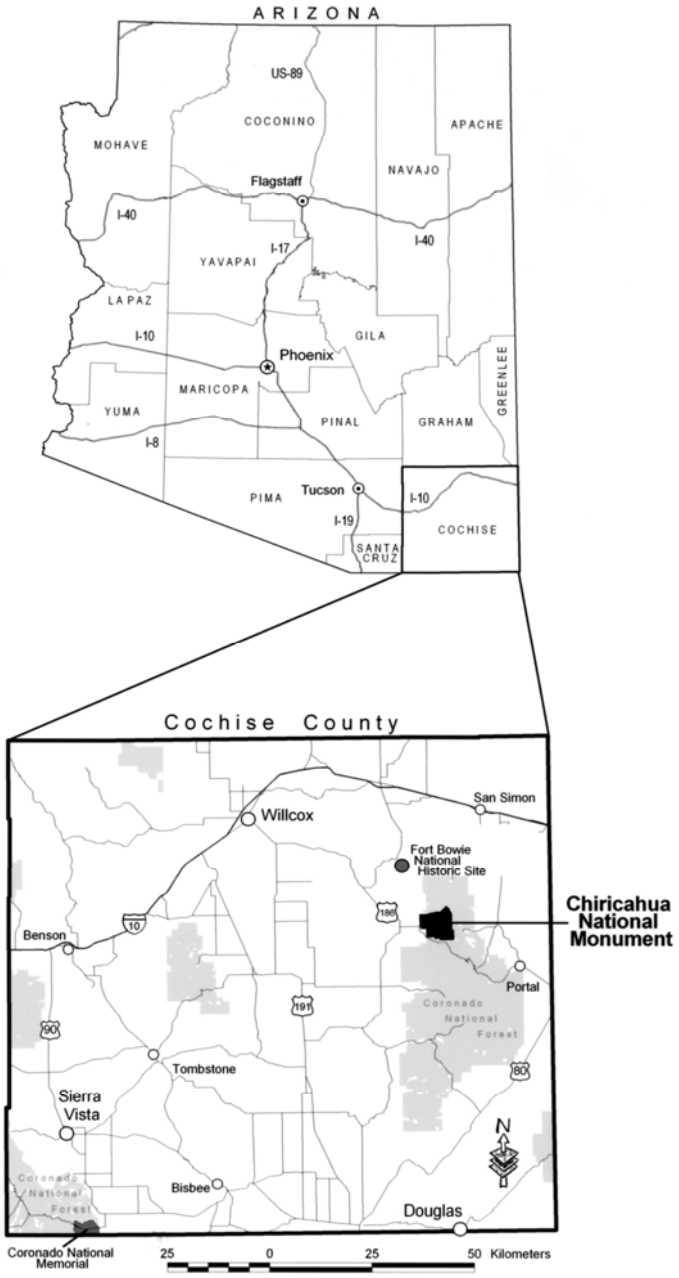

Figure 2.1. Location of Chiricahua NM in southeastern Arizona.

Table 2.1. Average monthly climate data for Chiricahua NM, 1909–2004. Data from WRCC (2005).

	Month												
Characteristic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Annual**
Maximum temperature (°C)	13.4	15.1	18.2	22.7	27.4	32.5	31.7	30.1	28.6	24.0	17.8	13.7	22.9
Minimum temperature (°C)	-1.2	-0.6	1.3	4.1	7.8	12.9	15.5	14.9	12.8	7.7	2.1	-1.1	6.3
Precipitation (cm)	3.7	3.0	3.0	1.2	0.8	2.1	10.4	10.4	4.4	3.0	2.6	4.1	4.1

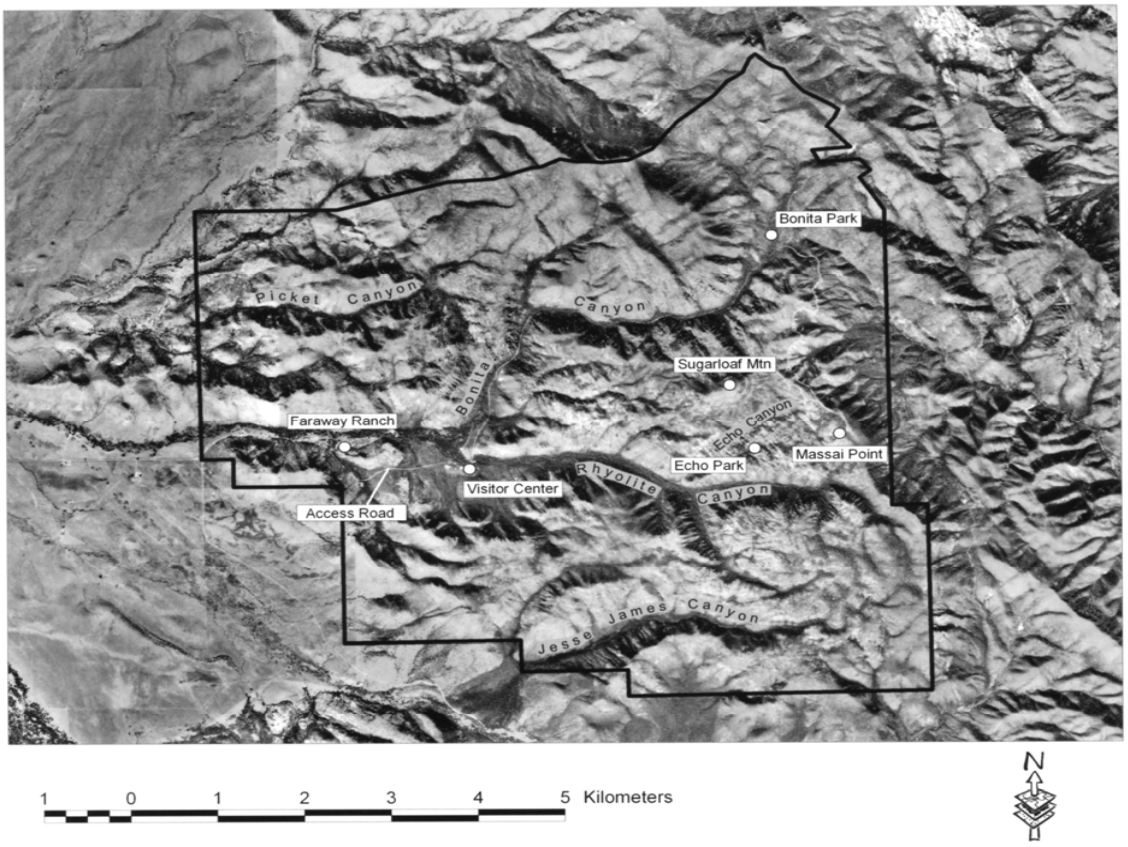

Figure 2.2. Study area and monument boundaries, Chiricahua NM, Digital Orthophoto Quarter Quad (DOQQ) image from 1996.

Vegetation

Chiricahua NM has seven plant communities (from Duncan [1990]):

- Madrean evergreen forest and woodland, which covers approximately 90% of the monument, containing mixed oak association, alligator juniper association, oak–Mexican pinyon–juniper association, oak–Chihuahuan pine association, oak–Apache pine association, and oak–pine association;
- Madrean mountain coniferous forest containing Douglas fir association, Douglas fir–mixed conifer association, and ponderosa pine–mixed conifer association;
- Relic conifer forest and woodland containing Arizona Cyprus association;
- Interior chaparral containing Toumey oak or Sonoran scrub oak–mixed sclerophyll association, and pointleaf manzanita association;
- Semi-desert grassland containing grama grass–mixed grass–mixed scrub association, and curly mesquite–mixed scrub association;
- Interior southwestern riparian deciduous forest, and woodland including Arizona sycamore association; and
- Warm temperate marshlands including the rush series.

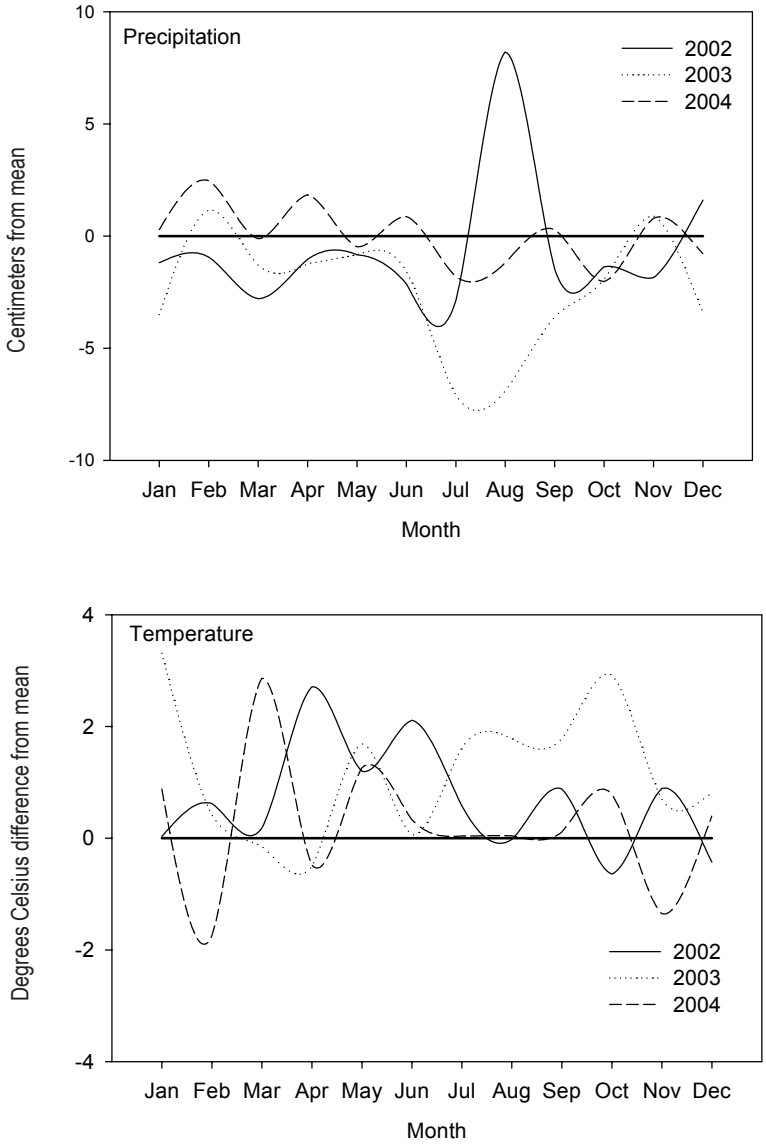

Figure 2.3. Comparison of monthly weather data during the inventory (2002–2004) compared to the mean (thick solid line in both figures; 1909–2004), Chiricahua NM. Data from WRCC (2005).

Natural Resource Management Issues

Fire

Suppression of fire has taken place in and around the monument over the last century and has led to changes in vegetation communities by increasing the density of woody plant species, fire-sensitive plant species, and fire fuel (NPS 1996, Taylor 2004). The increase of woody plant species has led to the decrease in semi-desert grasslands, savannahs, open chaparral and open woodland, and created homogenous vegetation structures (Taylor 2004). Currently, the monument is divided into two fire management units to allow some fire within the monument to burn and still protect against the spread of fire to adjacent lands (NPS 2004).

Adjacent Land Use

Cattle grazing is currently not permitted on the monument, though trespass of cattle from lands bordering the monument is occasional. The King of Lead Mine (now abandoned) borders the monument to the north and has extensive tailings associated with it. Water sources near the mine have been found to be impaired (Sprouse et al. 2002) and the tailings continue to leach heavy metals, sulfate, calcium, and chloride that impact water sources such as Bonita Creek (NPS 1996). Increasing housing development outside the boundaries is also a concern for the monument, because increasing development can cause a host of threats to natural resources, such as, feral animals, traffic, increased water demands, and visual intrusions to the natural landscape (NPS 1996).

Aircraft Noise

Low-flying military, law enforcement (U.S. Border Patrol), and private aircraft pass over the monument often at aboveground elevations of less than 300 m (NPS 1996). Flights pass directly over visitor-use areas, creating safety risks and disrupting the natural quiet and wildlife at the monument. Although no studies have been done on the effects of these overflights at the monument, aircraft overflights can produce changes in the physiology and behavior of some wildlife species (e.g., Ellis and Ellis 1991, Weisenberger et al. 1996).

Animal Poaching and Collection

Chiricahua NM has several species of plants and vertebrates that are of interest to illegal collectors and poachers. Many plants, such as some cacti, are of value for landscaping purposes (NPS 1996). Many species of reptiles, such as the rock rattlesnake, Sonoran mountain kingsnake, green rat snake, and twin-spotted rattlesnake are collected for the pet trade (NPS 1996, Prival and Schwalbe 2000).

Chapter 3: Plant Inventory

Previous Research

Several species lists have been compiled from specimens in the monument's herbarium and the University of Arizona Herbarium. The first known species list was by Clark (no date assigned), a monument naturalist, who collected specimens in the late 1930s. In the early 1970s, Reeves (1976) collected specimens and created a species list for the monument. More recently, there have been three additional species lists: Litzinger (1993), Reeves 1976 (summarized in Bennett et al. [1996]), and Hartman et al. (1998). Halvorson and Guertin (2003) mapped the distribution of 25 non-native species. In this report, we summarize the findings of all of these efforts as well as lists of specimens in the University of Arizona and Western Archaeological Conservation Center herbaria (Appendix A). A few vegetation surveys have been completed for the monument. Burns (1979) provided descriptions of dominant vegetation types in a few areas of the monument and Taylor (2004) investigated historical changes in vegetation communities as a result of fire suppression.

Methods

We surveyed for plants by general botanizing—opportunistically collecting plants when they were flowering or fruiting. We also sampled vegetation associated with VCP stations (see Chapter 5).

For this report, statistics such as the number of species collected exclude specimens that we could not identify to species (n = 7) unless there were no other specimens identified to species for that genus (n = 1; e.g., *Avena* sp.; Appendix A). We report multiple subspecies and/or varieties as "species" in the summary statistics. However, occasionally we collected a specimen that was identified to species and a specimen that was identified to subspecies (e.g., *Yucca baccata*). Barring additional information, we consider these to represent a single species.

Spatial Sampling Designs

In 2002 and 2003, we conducted general botanizing surveys by opportunistically collecting specimens along the most traveled routes, mostly along roads and trails, but also around the visitor center, housing areas, and throughout Bonita Canyon west of the campground.

General Botanizing

Field Methods

Whenever possible we collected at least one representative specimen (with reproductive structures) for each plant species that we encountered. We also maintained a list of species observed but not collected. When we collected a specimen, we assigned it a collection number and recorded the flower color, associated dominant vegetation, date, collector name(s), and UTM coordinates. We pressed and processed the specimens on site. Specimens remained pressed for two to three weeks and were later frozen for 48 hours or more to prevent infestation by insects and pathogens. Mounted specimens were accessioned into the University of Arizona Herbarium.

Effort

We collected specimens during 18 days of fieldwork: 13 days from 26 September to 1 November 2002 and four days from 5–9 May 2003.

Analysis

We present a variety of summary statistics: total number of species found and number and percent of native and non-native species. To estimate inventory completeness we graph the number of new species by the month and year of their first collection.

Results and Discussion

We collected 222 species, including 19 species that had not been previously documented at the monument (Appendix A). Among the species that we collected, one represented a new family for the monument (Aristolochiaceae) and three

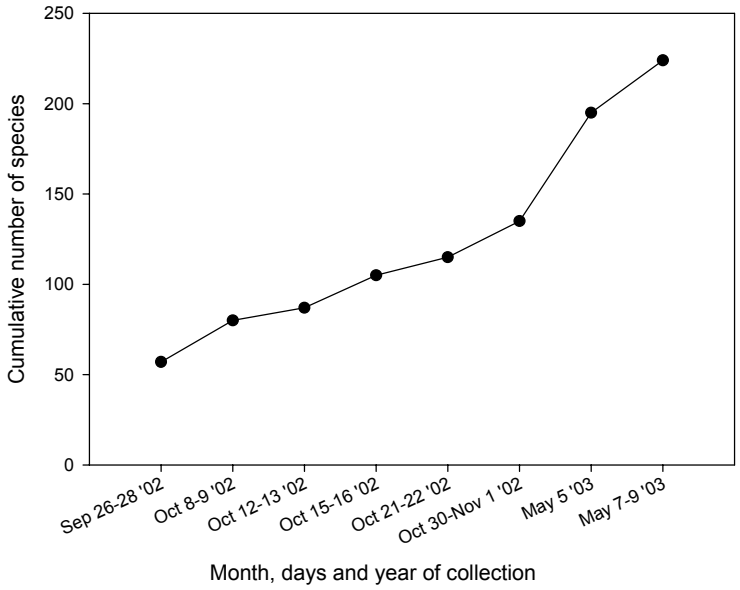

Figure 3.1. Species accumulation curve for the number of plant species collected that were new to our surveys based on month, day(s), and year of the most intensive collections, Chiricahua NM, 2002 and 2003.

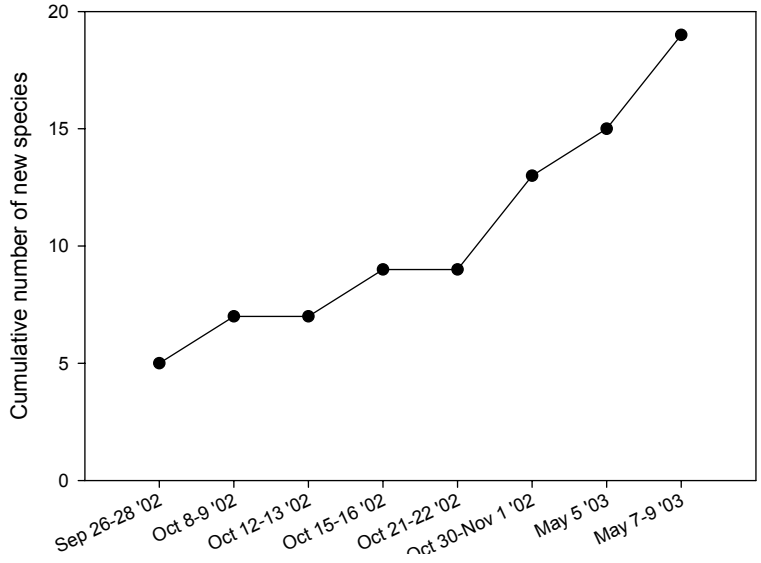

Figure 3.2. Species accumulation curve for the number of plant species new to the monument's flora based on our collection efforts, Chiricahua NM, 2002 and 2003.

represented new genera. Based on the results of our inventory and other studies, there have been a total of 845 species recorded at the monument (Appendix A).

We found two new species of non-native plants at the monument (Appendix A). In total, there have been 61 non-native species found, comprising 7% of the total flora. This is similar to nearby Fort Bowie National Historic Site, which has approximately 6% non-native flora (Powell et al. 2005b). Despite the low percentage of non-native species, it is also important to know other characteristics for each species including its distribution and abundance. Halvorson and Guertin (2003) mapped the distribution of 25 species of non-native plants at the monument and Lehmann lovegrass was the most widespread species. They also found the most non-native species on the west side of the monument.

The high species richness of plants at the monument is due to the variety of elevational gradients, precipitation patterns, and soil types. Also, the geographic location of the monument has a great influence from the Madrean biogeographic region, which has the among the highest plant species richness for any biogeographic region in Arizona (Bowers and McLaughlin 1982). Other floristic influences are from the Great Plains and Chihuahuan regions (Warren et al. 1992). For a complete review of elements affecting the species richness of plants in the Chiricahua Mountain region, see Bennett et al. (1996).

We did not find four federally listed as threatened, endangered or candidate species that may occur in the area (from USFWS 2005): delightful ladies'-tresses (*Spiranthes delitescens*), Cochise foxtail cactus (*Escobaria robbinsiorum*), Schaffner's grasswort (*Lilaeopsis schaffneriana* var. *recurva*), and Lemmon's fleabane (*Erigeron lemmonii*).

Inventory Completeness

It is difficult to determine if our surveys and those of others reviewed in Appendix A reached the goal of documenting 90% of the species in the monument. Evidence to suggest that we did achieve this goal is that the 19 new species that we found represented just 2.2% of the monument's known flora. Yet, a look at the species accumulation curves (Figs. 3.1 and 3.2) reveals the cumulative number of new species for our surveys (and for the monument) was not approaching an asymptote. All of the surveys that we conducted in 2002 were following an above-average monsoon rainfall. However, a greater number of new species were found in May 2003 following a winter rainfall season that was below average, indicating that additional surveys during the spring following above-average rainfall would likely yield many additional species.

Chapter 4: Amphibian and Reptile Inventory

Previous Research

Species Lists and Specimen Vouchers

Lowe and Holm (1987) created a species list based on their observations and what they thought should be present at Chiricahua NM. Though the report contains no documentation of their field effort, Peter Holm (*pers comm.*) said that they conducted approximately 30 days of field research in 1985, which subsequently formed the basis for Lowe and Holm (1992). Sipes (1975) created a species list of amphibians, turtles, and lizards based on observations by monument staff and volunteers. Lunsford (1980) created a species list of snakes with no documentation of where the information was derived. Because they lack thorough documentation, we do not consider further the lists by Sipes and Lunsford. We do, however, refer to the Lowe and Holm (1987) list and assume that all of the species on the list, except their "hypothetical" species, were observed by them. There have also been many specimen vouchers collected from within and near the monument (Appendices B, H).

Studies

Prival and Schwalbe (2000) studied commercially valuable snakes at Chiricahua NM and assessed the level of illegal collection at the monument. They surveyed for approximately 31 field days from July through September 1999, primarily in the lower Rhyolite Canyon and Echo Canyon Loop areas. They also spent 13 hours conducting road surveys in the monument, and they noted other species observed (Appendix B). More recently, Goode and Amarello (2004) studied banded rock rattlesnakes and mountain spiny lizards (the primary prey species of the banded rock rattlesnake). They also noted other species (Appendix B).

Methods

We surveyed amphibians and reptiles in 2002, 2003, and 2004 using six field methods. These included (1) plot-based "intensive" time-area constrained plots (TAC), (2) line transects, (3) more flexible, non-plot based "extensive" surveys (Table 4.1), (4) pitfall trapping, (5) road surveys, and (6) incidental observations. We used multiple methods because temporal and spatial variation in detectability is high, both within and among species and no one field method is appropriate for surveying all species. All surveys except road surveys were during daylight hours. Although methods were designed to detect both amphibians and reptiles, fewer amphibians were detected as they have more restricted activity periods (mainly nighttime during rainy weather or high humidity).

Sampling Designs

All survey areas were selected non-randomly. Much of our survey effort was located in the Bonita and Rhyolite canyons; areas that we felt would have the highest number of species at the monument. Surveys in other areas of the

Table 4.1. Comparisons of active search methods used during amphibian and reptile surveys at Chiricahua NM, 2002–2004.

	Survey method		
Characteristic	Time-area Constrained (TAC)	Line transect	Extensive
Area constrained	Yes	Yes	No
Configuration	Plot based	400 m transect, 5 m searched on either side of transect line	Non-plot based
Area (ha)	1 ha	1 ha	Variable
Time constrained	Yes, 1 hour	No	No
Advantages	Repeatable. Facilitates comparison with other areas; more complete richness and abundance data	Repeatable. Facilitates comparison with other areas; more complete richness and abundance data. Allows more flexibility than TAC plots	Maximum flexibility facilitating detection of rare species with restricted distributions
Disadvantages	Inefficient for developing complete species list. If surveys are unproductive, observers cannot leave survey area	Not as repeatable as intensive surveys because area is more difficult to restrict	Difficult to repeat surveys because exact route is unknown

monument were primarily restricted to near hiking trails. For road surveys, we constrained effort to the paved road, from the monument entrance to Massai Point.

Time-Area Constrained Plots

Field Methods

In 2003, we used plot-based, visual encounter surveys constrained by time and area (time-area constrained; TAC) to standardize effort (Crump and Scott 1994). We selected two, 1 ha (100 x 100 m) plots in Bonita Canyon for these surveys (Fig. 4.1). We surveyed each plot for one hour. We timed our surveys to coincide with periods of peak diurnal reptile activity, because activity levels vary with temperature. We surveyed all plots in the morning and began surveys between 0800 and 0930 hrs.

We searched plots visually and aurally and worked systematically from one end of a plot to the other to avoid duplicate records of the same individual. We also looked under rocks and organic litter and used a mirror to illuminate cracks and crevices. For each animal detected, we recorded species, sex and age class (if known), and microhabitat (ground, vegetation, rock, edifice, burrow, or water). We permanently marked plot corners with rubber-capped stakes and recorded UTM coordinates with a Trimble GPS (Appendix G). We measured weather data (temperature, % relative humidity, % cloud cover, and wind speed [km/h]) with hand-held Kestrel® 3000 weather meters (Nielson-Kellerman Inc., Boothwyn, PA) before and after surveys. We flagged the corners of each plot prior to the field season to ensure we stayed within the plot boundary during surveys.

Effort

We completed five one-hour surveys at each of the two plots from May through September 2003 (Table 4.2). We surveyed all plots with a single observer.

Analysis

We estimated relative abundance (number/ha/hr) for each species per plot by summing a species' detections across all visits for each plot and dividing by the number of survey hours.

Line-transect Surveys

Line-transects are more flexible than TAC plots because they are not constrained by time, but have the same effective search area (1 ha; Table 4.1). Transects allowed observers to spend more or less time on a survey depending on animal activity.

Field Methods

We established four transects in Bonita Canyon—two in lower and two in middle Bonita Canyon (Fig. 4.1). Two transects had their mid point in the middle of the TAC plot with the same name (Silver Spur Spring and Entrance Station). All transects were 400 m long. Prior to beginning the field season, we placed flags every 50 m along each transect to ensure that observers stayed within 12.5 m of the transect line. The timing of surveys and methods of data collection were the same as the TAC plots. We alternated the direction of travel for each survey between visits, and a single observer performed each survey.

Effort

We completed five surveys at each of the four transects from May through September 2003 (Table 4.2). The average time for each survey was approximately 45 minutes.

Analysis

We estimated relative abundance (number/ha/hr) for each species per transect by summing detections across all visits for each plot and dividing by the number of survey hours.

Extensive Surveys

Non-plot-based extensive surveys were used in areas where we expected high species richness, abundance, or species not previously detected. Typically, we selected areas for extensive surveys in canyons or along hiking trails. In contrast to TAC plots or line-transects, extensive surveys were not constrained by area or time (Table 4.1). We focused surveys during mornings or evenings when detectability of animals is highest (Ivanyi et al. 2000).

Field Methods

We located extensive surveys non-randomly. We relied upon visual detection and often looked under objects and illuminated cracks to detect

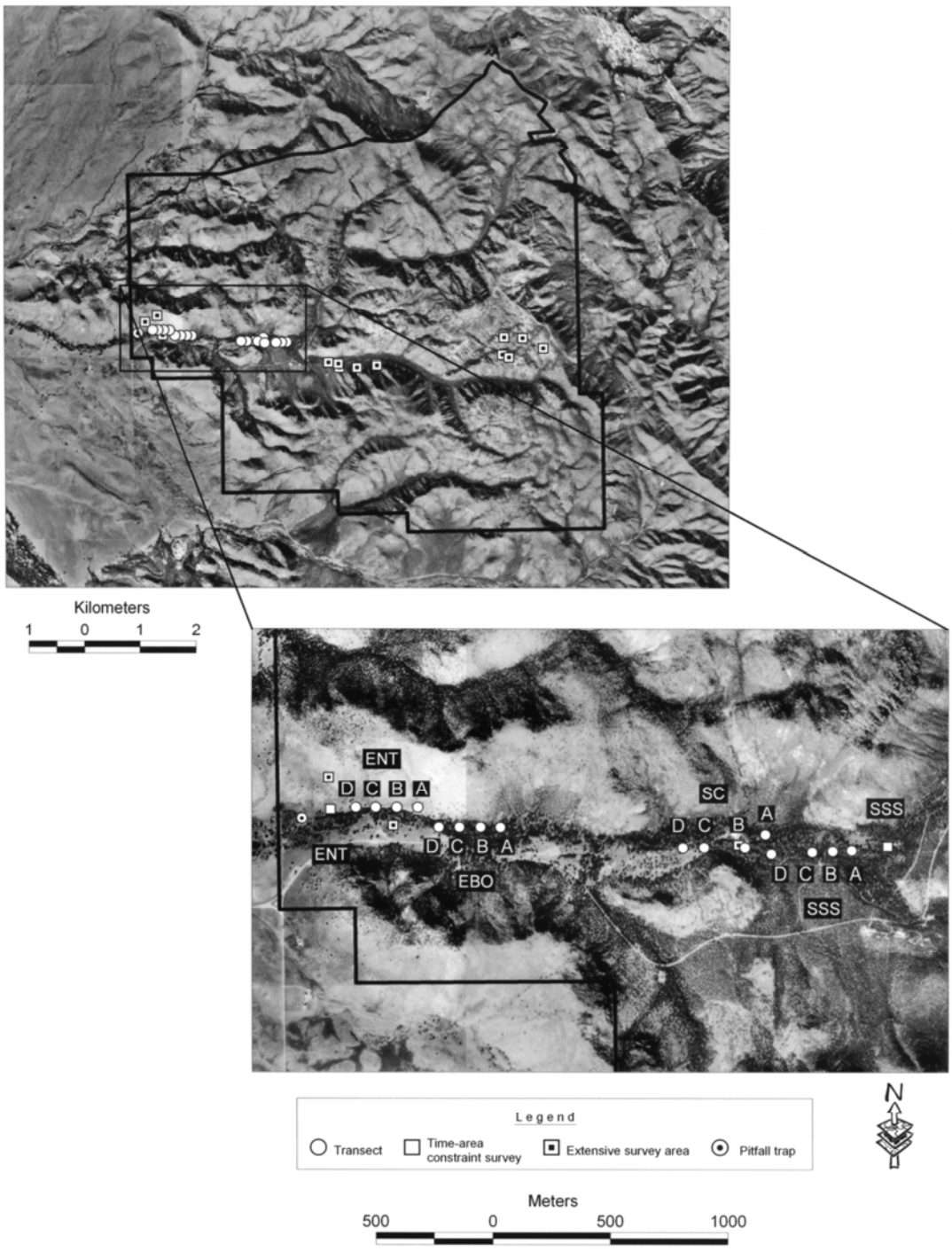

Figure 4.1. Locations of amphibian and reptile surveys, Chiricahua NM, 2002–2004. ENT = Entrance Station; EBO = East Bonita; SSS = Silver Spur Spring; SC = Sea Captain.

Table 4.2. Summary of survey effort for reptiles and amphibians, Chiricahua NM, 2002–2004.

Survey method	Community type or location	Name (Abbreviation)	Year	Number of surveys	Survey effort (hrs.)
TAC plot	Lower Bonita Canyon	Entrance Station (ENT)	2003	5	5.0
	Middle Bonita Canyon	Silver Spur Spring (SSS)	2003	5	5.0
Line transect	Lower Bonita Canyon	East Bonita (EBO)	2003	5	3.4
		Entrance Station (ENT)	2003	5	4.5
	Middle Bonita Canyon	Sea Captain (SC)	2003	5	3.0
		Silver Spur Spring (SSS)	2003	5	3.5
Extensive	Middle Bonita Canyon		2002	2	7.0
			2003	7	8.0
	Lower Bonita Canyon		2002	5	13.6
			2003	6	13.3
	Rhyolite Canyon		2002	7	23.5
			2003	7	9.7
	Natural Bridge		2003	2	6.6
	Semi-desert Grassland		2002	1	0.3
			2003	7	12.9
	High Elevation		2002	6	18.2
			2003	2	2.5
Road surveys	Main road		2002	5	9.6
			2003	19	30.5
Pitfall trapping	Near entrance station		2003	97	1962.0
			2004	22	528.0

hidden individuals. We began morning surveys before 1000 hrs and began most afternoon surveys after 1630 hrs to avoid the hottest times of day. Late afternoon/early evenings were emphasized, especially after the onset of the summer monsoon. Survey duration averaged 2.2 ± 0.19 (± SE) hours and ranged from 0.5 to 5.3 hours. For 90% of the surveys we used one observer and on the remainder of surveys, we used two observers. We recorded data using similar methods as TAC plots and line-transect surveys and noted UTM coordinates for each animal detected.

Survey crews did not record detailed environmental characteristics when they observed an animal during extensive surveys. Therefore, to identify areas of high species richness or relative abundance, we classified extensive surveys into six categories based on general vegetation characteristic or survey locations:

- **Middle Bonita Canyon** - east of Faraway Ranch and west of the campground. This area corresponded to the eastern portion of the repeat-visit VCP survey stations (for birds) of the Lower Bonita Canyon transect (see Chapter 5 for more information and pictures).
- **Lower Bonita Canyon** - starting at the boundary near the contact station and ending at Faraway Ranch. This area corresponds to the western portion of the birds repeat-visit VCP survey stations of the Lower Bonita Canyon transect (see Chapter 5 for more information and pictures).
- **Rhyolite Canyon** - from the visitor center trailhead to approximately 1.5 km east of the trailhead. Dense oak, pine, and Arizona cypress.
- **Semi-desert Grassland** - areas with some shrubs but mostly perennial grasses in the far northwest section of the monument and an area to the south of the contact station.
- **Natural Bridge** - along the trail of the same name from the road through piñon, oak, and juniper woodlands.
- **High Elevation** - mostly in the area of Echo and upper Rhyolite canyons. These areas are dominated by large pine trees.

Effort

We spent 115.6 hours on 52 surveys in 2002 and 2003. Survey effort was greater in 2002 (62.6 hours) than in 2003 (53 hours) (Table 4.2). This survey effort constituted approximately twice that of all other active search methods combined.

Analysis

We calculated relative abundance as the number of individuals detected for each species or all species combined per hour of effort for each plant community type or general location. For surveys completed by more than one observer per survey area, we summed survey duration and detection data for all surveyors when calculating effort and relative abundance.

Road Surveys

Driving roads is a common method for surveying for amphibians and reptiles and is suggested for augmenting species lists (Shaffer and Juterbock 1994). Road surveys involve driving slowly along a road, typically after sunset, and watching for animals. Because they are ectothermic, reptiles must seek out favorable microclimates for thermoregulation. Usually roads retain heat after the daily ambient temperature drops below temperatures favorable for animal activity. Thus, individuals seek out and "bask" on paved roads.

Field Methods

We drove the main access road in the late afternoons and early evenings. We recorded weather information at the beginning and end of each survey as described in other methods. We recorded each individual detected by species, sex and age (if known), location (either UTMs or mileage from beginning of survey), and whether the individual was found alive or dead.

Effort

We conducted 24 road surveys totaling 40.1 hours of effort (Table 4.2). Mean survey duration was 86 $\pm$ 6.3 (SE) minutes. We surveyed 13 August to 6 September 2002 and 19 May to 14 September 2003.

Analysis

Because survey routes varied in length and included a number of different segments surveyed in various orders, we pooled results from all routes and road segments. Mileage for each route was not recorded so we scaled estimates of relative abundance by time. We calculated relative abundance as the number of individuals detected for each species (or all species combined) per hour of effort.

Pitfall Trapping

Pitfall trapping is a live-trap, passive sampling technique useful for detecting species that are difficult to observe due to rarity, limited activity, or inconspicuous behavior (Corn 1994).

Field Methods

We constructed one pitfall trap array with three 19 L buckets spaced 8 m apart at angles of approximately 120 degrees from a central bucket (Gibbons and Semlitsch 1981). We dug shallow trenches connecting the central bucket to each outside bucket and placed drift fences (7.6 m long, 0.5 m tall aluminum-flashing supported by rebar) in each trench. We buried buckets so that their edges were at ground level and placed cover boards (50 x 50 cm pieces of plywood) over them to keep animals cool during day (Corn 1994).

To capture large snakes and other animals capable of escaping trap buckets, we placed one wire-mesh funnel-trap (tubes with inwardly-directed cones at each end) at midpoints along each side of drift fences (n = 6 traps) (Corn 1994). Animals entering funnels fell to the bottom of the tubes and were unable to escape. We typically opened traps around sunset and checked and closed them either around midnight or the following morning. We recorded species, and sex and age class (if known) for each animal captured.

Effort

The trap array was located on the west side of the monument adjacent to Bonita Creek (Fig. 4.1). We operated traps for 119 nights (97 in 2003 and 22 in 2004) for a total of 2,490 hours (Table 4.2). In 2003, we trapped from 20 May to 20 October. In 2004 Ruth Olsen, operated the pitfall array from 14 May to 30 July. We report her findings in this report.

Analysis

We report the number of animals captured per 100 hours of array operation.

Incidental Observations

We noted sightings of rare species or individuals of all species in unusual locations and recorded time and UTM coordinates of each observation. Incidental observations were often recorded

before or after a more formal survey and were useful in identifying additional species and to determine their distribution.

Specimen and Photographic Vouchers

Specimen vouchers are important to verify species identifications and can be useful if species are reclassified or split into multiple species. Many of the specimens that we collected had been previously killed on monument roads by vehicles. All specimen vouchers were deposited in the University of Arizona's herpetology collection. We also obtained photographic vouchers for each species that we were able to capture. We obtained a close-up photograph of each animal "in hand" and, if possible, another photograph of the animal in the natural surroundings it was found in. We recorded the same information for each photograph voucher as for specimen vouchers. In addition to documenting most species, these photos may be useful for interpretive purposes at the monument.

Problematic Species: Whiptail Lizards

Whiptail lizards (*Cnemidophorus* [*Aspidoscelus* by some sources] spp.) are notoriously difficult to identify in the field because of the similarity in appearance for several sympatric species (Stebbins 2003). Many parthenogenetic (non-sexually reproducing) whiptails may have arisen as hybrids from the same diploid, sexually reproducing parent species (Degenhardt et al. 1996). Several undescribed "parthenospecies" (Wright and Vitt 1993, Cole and Dessauer 1994) may exist in the desert southwest. When possible, we made an effort to identify all whiptails to species level and verified, via specimen vouchers, at least two species (Sonoran spotted and Chihuahuan spotted) on the monument. Lowe and Holm (1992) list the semi-desert grassland whiptail as being common in the monument's semi-desert grasslands. Given that "unknown whiptails" were the most commonly documented lizard found during surveys, and that we recorded one desert grassland whiptail during a transect, they perhaps occur on the monument in greater numbers than we documented. Additional research on these species will clarify their status at the monument.

Results

We observed 585 individuals representing 27 species at Chiricahua NM in 2002, 2003, and 2004 (Appendix B): one salamander, three anurans, one turtle, 11 lizards, and 11 snakes. We found one species that had not been previously recorded in the monument (Texas blind snake). We observed the most species during incidental observations (n = 22) and the fewest species during line-transect surveys (n = 5). We found no species with special conservation designations. Based on a review of all research, there have been a total of 33 species of amphibians and reptiles recorded at the monument (Appendix B).

Time-and-Area Constrained Search Plots

We observed eight species at two TAC plots in 2003 (Table 4.3). We found five species at the Silver Spur Spring plot and four species at the Entrance Station plot. Of the individuals that we were able to identify to species, only one species (Clark's spiny lizard) was found at both plots. Unknown whiptails accounted for 57% of the observations, but crews were comfortable enough with identifying Chihuahuan spotted and Sonoran spotted whiptails to species only on the Silver Spur Springs plot, though they were likely present on the Entrance Station plot as well. Mean encounter rate for plot surveys was 4.7 animals per hour.

Line-transect Surveys

We found five species on 20 surveys of four line transects in 2003 (Table 4.4). All species observed were lizards. All transects except the East Bonita transect (n = 4) had three species. We observed no animals on two (of five) visits to both Middle Bonita Canyon transects and on one (of five) visit to each of the Lower Bonita Canyon transects. The most common species on all transects was the Sonoran spotted whiptail, which, along with the ornate tree lizard, was found on three of the four transects. Mean encounter rate was 2.9 animals per hour.

Extensive Surveys

We found 17 species during extensive surveys (Table 4.5). We found the most species in Rhyolite Canyon (n = 9), although that area was

also the most frequently surveyed. We found four species to be present in four of the areas and six species in only one area. We found no animals on nine of 52 surveys over both years. We found a mean of 2.5 animals per hour (3.1 per hour in 2002 and 2.3 per hour in 2003).

For areas that were surveyed in both 2002 and 2003, species richness and composition changed substantially, though this was probably an artifact of less survey effort in 2003 (Table 4.2). The most common species were the mountain spiny lizard in Rhyolite Canyon and the High Elevation communities, the Clark's spiny lizard in Semi-desert Grasslands and Lower Bonita Canyon, the striped plateau lizard in Natural Bridge Trail, and the black-necked garter snake in Middle Bonita Canyon (Table 4.5).

Road Surveys

We found 14 species during road surveys: 11 species in both 2002 and 2003 (Table 4.6). The Great Plains toad was the most commonly encountered animal. We found three species during road surveys that were not found during any other formal survey method (Texas blind snake, western lyre snake, and night snake; Appendix B). On average, we found 2.3 animals per hour of surveys.

Pitfall Traps

We captured 69 individuals representing at least seven species of reptiles and amphibians in 2003 and 2004 (Table 4.7). Unknown whiptails accounted for over one half of the individuals captured. We did not trap any species that were not found during other survey methods, though two species were observed only during incidental surveys (Great Plains skink and desert grassland whiptail). We did not capture any animals on 95 of the 119 nights of trapping. Over the entire effort, capture efficiency averaged 0.52 animals per trap-array night.

Several rodents were captured in pitfalls as well, including eight animals identified only as "mouse," four unknown *Peromyscus* (deer mouse), three unknown desert shrews, one hispid pocket mouse, and one cotton rat.

Table 4.3. Total number of observations (sum) and relative abundance (mean ± SE) of reptiles and amphibians from TAC plots, Chiricahua NM, 2003.

	Entrance Station			Silver Spur Spring		
Species	Sum	Mean	SE	Sum	Mean	SE
western box turtle	2	0.4	0.24			
mountain spiny lizard				2	0.4	0.24
Clark's spiny lizard	2	0.4	0.24	1	0.2	0.20
striped plateau lizard				3	0.6	0.40
ornate tree lizard	1	0.2	0.20			
unknown whiptail	13	2.6	0.24	13	2.6	1.08
Chihuahuan spotted whiptail				5	1.0	0.55
Sonoran spotted whiptail				1	0.2	0.20
coachwhip	1	0.2	0.20			

Table 4.4. Total number of observations (sum) and relative abundance (mean ± SE) of amphibians and reptiles from line-transect surveys, by area and transect, Chiricahua NM, 2003.

	Middle Bonita Canyon						Lower Bonita Canyon					
	Sea Captain			Silver Spur Spring			East Bonita			Entrance Station		
Species	Sum	Mean	SE	Sum	Mean	SE	Sum	Mean	SE	Sum	Mean	SE
Clark's spiny lizard							5	1	0.45			
striped plateau lizard	1	0.2	0.20	4	0.8	0.37						
ornate tree lizard	2	0.4	0.24				2	0.4	0.24	3	0.6	0.40
unknown whiptail	1	0.2	0.20				2	0.4	0.40	7	1.4	0.68
Chihuahuan spotted whiptail				1	0.2	0.20						
Sonoran spotted whiptail				1	0.2	0.20	4	0.8	0.80	8	1.6	1.36

Table 4.5. Total number of observations (sum) and number of observations per hour of amphibians and reptiles during extensive surveys, by year and community type or area, Chiricahua NM, 2002 and 2003.

	Area/Community							
	Lower Bonita Canyon			Middle Bonita Canyon			Semi-desert Grasslands	
Species	Sum	2002	2003	Sum	2002	2003	Sum	2003
canyon treefrog				1	0.14		2	0.16
western box turtle	1		0.08					
mountain spiny lizard				5		0.63		
Clark's spiny lizard	11	0.22	0.60	2	0.29		11	0.85
striped plateau lizard				3	0.14	0.25		
ornate tree lizard	9	0.15	0.53				10	0.78
greater short-horned lizard	1	0.07						
unknown whiptail	36	1.10	1.58	4	0.43	0.13	22	1.71
Chihuahuan spotted whiptail	5	0.07	0.30	2	0.14	0.13		
Sonoran spotted whiptail	1	0.07						
Sonoran whipsnake	1		0.08				1	0.08
mountain patch-nosed snake	1		0.08				1	0.08
gopher snake							1	0.08
black-necked garter snake				6	0.86		1	0.08
black-tailed rattlesnake	2		0.15	1	0.14			
Number of animals	64			24			49	
Number of animals per hour		1.7	3.4		2.1	1.1		3.8

	Area/Community							
	Rhyolite Canyon			Natural Bridge Trail		High Elevation		
Species	Sum	2002	2003	Sum	2003	Sum	2002	2003
canyon treefrog						3	0.16	
mountain spiny lizard	29	1.11	0.31	1	0.15	90	4.73	1.60
Clark's spiny lizard	3	0.04	0.21					
striped plateau lizard	9	0.34	0.10	3	0.45	1		0.40
ornate tree lizard	1	0.04						
unknown whiptail	4	0.13	0.10	4	0.61	3	0.16	
Chihuahuan spotted whiptail	4	0.17				4	0.11	0.80
Sonoran spotted whiptail	3	0.13						
Madrean alligator lizard						3	0.16	
Sonoran mountain kingsnake	2		0.21					
black-necked garter snake						2	0.11	
rock rattlesnake	6	0.17	0.21			3	0.16	
black-tailed rattlesnake	2	0.09						
Number of animals	63			8		109		
Number of animals per hour		2.2	1.1		1.2		5.6	2.8

Table 4.6. Total number of amphibian and reptile observations (sum) and mean number of observations per hour from road surveys, Chiricahua NM, 2002 and 2003.

Group	Species	Sum	2002	2003
Amphibian	Mexican spadefoot	5	0.10	0.13
	Great Plains toad	40	0.10	1.28
	canyon treefrog	1		0.03
Reptile	mountain spiny lizard	1	0.10	
	Clark's spiny lizard	1		0.03
	Texas blind snake	5	0.10	0.13
	Sonoran whipsnake	1	0.10	
	mountain patch-nosed snake	1	0.10	
	gopher snake	4	0.10	0.10
	Sonoran mountain kingsnake	1		0.03
	western lyre snake	9	0.31	0.20
	night snake	8	0.31	0.16
	rock rattlesnake	7	0.21	0.16
	black-tailed rattlesnake	16	0.52	0.36

Table 4.7. Total number of animals captured (*n*) and number of captures per 100 hours of pitfall trap operation, Chiricahua NM, 2003 and 2004.

Group	Species	*n*	2003	2004
Amphibian	Mexican spadefoot	4	0.20	
	Great Plains toad	8	0.36	0.19
Reptile	greater short-horned lizard	2	0.10	
	Great Plains skink	11	0.56	
	unknown whiptail	39	1.12	3.22
	desert grassland whiptail	2		0.38
	mountain patch-nosed snake	1	0.05	
	black-necked garter snake	1	0.05	

Incidental Observations

We made 138 observations of 23 species outside of formal surveys from 2002 to 2004 (Appendix B). We found two species that were not observed using any formal survey method (tiger salamander and eastern collared lizard).

Voucher Specimens and Photographs

Thirteen individuals of at least 11 species were collected and vouchered by UA and monument personnel in 1999, 2002, and 2003 (Appendix G). Lastly, at least 22 species were photo-vouchered by UA and monument personnel.

Inventory Completeness

Our synthesis of past research at the monument (Lowe and Holm 1987 and 1992, Prival and Schwalbe 2000, and Goode and Amarello 2004) reveals that there have been 33 species observed or documented within the monument (Appendix B) and four species for which specimen voucher(s) were collected from within 5 km of the monument (Appendix H). Based on a review of Lowe and Holm (1987) and Rosen et al. (1996), there are an additional 14 species that have not been found in or near the monument, but that may occur there based on the known range and habitat needs of these species (Appendix E).

We detected 27 of the 33 species that are known to occur in the monument (Appendix B). We found one species (Texas blind snake) that was new to the monument and considered "hypothetical" by Lowe and Holm (1987). Based on our species accumulation curve for all field methods combined (Fig. 4.2), it appears that we recorded all but the most uncommon species. Further, recent results from previous studies have only confirmed two species that we did not find: the green rat snake and red-spotted toad. The Green rat snake is seen periodically in the monument. Prival and Schwalbe (2000) did not find any during their surveys but report two credible sightings: (1) 5 September 1999 across the road from the visitor center (observed by interpretive ranger Matt Van Saun) and (2) 26 August 1997 0.6 km north of the campground (observed by Dave Prival). Prival and Schwalbe report sightings of the red-spotted toad, but do not give specific location information.

Possible Species

Here we identify species that have not been confirmed to occur at the monument, but that may occur there based on the known natural history and distribution of the animals. Most of these species are found in the semi-desert grasslands of the monument and therefore may eventually be found near the contact station in the northwest portion of the monument.

Frogs and Toads

The Plains spadefoot, Couch's spadefoot, and green toad are locally abundant in the semi-desert grasslands that are bisected by Highways 186 and 181. If found in the monument, they will be at the western edge in the semi-desert grasslands and observed after the onset of monsoon rains. We looked specifically for Chiricahua leopard frogs in areas such as Bonita Canyon and Silver Spur Spring. The Chiricahua leopard frog (federally listed as a threatened species) has undergone major declines in southern Arizona due to habitat loss and degradation, predation by introduced species, and pathogens (USFWS 2002). No specimen vouchers or observations exist for this frog at the monument (Phil Rosen,

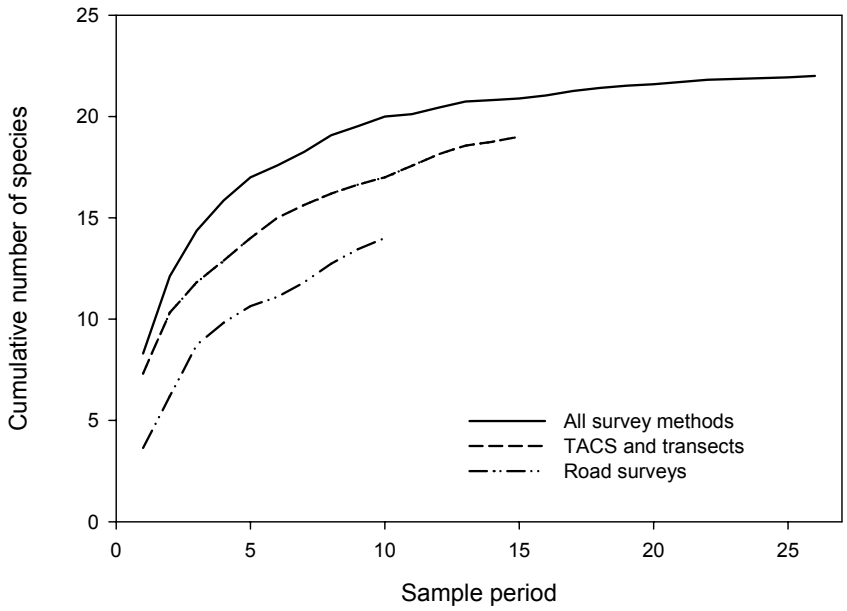

Figure 4.2. Species accumulation curve for amphibian and reptile surveys, Chiricahua NM 2002–2004. Each sample period represents one survey day.

pers. comm.), and it appears that its potential habitat at the monument is very small. Sredl et al. (1997) documented a massive die-off of Chiricahua leopard frogs less than 3 km south of the monument at Horsefall Canyon in 1994. The authors tentatively attributed the die off to high hydrogen sulfide levels, but the newly described pathogen *Batrachochytridium* may be another possibility. American bullfrogs have been reported from a stocktank about 200 m west of the monument (Peter Holm, *pers. comm.*). It appears that little habitat exists for their permanent establishment, though they are known to be long-distance dispersers and may be found on occasion.

Lizards

Seven species of lizards may be found in the monument, including: Slevin's bunchgrass lizard, Texas horned lizard, greater earless lizard, and Gila monster (Appendix E). If present on the monument, all species would occur on the west side of the monument in semi-desert grasslands and upland vegetation communities.

Snakes

There are nine species of snake that may occur in the monument (Appendix E) and four of these have been confirmed to occur within 5 km of the monument's west entrance: ring-necked snake, Chihuahuan hook-nosed snake, western hog-nosed snake, and Mojave rattlesnake. Below we review a few of the most likely snakes or those whose distribution needs clarification.

- The common kingsnake is one of the most common snakes seen in the semi-desert grassland areas around the Chiricahua Mountains (Rosen et al. 1986).
- The checkered garter snake is closely associated with breeding aggregations of desert anurans and is one of the most common species in the Sulphur Springs Valley (Rosen et al. 1996).
- The twin-spotted rattlesnake is on the list compiled by Lowe and Holm (1992) as "verified". However, we are unaware of any records from the monument and Prival and Schwalbe (2000) and Holycross (*pers. comm.*) suggest that little habitat exists in the monument. If they do occur in the

monument, they will be found at the highest elevations.

- Desert massasauga has been reported from the northern end of the Sulphur Springs Valley (Andy Holycross*, pers. comm.*). If present, it will be found in mesic areas near streams and ponds at lower elevations, probably near the monument entrance.

Discussion

The diversity of herpetofauna at the monument is not extraordinary for an area of its size and variety of biotic communities. By comparison, Swann et al. (2001) found nine amphibian and 31 reptile species approximately 25 km northwest of the monument at Fort Bowie National Historic Site (Fig. 2.1), which, at 400 ha, is approximately 10% of the size of Chiricahua NM. The location of Chiricahua NM at the edge of Sulphur Springs Valley, with riparian and semi-desert grassland vegetation communities, makes it possible for more species to be found in the monument than have been documented in the approximately one year of surveys by us and others (Lowe and Holm 1987, Prival and Schwalbe 2000, and Goode and Amarello 2004).

The monument has few riparian-obligate amphibians because of the lack of stock tanks or permanent pools (Lowe and Holm 1992). Several species are found just west of the monument that, to date, have not been documented at the monument. For reptiles, the highest species richness in the region is in areas below 1000 m elevation in desert communities. Based on our extensive surveys, we found 17 species of amphibians and reptiles in Bonita and lower Rhyolite canyons and the semi-desert grasslands compared to seven species in the higher elevation sites, though survey effort was considerably lower in the higher elevation areas. However, this pattern is consistent with known patterns of species richness in the region: where richness is highest in the middle elevation desert and semi-desert grassland areas; and progressively lower higher up the altitudinal gradient.

Almost all of the species that have been found infrequently at the monument (e.g., red-spotted toad, Great Plains skink, desert grassland whiptail, coachwhip, and green rat snake) have been found on the west side of the monument, either in the riparian area or in open areas of Bonita Canyon. These areas, and the more remote northwestern corner of the monument, contain the only areas of semi-desert grassland and mesic riparian vegetation. As such, they constitute the upper elevation extent of many species of reptiles and amphibians for the region. Therefore, the population dynamics of these species on lands outside of the monument can play a vital role in determining whether these species will occur in the monument. If we consider the monument to have marginal habitat for most of these species, whose core populations lay well outside of the monument, dispersal to the monument will only take place when either the conditions are not good in the core or when populations increase and dispersal (particularly of young individuals) is necessary. However, with the increasing conversion of the semi-desert grasslands outside of the monument to housing development and because of high mortality along roads (Rosen and Lowe 1994, Hall and Steidl 2003), the ability of animals to safely occupy new areas may not be possible. Therefore, the monument will likely experience a gradual decline of species richness for these species.

Comparison to Prival and Schwalbe (2000)

Prival and Schwalbe (2000) used visual encounter surveys to search for rock rattlesnakes and other commercially valuable snake species. They surveyed lower Rhyolite Canyon and the Echo Canyon Loop for a total of 160.8 person-hours in Rhyolite Canyon and 188.8 person hours in Echo Canyon Loop. Because plot, line transects, and extensive surveys were not in exactly the same locations, it makes comparisons between our studies difficult. However, the road surveys were in the same location. Prival and Schwalbe observed an average of 1.1 animals per survey hour compared to our 2.3 animals per hour. The species observed during each of the studies were also different. Prival and Schwalbe observed three species of snake (nightsnake, black-necked garter snake, and black-tailed rattlesnake) and we found nine species, including all the species found by Prival and Schwalbe. Prival and Schwalbe found one species during road surveys, red-spotted toad, which was not found by any other study.

Chapter 5: Bird Inventory

Previous Research

Fischer (2002) created the most recent checklist for the monument based on data from a number of earlier checklists and on distribution maps for the region (see citations therein). Snyder (1995) surveyed for raptors, including the Mexican spotted owl, which monument personnel survey for each year. From 1997 to 2002, personnel from the Southern Arizona Bird Observatory banded birds as a part of the Monitoring Avian Productivity and Survivorship (MAPS) program (DeSante and O'Grady 2000). MAPS data from 1997 to 2001 were summarized by Martinez and Hubbard (2003). Conway and Kirkpatrick (2001) surveyed for buff-breasted flycatchers in Bonita, Rhyolite, and Sarah Demming canyons on a single survey day in 2000. They also recorded all birds seen or heard at each survey station. In 2003 and 2004, Susan Wethington and others banded hummingbirds at the monument and other areas of the southwest as part of the Hummingbird Monitoring Network (Wethington 2004). To our knowledge, no effort has been made to determine the distribution and/or relative abundance of birds throughout the monument. Bird surveys, as part of pilot monitoring effort, also took place in the summer of 2005 (BFP, *unpublished data*).

Although there has been no detailed inventory of the bird community at the monument, other areas of the Chiricahua Mountains have received considerable attention. Much of this research focused on bird community structure across elevational gradients (e.g., Marshall 1957, Balda 1969) and much of our early knowledge of bird community structure in the southwest came from these studies. Many other single-species studies have also taken place in the mountain range. In 1996, Kathy Heitt (unpublished data; copy at I&M office in Tucson) created an annotated bibliography of over 500 citations related to birds of the Chiricahua Mountains and the region.

Methods

We surveyed for birds at Chiricahua NM in 2002, 2003, and 2004. The majority of our research took place in the springs of 2003 and 2004. We used four field methods: variable circular-plot (VCP) counts for diurnal breeding birds, nocturnal surveys for owls and nightjars, line transects for winter birds (i.e., 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 monument 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 our primary 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. 2002). This 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, which added many migratory species to our list.

We also sampled vegetation around repeat-visit VCP survey stations. Vegetation structure and plant species composition are important predictors of bird species richness or the presence of particular species (Rice et al. 1984, Strong and Bock 1990, Powell and Steidl 2002).

In most cases, we do not report observations that failed to determine species (e.g., "unknown woodpecker"). Ravens are an exception. Both Chihuahuan and common ravens occur at the monument and they are difficult to differentiate unless 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 Designs

We subjectively located all survey stations and transect sections (Figs. 5.1, 5.2). Because of the

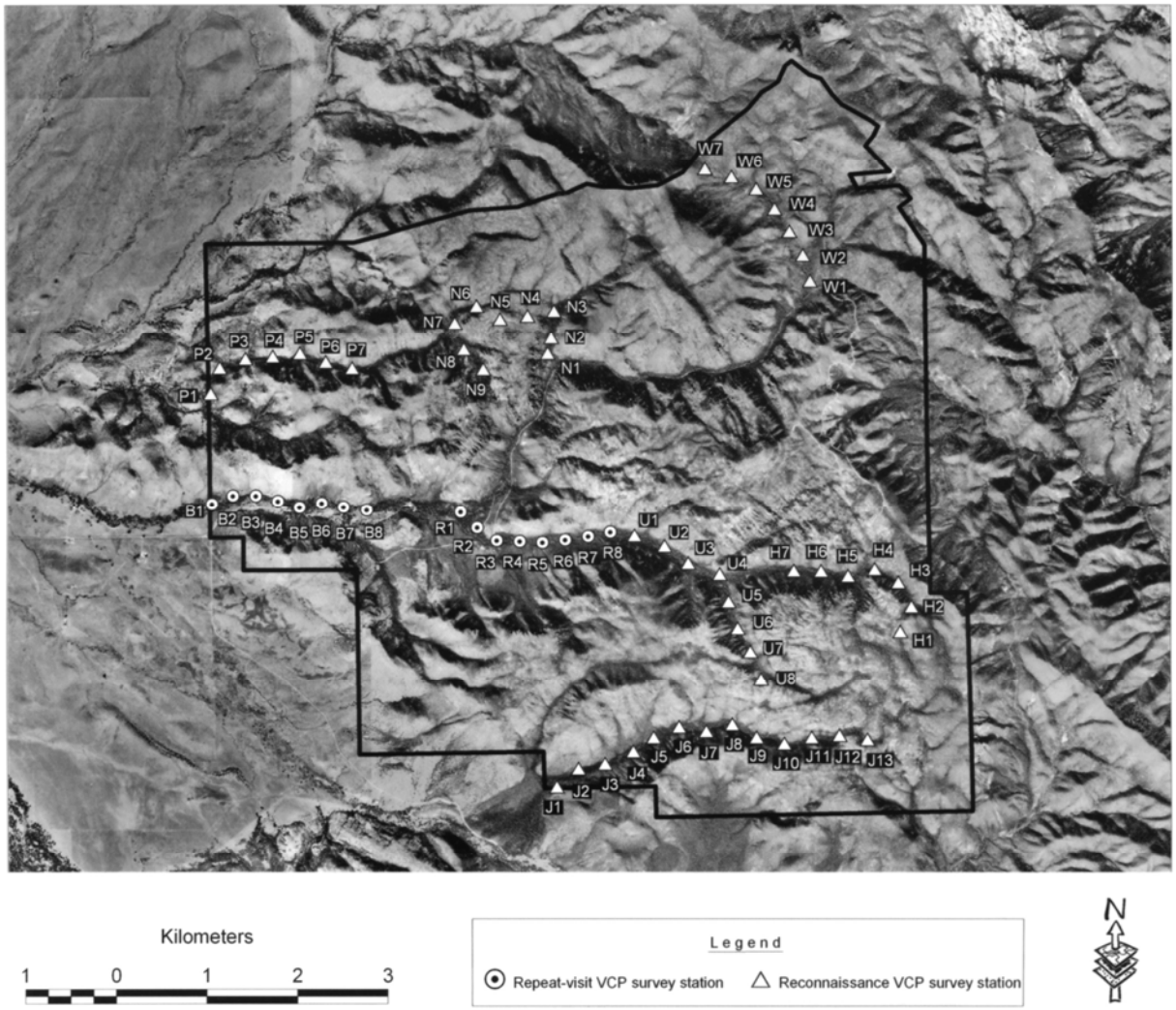

Figure 5.1. Locations of VCP bird-survey stations, Chiricahua NM, 2003 and 2004. B = Lower Bonita Canyon; R = Rhyolite Canyon; P = Picket Canyon; N = Natural Bridge Trail; W = Whitetail Pass; H = Hunt Canyon; J = Jesse James Canyon; U = Upper Bonita.

inaccessibility of most areas of the monument, we conducted reconnaissance VCP and nocturnal surveys along trails and roads (Figs. 5.1, 5.2).

Diurnal Surveys: VCP

Field Methods - Repeat-visit VCP Survey

We used the variable circular-plot (VCP) 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 established two transects in 2003 that we surveyed repeatedly in both 2003 and 2004. Each transect consisted of eight stations, located a minimum of 250 m apart to maintain independence among observations at the station. We surveyed each year from mid April through late June, the period of peak breeding activity for most species in southern Arizona.

Each year we visited both transects (Lower Bonita and Rhyolite canyons) at least five times each (Table 5.1). On each visit, we alternated the order in which we surveyed stations (along

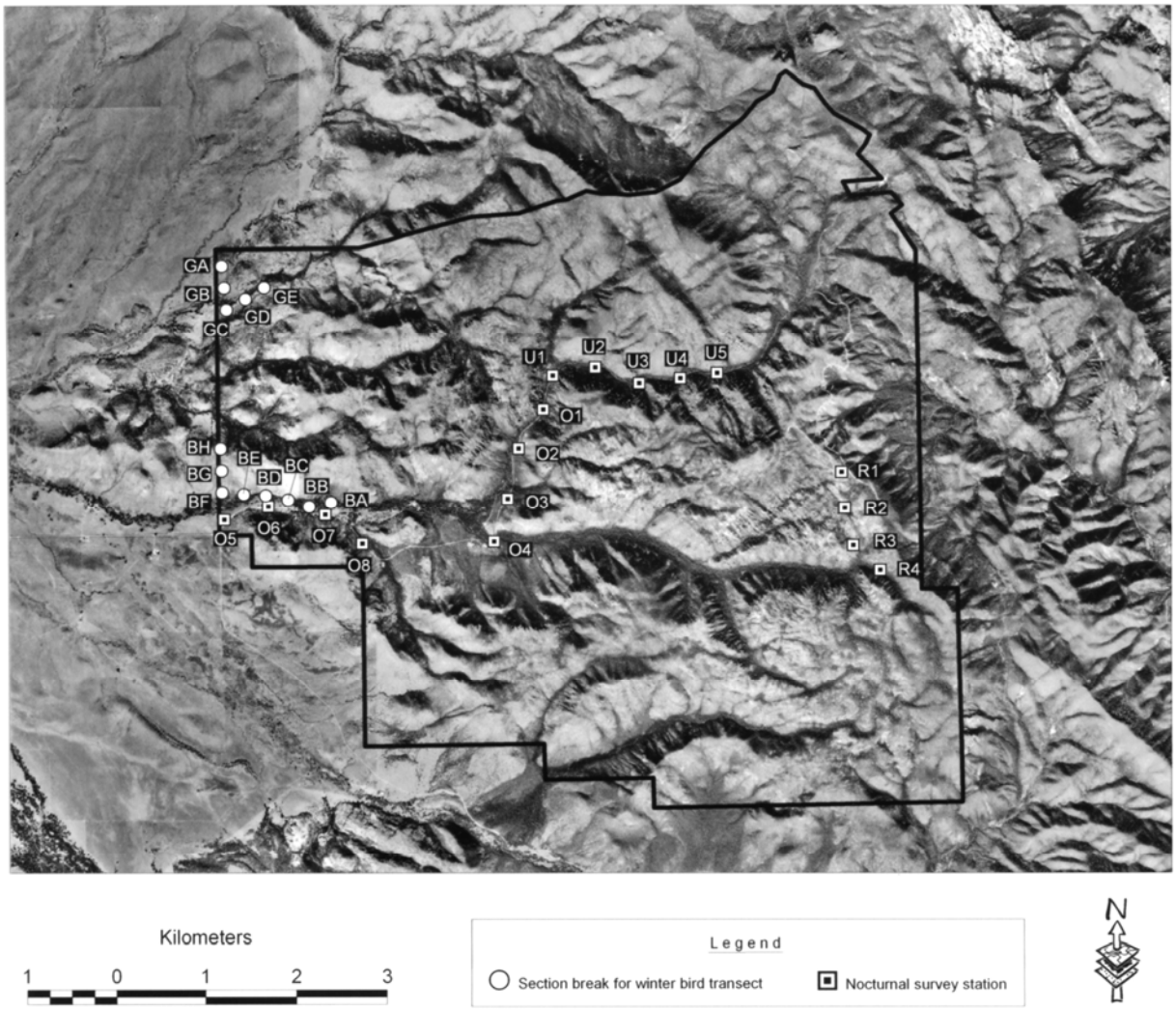

Figure 5.2. Locations of line-transect and nocturnal survey stations for birds, Chiricahua NM, 2002–2004. The first letter of the line-transect represents the location (B = Bonita, G = Grama) and the second letter represents the section. For nocturnal survey stations: O = Owl; U = Upper Road; R = Rhyolite.

a transect) to minimize bias by observer, time of day, and direction of travel. We did not survey when wind exceeded 15 km/h or when precipitation exceeded an intermittent drizzle. We began bird surveys approximately 30 minutes before sunrise and concluded them no later than three hours after sunrise.

We recorded a number of environmental variables at the beginning and end of each survey: wind speed (Beaufort scale), presence and severity of rain (qualitative assessment), air temperature (ºF), 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 from the start of the active period), and the sex and 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. If we observed a species during the "passive" count period (between the eight-minute counts), which had not been recorded previously at a station on that visit, we recorded its distance to the nearest station.

Effort - Repeat-visit VCP Surveys

We visited each of the eight stations along (1) the Lower Bonita Canyon transect five times in 2003 and seven times in 2004; and (2) the Rhyolite Canyon transect five times in 2003 and six times in 2004 (Table 5.1). We visited each station for eight minutes.

Field Method - Reconnaissance VCP Surveys

Most of our survey effort was focused on the two repeat-visit transects, but this left much of the monument unsurveyed. Therefore, to get better spatial coverage and still be able to make comparisons among transects, we established an additional seven transects, located throughout the monument, that we visited once in both 2003 and 2004 (one transect was surveyed in 2002 and 2004; Table 5.1, Fig. 5.1). For data collection we followed the same protocol as for repeat-visit VCPs except that we spent five minutes at each station (instead of eight minutes) and the distance between stations was usually >300 m.

Effort - Reconnaissance VCP Surveys

The number of survey stations along each transect ranged from seven to 13 (Table 5.1). We visited each station for five minutes. We visited each transect twice.

Analyses - All VCP Methods

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 (total number of visits multiplied by total number of stations). We reduced our full collection of observations for each repeat-visit VCP station (N = 2,364; 1,335 and 1,029 for Lower Bonita Canyon and Rhyolite Canyon transects, respectively) to a subset of data (n = 1,331; 729 and 602 for Lower Bonita Canyon and Rhyolite Canyon transects, respectively) that was more appropriate for estimating relative abundance. We used

Table 5.1. Summary of bird-survey effort, Chiricahua NM, 2002–2004. Sample size was used to calculate relative abundance for each transect and year.

Plot method	Transect name	Year	Number of stations	Number of visits	Sample size
Repeat-visit VCP	Lower Bonita Canyon	2003	8	5	40
		2004	8	7	56
	Rhyolite Canyon	2003	8	5	40
		2004	8	6	48
Reconnaissance VCP	Upper Bonita Canyon	2002	9	1	9
		2004	9	1	9
	Hunt Canyon	2003	7	1	7
		2004	7	1	7
	Jesse James Canyon	2003	13	1	13
		2004	13	1	13
	Natural Bridge Trail	2003	9	1	9
		2004	8	1	8
	Picket Canyon	2003	7	1	7
		2004	7	1	7
	Upper Rhyolite Canyon	2003	8	1	8
		2004	8	1	8
	Whitetail Pass	2003	7	1	7
		2004	7	1	7
Line-transect	Bonita Canyon	2002/2003	6-7	5	34
	Grama	2002/2003	4	3	12
Nocturnal Survey	Owl	2002	4	1	4
		2003	7-8	4	31
		2004	8	3	24
	Rhyolite	2003	4	1	4
	Upper Road	2003	2-3	2	5

only those detections that occurred ≤ 75 m from count stations (thereby excluding 446 and 321 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; for a review of factors influencing detectability, see Anderson (2001) and Farnsworth et al. (2002). We also excluded observations of birds that were flying over the station (87 and 56 observations, respectively), birds observed outside of the eight-minute count period (109 and 53 observations, respectively), and unknown species (15 and 15 observations, respectively). Some observations met more than one of these criteria for exclusion from analysis.

For reconnaissance VCP transects, we calculated relative abundance in the same way as for repeat-visit VCP transects. We do not make comparisons between reconnaissance and repeat-visit transects because sample sizes for reconnaissance VCP transects were inadequate for comparisons. Finally, we make comparisons of parameters and communities between years based on qualitative assessment of relative abundance and do not employ statistics, such as t-tests, to establish statistical differences of individual species between years.

Line-transect Surveys

Field Methods

We used a modified line-transect method (Bibby et al. 2002) to survey for birds from October 2002 to January 2003. Line transects differ from station transects (used in VCP surveys) in that an observer records birds seen or heard while the observer walks a line, rather than stands at a series of stations. The transect method is more effective during the non-breeding season because bird vocalizations are less conspicuous and frequent, and therefore birds tend to be more difficult to detect (Bibby et al. 2002).

We established two transects at the monument (Fig. 5.2). One transect, Lower Bonita Canyon, corresponded to the repeat-visit VCP transect of the same name. We established the Grama transect, located in the northwest corner of the monument, because that area had the largest section of semi-desert grassland in the monument, and this community has some of the highest species richness of any vegetation community during the non-breeding season.

Transects were broken into sections of approximately 250 m in length. For the Lower Bonita Canyon transect, the start and finish locations corresponded to the repeat-visit VCP. 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 VCP methods for details). We began surveys about 30 minutes after sunrise and continued until we completed the transect. As with VCP 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: ≤ 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", and we did not use techniques to attract birds (e.g., "pishing").

Effort

We surveyed each section of both transects at least three times in the winter of 2002 and 2003 (Table 5.1).

Analysis

Due to the low number of observations (n = 279) within 100 m of the transect lines, we used all observations (except unknown species; n = 321) to estimate abundance.

Nocturnal Surveys

Field Methods

To survey for owls we broadcast commercially available vocalizations (Colver et al. 1999) using a compact disc player and broadcaster (Bibby et al. 2002) and recorded other nocturnal species (nighthawks and poorwills) when detected. We established two nocturnal survey transects (Owl

and Upper Road) along the main access road and one in Rhyolite Canyon (Fig. 5.1). The Owl, Upper Road, and Rhyolite Canyon transects had six, five, and four stations, respectively, that were spaced a minimum of 500 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 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, flammulated, northern pygmy, northern saw-whet, western screech, and whiskered screech-owls. We excluded great horned owl from the broadcast sequence because of their aggressive behavior toward other owls. We did not survey for the Mexican spotted owl because that would have required a specific protocol and because the monument staff survey annually for them.

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 the Owl transect once in 2002, four times in 2003, and four times in 2004. We surveyed the Rhyolite and Upper Road transects once and twice, respectively, in 2003 only (Table 5.1).

Analysis

We calculated relative abundance as per VCP surveys.

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 observations using the standardized classification system, developed by the North American Ornithological Atlas Committee (NAOAC 1990), which characterizes 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 standardized and incidental surveys.

Analysis

We report frequency counts of incidental and breeding observations; we could not calculate relative abundance because it was not possible to standardize effort for this survey method.

Vegetation Sampling at Repeat-Visit VCP Stations

In 2004, we sampled vegetation associated with each of the repeat-visit VCP stations. 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 1999) 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 for a given category within 25 m of the plot center, we indicated this in the species column. For each individual plant, we recorded 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 1999). We collected these data to characterize gross vegetation characteristics around survey stations. In the event that future bird surveys detect marked changes in species or communities, the vegetation data reported in Appendix I will provide potential explanatory variables.

Results

We found 141 species during the two years of the study: 105 species during VCP surveys, 56 species during line-transect surveys, seven species during nocturnal surveys, and 100 species during incidental observations (Appendix C). We found 14 species that had not been previously recorded at the monument including: northern beardless tyrannulet, buff-breasted flycatcher, Bendire's thrasher, yellow warbler, summer tanager, northern cardinal, and pyrrhuloxia. Species of concern (by the U.S. Fish and Wildlife Service) that we found were: peregrine falcon, Mexican spotted owl, buff-breasted flycatcher, and loggerhead shrike. Based on a summary of our data and the existing data for the monument by Fischer (2002) and the Monitoring Avian Productivity and Survivorship program (MAPS), there have been 190 species of birds confirmed to occur at the monument (Appendix C).

Repeat-visit VCP Transects

We found 92 species based on all observations from repeat-visit VCP transects (Appendix C); the most species occurred along the Lower Bonita Canyon transect (n = 76) and fewer along the Rhyolite Canyon transect (n = 63). We found 29 species on the Lower Bonita Canyon transect and 16 species at the Rhyolite Canyon transect that we did not find at stations along the other transect. Among the species that we found only at the Lower Bonita Canyon transect, there were many common species including: Cassin's kingbird, house finch, canyon towhee, northern mockingbird, cactus wren, black-throated sparrow, Gambel's quail, and Lucy's warbler. Although not completely absent from the Rhyolite Canyon transect, the white-winged dove, brown-headed cowbird, and ladder-backed woodpecker were far more common along the Lower Bonita Canyon transect. In general, these species are more typically associated with open upland and desert riparian vegetation communities. Species that we found only along the Rhyolite Canyon transect included the painted redstart, northern pygmy-owl, and Grace's warbler. These species are primarily associated with pine-oak woodlands as are: white-breasted nuthatch, spotted towhee, black-headed grosbeak, and black-throated gray warbler, all of which were more common along the Rhyolite Canyon transect. Species that were similarly common along both transects included: ash-throated

flycatcher, acorn woodpecker, canyon wren, plumbeous vireo, Hutton's vireo, hepatic tanager, and Scott's oriole.

We were able to calculate relative abundance for 59 of the 76 species that we found along the Lower Bonita Canyon transect (Table 5.3). Each year there were 11 species that we did not record within 75 m of the transect stations that were recorded on the other year. Mostly these were uncommon species that we only recorded a few times. The most abundant species, based on an average of both years, were Cassin's kingbird, Bewick's wren, and house finch. Among the most common species, we recorded inter-annual differences in relative abundance for mourning and white-winged doves, dusky-capped flycatcher, Cassin's kingbird, brown-headed cowbird, and house finch. All of these species had higher mean relative abundance estimates in 2004 than in 2003 (see below for additional inter-annual differences).

We were able to calculate relative abundance for 45 of the 63 species that we observed along the Rhyolite Canyon transect: 29 species in 2003 and 40 species in 2004 (Table 5.3). The most common species, based on an average of both years, were the Mexican jay, dusky-capped flycatcher, Bewick's wren, and black-throated gray warbler. Two of the most common species found in 2004 (bushtit and brown creeper) were not found in 2003 and the acorn woodpecker and dusky-capped flycatcher had higher relative abundance estimates in 2004 than in 2003.

Among all species for which we were able to calculate relative abundance, estimates were greater in 2004 (0.226 ± 0.043) than in 2003 (0.133 ± 0.022) for the Lower Bonita Canyon transect (two-sample t-test, $t_{96} = 1.916$, $P > 0.01$) but were not different for the Rhyolite Canyon transect (2003 = 0.23 ± 0.045; 2004 = 0.22 ± 0.038; $t_{67} = 0.165$, $P = 0.87$). Difference in relative abundance estimates may have been a reflection of differences in population sizes, but could also have more likely reflected observer differences.

Reconnaissance VCP Transects

We found 69 species during visits to reconnaissance VCP transects in 2003 and 2004. Of these we were able to calculate relative abundance for 58 species (Table 5.4). The most widespread species, based on their presence at all or all but one transect, were: Mexican jay, bushtit, Bewick's wren, black-throated gray warbler, hepatic tanager, and spotted towhee. The mean number of species per transect was 24 Upper Bonita Canyon had the highest species richness ($n = 35$), though species richness and composition varied considerably within transects. For example, species richness at Whitetail Pass was nine in 2003 and 20 in 2004 (Table 5.4).

Line-transect Surveys

We found 58 species during surveys along two line-transects (Table 5.5). We found 31 species along the Grama transect and 50 species along the Lower Bonita Canyon transect, though the survey effort was much greater on the Lower Bonita Canyon transect. The most common species along the Grama transect were the chipping sparrow, dark-eyed junco, white-crowned sparrow, and Mexican jay and the most common species along the Lower Bonita Canyon transect were the chipping sparrow, Gambel's quail, and ruby-crowned kinglet (Table 5.5). Using this method we found six species that we did not find using any other survey method.

Nocturnal Surveys

We found seven species during nocturnal surveys in 2002, 2003, and 2004 (Table 5.6). We found no species at the Rhyolite Canyon transect and one species (whip-poor-will; four observations) at the Upper Road transect. We found seven species (five owls and two nightjars) in 2003 on the Owl transect, although we also surveyed more during that year (Table 5.1). We found the whiskered screech-owl in all three years and it was among the most common species in 2003 (Table 5.6). The elf owl was the most common species in both years, and in 2004 we found an average of one individual per survey station.

Table 5.2. Number of observations (sum) and relative abundance (mean ± SE) of birds during repeat-visit VCP surveys, Lower Bonita Canyon transect, Chiricahua NM, 2003 and 2004.

	2003 (*n* = 39)			2004 (*n* = 56)			2003 and 2004
Species	Sum	Mean	SE	Sum	Mean	SE	Mean
Gambel's quail	6	0.15	0.113	5	0.09	0.059	0.12
Cooper's hawk	3	0.08	0.057				0.03
white-winged dove	3	0.08	0.057	20	0.36	0.082	0.24
mourning dove	1	0.03	0.026	20	0.36	0.100	0.22
black-chinned hummingbird	2	0.05	0.036	7	0.13	0.051	0.09
broad-tailed hummingbird				9	0.16	0.056	0.09
acorn woodpecker	3	0.08	0.043	5	0.09	0.046	0.08
ladder-backed woodpecker				8	0.14	0.047	0.08
Arizona woodpecker				2	0.04	0.025	0.02
northern flicker	4	0.10	0.049	3	0.05	0.040	0.07
northern beardless-tyrannulet	3	0.08	0.043				0.03
western wood-pewee	2	0.05	0.036	27	0.48	0.088	0.31
gray flycatcher	2	0.05	0.036				0.02
Say's phoebe				3	0.05	0.030	0.03
dusky-capped flycatcher	3	0.08	0.043	28	0.50	0.111	0.33
ash-throated flycatcher	9	0.23	0.078	23	0.41	0.107	0.34
Cassin's kingbird	32	0.82	0.204	94	1.68	0.165	1.33
plumbeous vireo	4	0.10	0.049	12	0.21	0.055	0.17
Hutton's vireo	2	0.05	0.036	6	0.11	0.049	0.08
warbling vireo				2	0.04	0.025	0.02
Mexican jay	12	0.31	0.161	21	0.38	0.131	0.35
bridled titmouse	14	0.36	0.140	5	0.09	0.046	0.20
juniper titmouse				4	0.07	0.035	0.04
verdin	4	0.10	0.049				0.04
bushtit	4	0.10	0.080	22	0.39	0.150	0.27
white-breasted nuthatch	1	0.03	0.026	2	0.04	0.025	0.03
brown creeper	3	0.08	0.043				0.03
cactus wren	9	0.23	0.068	13	0.23	0.088	0.23
rock wren				1	0.02	0.018	0.01
canyon wren	1	0.03	0.026				0.01
Bewick's wren	24	0.62	0.094	64	1.14	0.118	0.93
house wren				2	0.04	0.025	0.02
ruby-crowned kinglet	4	0.10	0.049	3	0.05	0.030	0.07
American robin	1	0.03	0.026	4	0.07	0.035	0.05
northern mockingbird	3	0.08	0.043	11	0.20	0.069	0.15
Lucy's warbler	1	0.03	0.026	11	0.20	0.069	0.13
yellow warbler	1	0.03	0.026				0.01
yellow-rumped warbler	10	0.26	0.102	2	0.04	0.025	0.13
black-throated gray warbler	11	0.28	0.082	15	0.27	0.074	0.27
Townsend's warbler	1	0.03	0.026				0.01
Wilson's warbler	3	0.08	0.043	1	0.02	0.018	0.04
hepatic tanager	5	0.13	0.066	23	0.41	0.084	0.29
summer tanager	2	0.05	0.036	4	0.07	0.035	0.06
green-tailed towhee	1	0.03	0.026				0.01
spotted towhee	7	0.18	0.062	1	0.02	0.018	0.08
canyon towhee	10	0.26	0.102	19	0.34	0.082	0.31
rufous-crowned sparrow	3	0.08	0.043	1	0.02	0.018	0.04
chipping sparrow	20	0.51	0.332				0.21
black-throated sparrow	2	0.05	0.051	8	0.14	0.047	0.11
gray-headed junco	3	0.08	0.057				0.03
northern cardinal	1	0.03	0.026	4	0.07	0.035	0.05
black-headed grosbeak	1	0.03	0.026	10	0.18	0.068	0.12
blue grosbeak				2	0.04	0.025	0.02
brown-headed cowbird	1	0.03	0.026	17	0.30	0.072	0.19
hooded oriole				1	0.02	0.018	0.01
Bullock's oriole				9	0.16	0.056	0.09
Scott's oriole	5	0.13	0.054	3	0.05	0.040	0.08
house finch	5	0.13	0.054	42	0.75	0.153	0.49
lesser goldfinch	4	0.10	0.080	7	0.13	0.051	0.12

Table 5.3. Number of observations (sum) and relative abundance (mean ± SE) of birds during repeat-visit VCP surveys, Rhyolite Canyon transect, Chiricahua NM, 2003 and 2004.

	2003 (*n* = 38)		2004 (*n* = 48)	
Species	Sum	SE	Sum	SE
Montezuma quail	1	0.026		
band-tailed pigeon	1	0.026		
mourning dove	6	0.060	1	0.021
northern pygmy-owl			1	0.021
black-chinned hummingbird	1	0.026		
broad-tailed hummingbird			1	0.021
acorn woodpecker	1	0.026	13	0.083
ladder-backed woodpecker			1	0.021
Arizona woodpecker	7	0.091	17	0.076
northern flicker	4	0.050	9	0.064
olive-sided flycatcher			1	0.021
western wood-pewee	12	0.107	18	0.092
cordilleran flycatcher			1	0.021
dusky-capped flycatcher	14	0.096	50	0.302
ash-throated flycatcher	7	0.064	16	0.096
brown-crested flycatcher			2	0.029
sulphur-bellied flycatcher			4	0.040
plumbeous vireo	9	0.079	12	0.070
Hutton's vireo	8	0.086	5	0.045
warbling vireo	2	0.037	1	0.021
Mexican jay	39	0.286	32	0.144
bridled titmouse	19	0.154	26	0.133
bushtit			14	0.160
white-breasted nuthatch	7	0.064	7	0.059
brown creeper			13	0.077
canyon wren	3	0.044		
Bewick's wren	21	0.111	33	0.104
house wren			1	0.021
ruby-crowned kinglet	10	0.082	1	0.021
blue-gray gnatcatcher			3	0.046
hermit thrush			2	0.029
American robin	14	0.109	19	0.077
Virginia's warbler	1	0.026	1	0.021
yellow-rumped warbler	2	0.053	1	0.021
black-throated gray warbler	21	0.098	41	0.115
Grace's warbler	6	0.060		
Wilson's warbler			1	0.021
red-faced warbler			1	0.021
painted redstart	3	0.044	4	0.040
hepatic tanager	2	0.037	22	0.089
western tanager			2	0.029
spotted towhee	12	0.093	12	0.063
black-headed grosbeak	6	0.071	16	0.075
brown-headed cowbird			4	0.040
Scott's oriole	12	0.085	13	0.071

Incidental and Breeding Observations

We recorded observations of 100 species outside of formal surveys, 19 of which were not found during other survey methods (Appendix C). Species of note include: wild turkey, peregrine falcon, zone-tailed hawk, Mexican spotted owl, and buff-breasted flycatcher. We found evidence of nesting for 21 species, including the prairie falcon (Table 5.7). The most breeding observations were for the Mexican jay and hepatic tanager.

General Vegetation Characteristics at Repeat-visit VCP Stations

We subjectively placed the two repeat-visit VCP transects in areas that we believed would have the highest species richness and had the easiest access: Bonita and Rhyolite canyons (Fig. 5.3 see also Fig. 5.1 for aerial view). The Bonita Canyon transect incorporated elements of riparian vegetation such as Arizona sycamore and Arizona cypress. These species, along with some juniper and oak, provided a narrow band of vegetation

Table 5.4. Mean relative abundance of birds observed during reconnaissance VCP surveys, by transect, Chiricahua NM, 2002–2004.

	Picket		Whitetail Pass		Upper Rhyolite Canyon		Natural Bridge Trail		Jesse James Canyon		Hunt Canyon		Upper Bonita Canyon	
Species	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2002	2004
mourning dove	0.3	0.6						0.1						0.1
common ground-dove									0.2					
northern pygmy-owl											0.1			
broad-billed hummingbird								0.1						
magnificent hummingbird							0.1		0.1					
broad-tailed hummingbird		0.1		0.1						0.1				
acorn woodpecker													0.7	0.1
ladder-backed woodpecker	0.1													
hairy woodpecker						0.1					0.1	0.4		
Arizona woodpecker				0.1						0.3			0.1	0.3
northern flicker					0.1						0.3		0.1	
greater pewee			0.5											
western wood-pewee		0.3	0.3	0.9			0.2	0.1	0.1			0.1	0.3	
Say's phoebe														0.1
dusky-capped flycatcher			0.2	0.4		0.1			0.2	0.4	0.4	0.3	0.1	0.8
ash-throated flycatcher		0.7					0.3	0.1	0.1	0.2	0.1		0.8	0.2
Cassin's kingbird		0.3												0.2
plumbeous vireo			0.3	1.0				0.1					0.2	0.1
Hutton's vireo	0.6			0.1	0.1	0.1				0.3	0.3	0.6		0.1
Steller's jay										0.1	0.3			
western scrub-jay								0.3		0.1				
Mexican jay	1.3			0.7	0.4	1.0	0.8	0.1		0.5	1.1	0.6	0.6	0.6
Mexican chickadee												0.3		
bridled titmouse	0.4	0.3			0.3	0.3	0.1		0.2	0.5	0.6		1.6	0.3
juniper titmouse	0.1						0.1							
bushtit	0.3	0.3	0.7	0.7	0.5	0.5	0.3	0.3	0.4			0.1	0.8	
red-breasted nuthatch												0.1		
white-breasted nuthatch				0.3		0.1	0.2	0.1		0.1	0.1		0.6	0.4
brown creeper					0.3						0.4		0.1	0.1
rock wren	0.1	0.4												
canyon wren					0.3								0.1	
Bewick's wren	1.1	0.7	0.2	0.9	0.1	0.3	0.8	0.8	0.2	1.0	0.1	0.3	0.4	1.2
ruby-crowned kinglet	0.1							0.1			0.4			0.1
blue-gray gnatcatcher										0.1				
Townsend's solitaire	0.3													
hermit thrush	0.3			0.1		0.1								0.1
American robin				0.1	0.3	0.1							0.1	
crissal thrasher		0.1												
orange-crowned warbler														0.1
yellow-rumped warbler														0.6
black-throated gray warbler	0.4			0.4	0.3	0.8		0.6		0.5	0.3	0.1	0.1	1.0
Grace's warbler				0.4	0.1		0.1	0.3			0.1	0.4		
red-faced warbler											0.3	0.6		
painted redstart			0.2	0.1		0.6			0.2	0.1		0.3		0.3
hepatic tanager			0.3		0.1	0.3	0.2	0.5	0.2	0.6		0.9	0.1	0.3
western tanager												0.1		
spotted towhee	0.4		0.5	0.1	0.3		0.8	0.3	0.3	0.5	0.4	0.3	0.8	0.1
canyon towhee							0.1						0.1	
rufous-crowned sparrow	0.3	0.1		0.1				0.3						0.1
black-throated sparrow		0.3						0.1						
dark-eyed junco	1.0													
yellow-eyed junco		0.3		0.1				0.1				0.1		
black-headed grosbeak		0.1		0.4	0.3	0.3		0.6	0.5	0.5		0.1	0.1	0.4
brown-headed cowbird		0.1		0.4				0.1					0.1	
Bullock's oriole										0.1				0.2
Scott's oriole		0.4				0.1	0.2			0.1	0.3			0.2
house finch		0.3											0.6	
lesser goldfinch													0.1	
Species richness by year	16	17	9	20	14	15	14	20	12	19	18	18	23	26
Species richness by site	28		22		20		25		23		27		35	

Table 5.5. Total number of observations (sum) and relative abundance (mean ± SE) of birds observed along line-transects, Chiricahua NM, 2002 and 2003.

	Grama (*n* = 12)			Bonita (*n* = 32)		
Species	Sum	Mean	SE	Sum	Mean	SE
Gambel's quail				30	0.94	0.592
Montezuma quail	1	0.08	0.083			
northern harrier				1	0.03	0.031
red-tailed hawk	3	0.25	0.131	1	0.03	0.031
golden eagle	1	0.08	0.083			
prairie falcon				1	0.03	0.031
mourning dove	1	0.08	0.083			
acorn woodpecker				3	0.09	0.069
Williamson's sapsucker				1	0.03	0.031
red-naped sapsucker				5	0.16	0.079
ladder-backed woodpecker	2	0.17	0.112	4	0.13	0.074
hairy woodpecker				1	0.03	0.031
Arizona woodpecker				3	0.09	0.052
northern flicker	3	0.25	0.131	8	0.25	0.078
Say's phoebe				1	0.03	0.031
Cassin's kingbird				11	0.34	0.199
Hutton's vireo				2	0.06	0.043
Mexican jay	18	1.50	1.077	16	0.50	0.211
common raven				3	0.09	0.069
mountain chickadee	4	0.33	0.256	12	0.38	0.228
bridled titmouse	2	0.17	0.167	20	0.63	0.367
verdin	1	0.08	0.083	1	0.03	0.031
bushtit				3	0.09	0.094
red-breasted nuthatch				1	0.03	0.031
white-breasted nuthatch				3	0.09	0.052
brown creeper				1	0.03	0.031
cactus wren	1	0.08	0.083	7	0.22	0.098
rock wren	2	0.17	0.112	4	0.13	0.059
canyon wren	1	0.08	0.083			
Bewick's wren	4	0.33	0.188	10	0.31	0.105
house wren				1	0.03	0.031
ruby-crowned kinglet	7	0.58	0.288	23	0.72	0.175
western bluebird				21	0.66	0.329
Townsend's solitaire	4	0.33	0.142	1	0.03	0.031
American robin	3	0.25	0.131	2	0.06	0.043
crissal thrasher	1	0.08	0.083			
phainopepla	4	0.33	0.188			
hepatic tanager				3	0.09	0.052
spotted towhee	10	0.83	0.167	17	0.53	0.168
canyon towhee	5	0.42	0.149	19	0.59	0.155
rufous-crowned sparrow	1	0.08	0.083	13	0.41	0.126
chipping sparrow	120	10.00	5.742	69	2.16	1.311
Brewer's sparrow	7	0.58	0.499			
black-chinned sparrow				2	0.06	0.063
vesper sparrow	2	0.17	0.112	1	0.03	0.031
Lincoln's sparrow				2	0.06	0.043
black-throated sparrow	2	0.17	0.112	11	0.34	0.188
white-crowned sparrow	18	1.50	1.077			
dark-eyed junco	23	1.92	1.356	25	0.77	0.395
northern cardinal				1	0.03	0.031
pyrrhuloxia				1	0.03	0.031
western meadowlark				1	0.03	0.031
Cassin's finch				1	0.03	0.031
house finch	1	0.08	0.083	15	0.47	0.294
pine siskin				21	0.66	0.625
lesser goldfinch				7	0.22	0.219

along the canyon bottom. The width and density of vegetation increased on the eastern half of the transect where all species of dominant plants increase in density (Table 5.8). The south-facing slopes and open areas to the south along Bonita Canyon had a variety of scattered shrubs such as Schott's yucca, Apache plume, and catclaw mimosa (Appendix I). The transect ends near the western-most station of the Rhyolite Canyon transect which has much higher density of pine and oaks than the Bonita Canyon transect (Table 5.8). Rhyolite Canyon is narrower and more steep sided than Bonita Canyon. In general, the dense overstory vegetation precluded the establishment of shrubs and subshrubs in the understory. As a result, most of the plants in the understory were young pine and oak trees.

Inventory Completeness

Based on our surveys and a review of past studies and current projects, we believe that the inventory of birds that regularly use the monument is nearly complete. An examination of the species accumulation curve for our work indicates that our effort alone was not sufficient to document all of the species that occur at the monument, though the cumulative number of new species was

Table 5.6. Total number of observations (sum) and relative abundance (mean ± SE) of birds observed during nocturnal surveys, Owl transect, Chiricahua NM, 2002–2004.

	2002 (*n* = 4)			2003 (*n* = 31)			2004 (*n* = 24)		
Species	Sum	Mean	SE	Sum	Mean	SE	Sum	Mean	SE
barn owl				1	0.03	0.032			
western screech-owl	2	0.50	0.500	6	0.19	0.086	1	0.04	0.042
whiskered screech-owl	1	0.25	0.250	10	0.32	0.108	3	0.13	0.069
northern pygmy-owl				2	0.06	0.045	4	0.17	0.098
elf owl				12	0.39	0.120	21	0.88	0.184
common poorwill				7	0.23	0.089	12	0.50	0.147
whip-poor-will				5	0.16	0.067	4	0.17	0.098

Table 5.7. Number of observations for each breeding behavior for birds, from all survey types, Chiricahua NM, 2003 and 2004. Breeding behaviors follow standards set by NAOAC (1990).

	Nest				Adults carrying		Other			
Species	Building	With eggs	With young	Occupied	Food	Nesting material	Distraction displays	Feeding recently fledged young	Recently fledged young	**Totals**
prairie falcon				1						**1**
black-chinned hummingbird	1			3			1			**5**
broad-tailed hummingbird	1	1								**2**
Arizona woodpecker					1					**1**
western wood-pewee				1				1		**2**
dusky-capped flycatcher					1			1		**2**
ash-throated flycatcher			2					1		**3**
Cassin's kingbird	2				1					**3**
plumbeous vireo							1	1		**2**
Mexican jay	3		3	1		1		1		**9**
bridled titmouse					3	1				**4**
bushtit					1	1		1		**3**
white-breasted nuthatch					1					**1**
Bewick's wren					3			1		**4**
Virginia's warbler					1					**1**
black-throated gray warbler					1		1			**2**
painted redstart	1							1	1	**3**
hepatic tanager	3				4					**7**
yellow-eyed junco									1	**1**
black-headed grosbeak	1				1					**2**
Scott's oriole	1	2						1		**4**
Totals	**13**	**3**	**5**	**6**	**18**	**3**	**3**	**9**	**2**	**62**

Figure 5.3. Photographs of bird survey stations along both repeat-visit VCP transects: Bonita Canyon (A and B) and Rhyolite Canyon (C and D). Photo A is looking east from station number 3; B is looking west from station number 5; C is looking north from station number 4; and D is looking east from station number 6. See Fig. 5.1 for location of stations.

approaching an asymptote (Fig. 5.4). Despite a considerable review of existing information from the monument and his own field notes, the list by Fischer (2002) was incomplete; we found 14 species that were not on his list (Appendix C). The MAPS program also found two species (Lucifer and calliope hummingbirds) that were not on Fischer's list. Some of the species that we found to be "new" to the monument, such as mountain chickadee, verdin, Lucy's warbler, and northern cardinal, were not uncommon during our surveys, indicating that, prior to this effort, there had been inadequate research at the monument from which a fairly comprehensive species list could be created.

Because birds are highly mobile animals, it is almost impossible to compile a truly complete list of birds, especially for a place like the Chiricahua Mountains, which is well known for rare species that seldom enter the U.S. from Mexico. Because of the variety of vegetation communities at the monument, and in Bonita Canyon in particular, we believe that rare bird species will be added to the list for many years to come.

Discussion

Based on our research and that by others, Chiricahua NM has a fairly diverse bird community. This diversity results from two main factors. First, the Chiricahua Mountains have one of the highest diversities of landbirds of any area in the United States; many species that are found there have their northern-most distribution in this and nearby mountain ranges. Most of these species are associated with vegetation communities, such as the Madrean pine-oak woodlands, found primarily in Mexico. The monument's location at the northern edge of this Madrean biogeographical province ensures that rare species, such as Lucifer, white-eared, and violet-crowned hummingbirds, and elegant

and eared trogons, are not uncommon visitors to the monument. The second factor determining the diversity of birds at the monument is the variety of biotic communities within the monument itself: from semi-desert grasslands in the northeastern corner to the pine and coniferous forests in the southeastern corner of the monument. The diversity of major vegetation communities and the variety and gradient of topographic features are major determinants of bird diversity in the southwest and elsewhere (e.g., Strong and Bock 1990).

Though they shared some similarities, differences in bird communities were pronounced between the two repeat-visit VCP transects, which are in close proximity to each other (Table 5.2, 5.3). These differences reflected the dominant vegetation of the areas: desert riparian and desert scrub along Lower Bonita Canyon and pine-oak woodland along Rhyolite Canyon. Although many environmental factors influence bird communities, vegetation characteristics are one of the most important predictors of avian community structure (James 1971). Important vegetation characteristics include vertical structure (Cody 1981), horizontal patchiness (Roth 1976, Kotliar and Weins 1990), and floristics (Rice et al. 1984, Strong and Bock 1990). The changes in these resources at the monument are exemplified in the gradient from the tree-lined Bonita Canyon at the western end of the Lower Bonita Canyon transect, to closed-canopy pine-oak woodland along Rhyolite Canyon transect (Table 5.8, Fig. 5.3). Similarly, the bird communities reflected these differences. Species typical of desert riparian or scrub communities include the abundant Cassin's kingbird, house finch, white-winged dove, canyon towhee, cactus wren, black-throated sparrow, and Gambel's quail. The Rhyolite Canyon transect was dominated by species typical of oak woodland community: dusky-capped flycatcher, white-breasted nuthatch, black-throated gray warbler, painted redstart, and black-headed grosbeak. Many of the reconnaissance transects were in high-elevation pine woodlands and we found species commonly associated with those communities such as hairy woodpecker, greater pewee, Steller's jay, Mexican chickadee, red-breasted nuthatch, red-faced warbler, and western tanager (Table 5.4).

The semi-desert grassland vegetation community is represented in the northwestern corner of the monument. This area has likely undergone one of the most dramatic changes in vegetation structure of any area of the monument, and these changes have likely affected the bird community. The principal reasons for these

Table 5.8. Mean density (stems/ha) of the most common tree species at each station along the two repeat-visit VCP transects, Chiricahua NM, 2004. Data summarized from Appendix I. Density derived from individuals observed in the "tree" and "potential cavity-nesting" categories from point-quarter sampling. Only species with ≥5 individuals per station are included in this summary.

		Tree species										
Transect (canyon)	Station	Arizona madrone	Arizona cypress	velvet mesquite	Arizona walnut	alligator juniper	Chihuahuan pine	ponderosa pine	Arizona sycamore	Arizona white oak	Emory oak	silverleaf oak
Bonita	1		4.5	1.4	6.5	11.8					0.8	
	2		2.5	5.0	3.6	6.3			6.0	2.0	5.0	
	3		25.0	26.4		67.5			11.9		19.1	
	4		9.3	3.4	1.8	6.3				1.1	1.3	
	5		8.5			61.5					55.1	
	6		24.4			70.3				31.3	42.5	
	7		32.0	6.4	9.3	37.9			6.4	8.1	27.3	
	8		28.2	2.9	1.4	41.3			5.3	5.3	24.6	
Rhyolite	1		91.6			81.9		7.6	7.6	28.6	38.2	
	2	12.0	29.7			25.8		21.7		51.6	53.5	12.0
	3	8.2	33.0			20.3	20.3	8.8		33.0	12.1	39.5
	4					179.5	118.4	31.8		123.5	91.6	91.6
	5	60.7	7.3				75.3	482.0		684.7		250.1
	6	4.9	2.5			2.5	63.3	28.2		143.7		115.8
	7	29.8	14.9					18.2		72.8		161.6
	8		26.5				20.2	6.2		25.7		95.2

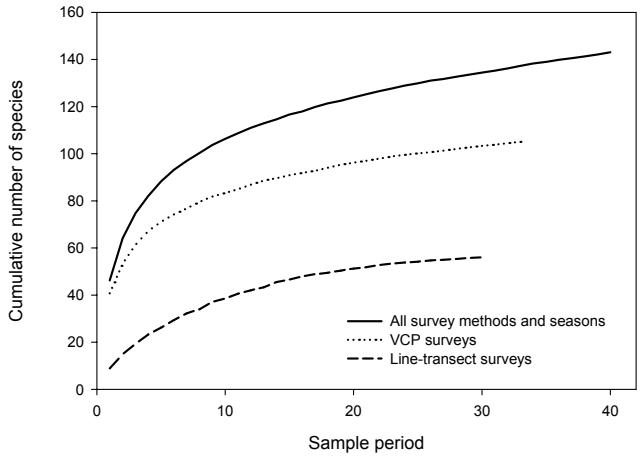

Figure 5.4. Species accumulation curves for bird surveys, Chiricahua NM, 2002–2004. Each sample period for "all survey methods" and "VCP surveys" consists of randomized batches of 100 observations. The batch size for line-transect surveys is 10 observations.

changes are that non-native Lehmann lovegrass has replaced native grass species, and velvet mesquite has become widespread. Since its introduction in the 1930s, Lehmann lovegrass has spread to occupy more than 400,000 ha in southern Arizona, with little indication that its spread is complete (E. L. Geiger, unpublished data). Initial studies indicate that relative abundance of birds and other taxa in these semi-desert grasslands is lower in areas dominated by non-native grasses (Bock et al. 1986). The native velvet mesquite has also increased in density and distribution in southeastern Arizona since the late 1800s, primarily due to disruption of historical fire regimes and overgrazing (Humphrey 1974, Brown 1994, Van Auken 2000). This encroachment has taken place at the monument and this has likely changed the bird community. The loss of native semi-desert grasslands (including the invasion of non-native grasses and its conversion to mesquite woodland) has been identified as a primary factor in population declines of grassland birds as a group (Herkert 1994, Knopf 1994, Peterjohn and Sauer 1999), including: Botteri's, Cassin's, and grasshopper sparrows. We found none of these species in the monument, though they have been found there in the past (Appendix C).

Montane forest birds of the southwestern "sky islands" have evolved in forests that experience low to moderate burns approximately every decade (Ganey et al. 1996, Swetnam and Baisan 1996). Yet active fire suppression has reduced the frequency of these low and moderate burns, which have been replaced by high-intensity burns (Allen 1996, Pyne 1996, Swetnam et al. 1999) that radically alter forest structure (Swetnam and Baisan 1996). Kirkpatrick and Conway (2006), partially using data collected in the monument, found a number of bird species to be positively associated with the occurrence of fire in pine-oak woodlands. In particular, they found Hairy woodpecker, greater pewee, western wood pewee, white-breasted nuthatch, Virginia's warbler, house wren, spotted towhee, and yellow-eyed junco to be positively associated with moderate- to high-intensity fires. With the exception of western wood pewee and white-breasted nuthatch, we found few individuals of the other species (Appendix C). We found a single buff-breasted flycatcher in Picket Canyon, an area that had been recently burned and the understory cleared of vegetation. Buff-breasted flycatchers have a small breeding population in the United States (about 100 individuals and areas of open understory caused by fire appear to be

their preferred habitat (Conway and Kirkpatrick 2001). With the increased use of fire to restore the pine-oak woodland in the monument, there may be a population increase in some species, such as the buff-breasted flycatcher, that prefer an open understory.

One of the most important resources for birds is the sycamore trees that line Bonita Canyon. Although we did not measure resources being used by birds at the monument, we found a number of species that have been known to prefer sycamore trees for nesting including Cassin's kingbird, summer tanager, and lesser goldfinch. Research on bird communities in the southwest 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). This is due, in part, to the variety of microhabitats that riparian vegetation provide for nesting (Powell and Steidl 2002), cover, and foraging. Riparian trees provide an abundance of nest substrates for primary- (i.e., primarily woodpeckers) and secondary-cavity-nesting species (e.g., elegant trogon, Lucy's warbler, and Bewick's wren).

Chapter 6: Mammal Inventory

Previous Research

The inventory of mammals at the monument is nearly complete. Duncan (1990) conducted a comprehensive inventory of small mammals, which also included sightings of medium and large mammals. More recently, Krebbs (2005) completed surveys for bats. Koprowski (2004) surveyed for medium and large mammals using infrared-triggered cameras. We summarize the findings of these studies in Appendix D.

Methods

We surveyed for mammals using three field methods: (1) live trapping for small terrestrial, nocturnal mammals (primarily rodents, herein referred to as "small mammals"), (2) infrared-triggered (Trailmaster) cameras for medium and large mammals, and (3) incidental observations for all mammals.

Spatial Sampling Designs

We trapped small mammals at six plots (01, 05, 06, 09, 10, and 11) in areas previously trapped by Duncan (1990) and five additional plots (02, 03, 04, 07, and 08) in areas that had been trapped previously. These areas included low-elevation riparian areas, semi-desert grasslands (to find northern pygmy mouse) and rocky slopes with oak–juniper vegetation (to find rock pocket mouse) (Fig. 6.1). We chose the location of plots non-randomly to document as many species as possible. We subjectively placed Trailmaster cameras in areas that appeared to have increased animal activity, usually near riparian areas.

Small Mammal Trapping

Field Methods

We trapped small mammals at Chiricahua NM in 2002 (Table 6.1). We used Sherman® live traps (large, folding aluminum or steel, 3 x 3.5 x 9"; H. B. Sherman, Inc., Tallahassee, FL) set in grids with 15-m-spacing among traps arranged in configurations of five rows and five columns (except one plot [05] with one row of five traps and one plot [06] with five rows of 10 traps). We opened and baited (one tablespoon; 16 parts dry oatmeal to one part peanut butter) traps in the evening then checked and closed traps the following morning. We placed a small amount of polyester batting in each trap to prevent mortality from the cold. We marked each captured animal with a semi-permanent marker to facilitate recognition; these "batch marks" appeared to last for the duration of the sampling period (one to three days). For each animal we recorded species, sex, age class (adult, subadult, or juvenile), reproductive condition, weight, and measurements for right-hind foot, tail, ear, head, and body. For males, we recorded reproductive condition as either scrotal or non-reproductive. For females, we recorded reproductive condition as one or more of the following: non-reproducing, open pubis, closed pubis, enlarged nipples, small nipples, lactating, post lactating, or not lactating.

Effort

We trapped 11 plots in 2002 for a total of 687 trap nights. The number of trap nights varied by plot (Table 6.1; see Analysis section below).

Table 6.1. Summary of small-mammal trapping effort, by plot, Chiricahua NM, 2002.

Community type	Plot no.	Nights of trapping	Traps per night	Sprung traps	Trap nights
Riparian	01	4	25	29	85.5
	09	2	25	15	42.5
Rocky Slope	02	4	25	38	81.0
	10	2	25	23	38.5
	11	1	25	21	14.5
Semi-desert Grassland	03	4	25	25	87.5
	04	2	25	9	45.5
	05	1	5	2	4.0
	06	4	50	122	139.0
	07	3	25	12	69.0
	08	4	25	40	80.0

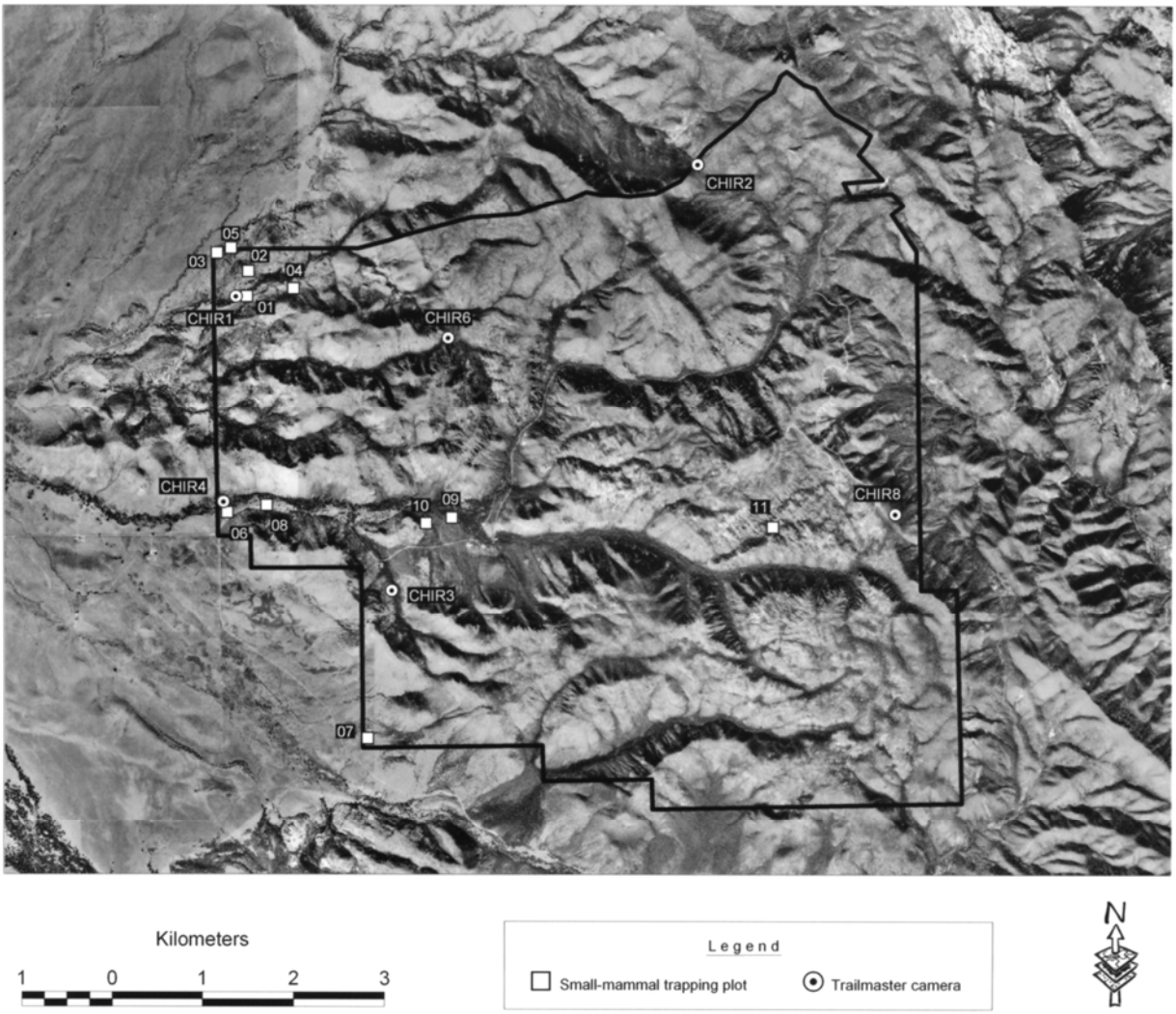

Figure 6.1. Locations of small-mammal trapping plots and Trailmaster cameras, Chiricahua NM, 2002 and 2003.

Analysis

We calculated relative abundance by plot and sampling period (i.e., one to four trapping nights at each plot) by dividing the number of captures by the number of trap nights (number of traps multiplied by number of nights they were open) after accounting for sprung traps (misfired or occupied; Beauvais and Buskirk 1999). Sprung traps reduce trap effort because they are no longer "available" to capture animals; we account for this by multiplying the number of sprung traps by 0.5 (lacking specific information, we estimate sprung traps were available for half of the night; Nelson and Clark 1973). We provide summaries of trapping effort for each plot.

Trailmaster Cameras

Field Methods

We used infrared-triggered cameras (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. 6.2). The transmitter sends an infrared beam to the

receiver at a specified rate (five 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 placed the receiver and transmitter approximately 20 cm above the ground to ensure that medium and large mammals were captured on film but smaller animals, such as rodents and birds, were avoided. We cleared vegetation from the area to avoid disruption of the infrared beam. 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 areas that would capture the most species and highest numbers of animals, typically along animal trails and near water. 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.

Effort

We placed Trailmaster cameras at six sites throughout the monument (Whitetail Creek, Whitetail Pass, Newton Canyon, Bonita Creek, Picket Canyon, and Massai Point; Fig. 6.1). The number of days that each camera was in operation ranged from 20 to 80 days (mean = 28 ± 23 [SD]; Table 6.2) for a total of 284 days of operation. We operated two cameras simultaneously in 2002 and 2003.

Analysis

Infrared-triggered cameras are the most cost-effective and definitive 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 distinguish among most individuals, which precludes unbiased estimates of abundance (i.e., one must attempt to determine if one animal has been photographed repeatedly or a new individual is in each photo). Notable exceptions are species with distinctive markings that can be differentiated among individuals, such as bobcats (Heilbrun et al. 2003). We were not able to use size or physical abnormality to differentiate individuals. Therefore, we report the number of times a species was photographed.

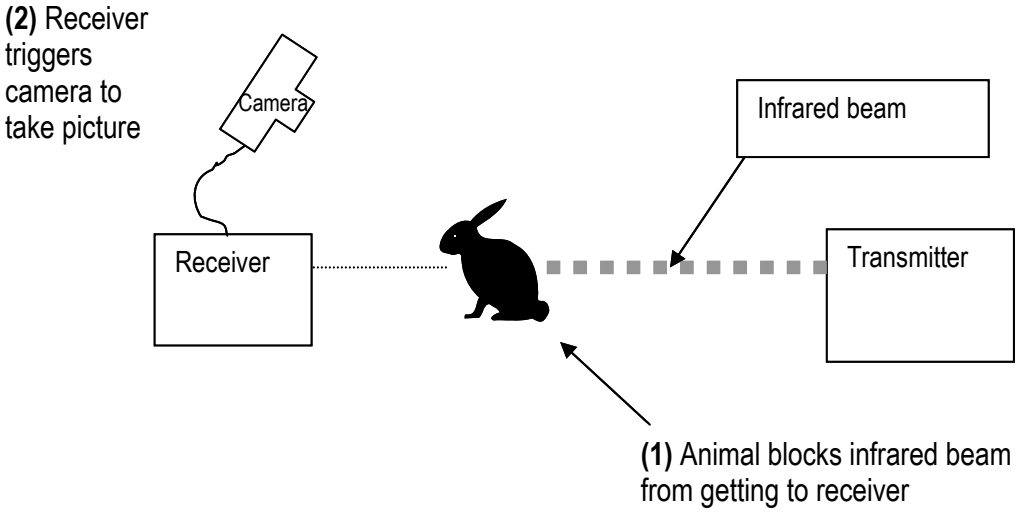

Figure 6.2. Diagram of Trailmaster camera set-up. Image based on Swann et al. (2004).

Incidental Observations

As with other taxa, we recorded UTM coordinates of mammal sightings. Observers from all field crews (e.g., bird crew as well as mammal crew) recorded mammal sightings and signs such as identifiable tracks or scat, and took vouchers photographs when possible.

Results

We observed or documented 34 mammal species in the monument in 2002, 2003, and 2004 (Appendix D), including two species that were new to the monument (rock pocket mouse and northern pygmy mouse). We observed the most species (n = 15) via both incidental observations and small mammal trapping and twelve species with Trailmaster cameras. We documented one non-native species (house mouse) at two plots on the westernmost boundary of the monument (Appendix J). We documented four species of concern: rock pocket mouse, cactus mouse, Mexican fox squirrel, and yellow-nosed cotton rat (Appendix D).

Small-mammal Trapping

We trapped 15 species in 687 trap nights at the monument (Table 6.3). We found the most species (n = 12) in the semi-desert grassland plots compared to the rocky slope (n = 4) and riparian (n = 3) plots. The brush mouse was the most

Table 6.2. Summary of Trailmaster camera effort, Chiricahua NM, 2002 and 2003.

General Location	Camera name	Year	Start date	End date	Number of Days Open
Bonita Creek	CHIR4	2003	10 Feb	12 Feb	2
		2003	18 Feb	14 Mar	24
		2003	19 Mar	9 Apr	21
Whitetail Creek	CHIR1	2002	12 Oct	2 Dec	51
		2002	5 Dec	15 Dec	10
Newton Canyon	CHIR3	2002-2003	27 Dec	16 Jan	20
Picket Canyon	CHIR6	2003	7 May	26 Jul	80
Whitetail Pass	CHIR2	2002	21 Nov	4 Dec	13
		2002-2003	27 Dec	4 Feb	39
Massai Point	CHIR 8	2003	19 Aug	12 Sep	24

Table 6.3. Total number of small mammals trapped (n) and percent relative abundance (RA), by community type, Chiricahua NM, 2002. Data summaries are for all plots, visits, and trap nights within each community type. See Appendix J for additional trapping results by plot and visit. See Table 6.1 for trapping effort by plot.

	Community type					
	Semi-desert grassland		Riparian		Rocky slope	
Species	n	RA	n	RA	n	RA
silky pocket mouse	8	1.9	1	0.8		
rock pocket mouse					4	3.0
hispid pocket mouse	24	5.6				
Merriam's kangaroo rat	4	0.9				
Plains harvest mouse	1	0.2				
cactus mouse					1	0.7
deer mouse or white-footed mouse	1	0.2				
brush mouse	11	2.6	6	4.7	9	6.7
northern rock mouse					2	1.5
northern pygmy mouse	2	0.5				
southern grasshopper mouse	4	0.9				
western white-throated woodrat	3	0.7	1	0.8		
yellow-nosed cotton rat	7	1.6				
Arizona cotton rat	10	2.4				
house mouse	4	0.9				

abundant species on the monument and we found it in all communities (Appendix J). The hispid pocket mouse was the most common species in the semi-desert grassland plots and was not documented in any other community type. Three species (rock pocket mouse, cactus mouse and northern rock mouse) were only found on rocky slope plots. Based on presence across plots, the brush mouse and silky pocket mouse were the most widespread; they were found at four of the 11 plots (Appendix J). The hispid pocket mouse and southern grasshopper mouse were the next most widespread; they were found on three plots. All other species were found on two or fewer plots.

We found no species on two plots (04 and 09) and as many as nine species on a single night of trapping at one plot (06). The most species that we found on a plot was 10 (plot 06), though this was over four nights and 186.5 trap nights. Not accounting for the differences in trapping effort among plots, the mean number of species trapped per plot was 2.7 ± 0.82 (SE).

We trapped one animal in the semi-desert grassland community that was identified as either being a deer mouse or a white-footed mouse (Table 6.3). Both of these species occur at the monument (Duncan 1990), but they are difficult to differentiate. Because the animal was not vouchered, we could not make a positive identification.

Medium and Large Mammals

We took 102 photographs of 12 species of mammals in 284 days of Trailmaster camera operation. The most frequently photographed species were the common gray fox, desert cottontail, and striped skunk (Table 6.4). Because many of the most frequently photographed species had many consecutive photographs on the same roll of film, these species may be less common than the number of photographs indicates.

The number of photographs from each site ranged from five (CHIR3 and CHIR8) to 37 (CHIR4; Table 6.4). The camera at Bonita Creek had the highest number of species (n = 11). The Newton Canyon and Massai Point cameras had the lowest number of species (n = 3 each).

Although eastern and desert cottontails have been documented at the monument (Maza 1965, Hoffmeister 1986, Duncan 1990), we could not differentiate these species from our photographs. According to Hoffmeister (1986), desert cottontails do not occur in ponderosa-fir forest or higher. We photographed cottontails at elevations up to 2073 m in ponderosa pine–mixed conifer association (CHIR8) and down to 1524 m in the semi-desert grasslands (CHIR4). Based on the elevations and community types in which photographs of cottontails were taken, we assume that we documented both species of cottontails.

Table 6.4. Number of photographs of mammals from Trailmaster cameras, by camera number, Chiricahua NM, 2002 and 2003. See Table 6.2 for survey effort.

	Camera						
Species	CHIR1	CHIR2	CHIR3	CHIR4	CHIR6	CHIR8	**Total Number of Photographs**
ringtail		2		3			**5**
unknown skunk				3	1		**4**
striped skunk	1	1		7	2		**11**
hooded skunk	1			1			**2**
white-backed hog-nosed skunk	1					1	**2**
coyote		1		1			**2**
common gray fox	19	5	2	10	1	1	**38**
mountain lion		1		2			**3**
bobcat				2			**2**
eastern cottontail						3	**3**
desert cottontail			1	4	18		**23**
collared peccary		1		3			**4**
unknown deer				1			**1**
white-tailed deer			2				**2**

Incidental Observations

We recorded 71 observations of 15 species outside of formal surveys and observed six species that we did not find during any other survey method: white-nosed coati, cliff chipmunk, Mexican fox squirrel, rock squirrel, American black bear, and an unknown desert shrew (identifiable to species only by DNA tests, found in pitfall traps set out for amphibians and reptiles).

Voucher Specimens and Photographs

We collected 10 voucher specimens representing nine species including one species of bat (California myotis; Appendix G). We collected many of these specimens during the course of fieldwork (e.g., small mammal trapping). Others were found as bones; sometimes bones served as the sole documentation of a species, as in the case of the California myotis. We collected photographs of 14 species from Trailmaster cameras and other incidental photo vouchers (Appendix G).

Inventory Completeness

Based on a list of species that have either been previously observed or are likely in the area (Appendices D and F), we believe that we and others (Duncan 1990, Koprowski 2004, and Krebbs 2005) have recorded or documented almost all of the mammals (68 species) that could occur in the monument. The monument has one of the most complete inventories of any park unit in the Sonoran Desert Network. Yet our effort alone was insufficient for reaching the 90% species goal. To assess completeness of our inventory effort, we address each group separately.

Small Mammals

Based on the species accumulation curve, it appears that we recorded most species that were present in the areas trapped (Fig. 6.3). However, based on number of species previously documented that we did not find (e.g., eight species by Duncan [1990]; Appendix D), we did not reach the 90% species goal for small mammals. Assuming these species are still present at the monument, they represent a substantial portion of the rodent community of the monument.

Medium and Large Mammals

We believe we recorded most of the common medium and large mammals, though the species accumulation curve shows little sign of leveling off (Fig. 6.3). We did not find three species that have been recorded by other studies: northern raccoon, black-tailed jackrabbit, and American badger (Appendix D).

List of Possible Species

There are nine species of mammals that have not been documented but that may occur within the monument:

- **Arizona shrew** has been documented in the Chiricahua Mountains (Hoffmeister 1986), however, if it were to be found at the monument it would most likely be found near the eastern boundary of the monument in high-elevation grasslands (meadows) near water.
- **Long-tailed weasel** has been documented south of the monument (Hoffmeister 1986) and is typically found in mountainous areas where there is available surface water.
- **Western spotted skunk** has been documented near the monument (Hoffmeister 1986) and is likely to occur there.
- **Harris's antelope squirrel** has been documented south of the monument (Hoffmeister 1986) but prefers saltbush-creosote-bursage desert with rocky soils, which is not present in the monument. If present, it would likely occur on the extreme western boundary.
- **Mule deer** are found mostly in semi-desert grasslands and chaparral and are suspected of being present at the monument (Duncan 1990). If present, they will most likely be found on the western portion of the monument.
- Three species of rodents, **Sonoran Desert pocket mouse**, **Bailey's pocket mouse**, and **banner-tailed kangaroo rat**, are thought to occur at the monument during peak population years in the semi-desert grasslands (Duncan 1990). All three have

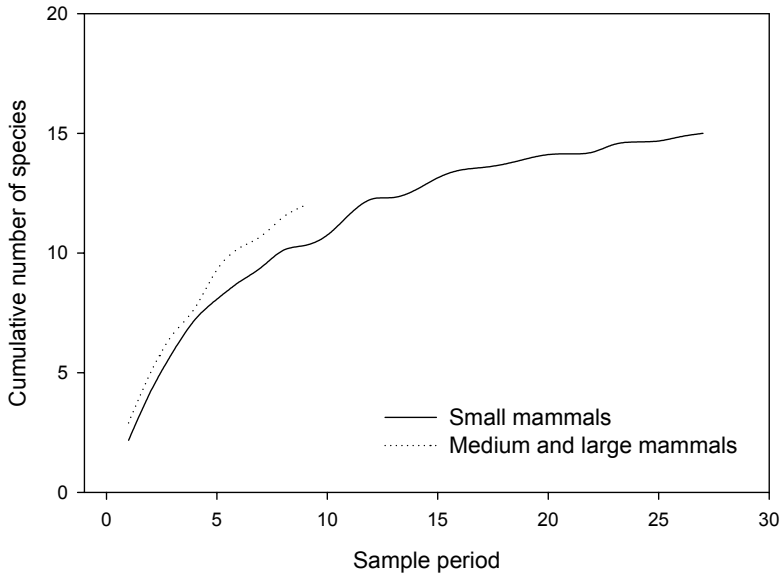

Figure 6.3. Species accumulation curve for mammal surveys, Chiricahua NM, 2002 and 2003. Each sample period represents one visit to one plot or camera site.

been found at nearby Fort Bowie National Historic Site (see citations in Powell et al. 2005b).

- **Porcupine** has been observed at Fort Bowie National Historic Site (Swann et al. 2001) and Duncan (1990) believed they occurred in the monument. There is evidence showing that this species is experiencing a range-wide decline in abundance and distribution (Don Swann, *pers. comm.*).
- **Jaguar** has been documented within the monument by a specimen that was collected in 1912 from Bonita Canyon (Brown 2001, Cahalane 1939). This very rare species has been documented in the region in the last 10 years and may possibly occur at the monument.

Discussion

Extensive inventory work by our effort and others (Hoffmeister 1986, Duncan 1990, Koprowski 2004, and Krebbs 2005), has documented that Chiricahua National Monument has the highest mammal species richness of any park unit in the Sonoran Desert Network. There are several reasons for this extraordinary richness. First, the monument lies at the confluence of Chihuahuan and Sonoran Deserts, and has influences from the Madrean and Rocky Mountain ecological provinces. Because it is at the edge of so many biogeographic zones, the monument has mammal species that are typical of those areas.

Although each species has different habitat requirements, there are some important resources in the monument that are responsible for high species richness for some groups. The semi-desert grassland plant community, on the western edge of the monument, contained more than twice as many small mammal species as any other community in the monument (Table 6.3). Semi-desert grasslands are known to support more species of rodents than any other community in the region, primarily because forbs and grasses are especially dense there and rodents require these for food and cover (Price 1978, Stamp and Ohmart 1979, Hoffmeister 1986, Sureda and Morrison 1999). Although the semi-desert grasslands had the most species, the other communities also contributed to the species richness of the monument, particularly species that require rocky slopes. Species richness of bats is also high at the monument; 20 species have been documented in the last few years (Appendix D). Most insectivorous bats use the

small areas of open water in Bonita Canyon to drink and forage and (presumably) the extensive rock formations throughout the monument to roost and breed. Bonita Canyon is also an important area for medium and large mammals (Table 6.4).

Urbanization of natural areas is having a negative impact on native terrestrial mammal communities and populations throughout the region (e.g., Powell et al. 2004) either because of direct mortality from roads and hunting or harassment by humans and their pets (see Chapter 7 for more information). Although some of these activities occur adjacent to the monument, they are not as extensive as in many other park units in the Sonoran Desert Network. Because the monument is almost completely surrounded by the Coronado National Forest and because much of the Chiricahua Mountains is largely undeveloped, the area provides some of the most unfragmented habitat in the region for wide-ranging species such as many of the medium and large mammals.

Comparison with Duncan (1990)

A majority of our survey effort involved small mammal trapping at plots in the western portion of the monument (semi-desert grasslands), which produced high trap success for species such as the hispid pocket mouse, brush mouse, and Arizona cotton rat (Table 6.3). Although trap success was higher there compared to other community types, we did not find the western harvest mouse, fulvous harvest mouse and tawny-bellied cotton rat, which are normally found in semi-desert grassland areas and that were trapped by Duncan (1990). However, we did trap one new native species for the monument, the northern pygmy mouse, and one non-native species, the house mouse, on the semi-desert grassland plots.

Although the rocky slope plots had lower trap success than the semi-desert grassland plots, they were productive in documenting the presence of three species found only on these plots: rock pocket mouse (new to monument), northern rock mouse and cactus mouse (Table 6.3). Duncan (1990) trapped two species of small mammals common to rocky slopes - the piñon mouse and Mexican woodrat, both trapped in areas of the monument we did not trap. We did not find these species; they may be found with additional trapping effort (see Chapter 8).

Duncan (1990) reported that the brush mouse was the most widespread species at the monument. Our results concur; this species was found in every community type (Table 6.3). However, in semi-desert grassland community, Duncan found the cactus mouse and Ord's kangaroo rat were the most common species. We did not find either of these species on the semi-desert grassland plots and we did not find the Ord's kangaroo rat on any plot. This is of particular concern because both of these species were found in the same area by Duncan. The species that we found to be most common in the semi-desert grassland were the hispid pocket mouse, deer mouse, and western white-throated woodrat. Although Duncan found the deer mouse and western white-throated woodrat to be fairly common in semi-desert grasslands, the hispid pocket mouse was not common. The three species that Duncan found that we did not (western harvest mouse, fulvous harvest mouse, tawny-bellied cotton rat) were not common in his study. In the oak and juniper (rocky slope) community, our results concur with those of Duncan: the cactus mouse and brush mouse were common and the northern rock mouse was occasional. Finally, the cactus mouse was one of the most common species found during Duncan's (1990) study; it was found in all community types that we sampled. However, we found only one individual of this species in the rocky slope community.

Comparison with Koprowski (2004)

It is difficult to compare the results of our Trailmaster camera periods with those of Koprowski (2004) because his report does not provide data by vegetation community or location. Using Trailmaster cameras, we documented four species that Koprowski did not (coyote, eastern cottontail, desert cottontail, and collared peccary) and Koprowski documented four species that we did not (Mexican fox squirrel, white-nosed coati, American black bear, and northern raccoon). We observed all but one of these species (northern raccoon) incidentally. Koprowski also used scent stations to record the presence of mammals. Using this survey method he recorded evidence of the coyote.

Extirpated Species

Two species have been extirpated from the area in and around Chiricahua NM: grizzly bear and Mexican gray wolf. The last grizzly bear in the region was likely killed in 1895 southeast of the Chiricahua Mountains (Cahalane 1939). The Mexican gray wolf is believed to be extirpated from the Chiricahua Mountains; however they do still occur south into Mexico and beginning in the 1990s they were reintroduced into eastern Arizona. Because of these reintroductions, it is possible that this species may occur at the monument in the future.

Chapter 7: Management Implications

Residential Development

One of the most serious threats to the biological richness of the monument may be residential development outside the boundaries. Impacts from development of the semi-desert grasslands are likely to have the most impact on the terrestrial vertebrates through mortality from automobiles (Rosen and Lowe 1994, Trombulak and Frissell 2000, Cain et al. 2003). Fragmentation of land surrounding the monument may disrupt animal movement patterns and cause the loss of habitat for all vertebrates (e.g., Mills et al. 1989, Theobald et al. 1997), particularly larger mammals (Riley et al. 2003). Harassment of native wildlife from household pets is also a major problem and one of the leading causes of native vertebrate mortality (Coleman and Temple 1993).

Effects of Fire on Plants and Vertebrates

Fire is the most important natural event at the monument and it has important, and largely unknown, effects on all plant and vertebrate populations and communities there. Recognizing this, the monument has an active fire management plan that includes the use of prescribed fire to meet the management objective of returning natural fire regimes to some areas of the monument (NPS 2004). In areas of prescribed fires, monument personnel assess fuel loads and monitor changes in vegetation before and after burns. They also assess the potential impact of any prescribed fire on species that are protected under the Endangered Species Act, most notably the Mexican spotted owl. We applaud monument personnel on their use of fire as a restoration tool, but we believe that a more thorough investigation of vertebrate community response, in particular, would provide useful information. Facilitating research on the effects of fire on wildlife (e.g., Goode and Amarillo 2004) is a positive step and would be most helpful if were directed at understanding both a restored fire regime and at the effects of not emulating more natural fire regimes and having to deal with the associated severe fire activity that results from unnaturally long periods between fire events. Because the monument is so small, the management of plant communities and vertebrates would be helped by a landscape perspective. In dealing with management issues that relate to fire, plant community types, and wide ranging animals and their habitat needs, many benefits can be gained by working collaboratively with surrounding managers. The monument may want to look to the Huachuca Firescape project as a model to follow.

Visitor Impacts

Chiricahua NM receives about 80,000 visitors a year and the number of visitors is expected to continue to increase. As the number of visitors increases, so does the number of automobiles on the roads, which in turn leads to the dispersal and establishment of new species, particularly non-native plant species (Seabloom et al. 2003). Runoff from roads may contribute to this apparent pattern (i.e., seeds are more likely to germinate in areas receiving more moisture), and soils along the main access road to the monument are more likely to be disturbed (facilitating seed germination and plant establishment) than are soils in other parts of the monument. Increased vehicular traffic will also likely increase the mortality of terrestrial vertebrates or result in the modification of their behavior (as for residential development, above). Visitors hiking the trails in the monument may also affect wildlife movement patterns or cause direct mortality.

Poaching

Prival and Schwalbe (2000) studied the relative abundance and distribution of commercially valuable snakes and noted that the impact of collecting on snake populations in the monument is unknown. Based on the number and rarity of some species of collectable snakes (e.g., Sonoran mountain kingsnake and green rat snake) it seems that the monument would be an unlikely area for the collection of these species. However, the relatively high abundance of rock rattlesnakes, a

species with a high commercial value, may make the monument a target for poachers. Monument employees should be trained to recognize poaching-related activities and be made aware of the various collecting devices used by collectors. Prival and Schwalbe (2000) provide a good discussion of these topics and this information should be presented periodically to monument staff.

Chapter 8: Additional Inventories and Research

In general, we feel that we have succeeded in balancing our efforts between qualitative surveys designed to detect the maximum number of species with quantitative, repeatable surveys designed to estimate relative abundance with an associated measure of precision. As mentioned in each chapter, we believe that all taxa are at or near the 90% completion goal. Additional inventories and research will undoubtedly add new species to the list and below we discuss each group separately. In addition to completing more fieldwork, we also advocate searching natural history collections for specimens that were collected from the area. Most major collections have been made, or are in the process of being made, accessible over the Internet, thereby making it easy to query for specimens from the monument. This task may best be accomplished by Sonoran Desert Network I&M personnel, who can complete this task for all network units.

Plants

Additional general botanizing surveys, carried out following both winter and summer seasons of above-average rainfall, should increase the species list for annual plants and may possibly detect species that were not recorded by our field crews but were found by others (Appendix A). We suggest that future surveys target areas where non-native plants are likely to become established, such as along the main access road, particularly in the area where crews disturbed soils in order to put in underground utility lines. Finally, we encourage establishment of permanent vegetation plots (e.g., Powell et al. 2005a), placed throughout the monument, to facilitate monitoring long-term vegetation changes.

Amphibians and Reptiles

We suggest that any future inventories concentrate effort on the west boundary of the monument, both in the riparian area of Bonita Canyon and in the drainages and areas around Picket and Little Picket canyons in the northwest corner of the monument. These are the most likely locations to find many species on our hypothetical list (Appendix E). The collection of road-killed animals, particularly snakes and toads, from along the main access road has proven to be an effective tool to add species to the monument's list. Other inventory efforts in the Sonoran Desert Network units have benefited from collection of these indisputable forms of evidence (Don Swann, *pers. comm.*). Given the abundance of road-killed animals, particularly herpetofauna we encourage monument staff to undertake a long-term road-kill study.

Birds

Additional surveys during the winter season and during the spring and fall migrations will pick up species missed by our efforts. 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., Cave Creek Canyon near Portal, and Sonoita Creek Preserve in southern Arizona) have bird lists that can be considered to be complete.

Mammals

We suggest additional small-mammal trapping throughout the eastern portion of the monument to search for the many species of rodents documented by others (Duncan 1990, UA Mammal Collection) but not by our effort (see Chapter 6). The absence of these species would mean a loss of species for the monument, but more work needs to be conducted before reaching this conclusion. Pitfall traps set at higher elevations may document a new species to the monument: Arizona shrew, a species that is considered possible by Hoffmeister (1986). Snap traps set in meadows may also be helpful in documenting the Botta's pocket gopher, which has been previously documented.

Additional Trailmaster camera work throughout the monument, particularly near water sources, will document the presence of additional medium and large terrestrial mammals (e.g., mule deer and western spotted skunk). Camera

operation and maintenance are fairly simple and rewarding tasks for technically proficient staff members or volunteers. Care should be taken in determining where to place camera units because cameras can be damaged or stolen.

Chapter 9: Literature Cited

Allen, L. S. 1996. Ecological role of fire in the Madrean province, p. 5–10. *In* Effects of fire on Madrean Province ecosystems. United States Department of Agriculture Forest Service General Technical Report RM-GTR-289. Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO.

American Ornithologists' Union (AOU). 1998. Checklist of North American birds, seventh edition. American Ornithologists' Union and Allen Press Inc., Lawrence, KS.

American Ornithologists' Union (AOU). 2003. Forty-second supplement to the American Ornithologists' Union checklist of North American birds. Auk 117:847–858.

Anderson, D. R. 2001. The need to get the basics right in wildlife field studies. Wildlife Society Bulletin 29:1294–1297.

Baker, R. J., L. C. Bradley, R. D. Bradley, J. W. Dragoo, M. D. Engstrom, R. S. Hoffmann, C. A. Jones, F. Reid, D. W. Rice, and C. Jones. 2003. Revised checklist of North American mammals north of Mexico, 2003. Occasional Papers of the Museum of Texas Tech University 229:1–23.

Balda, R. P. 1969. Foliage use by birds of the oak-juniper woodland and ponderosa pine forest in southern Arizona. Condor 71:399–412.

Beauvais, G. P., and S. W. Buskirk. 1999. Modifying estimates of sampling effort to account for sprung traps. Wildlife Society Bulletin 27:39–43.

Bednarz, J. C., and R. J. Raitt. 2002. Chihuahuan raven (*Corvus cryptoleucus*). *In* The birds of North America, No. 606. A. Poole and F. Gill, editors. The Birds of North America, Inc., Philadelphia, PA.

Bennett, P. S., R. R. Johnson, and M. R. Kunzmann. 1996. An annotated list of vascular plants of the Chiricahua Mountains. Special Report No. 12. United States Geological Survey, Cooperative Park Studies Unit, University of Arizona, Tucson, AZ.

Bibby, C. J., N. D. Burgess, and D. A. Hill. 2002. Bird census techniques. Academic Press, London, England.

Bock, C. E., J. H. Bock, K. L. Jepson, and J. C. Ortega. 1986. Ecological effects of planting African lovegrasses in Arizona. National Geographic Research 2:456–463.

Bowers, J. E., and S. P. McLaughlin. 1982. Plant species diversity in Arizona. Madroño 29: 227–233.

Brown, D. E. 1994. Biotic communities: southwestern United States and northwestern Mexico. University of Utah Press, Salt Lake City, UT.

Brown, D. E. 2001. Borderland Jaguars: Tigres de la Frontera. University of Utah Press, Salt Lake City, UT.

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press, London, England.

Burns, J. M. 1979. The vegetation type survey of Chiricahua National Monument. Unpublished report to Chiricahua National Monument, Arizona. Report copies available at NPS – Sonoran Desert Network, 7660 E. Broadway Blvd., #303, Tucson, AZ 85710.

Cahalane, V. H. 1939. Mammals of the Chiricahua Mountains, Cochise County, Arizona. Journal of Mammalogy 20:418-440.

Cain, A. T., V. R. Touvila, D. G. Hewitt, and M. E. Tewes. 2003. Effects of a highway and mitigation projects on bobcats in southern Texas. Biological Conservation 114:189–197.

Carothers, S.W., R. R. Johnson, and S.W. Atchinson. 1974. Population structure and social organization of southwestern riparian birds. American Zoologist 14:97–108.

Clark, O. M. No Date. Checklist of plants for Chiricahua National Monument. Unpublished list to Chiricahua National Monument.

Cody, M. L. 1981. Habitat selection in birds: the roles of vegetation structure, competitors, and productivity. BioScience 31:170–113.

Cole, C. J., and H. C. Dessauer. 1994. Unisexual lizards (genus *Cnemidophorus*) of the Madrean Archipelago. Pp. 267–273 *In* Biodiversity and management of the Madrean Archipelago: the Sky Islands of Southwestern United States and northwestern Mexico. General Technical Report RM-GTR-264. United States Department of Agriculture, Rocky Mountain Research Station, Ft. Collins, Colorado.

Coleman, J. S., and S. A. Temple. 1993. Rural residents' free-ranging domestic cats: a survey. Wildlife Society Bulletin 21:381–390.

Colver, K. J., D. Stokes, and L. Stokes. 1999. Stokes field guide to bird songs. Time Warner, New York, NY.

Conway, C. J., and C. Kirkpatrick. 2001. Population status, detection probability, and effects of fire on buff-breasted flycatchers. Final report to the Arizona Game and Fish Department, Phoenix, AZ.

Corn, S. P. 1994. Straight-line drift fences and pitfall traps. Pp. 109–117. *In* W. R. Heyer, M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster, editors. Measuring and monitoring biodiversity: standard methods for amphibians. Smithsonian Institution Press, Washington, D.C.

Crump, M. L., and N. J. Scott. 1994. Visual encounter surveys. Pp. 84–92. *In* W. R. Heyer, M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster, editors. Measuring and monitoring biodiversity: standard methods for amphibians. Smithsonian Institution Press, Washington, D.C.

Cutler, T. L., and D. E. Swann. 1999. Using remote photography in wildlife ecology: a review. Wildlife Society Bulletin 27:571–581.

Davis, K., and W. L. Halvorson. 2000. A study plan to inventory vascular plants and vertebrates: Sonoran Desert Network. Proposal to Sonoran Desert Inventory and Monitoring Program, National Park Service, Tucson, AZ.

Degenhardt, W. G., C. W. Painter, and A. H. Price. 1996. Amphibians and reptiles of New Mexico. University of New Mexico Press, Albuquerque, NM.

Denny, D. W., and C. R. Peacock. 2000. Soil survey of Chiricahua National Monument, Arizona. Technical Report No. 65. United States Geological Survey, Sonoran Desert Field Station, University of Arizona, Tucson, AZ.

DeSante, D. F., and D. R. O'Grady. 2000. The monitoring avian productivity and survivorship (MAPS) program: 1997 and 1998 report. Bird Populations 5:49–101.

Duncan, D. K. 1990. Small mammal inventory of Chiricahua National Monument, Cochise County, Arizona. Technical Report No. 30. Cooperative National Park Resources Studies Unit, University of Arizona, Tucson, AZ.

Ellis, D. H., and C. H. Ellis. 1991. Raptor response to low-level jet aircraft and sonic booms. Environmental Pollution 74:53–83.

Farnsworth, G. L., K. H. Pollock, J. D. Nichols, T. R. Simons, T. R. Hines, and J. E. Sauer. 2002. A removal model for estimating detection probabilities from point-count surveys. Auk 119:414–425.

Fischer, D. 2002. A checklist of birds of Chiricahua National Monument and Fort Bowie National Historic Site. Southwest Parks and Monuments Association, Tucson, AZ.

Fuller, M. R., and J. A. Mosher. 1987. Raptor survey techniques. Pp. 37–66. *In* B. A. Geron-Pendleton, B. A. Millsap, K. W. Cline, and D. M. Bird, editors. Raptor management techniques manual. National Wildlife Federation, Washington, D.C.

Ganey, J. L., W. M. Block, and P. F. Boucher. 1996. Effects of fire on birds in Madrean forests and woodlands. Pp. 144–154. *In* Effects of fire on Madrean province ecosystems. General Technical Report RM-GTR-289. United States Department of Agriculture Forest Service, Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO.

Gibbons, J. M., and R. D. Semlitsch. 1981. Terrestrial drift fence with pitfall traps: an effective technique for quantitative sampling of animal populations. Brimleyana 7:1–6.

Goode, M., and M. Amarello. 2004. Effects of fire on banded rock rattlesnakes (*Crotalus lepidus*) at Chiricahua National Monument. Final Report to the Sonoran Desert Network Inventory and Monitoring Program, Tucson, AZ.

Hall, D. H., and R. J. Steidl. 2003. Ecology and conservation of desert box turtle (*Terrapene ornate luteola*) in Arizona. Project number 102003. Unpublished report to the Arizona Game and Fish Department, Phoenix, AZ.

Halvorson, W. L., and P. Guertin. 2003. USGS Weeds in the west project: status of introduced plants in southern Arizona parks. U.S. Geological Survey, Sonoran Desert Research Station, University of Arizona, Tucson, AZ.

Hartman, E., M. L. Rottmann, and B. Siems. 1998. A vascular plant inventory for Chiricahua National Monument. Unpublished list to Chiricahua National Monument.

Hayek, L. C., and M. A. Buzas. 1997. Surveying natural populations. Columbia University Press, New York, NY.

Heilbrun, R. D., N. J. Silvy, M. E. Tewes, and M. J. Peterson. 2003. Using automatically triggered cameras to identify individual bobcats. Wildlife Society Bulletin 31:748–755.

Heritage Data Management System (HDMS). 2004. Arizona Game and Fish Department. Accessed 17 June 2009 from: http://www.gf.state.az.us/w_c/edits/species_concern.shtml.

Herkert, J. R. 1994. Breeding bird communities of midwestern prairie fragments - the effects of prescribed burning and habitat-area. Natural Areas Journal 14:128–135.

Hoffmeister, D. F. 1986. Mammals of Arizona. The University of Arizona Press, Tucson, AZ.

Humphrey, R. R. 1974. Fire in the deserts and desert grasslands of North America. Pages 365–400 *In* T. T. Kozlowski, and C. E. Algren, editors. Fire and ecosystems. Academic Press, London, England.

Integrated Taxonomic Information System (ITIS). 2005. Accessed on 20 March 2005. http://www.itis.gov/.

Ivanyi, C., J. Perry, T. R. Van Devender, and H. Lawler. 2000. Reptile and amphibian accounts. Pp. 533-585. *In* S. J. Phillips and P. W. Comus, editors. A natural history of the Sonoran Desert. Arizona-Sonora Desert Museum Press, Tucson, AZ.

James, F. C. 1971. Ordinations of habitat relationships among breeding birds. Wilson Bulletin 83:215–236.

Kirkpatrick, C., C. J. Conway, and P. B. Jones. 2006. Distribution and relative abundance of forest birds in relation to burn severity in southeastern Arizona. Journal of Wildlife Management 70:1005-1012.

Knopf, F. L. 1994. Avian assemblages on altered grasslands. Studies in Avian Biology 15:247–257.

Koprowski, J. L. 2004. A survey of carnivore community structure at Chiricahua National Monument. Unpublished report to Sonoran Desert Inventory and Monitoring Program, National Park Service, Tucson, AZ.

Kotliar, N. B., and J. A. Weins. 1990. Multiple scales of patchiness and patch structure: a hierarchical framework for the study of heterogeneity. Oikos 59:253–260.

Krebbs, K. 2005. Bat species and abundance at the Chiricahua National Monument and Fort Bowie National Historic Site. Unpublished report to Sonoran Desert Inventory and Monitoring Program, National Park Service, Tucson, AZ.

Krebs, C. J. 1999. Ecological methodology. Second edition. Addison-Wesley Educational, Menlo Park, CA.

Kucera, T. E., and R. H. Barrett. 1993. The Trailmaster camera system for detecting wildlife. Wildlife Society Bulletin 21:505–508.

Latta, M. J., C. J. Beardmore, and T. E. Corman. 1999. Arizona Partners in Flight conservation plan. Technical Report 142. Nongame and Endangered Wildlife Program, Arizona Game and Fish Department, Phoenix, AZ.

Litzinger, W. J. 1993. Checklist of vascular plants of Chiricahua National Monument. Unpublished report to Chiricahua National Monument, National Park Service, Willcox, Arizona.

Lowe, C. H., and P. A. Holm. 1987. The amphibians and reptiles of Chiricahua National Monument, Arizona. Unpublished report to the Cooperative National Park Resources Studies Unit, University of Arizona, Tucson, AZ.

Lowe, C. H., and P. A. Holm. 1992. A checklist of amphibians and reptiles of Chiricahua National Monument. Southwest Parks and Monuments Association, Tucson, AZ.

Lunsford, H. F. 1980. Snakes of the Chiricahua National Monument. Southwest Parks and Monuments Association, Tucson, AZ.

Marshall, J. T., Jr., 1957. Birds of the pine-oak woodland in southern Arizona and adjacent Mexico. Pacific Coast Avifauna No. 342.

Martinez, G., and A. Hubbard. 2003. Monitoring avian productivity: analysis of MAPS data from Sonoran Desert Parks. Unpublished report to Sonoran Desert Inventory and Monitoring Program, National Park Service, Tucson, AZ.

Maza, B. G. 1965. The mammals of the Chiricahua Mountain Region, Cochise County, Arizona. M. S. Thesis, University of Arizona, Tucson, AZ.

Mills, G. S., J. B. Dunning Jr., and J. M. Bates. 1989. Effects of urbanization of breeding bird community structure in southwestern desert habitats. Condor 91:416–428.

National Park Service (NPS). 1992. NPS-75: Natural resources inventory and monitoring guidelines. U.S. Dept. of Interior, Washington, D.C.

National Park Service (NPS). 1996. Natural and cultural resources management plan. Chiricahua National Monument, Willcox, AZ.

National Park Service (NPS). 2004. Fire management plan, draft environmental impact statement. Chiricahua National Monument, Willcox, AZ.

National Park Service (NPS). 2005. NPS visitation database reports. Accessed on 09 January 2005. http://www2.nature.nps.gov/NPstats/npstats.cfm

Nelson, L., and F. W. Clark. 1973. Correction for sprung traps in catch/effort calculations of trapping results. Journal of Mammology 54:295–298.

North American Ornithological Atlas Committee (NAOAC). 1990. Handbook for atlasing North American breeding birds. C. Smith, editor. Accessed 13 July 2001 from: http://bsc-eoc.org/norac/atlascont.htm.

Peterjohn, B. G., and J. R. Sauer. 1999. Population status of North American grassland birds from the North American Breeding Bird Survey, 1966-1996. Studies in Avian Biology:27–44.

Powell, B. F., E. W. Albrecht, W. L. Halvorson, C. A. Schmidt, P. Anning, and K. Docherty. 2005a. Vascular plant and vertebrate inventory of Tumacácori National Historical Park. USGS Open File Report 2005-1142. U.S. Geological Survey, Southwest Biological Sciences Center, Sonoran Desert Research Station, University of Arizona, Tucson.

Powell, B. F., E. W. Albrecht, W. L. Halvorson, C. A. Schmidt, and K. Docherty. 2004. Vascular plant and vertebrate inventory of Casa Grande Ruins National Monument. Final report to the National Park Service, Sonoran Desert Inventory and Monitoring Program, Tucson, AZ.

Powell, B. F., C. A. Schmidt, W. L. Halvorson, and P. Anning. 2005b. Vascular plant and vertebrate inventory of Fort Bowie National Historic Site. Final report to the National Park Service, Sonoran Desert Inventory and Monitoring Program, Tucson, AZ.

Powell, B. F., and R. J. Steidl. 2002. Habitat selection by riparian songbirds breeding in southern Arizona. Journal of Wildlife Management 66:1096–1103.

Price, M. V. 1978. The role of microhabitat in structuring desert rodent communities. Ecology 59:910–921.

Prival, D. B., and C. R. Schwalbe. 2000. Conservation and management of commercially valuable snake species at Chiricahua National Monument. Unpublished report to the Southwest Parks and Monuments Association, Globe, AZ.

Pyne, S. J. 1996. Nouvelle southwest. Pp. 10–16. *In* W. Covington and P. K. Wagner editors. Conference on adaptive ecosystems restoration and management: restoration of cordilleran conifer landscapes of North America. General Technical Report RM-GTR-278. United States Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO.

Ralph, C. J., J. R. Sauer, and S. Droege, technical editors. 1995. Monitoring bird populations by point counts. General Technical Report PSW-GTR-149. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, CA.

Rappole, J. H. 1995. The ecology of migrant birds: a neotropical perspective. Smithsonian Institution Press, Washington, D.C.

Reeves, T. 1976. Vegetation and flora of Chiricahua National Monument, Cochise County, Arizona. Master's thesis from Arizona State University, Tempe, Arizona.

Reynolds, R. T., J. M. Scott, and R. A. Nussbaum. 1980. A variable circular-plot method for estimating bird numbers. Condor 82:309–313.

Rice, J., B. W. Anderson, and R. D. Ohmart. 1984. Comparison of the importance of different habitat attributes to avian community organization. Journal of Wildlife Management 48:895–911.

Riley, S. P. D., R. M. Sauvajot, T. K. Fuller, E. C. York, D. A. Kamradt, C. Bromley, and R. K. Wayne. 2003. Effects of urbanization and habitat fragmentation on bobcats and coyotes in southern California. Conservation Biology 17:566–576.

Rosen, P. C., and C. H. Lowe. 1994. Highway mortality of snakes in the Sonoran Desert of southern Arizona. Biological Conservation 68:143–148.

Rosen, P. C., S. S. Sartorius, C. R. Schwalbe, P. A. Holm, and C. H. Lowe. 1996. Herpetology of the Sulphur Springs Valley, Cochise County, Arizona. Pp. 65–80. *In* E. Tellman, D. M. Finch, C. Edminster, and R. Hamre, editors. The future of grasslands: identifying issues, seeking solutions. Proceedings RMRS-P-3. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Roth, R. L. 1976. Spatial heterogeneity and bird species diversity. Ecology 57:773–782.

Seabloom, E. W., E. T. Borer, V. L. Boucher, R. S. Burton, K. L. Cottingham, L. Goldwasser, W. K. Gram, B. E. Kendall, and F. Micheli. 2003. Competition, seed limitation, disturbance, and reestablishment of California native annual forbs. Ecological Applications 13:575–592.

Shaffer, H. B., and J. E. Juterbock. 1994. Night driving. Pp. 163–166. *In* W. R. Heyer, M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster, editors. Measuring and monitoring biodiversity: standard methods for amphibians. Smithsonian Institution Press, Washington, D.C.

Sipes, M. 1975. Amphibians, turtles, and lizards of Chiricahua National Monument. Southwest Parks and Monuments Association, Tucson, AZ.

Snyder, H. 1995. Survey of the endangered and threatened raptors of the Chiricahua National Monument: northern goshawk, peregrine falcon, and Mexican spotted owl. Unpublished report to the Chiricahua National Monument, AZ.

Sprouse, T., R. Emanuel, and B. Tellman. 2002. Final report: surface water quality monitoring overview and assessment for the Sonoran Desert Network, National Park Service. Unpublished report. Water Resources Research Center, University of Arizona, Tucson, AZ.

Sredl, M. J., E. P. Collins, and J. M. Howland. 1997. Ranid frog mark-recapture. Pp. 3–20. *In* M. J. Sredl, editor. Ranid frog conservation and management. Technical Report 121. Arizona Game and Fish Department, Phoenix, AZ.

Stamp, N. E., and R. D. Ohmart. 1979. Rodents of desert shrub and riparian woodland habitats of the Sonoran Desert. Southwestern Naturalist 24:279–289.

Stebbins, R. C. 2003. Western reptiles and amphibians. Houghton-Mifflin Co., New York, NY.

Stohlgren, T. J., J. F. Quinn, M. Ruggiero, and G. S. Waggoner. 1995. Status of biotic inventories in U.S. national parks. Biological Conservation 71:97–106.

Strong, T. R., and C. E. Bock. 1990. Bird species distribution in riparian habitats in southeastern Arizona. Condor 92:866–885.

Sureda, M., and M. L. Morrison. 1999. Habitat characteristics of small mammals in southeastern Utah. Great Basin Naturalist 59:323–330.

Swann, D. E., M. J. Goode, and C. R. Schwalbe. 2001. Inventory and recommendations for long-term monitoring of reptiles and amphibians at Fort Bowie National Historic Site, Arizona. Report to Southern Arizona Office, National Park Service, Phoenix, AZ.

Swann, D. E., C. C. Hass, D. C. Dalton, and S. A. Wolf. 2004. Infrared-triggered cameras for detecting wildlife: an evaluation and review. Wildlife Society Bulletin 32:1–9.

Swetnam, T. W., C. D. Allen, and J. Betancourt. 1999. Applied historical ecology: using the past to manage the future. Ecological Applications 9:1189–1206.

Swetnam, T. W., and C. H. Baisan. 1996. Fire histories of montane forests in Madrean borderlands. Pp. 15–16. In effects of fire on Madrean province ecosystems. General Technical Report RM-GTR-289. United States Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Ft. Collins, CO.

Szaro, R. C., and M. D. Jakle. 1985. Avian use of a desert riparian island and its adjacent scrub habitat. Condor 87:511–519.

Taylor, A. H. 2004. Vegetation change in Chiricahua National Monument, Arizona Phase II. Final Report to the National Park Service, Chiricahua National Monument.

Theobald, D. M., J. R. Miller, and N. T. Hobbs. 1997. Estimating the cumulative effects of development on wildlife habitat. Landscape and Urban Planning 39:25–36.

Thompson, S. K. 1992. Sampling. John Wiley and Sons, New York, NY.

Trombulak, S. C., and C. A. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14:18–30.

United States Department of Agriculture (USDA). 2005. The PLANTS Database, Version 3.5. National Plant Data Center, Natural Resources Conservation Service, Baton Rouge, LA. Accessed on 30 June 2005 from: http://plants.usda.gov .

United States Fish and Wildlife Service. 2002. Endangered and threatened wildlife and plants; listing of the Chiricahua leopard frog (*Rana chiricahuensis*); final rule. Federal Register 67(114):40790–40811.

United States Fish and Wildlife Service. 2005. Threatened and endangered species. Accessed on 17 June 2009. http://www.fws.gov/southwest/es/arizona/Threatened.htm

Van Auken, O. W. 2000. Shrub invasions of North American semiarid grasslands. Annual Review of Ecology and Systematics 31:197–215.

Warren, P. L., M. S. Hoy, and W. E. Hoy. 1992. Vegetation and flora of Fort Bowie National Historic Site, Arizona. National Park Service Technical Report NPS/WRUA/NRTR-92/43.

Weisenberger, M. E., P. R. Krausman, M. C. Wallace, D. W. DeYoung, and O. E. Maughan. 1996. Effects of simulated jet aircraft noise on heart rate and behavior of desert ungulates. Journal of Wildlife Management 60:52–61.

Western Regional Climate Center (WRCC). 2005. Arizona climate summaries from Chiricahua National Monument. Accessed on 15 February 2005 from: http://www.wrcc.dri.edu/summary/climsmaz.html.

Wethington, S. 2004. Hummingbird Monitoring Network website. Accessed on 15 March 2005. http://www.thegeorgewalkerhouse.com/id55.htm.

Wright, J. W., and L. J. Vitt. 1993. Biology of the whiptail lizards (genus *Cnemidophorus*). Oklahoma Museum of Natural History, Norman.

Appendix A. Plant species that were observed or collected in this study, Chiricahua NM. List also includes specimens located in herbaria and other lists and studies from the monument. Species in bold-faced type are non-native according to USDA (2005).

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Acanthaceae	*Anisacanthus thurberi* (Torr.) Gray	Thurber's desert honeysuckle					X	X	X	X	
	Dyschoriste decumbens (Gray) Kuntze	spreading snakeherb				X	X	X	X	X	
	Siphonoglossa longiflora (Torr.) Gray	longflower tubetongue				X	X	X	X	X	
Aceraceae	*Acer grandidentatum* Nutt.	bigtooth maple						X		X	
Agavaceae	*Agave americana* L.	American century plant	X								
	Agave palmeri Engelm.	Palmer's century plant	X			X	X	X	X	X	
	Agave parryi Engelm.	Parry's agave	X			X	X	X	X	X	
	Yucca baccata Torr.	banana yucca	X	X		X	X	X	X	X	
	Yucca baccata var. brevifolia (Schott ex Torr.) L. Benson & Darrow	Spanish dagger		X							
	Yucca elata (Engelm.) Engelm.	soaptree yucca	X	X		X	X	X	X	X	
	Yucca schottii Engelm.	Schott's yucca	X			X	X	X	X	X	
	Yucca thompsoniana Trel.	Thompson's yucca		X							
Aizoaceae	*Trianthema portulacastrum* L.	desert horsepurslane					X	X	X	X	
Amaranthaceae	*Alternanthera pungens* Kunth	khakiweed					X	X	X	X	
	Amaranthus arenicola I.M. Johnston	sandhill amaranth					X	X		X	
	***Amaranthus blitoides* S. Wats.**	**mat amaranth**	**X**			**X**	**X**	**X**	**X**	**X**	
	Amaranthus hybridus L.	slim amaranth				X			X		
	Amaranthus palmeri S. Wats.	carelessweed			X		X	X	X	X	
	Amaranthus powellii S. Wats.	Powell's amaranth			X						
	Amaranthus pringlei S. Wats.	Pringle's amaranth							X		
	Froelichia arizonica Thornb. ex Standl.	Arizona snakecotton					X	X	X	X	
	Froelichia gracilis (Hook.) Moq.	slender snakecotton			X	X	X		X	X	
	Gomphrena caespitosa Torr.	tufted globe amaranth	X		X	X	X	X	X	X	
	Gomphrena nitida Rothrock	pearly globe amaranth	X			X	X	X	X	X	
	Gomphrena sonorae Torr.	Sonoran globe amaranth	X		X		X	X	X		
	Guilleminea densa (Humb. & Bonpl. ex Willd.) Moq.	small matweed			X		X		X		
	Guilleminea densa var. densa (Humb. & Bonpl. ex Willd.) Moq.	small matweed				X		X		X	
Anacardiaceae	*Rhus aromatica* Ait.	fragrant sumac	X		X						
	Rhus aromatica Ait. *var. aromatica*	fragrant sumac					X	X			
	Rhus glabra L.	smooth sumac			X	X	X	X	X	X	
	Rhus microphylla Engelm. ex Gray	littleleaf sumac			X	X	X	X	X	X	
	Rhus trilobata Nutt.	skunkbush sumac				X					
	Rhus trilobata var. pilosissima Engelm.	pubescent squawbush			X		X	X	X		
	Rhus trilobata var. racemulosa (Greene) Barkl.	skunkbush sumac			X						
	Rhus virens var. choriophylla (Woot. & Standl.) L. Benson	evergreen sumac	X		X	X	X	X	X	X	
	Toxicodendron radicans (L.) Kuntze	eastern poison ivy									
	Toxicodendron radicans ssp. divaricatum (Greene) Gillis	eastern poison ivy					X	X	X		
	Toxicodendron radicans ssp. radicans (L.) Kuntze	eastern poison ivy	X			X					
	Toxicodendron rydbergii (Small ex Rydb.) Greene	western poison ivy			X		X	X	X	X	

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Apiaceae	*Cymopterus acaulis var. fendleri* (Gray) Goodrich	Fendler's springparsley					X	X			
	Cymopterus multinervatus (Coult. & Rose) Tidestrom	purplenerve springparsley					X	X	X		
	Lomatium nevadense (S. Wats.) Coult. & Rose	Nevada biscuitroot						X	X		
	Pseudocymopterus montanus (Gray) Coult. & Rose	alpine false springparsley				X	X	X	X	X	
	Yabea microcarpa (Hook. & Arn.) K.-Pol.	false carrot					X	X	X		
Apocynaceae	*Apocynum androsaemifolium* L.	spreading dogbane				X					
	Apocynum cannabinum L.	Indianhemp					X	X	X	X	
	Macrosiphonia brachysiphon (Torr.) Gray	Huachuca Mountain rocktrumpet					X	X	X	X	
Aristolochiaceae	*Aristolochia watsonii* Woot. & Standl.	Watson's dutchman's pipe	X								
Asclepiadaceae	*Asclepias arenaria* Torr.	sand milkweed				X					
	Asclepias asperula (Dcne.) Woods.	spider milkweed			X						
	Asclepias asperula (Dcne.) Woods. *ssp. asperula*	spider milkweed							X	X	
	Asclepias asperula ssp. capricornu (Woods.) Woods.	antelopehorns				X	X	X		X	
	Asclepias fascicularis Dcne.	Mexican whorled milkweed				X					
	Asclepias glaucescens Kunth	nodding milkweed					X	X	X	X	
	Asclepias lemmonii Gray	Lemmon's milkweed					X	X	X	X	
	Asclepias linaria Cav.	pineneedle milkweed					X	X	X	X	
	Asclepias macrotis Torr.	longhood milkweed				X					
	Asclepias nummularia Torr.	tufted milkweed			X	X	X	X	X	X	
	Asclepias nyctaginifolia Gray	Mojave milkweed					X	X	X		
	Asclepias quinquedentata Gray	slimpod milkweed				X	X	X	X	X	
	Asclepias speciosa Torr.	showy milkweed				X		X		X	
	Asclepias subverticillata (Gray) Vail	horsetail milkweed				X	X	X	X	X	
	Asclepias tuberosa L.	butterfly milkweed				X	X	X		X	
	Asclepias tuberosa ssp. interior Woods.	butterfly milkweed							X		
	Funastrum crispum (Benth.) Schlechter	wavyleaf twinevine	X			X	X	X	X	X	
Aspleniaceae	*Asplenium resiliens* Kunze	blackstem spleenwort			X	X	X	X	X	X	
	Asplenium trichomanes L.	maidenhair spleenwort					X	X	X	X	
Asteraceae	*Acourtia nana* (Gray) Reveal & King	dwarf desertpeony					X	X	X	X	
	Acourtia thurberi (Gray) Reveal & King	Thurber's desertpeony	X				X	X	X	X	
	Ageratina herbacea (Gray) King & H.E. Robins.	fragrant snakeroot	X		X		X	X	X		
	Ageratina paupercula (Gray) King & H.E. Robins.	Santa Rita snakeroot			X			X	X		
	Ambrosia psilostachya DC.	Cuman ragweed					X	X	X	X	
	Antennaria marginata Greene	whitemargin pussytoes					X	X			
	Antennaria parvifolia Nutt.	small-leaf pussytoes						X	X		
	Artemisia carruthii Wood ex Carruth.	Carruth's sagewort	X			X	X	X	X	X	
	Artemisia dracunculus L.	tarragon					X	X		X	
	Artemisia dracunculus ssp. dracunculus L.	wormwood							X		
	Artemisia ludoviciana Nutt.	white sagebrush	X		X	X				X	
	Artemisia ludoviciana ssp. mexicana (Willd. ex Spreng.) Keck	white sagebrush					X	X	X	X	
	Artemisia ludoviciana ssp. sulcata (Rydb.) Keck	white sagebrush						X	X		

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Asteraceae	*Baccharis pteronioides* DC.	yerba de pasmo	X			X	X	X	X	X	
	Baccharis salicifolia (Ruiz & Pavón) Pers.	mule's fat			X	X	X	X	X	X	
	Baccharis sarothroides Gray	desertbroom					X	X	X	X	
	Baccharis thesioides Kunth	Arizona baccharis	X			X	X	X	X	X	
	Baccharis wrightii Gray	Wright's baccharis							X		
	Bahia biternata Gray	slimlobe bahia					X	X	X		
	Bahia dissecta (Gray) Britt.	ragleaf bahia			X	X	X	X	X	X	
	Baileya multiradiata Harvey & Gray ex Gray	desert marigold					X	X	X		
	Berlandiera lyrata Benth.	lyreleaf greeneyes			X	X	X	X	X		
	Bidens bigelovii Gray	Bigelow's beggarticks					X	X	X	X	
	Bidens heterosperma Gray	Rocky Mountain beggarticks	X				X	X	X		
	Bidens leptocephala Sherff	fewflower beggarticks				X	X	X	X		
	Brickellia betonicifolia Gray	betonyleaf brickellbush	X		X		X	X	X	X	
	Brickellia californica (Torr. & Gray) Gray	California brickellbush			X		X	X	X	X	
	Brickellia eupatorioides var. chlorolepis (Woot. & Standl.) B.L. Turner	false boneset	X		X		X	X	X	X	
	Brickellia eupatorioides (L.) Shinners *var. eupatorioides*	false boneset				X					
	Brickellia eupatorioides var. gracillima (Gray) B.L. Turner	false boneset						X			
	Brickellia floribunda Gray	Chihuahuan brickellbush					X	X	X	X	
	Brickellia grandiflora (Hook.) Nutt.	tasselflower brickellbush	X		X	X	X	X	X	X	
	Brickellia lemmonii Gray	Lemmon's brickellbush	X		X	X	X	X	X	X	
	Brickellia pringlei Gray	Pringle's brickellbush					X	X	X	X	
	Brickellia simplex Gray	Sonoran brickellbush					X	X	X	X	
	Brickellia venosa (Woot. & Standl.) B.L. Robins.	veiny brickellbush					X	X	X	X	
	Brickelliastrum fendleri (Gray) King & H.E. Robins.	Fendler's brickellbush				X	X	X	X	X	
	Carminatia tenuiflora DC.	plumeweed	X		X		X	X	X		
	Carphochaete bigelovii Gray	Bigelow's bristlehead	X		X	X	X	X	X	X	
	***Centaurea melitensis* L.**	**Maltese star-thistle**			**X**	**X**	**X**	**X**	**X**	**X**	
	***Centaurea rothrockii* Greenm.**	**Rothrock's knapweed**							**X**		
	Chaetopappa ericoides (Torr.) Nesom	rose heath	X		X	X	X	X	X	X	
	Cirsium neomexicanum Gray	New Mexico thistle				X	X	X	X	X	
	Cirsium ochrocentrum Gray	yellowspine thistle				X	X	X	X	X	
	Cirsium rothrockii (Gray) Petrak	Rothrock's thistle				X	X	X	X	X	
	Conyza canadensis (L.) Cronq.	Canadian horseweed			X		X	X		X	X
	Conyza canadensis (L.) Cronq. *var. canadensis*	Canadian horseweed				X			X		
	Cosmos parviflorus (Jacq.) Pers.	southwestern cosmos			X	X	X	X	X	X	
	Ericameria laricifolia (Gray) Shinners	turpentine bush	X				X	X	X	X	
	Ericameria nauseosa var. latisquamea (Gray) Nesom & Baird	rubber rabbitbrush			X		X	X	X	X	
	Ericameria nauseosa var. nauseosa (Pallas ex Pursh) Nesom & Baird	rubber rabbitbrush				X				X	
	Erigeron colomexicanus A. Nels.	running fleabane			X				X		
	Erigeron concinnus (Hook. & Arn.) Torr. & Gray	Navajo fleabane	X								
	Erigeron divergens Torr. & Gray	spreading fleabane				X	X	X		X	

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Asteraceae	*Erigeron eximius* Greene	sprucefir fleabane					X	X	X	X	
	Erigeron flagellaris Gray	trailing fleabane				X	X	X	X	X	
	Erigeron modestus Gray	plains fleabane					X	X		X	
	Erigeron neomexicanus Gray	New Mexico fleabane	X		X	X	X	X	X	X	
	Erigeron oreophilus Greenm.	chaparral fleabane			X	X	X	X	X	X	
	Erigeron speciosus (Lindl.) DC.	aspen fleabane	X		X						
	Erigeron speciosus var. macranthus (Nutt.) Cronq.	aspen fleabane				X		X	X		
	Erigeron vreelandii Greene	Vreeland's erigeron					X	X	X	X	
	Gaillardia pinnatifida Torr.	red dome blanketflower			X	X	X	X	X	X	
	Gaillardia pulchella Foug.	firewheel				X	X	X		X	
	Gaillardia pulchella Foug. *var. pulchella*	firewheel							X		
	Gamochaeta falcata (Lam.) Cabrera	narrowleaf purple everlasting					X	X	X		
	Gutierrezia sarothrae (Pursh) Britt. & Rusby	broom snakeweed	X		X	X	X	X	X	X	
	Gymnosperma glutinosum (Spreng.) Less.	gumhead	X		X	X	X	X	X	X	
	Helianthus ciliaris DC.	Texas blueweed	X								
	Helianthus petiolaris Nutt.	prairie sunflower				X	X	X	X	X	
	Heliomeris longifolia var. annua (M.E. Jones) Yates	longleaf false goldeneye					X	X	X	X	
	Heliomeris longifolia var. longifolia (Robins. & Greenm.) Cockerell	longleaf false goldeneye			X		X	X	X	X	
	Heliomeris multiflora var. multiflora Nutt.	showy goldeneye			X		X	X	X	X	
	Heterosperma pinnatum Cav.	wingpetal	X		X		X	X	X	X	
	Heterotheca subaxillaris (Lam.) Britt. & Rusby	camphorweed				X	X	X	X	X	X
	Heterotheca villosa var. minor (Hook.) Semple	hairy false goldenaster				X		X			
	Heterotheca villosa var. nana (Gray) Semple	hairy false goldenaster					X	X			
	Heterotheca viscida (Gray) Harms	cliff false goldenaster			X		X	X	X	X	
	Hieracium carneum Greene	Huachuca hawkweed			X		X	X	X	X	
	Hieracium fendleri Schultz-Bip.	yellow hawkweed					X				
	Hieracium fendleri var. discolor Gray	yellow hawkweed						X	X		
	Hymenothrix wislizeni Gray	TransPecos thimblehead					X	X	X	X	
	Hymenothrix wrightii Gray	Wright's thimblehead	X		X	X	X	X	X	X	
	Hymenoxys microcephala (Gray) Bierner	Apache Passe rubberweed	X		X	X	X	X	X	X	
	Isocoma tenuisecta Greene	burroweed					X	X	X	X	
	Lactuca graminifolia Michx.	grassleaf lettuce					X	X	X	X	
	***Lactuca serriola* L.**	**prickly lettuce**			X	X	X	X	X	X	X
	Lactuca tatarica var. pulchella (Pursh) Breitung	blue lettuce					X	X	X		
	Laennecia coulteri (Gray) Nesom	conyza				X	X	X	X	X	X
	Laennecia schiedeana (Less.) Nesom	pineland marshtail					X	X	X		
	Laennecia sophiifolia (Kunth) Nesom	leafy marshtail					X	X	X		
	Lasianthaea podocephala (Gray) K. Becker	San Pedro daisy			X	X	X	X	X	X	
	Machaeranthera bigelovii (Gray) Greene *var. bigelovii*	Bigelow's tansyaster				X					
	Machaeranthera canescens var. incana (Lindl.) Gray	hoary tansyaster				X	X	X	X	X	
	Machaeranthera canescens (Pursh) Gray *ssp. canescens*	hoary tansyaster						X	X		
	Machaeranthera gracilis (Nutt.) Shinners	slender goldenweed				X	X	X	X	X	
	Machaeranthera parviflora Gray	smallflower tansyaster			X						
	Machaeranthera pinnatifida var. pinnatifida (Hook.) Shinners	lacy tansyaster						X	X		
	Machaeranthera scabrella (Greene) Shinners						X	X			
	Machaeranthera tagetina Greene	mesa tansyaster			X	X		X		X	

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Asteraceae	*Machaeranthera tanacetifolia* (Kunth) Nees	tanseyleaf tansyaster					X	X	X		
	Malacothrix fendleri Gray	Fendler's desertdandelion					X	X	X	X	
	Melampodium longicorne Gray	Arizona blackfoot	X				X	X	X	X	
	Melampodium strigosum Stuessy	shaggy blackfoot			X		X	X	X		
	Packera neomexicana var. neomexicana (Gray) W.A. Weber & A. Löve	New Mexico groundsel	X		X	X	X	X	X	X	
	Parthenium incanum Kunth	mariola					X	X	X	X	
	Pectis angustifolia Torr.	lemonscent						X			
	Pectis angustifolia Torr. *var. angustifolia*	narrowleaf pectis					X		X		
	Pectis filipes Harvey & Gray	fivebract cinchweed			X	X				X	
	Pectis filipes var. subnuda Fern.	fivebract cinchweed					X	X	X	X	
	Pectis longipes Gray	longstalk cinchweed					X	X	X		
	Pectis papposa Harvey & Gray *var. papposa*	manybristle cinchweed					X	X	X		
	Pectis prostrata Cav.	spreading cinchweed			X	X	X	X	X	X	
	Perityle cochisensis (Niles) A. Powell	Cochise rockdaisy	X		X		X	X	X	X	
	Psacalium decompositum (Gray) H.E. Robins. & Brett.	desert Indianbush			X		X	X	X	X	
	Pseudognaphalium canescens (DC.) W.A. Weber	Wright's cudweed	X								
	Pseudognaphalium canescens ssp. canescens (DC.) W.A. Weber	Wright's cudweed				X	X	X	X	X	
	Pseudognaphalium macounii (Greene) Kartesz, comb. nov. ined.	Macoun's cudweed			X		X	X			
	Pseudognaphalium pringlei (Gray) A. Anderb.	Pringle's cudweed					X	X	X	X	
	Pseudognaphalium stramineum (Kunth) W.A. Weber	cottonbatting plant					X	X	X	X	
	Pseudognaphalium viscosum (Kunth) W.A. Weber	winged cudweed							X		
	Psilactis asteroides Gray	New Mexico tansyaster			X						
	Rudbeckia laciniata L.	cutleaf coneflower						X	X		
	Sanvitalia abertii Gray	Albert's creeping zinnia			X	X	X	X	X	X	
	Schkuhria anthemoidea var. wrightii (Gray) Heiser	Wright's false threadleaf					X	X			
	Schkuhria pinnata var. wislizeni (Gray) B.L. Turner	Wislizenus' false threadleaf			X	X			X	X	
	Senecio flaccidus var. flaccidus Less.	threadleaf ragwort			X	X	X	X	X	X	
	Senecio flaccidus var. monoensis (Greene) B.L. Turner & T.M. Barkl.	Mono ragwort	X								
	Senecio parryi Gray	mountain ragwort				X	X	X	X	X	
	Senecio wootonii Greene	Wooton's ragwort			X	X	X	X		X	
	Solidago canadensis var. scabra Torr. & Gray	Canada goldenrod				X	X	X	X		
	Solidago missouriensis Nutt.	Missouri goldenrod	X			X	X	X		X	
	Solidago missouriensis Nutt. *var. missouriensis*	Missouri goldenrod							X		
	Solidago velutina DC.	threenerve goldenrod			X		X	X	X	X	
	Solidago wrightii Gray	Wright's goldenrod			X	X	X	X		X	
	Solidago wrightii var. adenophora Blake	Wright's goldenrod							X		
	***Sonchus asper* (L.) Hill**	**spiny sowthistle**				X	X	X	X	X	
	***Sonchus oleraceus* L.**	**common sowthistle**					X	X	X	X	
	Stephanomeria exigua Nutt.	small wirelettuce			X				X		
	Stephanomeria minor var. minor (Hook.) Nutt.	narrowleaf wirelettuce				X		X		X	
	Stephanomeria pauciflora (Torr.) A. Nels.	brownplume wirelettuce			X		X	X	X		
	Stephanomeria thurberi Gray	Thurber's wirelettuce					X	X	X	X	
	Stevia serrata Cav.	sawtooth candyleaf	X			X	X	X	X	X	
	Symphyotrichum falcatum var. commutatum (Torr. & Gray) Nesom	white prairie aster	X				X	X	X	X	
	Tagetes micrantha Cav.	licorice marigold	X		X	X	X	X	X	X	

			Herbarium specimen			Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Asteraceae	***Taraxacum officinale* G.H. Weber ex Wiggers**	**common dandelion**				X	X	X	X	X	
	Thelesperma megapotamicum (Spreng.) Kuntze	Hopi tea greenthread				X	X	X	X	X	
	Trixis californica Kellogg	American threefold					X	X	X	X	
	Uropappus lindleyi (DC.) Nutt.	Lindley's silverpuffs				X	X	X	X	X	
	Verbesina encelioides (Cav.) Benth. & Hook. f. ex Gray	golden crownbeard	X		X	X			X	X	
	Verbesina encelioides ssp. exauriculata (Robins. & Greenm.) J.R. Coleman	golden crownbeard					X	X		X	
	Verbesina longifolia (Gray) Gray	longleaf crownbeard	X		X	X	X	X	X	X	
	Viguiera cordifolia Gray	heartleaf goldeneye	X				X	X	X	X	
	Viguiera dentata (Cav.) Spreng.	toothleaf goldeneye	X		X	X	X	X	X	X	
	Xanthium strumarium L.	rough cockleburr			X		X	X		X	X
	Xanthium strumarium var. canadense (P. Mill.) Torr. & Gray	Canada cockleburr				X			X		
	Zinnia grandiflora Nutt.	Rocky Mountain zinnia			X	X	X	X	X	X	
Berberidaceae	*Berberis wilcoxii* Kearney	Wilcox's barberry			X		X	X	X	X	
	Mahonia repens (Lindl.) G. Don	creeping barberry									
	Mahonia trifoliolata (Moric.) Fedde	algerita				X					
Bignoniaceae	*Chilopsis linearis* (Cav.) Sweet	desert willow			X	X	X	X		X	
	Chilopsis linearis (Cav.) Sweet *ssp. linearis*	desert willow							X		
Boraginaceae	*Cryptantha cinerea* (Greene) Cronq. *var. cinerea*	James' cryptantha	X				X	X	X	X	
	Cryptantha crassisepala (Torr. & Gray) Greene	thicksepal cryptantha	X				X	X	X	X	
	Hackelia floribunda (Lehm.) I.M. Johnston	manyflower stickseed				X					
	Hackelia pinetorum (Greene ex Gray) I.M. Johnston	Livermore stickseed			X						
	Heliotropium fruticosum L.	Key West heliotrope					X	X	X	X	
	Lappula occidentalis var. cupulata (Gray) Higgins	flatspine stickseed				X	X	X	X	X	
	Lappula occidentalis var. occidentalis (S. Wats.) Greene	flatspine stickseed			X		X	X	X	X	
	Lithospermum cobrense Greene	smoothhroat stoneseed				X	X	X	X	X	
	Lithospermum confine I.M. Johnston	Arizona stoneseed			X						
	Lithospermum incisum Lehm.	narrowleaf stoneseed			X		X	X	X	X	
	Lithospermum multiflorum Torr. ex Gray	manyflowered stoneseed			X	X	X	X	X	X	
	Plagiobothrys arizonicus (Gray) Greene ex Gray	Arizona popcornflower	X				X	X	X	X	
Brassicaceae	*Arabis perennans* S. Wats.	perennial rockcress	X				X	X	X	X	
	***Brassica rapa var. rapa* L.**	**field mustard**					X	X	X	X	
	***Capsella bursa-pastoris* (L.) Medik.**	**shepherd's purse**	X								
	Descurainia incana ssp incana (Bernh. ex Fisch. & C.A. Mey.)	mountain tansymustard				X					
	Descurainia obtusa ssp. obtusa (Greene) O.E. Schulz	blunt tansymustard					X	X	X	X	
	Descurainia pinnata (Walt.) Britt.	western tansymustard	X				X	X		X	
	Descurainia pinnata ssp. glabra (Woot. & Standl.) Detling	western tansymustard							X		
	***Descurainia sophia* (L.) Webb ex Prantl**	**herb sophia**				X	X	X	X	X	X
	Draba aurea Vahl ex Hornem.	golden draba						X			
	Draba cuneifolia Nutt. ex Torr. & Gray	wedgeleaf draba				X				X	
	Draba cuneifolia Nutt. ex Torr. & Gray *var. cuneifolia*	wedgeleaf draba					X	X	X		
	Draba helleriana var. bifurcata C.L. Hitchc.	Heller's draba			X						
	Dryopetalon runcinatum Gray	rockmustard	X		X		X	X	X	X	
	Erysimum capitatum (Dougl. ex Hook.) Greene	sanddune wallflower	X		X	X	X	X		X	
	Erysimum capitatum var. capitatum (Dougl. ex Hook.) Greene	sanddune wallflower							X		
	Lepidium lasiocarpum Nutt. *var. lasiocarpum*	shaggyfruit pepperweed					X	X	X	X	

			Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Brassicaceae	*Lepidium thurberi* Woot.	Thurber's pepperweed				X	X	X	X	X	
	Lesquerella gordonii (Gray) S. Wats.	Gordon's bladderpod					X	X	X	X	
	Pennellia longifolia (Benth.) Rollins	longleaf mock thelypody					X	X	X	X	
	Pennellia micrantha (Gray) Nieuwl.	mountain mock thelypody			X	X	X	X	X	X	
	Rorippa nasturtium-aquaticum (L.) Hayek	watercress				X	X	X	X	X	
	Schoenocrambe linearifolia (Gray) Rollins	slimleaf plainsmustard			X	X	X	X	X	X	
	Sisymbrium auriculatum Gray	eared hedgemustard				X					
	***Sisymbrium irio* L.**	**London rocket**					X	X	X	X	X
	Thelypodium wrightii Gray	Wright's thelypody			X	X	X			X	
	Thelypodium wrightii Gray *ssp. wrightii*	Wright's thelypody						X	X		
	Thlaspi montanum var. fendleri (Gray) P. Holmgren	Fendler's pennycress				X	X	X	X	X	
	Thysanocarpus curvipes Hook.	sand fringepod					X	X	X		
Cactaceae	*Echinocereus coccineus var. arizonicus* (Rose ex Orcutt) Ferguson	Arizona hedgehog cactus					X	X	X		
	Echinocereus coccineus Engelm. *var. coccineus*	scarlet hedgehog cactus				X	X	X	X	X	
	Echinocereus fendleri (Engelm.) F. Seitz	pinkflower hedgehog cactus				X	X	X			
	Echinocereus fendleri var. ledingii (Peebles) N.P. Taylor	Leding's hedgehog cactus	X				X	X	X	X	
	Echinocereus fendleri var. rectispinus (Peebles) L. Benson	pinkflower hedgehog cactus							X		
	Echinocereus pectinatus (Scheidw.) Engelm.	rainbow cactus				X			X		
	Echinocereus polyacanthus Engelm.	Mojave mound cactus			X						
	Echinocereus rigidissimus (Engelm.) Haage f.	rainbow hedgehog cactus	X				X	X		X	
	Echinocereus triglochidiatus Engelm.	kingcup cactus	X			X					
	Escobaria vivipara var. bisbeeana (Orcutt) D.R. Hunt	Bisbee spinystar					X	X	X	X	
	Opuntia chlorotica Engelm. & Bigelow	dollarjoint pricklypear	X			X	X	X	X	X	
	Opuntia engelmannii Salm-Dyck	cactus apple			X	X					
	Opuntia engelmannii Salm-Dyck *var. engelmannii*	cactus apple					X	X	X	X	
	Opuntia macrorhiza Engelm. *var. macrorhiza*	twistspine pricklypear				X	X	X	X		
	Opuntia phaeacantha Engelm.	tulip pricklypear				X					
	Opuntia phaeacantha var. major Engelm.	Mojave pricklypear					X	X	X	X	
	Opuntia spinosior (Engelm.) Toumey	walkingstick cactus	X			X	X	X	X	X	
Campanulaceae	*Lobelia cardinalis* L.	cardinalflower			X	X	X	X	X	X	
Capparaceae	*Polanisia dodecandra ssp. trachysperma* (Torr. & Gray) Iltis	sandyseed clammyweed					X	X	X	X	
	Wislizenia refracta Engelm.	spectacle fruit					X	X	X		
Caprifoliaceae	*Lonicera albiflora* Torr. & Gray	western white honeysuckle			X	X	X	X	X	X	
	Lonicera arizonica Rehd.	Arizona honeysuckle			X			X		X	
	***Lonicera japonica* Thunb.**	**Japanese honeysuckle**					X	X	X		
	Symphoricarpos oreophilus Gray	mountain snowberry				X	X	X		X	
	Symphoricarpos oreophilus Gray *var. oreophilus*	mountain snowberry							X		
	Symphoricarpos palmeri G.N. Jones	Palmer's snowberry					X	X	X	X	
Caryophyllaceae	*Arenaria fendleri* Gray	Fendler's sandwort						X		X	
	Arenaria lanuginosa ssp. saxosa (Gray) Maguire	spreading sandwort	X		X	X	X	X	X	X	
	Cerastium nutans Raf.	nodding chickweed				X					
	Cerastium texanum Britt.	Texas chickweed					X	X	X	X	
	Drymaria glandulosa K. Presl	Fendler's drymary	X				X	X	X	X	
	Drymaria leptophylla (Cham. & Schlecht.) Fenzl ex Rohrb.	canyon drymary	X			X	X	X	X	X	
	Drymaria molluginea (Lag.) Didr.	slimleaf drymary				X	X	X	X	X	
	Silene laciniata Cav.	cardinal catchfly				X		X			
	Silene laciniata ssp. greggii (Gray) C.L. Hitchc. & Maguire	cardinal catchfly	X				X		X	X	

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Celastraceae	*Paxistima myrsinites* (Pursh) Raf.	Oregon boxleaf			X	X	X	X	X	X	
Chenopodiaceae	*Atriplex elegans* (Moq.) D. Dietr.	wheelscale saltbush					X	X			
	Atriplex elegans (Moq.) D. Dietr. *var. elegans*	wheelscale saltbush							X		
	***Chenopodium album* L.**	**lambsquarters**				X	X	X	X	X	
	Chenopodium fremontii S. Wats.	Fremont's goosefoot			X		X	X		X	
	Chenopodium fremontii S. Wats. *var. fremontii*	Fremont's goosefoot							X		
	Chenopodium graveolens Willd.	fetid goosefoot	X		X		X	X	X	X	
	Chenopodium leptophyllum (Moq.) Nutt. ex S. Wats.	narrowleaf goosefoot					X	X	X	X	
	Chenopodium neomexicanum Standl.	New Mexico goosefoot					X	X		X	
	Monolepis nuttalliana (J.A. Schultes) Greene	Nuttall's povertyweed					X	X	X		
	***Salsola kali* L.**	**Russian thistle**				X			X		
	***Salsola tragus* L.**	**prickly Russian thistle**			X		X	X		X	
Commelinaceae	*Commelina dianthifolia* Delile	birdbill dayflower			X	X	X	X	X	X	
	Tradescantia pinetorum Greene	pinewoods spiderwort			X	X	X	X	X	X	
Convolvulaceae	***Convolvulus arvensis* L.**	**field bindweed**				X	X	X	X		
	Convolvulus equitans Benth.	Texas bindweed						X		X	
	Dichondra brachypoda Woot. & Standl.	New Mexico ponysfoot			X		X	X	X	X	
	Dichondra micrantha Urban	Asian ponysfoot				X					
	Evolvulus arizonicus Gray	wild dwarf morning-glory						X	X		
	Evolvulus sericeus Sw.	silver dwarf morning-glory			X	X	X	X		X	
	Evolvulus sericeus var. sericeus Sw.	silver dwarf morning-glory							X		
	Ipomoea capillacea (Kunth) G. Don	purple morning-glory			X	X	X	X	X		
	***Ipomoea coccinea* L.**	redstar				X	X			X	
	Ipomoea costellata Torr.	crestrib morning-glory	X		X	X	X	X	X	X	
	Ipomoea cristulata Hallier f.	Transpecos morning-glory			X		X	X	X	X	
	***Ipomoea hederacea* Jacq.**	**ivyleaf morning-glory**				X	X			X	
	Ipomoea hederifolia L.	scarletcreeper						X	X	X	
	Ipomoea plummerae Gray	Huachuca Mountain morning-glory			X	X	X	X	X	X	
	***Ipomoea purpurea* (L.) Roth**	**tall morning-glory**			X			X	X		X
	Ipomoea tenuiloba Torr.	spiderleaf			X	X	X	X	X	X	
Crassulaceae	*Graptopetalum rusbyi* (Greene) Rose	San Francisco River leatherpetal					X	X	X		
	Sedum cockerellii Britt.	Cockerell's stonecrop					X	X	X	X	
	Sedum wrightii Gray	Wright's stonecrop				X					
Crossosomataceae	*Apacheria chiricahuensis* C.T. Mason	apachebush	X		X		X	X	X	X	
Cucurbitaceae	*Apodanthera undulata* Gray	melon loco				X	X	X	X	X	
	Cucurbita digitata Gray	fingerleaf gourd				X	X	X	X	X	
	Cucurbita foetidissima Kunth	Missouri gourd				X	X	X	X	X	
Cupressaceae	*Cupressus arizonica* Greene	Arizona cypress	X		X	X	X	X	X	X	
	Juniperus coahuilensis (Martinez) Gaussen ex R.P. Adams	redberry juniper			X			X	X		
	Juniperus deppeana Steud.	alligator juniper	X		X	X	X	X	X	X	
	Juniperus monosperma (Engelm.) Sarg.	oneseed juniper				X	X	X		X	
Cyperaceae	*Bulbostylis capillaris* (L.) Kunth ex C.B. Clarke	densetuft hairsedge	X		X		X	X		X	
	Bulbostylis capillaris (L.) Kunth ex C.B. Clarke ssp. capillaris	densetuft hairsedge							X		
	Bulbostylis funckii (Steud.) C.B. Clarke	Funck's hairsedge				X					

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Cyperaceae	*Carex chihuahuensis* Mackenzie	Chihuahuan sedge	X		X						
	Carex geophila Mackenzie	White Mountain sedge						X			
	Carex leucodonta Holm	Huachuca Mountain sedge					X	X	X	X	
	Carex praegracilis W. Boott	clustered field sedge					X	X	X	X	
	Carex senta Boott	swamp carex				X	X	X	X	X	
	Carex ultra Bailey	Cochise sedge	X		X						
	***Cyperus esculentus* L.**	**chufa flatsedge**				X	X	X	X	X	X
	Cyperus fendlerianus Boeckl.	Fendler's flatsedge			X	X	X	X		X	
	Cyperus manimae Kunth	spectacular flatsedte					X	X	X		
	Cyperus retroflexus Buckl.	oneflower flatsedge					X	X	X		
	Cyperus sphaerolepis Boeckl.	Rusby's flatsedge			X	X	X	X	X	X	
	Cyperus squarrosus L.	bearded flatsedge			X	X	X	X	X	X	
	Eleocharis bella (Piper) Svens.	beautiful spikerush						X			
	Eleocharis erythropoda Steud.	bald spikerush				X					
	Eleocharis montevidensis Kunth	sand spikerush					X	X	X	X	
	Eleocharis rostellata (Torr.) Torr.	beaked spikerush					X	X	X	X	
	Lipocarpha aristulata (Coville) G. Tucker	awned halfchaff sedge					X	X			
	Lipocarpha drummondii (Nees) G. Tucker	Drummond's halfchaff sedge					X	X	X		
	Lipocarpha micrantha (Vahl) G. Tucker	smallflower halfchaff sedge			X						
	Scirpus americanus (Pers.) Volk. ex Schinz & R. Keller	chairmaker's bulrush			X						
Dryopteridaceae	*Cystopteris fragilis* (L.) Bernh.	brittle bladderfern					X	X			
	Cystopteris reevesiana Lellinger	Reeves' bladderfern							X		
	Dryopteris filix-mas (L.) Schott	male fern				X	X	X	X	X	
	Phanerophlebia auriculata Underwood	eared veinfern				X	X	X	X	X	
	Woodsia mexicana Fée	phanerophlebia				X	X	X		X	
	Woodsia plummerae Lemmon	Plummer's cliff fern					X	X	X	X	
Ebenaceae	***Diospyros kaki* L. f.**	**Japanese persimmon**					X	X	X		
Ephedraceae	*Ephedra trifurca* Torr. ex S. Wats.	longleaf jointfir					X	X	X	X	
Equisetaceae	*Equisetum ×ferrissii* Clute (pro sp.)	ferris horsetail			X		X	X	X	X	
	Equisetum hyemale L.	scouringrush horsetail	X								
	Equisetum hyemale var. affine (Engelm.) A.A. Eat.	scouringrush horsetail					X	X	X		
	Equisetum laevigatum A. Braun	smooth horsetail	X			X	X	X	X	X	
Ericaceae	*Arbutus arizonica* (Gray) Sarg.	Arizona madrone	X		X	X	X	X	X	X	
	Arctostaphylos pringlei Parry	Pringle manzanita			X	X	X	X	X	X	
	Arctostaphylos pungens Kunth	pointleaf manzanita	X			X	X	X	X	X	
Euphorbiaceae	*Acalypha neomexicana* Muell.-Arg.	New Mexico copperleaf			X	X	X	X	X	X	
	Acalypha phleoides Cav.	shrubby copperleaf	X		X	X	X	X	X	X	
	Chamaesyce albomarginata (Torr. & Gray) Small	whitemargin sandmat			X	X	X	X	X	X	
	Chamaesyce dioica (Kunth) Millsp.	royal sandmat					X	X	X	X	
	Chamaesyce glyptosperma (Engelm.) Small	ribseed sandmat				X		X		X	
	Chamaesyce hyssopifolia (L.) Small	hyssopleaf sandmat			X		X	X	X	X	
	Chamaesyce prostrata (Ait.) Small	prostrate sandmat					X	X	X	X	
	Chamaesyce revoluta (Engelm.) Small	threadstem sandmat			X	X	X	X	X	X	
	Chamaesyce serpyllifolia ssp. serpyllifolia (Pers.) Small	thymeleaf sandmat	X		X	X	X	X	X	X	
	Chamaesyce serrula (Engelm.) Woot. & Standl.	sawtooth sandmat					X	X	X	X	
	Chamaesyce stictospora (Engelm.) Small	slimseed sandmat						X			

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Euphorbiaceae	*Euphorbia bilobata* Engelm.	blackseed spurge	X		X	X	X	X	X	X	
	Euphorbia brachycera Engelm.	horned spurge	X		X	X	X	X	X	X	
	Euphorbia cuphosperma (Engelm.) Boiss.	hairy-fruit spurge	X		X						
	***Euphorbia dentata* Michx.**	**toothed spurge**					X	X	X	X	
	Euphorbia exstipulata Engelm.	squareseed spurge	X								
	Euphorbia heterophylla L.	Mexican fireplant			X						
	Tragia nepetifolia Cav.	catnip noseburn					X	X	X		
	Tragia ramosa Torr.	branched noseburn	X		X	X	X	X	X	X	
Fabaceae	*Acacia angustissima* (P. Mill.) Kuntze	prairie acacia			X	X					
	Acacia angustissima var. suffrutescens (Rose) Isely	prairie acacia					X	X	X		
	Amorpha fruticosa L.	desert false indigo			X	X	X	X	X	X	
	Astragalus allochrous Gray	halfmoon milkvetch			X						
	Astragalus allochrous var. playanus Isely	halfmoon milkvetch					X	X	X		
	Astragalus cobrensis Gray	copper mine milkvetch				X					
	Astragalus cobrensis var. maguirei Kearney	Maguire's milkvetch					X	X	X		
	Astragalus nothoxys Gray	sheep milkvetch	X			X	X	X	X	X	
	Astragalus nuttallianus var. austrinus (Small) Barneby	smallflowered milkvetch					X	X	X	X	
	Astragalus thurberi Gray	Thurber's milkvetch					X	X	X	X	
	Calliandra humilis Benth.	dwarf stickpea	X								
	Calliandra humilis Benth. *var. humilis*	dwarf stickpea					X	X	X	X	
	Calliandra humilis var. reticulata (Gray) L. Benson	dwarf stickpea	X		X	X	X	X	X	X	
	Chamaecrista nictitans (L.) Moench	partridge pea	X								
	Chamaecrista nictitans var. leptadenia (Greenm.) Gandhi & Hatch	partridge pea			X	X	X	X	X	X	
	Clitoria mariana L.	Atlantic pigeonwings			X	X	X	X	X	X	
	Cologania angustifolia Kunth	longleaf cologania			X	X	X	X	X	X	
	Cologania lemmonii Gray	Lemmon's cologania			X	X	X	X	X		
	Coursetia caribaea var. caribaea (Jacq.) Lavin	anil falso				X	X	X		X	
	Coursetia caribaea var. sericea (Gray) Lavin	anil falso							X		
	Crotalaria pumila Ortega	low rattlebox	X		X	X	X	X	X	X	
	Crotalaria sagittalis L.	arrowhead rattlebox					X	X	X		
	Dalea albiflora Gray	whiteflower prairie clover	X		X	X	X	X	X	X	
	Dalea candida Michx. ex Willd.	white prairie clover				X					
	Dalea candida Michx. ex Willd. *var. candida*	white prairie clover					X		X		
	Dalea candida var. oligophylla (Torr.) Shinners	white prairie clover						X			
	Dalea filiformis Gray	Sonoran prairie clover			X	X	X	X	X	X	
	Dalea grayi (Vail) L.O. Williams	Gray's prairie clover					X	X	X	X	
	Dalea nana var. carnescens Kearney & Peebles	dwarf prairie clover					X	X	X	X	
	Dalea pogonathera Gray	bearded prairie clover					X	X	X	X	
	Dalea versicolor Zucc.	oakwoods prairie clover			X						
	Dalea versicolor var. sessilis (Gray) Barneby	oakwoods prairie clover	X			X	X	X	X	X	
	Desmanthus cooleyi (Eat.) Trel.	Cooley's bundleflower				X	X	X	X	X	
	Desmodium batocaulon Gray	San Pedro ticktrefoil	X		X	X	X	X	X	X	
	Desmodium cinerascens Gray	spiked ticktrefoil					X	X	X		
	Desmodium grahamii Gray	Graham's ticktrefoil			X	X	X	X	X	X	
	Desmodium neomexicanum Gray	New Mexico ticktrefoil			X		X	X	X		
	Desmodium procumbens (P. Mill.) A.S. Hitchc.	western trailing ticktrefoil	X								

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Fabaceae	*Desmodium rosei* Schub.	Rose's ticktrefoil			X	X	X	X	X	X	
	Galactia wrightii Gray	Wright's milkpea	X			X	X	X		X	
	Galactia wrightii var. mollissima Kearney & Peebles	Wright's milkpea							X		
	Hoffmannseggia glauca (Ortega) Eifert	Indian rushpea				X	X	X	X	X	
	Indigofera sphaerocarpa Gray	Sonoran indigo				X	X	X	X	X	
	Lathyrus graminifolius (S. Wats.) White	grassleaf pea	X			X	X	X	X	X	
	Lotus greenei Ottley ex Kearney & Peebles	Greene's bird's-foot trefoil				X	X	X	X	X	
	Lotus humistratus Greene	foothill deervetch					X	X	X	X	
	Lotus plebeius (Brand) Barneby	New Mexico bird's-foot trefoil	X		X		X	X	X	X	
	Lotus wrightii (Gray) Greene	Wright's deervetch					X	X	X	X	
	Lupinus brevicaulis S. Wats.	shortstem lupine					X	X	X	X	
	Lupinus caudatus ssp. argophyllus (Gray) L. Phillips	Kellogg's spurred lupine			X						
	Lupinus concinnus J.G. Agardh	scarlet lupine					X	X	X	X	
	Lupinus lemmonii C.P. Sm.	Lemmon's lupine			X	X	X	X	X	X	
	***Macroptilium gibbosifolium* (Ortega) A. Delgado**	**variableleaf bushbean**			X	X	X	X	X	X	
	Marina calycosa (Gray) Barneby	San Pedro false prairie-clover					X	X	X	X	
	***Medicago sativa* L.**	**alfalfa**					X	X	X	X	
	***Melilotus alba* Medikus**	**white sweetclover**									X
	***Melilotus officinalis* (L.) Lam.**	yellow sweetclover					X	X	X	X	
	Mimosa aculeaticarpa var. biuncifera (Benth.) Barneby	catclaw mimosa			X	X	X	X	X	X	
	Mimosa dysocarpa Benth.	velvetpod mimosa	X		X	X	X	X	X	X	
	Oxytropis lambertii Pursh	purple locoweed			X	X			X	X	
	Oxytropis lambertii var. bigelovii Gray	purple locoweed	X				X	X		X	
	Phaseolus acutifolius Gray	tepary bean			X	X					
	Phaseolus acutifolius var. tenuifolius Gray	tepary bean					X	X	X	X	
	Phaseolus filiformis Benth.	slimjim bean				X					
	Phaseolus grayanus Woot. & Standl.	Gray's bean			X		X	X		X	
	Phaseolus maculatus Scheele	spotted bean			X		X	X	X	X	
	Phaseolus parvulus Greene	Pinos Altos Mountain bean			X						
	Phaseolus ritensis M.E. Jones	Santa Rita Mountain bean				X	X	X	X	X	
	Prosopis glandulosa var. torreyana (L. Benson) M.C. Johnston	western honey mesquite	X				X	X	X	X	
	***Prosopis juliflora* (Sw.) DC.**	**mesquite**				X					
	Prosopis velutina Woot.	velvet mesquite			X						
	Psoralidium tenuiflorum (Pursh) Rydb.	slimflower scurfpea			X	X	X	X	X	X	
	Rhynchosia senna var. texana (Torr. & Gray) M.C. Johnston	Texas snoutbean				X	X	X	X		
	Robinia neomexicana Gray	New Mexico locust	X		X	X	X	X		X	
	Robinia neomexicana Gray *var. neomexicana*	New Mexico locust							X		
	Senna bauhinioides (Gray) Irwin & Barneby	twinleaf senna				X	X	X	X	X	
	Tephrosia tenella Gray	red hoarypea			X		X	X	X	X	
	Thermopsis divaricarpa A. Nels.	spreadfruit goldenbanner					X	X		X	
	Thermopsis montana Nutt. *var. montana*	mountain goldenbanner							X		
	***Trifolium repens* L.**	**white clover**				X	X	X	X	X	
	Vicia americana Muhl. ex Willd.	American vetch					X	X		X	
	Vicia americana Muhl. ex Willd. *ssp. americana*	American vetch							X		
	Vicia pulchella Kunth	sweetclover vetch			X	X	X	X	X	X	

Family	Scientific name	Common name	UA	Herbarium specimen		Previous study/list					
				WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Fagaceae	*Quercus arizonica* Sarg.	Arizona white oak	X		X	X	X	X	X	X	
	Quercus dunnii Kellogg	Palmer oak	X		X	X	X	X	X	X	
	Quercus emoryi Torr.	Emory oak	X		X	X	X	X	X	X	
	Quercus gambelii Nutt.	Gambel oak			X	X	X	X		X	
	Quercus gambelii Nutt. *var. gambelii*	Gambel oak							X		
	Quercus hypoleucoides A. Camus	silverleaf oak	X		X	X	X	X	X	X	
	Quercus rugosa Née	netleaf oak	X		X	X	X	X	X	X	
	Quercus toumeyi Sarg.	Toumey oak	X		X	X	X	X	X	X	
Fouquieriaceae	*Fouquieria splendens* Engelm.	ocotillo	X		X	X	X	X	X	X	
Fumariaceae	*Corydalis aurea* Willd.	scrambled eggs	X			X	X	X		X	
	Corydalis curvisiliqua ssp. occidentalis (Engelm. ex Gray) W.A. Weber	curvepod fumewort							X		
Garryaceae	*Garrya wrightii* Torr.	Wright's silktassel	X		X	X	X	X	X	X	
Gentianaceae	*Centaurium calycosum* (Buckl.) Fern.	Arizona centaury				X	X	X	X	X	
	Frasera speciosa Dougl. ex Griseb.	elkweed			X	X	X	X	X	X	
	Gentianella microcalyx (J.G. Lemmon) J. Gillett	Chiricahua dwarf gentian					X	X	X		
Geraniaceae	***Erodium cicutarium* (L.) L'Hér. ex Ait.**	**redstem stork's bill**					X	X			
	***Erodium cicutarium ssp. jacquinianum* (Fisch., C.A. Mey. & Avé-Lall.) Briq.**	**redstem stork's bill**							X		
	Geranium caespitosum James	pineywoods geranium			X	X	X	X	X	X	
	Geranium caespitosum var. eremophilum (Woot. & Standl.) W.C. Martin & C.R. Hutchins	purple cluster geranium					X	X	X	X	
Hydrangeaceae	*Fendlera rupicola* Gray	cliff fendlerbush				X	X	X	X	X	
	Fendlerella utahensis (S. Wats.) Heller	Utah fendlerbush	X		X	X				X	
	Fendlerella utahensis var. cymosa (Greene ex Woot. & Standl.) Kearney & Peebles	Utah fendlerbush			X		X	X	X	X	
	Philadelphus argenteus Rydb.	silver mock orange			X				X		
	Philadelphus madrensis Hemsl.	desert mountain mock orange					X	X	X	X	
	Philadelphus microphyllus Gray	littleleaf mock orange			X	X			X		
Hydrophyllaceae	*Nama dichotomum* (Ruiz & Pavón) Choisy	wishbone fiddleleaf			X		X	X	X		
	Nama hispidum Gray	bristly nama			X	X	X	X	X	X	
	Phacelia arizonica Gray	Arizona phacelia					X	X	X	X	
Juglandaceae	*Juglans major* (Torr.) Heller	Arizona walnut	X		X	X	X	X	X	X	
Juncaceae	*Juncus balticus* Willd.	Baltic rush					X	X		X	
	Juncus balticus var. montanus Engelm.	mountain rush							X		
	Juncus bufonius L.	toad rush						X		X	
	Juncus dudleyi Wieg.	Dudley's rush					X	X		X	
	Juncus interior Wieg.	inland rush				X	X	X	X	X	
	Juncus mexicanus Willd. ex J.A. & J.H. Schultes	Mexican rush					X	X	X		
	Juncus saximontanus A. Nels.	Rocky Mountain rush			X	X	X	X	X	X	
	Juncus tenuis Willd.	poverty rush							X		
Krameriaceae	*Krameria lanceolata* Torr.	trailing krameria			X	X	X	X		X	
Lamiaceae	*Agastache breviflora* (Gray) Epling	TransPecos giant hyssop			X		X	X	X	X	
	Agastache pallidiflora (Heller) Rydb.	Bill Williams Mountain giant hyssop				X					
	Hedeoma dentata Torr.	dentate false pennyroyal	X		X	X	X	X	X	X	

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Lamiaceae	*Hedeoma hyssopifolia* Gray	aromatic false pennyroyal	X		X	X	X	X	X	X	
	Hedeoma nana (Torr.) Briq.	dwarf false pennyroyal					X	X			
	Hedeoma nana (Torr.) Briq. *ssp. nana*	dwarf false pennyroyal							X		
	Hedeoma oblongifolia (Gray) Heller	oblongleaf false pennyroyal	X				X	X	X		
	***Marrubium vulgare* L.**	**horehound**	X		X	X	X	X	X	X	X
	Monarda citriodora ssp. austromontana (Epling) Scora	lemon beebalm			X		X	X	X	X	
	Monarda citriodora Cerv. ex Lag. *var. citriodora*	lemon beebalm				X					
	Monarda fistulosa var. menthifolia (Graham) Fern.	wild bergamot			X	X	X	X	X	X	
	***Nepeta cataria* L.**	**catnip**				X	X	X	X	X	
	Salvia lemmonii Gray	Lemmon's sage			X	X	X	X	X	X	
	***Salvia microphylla* Benth.**	**baby sage**				X					
	Salvia subincisa Benth.	sawtooth sage	X		X	X	X	X	X	X	
	Stachys coccinea Ortega	scarlet hedgenettle			X	X	X	X	X		
	Trichostema arizonicum Gray	Arizona bluecurls	X		X	X	X	X	X	X	
Liliaceae	*Allium cernuum* Roth	nodding onion			X	X	X	X		X	
	Allium cernuum var. neomexicanum (Rydb.) J.F. Macbr.	New Mexican nodding onion							X		
	***Asparagus officinalis* L.**	garden asparagus				X	X	X	X	X	
	Calochortus ambiguus (M.E. Jones) Ownbey	doubting mariposa lily				X	X	X	X	X	
	Dasylirion wheeleri S. Wats.	common sotol	X	X	X	X	X	X	X	X	
	Dichelostemma capitatum (Benth.) Wood *ssp. capitatum*	bluedicks	X			X	X	X	X	X	
	Echeandia flavescens (J.A. & J.H. Schultes) Cruden	Torrey's craglily	X		X	X	X	X	X	X	
	Maianthemum racemosum ssp. racemosum (L.) Link	feathery false lily of the vally				X	X	X	X	X	
	Maianthemum stellatum (L.) Link	starry false lily of the vally			X				X		
	Milla biflora Cav.	Mexican star			X	X	X	X	X	X	
	Nolina microcarpa S. Wats.	sacahuista	X	X	X	X	X	X	X	X	
	Nolina texana S. Wats.	Texas sacahuista		X							
	Zephyranthes longifolia Hemsl.	copper zephyrlily					X	X		X	
Linaceae	*Linum aristatum* Engelm.	bristle flax				X	X	X	X	X	
	Linum lewisii Pursh	prairie flax				X	X	X		X	
	Linum lewisii Pursh *var. lewisii*	prairie flax							X		
	Linum neomexicanum Greene	New Mexico yellow flax			X	X	X	X	X	X	
Loasaceae	*Mentzelia albicaulis* (Dougl. ex Hook.) Dougl. ex Torr. & Gray	whitestem blazingstar					X	X	X	X	
	Mentzelia multiflora var. integra M.E. Jones	Adonis blazingstar							X		
	Mentzelia multiflora (Nutt.) Gray *var. multiflora*	Adonis blazingstar					X	X			
	Mentzelia pumila Nutt. ex Torr. & Gray	dwarf mentzelia				X				X	
	Mentzelia texana Urban & Gilg	Texas blazingstar					X	X	X	X	
Lythraceae	*Cuphea wrightii* Gray	Wright's waxweed	X								
	Lythrum californicum Torr. & Gray	California loosestrife				X	X	X	X	X	
Malpighiaceae	*Aspicarpa hirtella* L.C. Rich.	chaparral asphead			X						
Malvaceae	*Anoda cristata* (L.) Schlecht.	crested anoda			X	X	X	X	X	X	
	Hibiscus biseptus S. Wats.	Arizona rosemallow			X						
	***Sida abutifolia* P. Mill.**	**spreading fanpetals**	X		X	X	X	X	X	X	
	Sida neomexicana Gray	New Mexico fanpetals			X	X	X	X	X	X	
	Sida spinosa L.	prickly fanpetals			X		X	X	X		
	Sphaeralcea ambigua Gray	desert globemallow				X					
	Sphaeralcea angustifolia (Cav.) G. Don	copper globemallow					X	X	X	X	

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Malvaceae	*Sphaeralcea emoryi* Torr. ex Gray	Emory's globemallow					X	X	X	X	
	Sphaeralcea fendleri Gray	Fendler's globemallow					X	X	X	X	
	Sphaeralcea hastulata Gray	spear globemallow			X	X	X	X	X	X	
	Sphaeralcea laxa Woot. & Standl.	caliche globemallow			X		X	X	X	X	
	Sphaeralcea wrightii Gray	Wright's globemallow				X		X		X	
Molluginaceae	*Mollugo verticillata* L.	green carpetweed				X	X	X	X	X	
Nyctaginaceae	*Allionia incarnata* L.	trailing windmills				X	X	X	X	X	
	Boerhavia coccinea P. Mill.	scarlet spiderling			X	X	X	X		X	X
	Boerhavia diffusa L.	red spiderling						X	X		
	Boerhavia erecta L.	erect spiderling			X	X	X	X	X	X	
	Boerhavia purpurascens Gray	purple spiderling			X	X	X	X	X	X	
	Mirabilis albida (Walt.) Heimerl	white four o'clock	X				X	X	X		
	Mirabilis coccinea (Torr.) Benth. & Hook. f.	scarlet four o'clock				X	X	X	X	X	
	Mirabilis comata (Small) Standl.	hairy-tuft four o'clock			X	X				X	
	Mirabilis linearis (Pursh) Heimerl	narrowleaf four o'clock	X		X	X	X	X	X	X	
	Mirabilis longiflora L.	sweet four o'clock			X	X	X	X	X	X	
	Mirabilis longiflora var. wrightiana (Gray ex Britt. & Kearney) Kearney & Peebles	sweet four o'clock			X						
	Mirabilis nyctaginea (Michx.) MacM.	heartleaf four o'clock					X	X	X		
Oleaceae	*Fraxinus anomala* Torr. ex S. Wats.	singleleaf ash				X					
	Fraxinus velutina Torr.	velvet ash	X		X		X	X	X	X	
Onagraceae	*Calylophus hartwegii* (Benth.) Raven *ssp. hartwegii*	Hartweg's sundrops				X					
	Calylophus toumeyi (Small) Towner	Toumey's sundrops			X		X	X	X	X	
	Epilobium canum ssp. latifolium (Hook.) Raven	hummingbird trumpet			X	X	X	X	X	X	
	Epilobium ciliatum ssp. ciliatum Raf.	fringed willowherb	X		X	X			X	X	
	Epilobium ciliatum ssp. watsonii (Barbey) Hoch & Raven	fringed willowherb					X	X			
	Gaura coccinea Nutt. ex Pursh	scarlet beeblossom				X	X	X	X	X	
	Gaura hexandra ssp. gracilis (Woot. & Standl.) Raven & Gregory	harlequinbush			X	X	X	X	X	X	
	Gaura mollis James	velvetweed					X	X	X		
	Oenothera albicaulis Pursh	whitest evening-primrose				X	X	X	X	X	
	Oenothera caespitosa Nutt.	tufted evening-primrose					X	X		X	
	Oenothera caespitosa ssp. caespitosa Nutt.	tufted evening-primrose							X		
	Oenothera elata ssp. hirsutissima (Gray ex S. Wats.) W. Dietr.	Hooker's evening-primrose							X		
	Oenothera elata ssp. hookeri (Torr. & Gray) W. Dietr. & W.L. Wagner	Hooker's evening-primrose				X	X	X		X	
	Oenothera primiveris Gray	desert evening-primrose	X				X	X	X	X	
Orchidaceae	*Hexalectris spicata* (Walt.) Barnh.	spiked crested coralroot					X	X	X		
	Hexalectris warnockii Ames & Correll	Texas crested coralroot				X	X	X	X	X	
	Malaxis macrostachya (Lex.) Kuntze	Chiricahua adder's-mouth orchid				X	X	X	X	X	
Orobanchaceae	*Conopholis alpina var. mexicana* (Gray ex S. Wats.) Haynes	Mexican cancer-root				X	X	X	X	X	
Oxalidaceae	*Oxalis alpina* (Rose) Rose ex R. Knuth	alpine woodsorrel			X	X	X	X	X	X	
	Oxalis albicans ssp. pilosa (Nutt.) Eiten	radishroot woodsorrel			X						
	Oxalis corniculata L.	creeping woodsorrel						X			
	Oxalis decaphylla Kunth	tenleaf woodsorrel					X	X	X	X	
Oxalidaceae	*Oxalis stricta* L.	common yellow oxalis	X			X	X	X	X	X	
Papaveraceae	*Argemone pleiacantha* Greene	southwestern pricklypoppy	X							X	

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Papaveraceae	*Argemone pleiacantha* Greene *ssp. pleiacantha*	southwestern pricklypoppy						X	X		
	Argemone polyanthemos (Fedde) G.B. Ownbey	crested pricklypoppy				X	X	X			
	Eschscholzia californica Cham.	California poppy						X			
	Eschscholzia californica ssp. mexicana (Greene) C. Clark	California poppy					X	X	X	X	
Pedaliaceae	*Proboscidea parviflora* (Woot.) Woot. & Standl.	doubleclaw			X	X	X	X	X	X	
Phytolaccaceae	*Phytolacca americana* L.	American pokeweed				X	X	X	X	X	
Pinaceae	*Pinus arizonica* Engelm.	Arizona pine							X		
	Pinus arizonica Engelm. *var. arizonica*	Arizona pine				X	X	X		X	
	Pinus cembroides Zucc.	Mexican pinyon	X			X	X			X	
	Pinus discolor D.K. Bailey & Hawksworth	border pinyon			X			X	X		
	Pinus edulis Engelm.	twoneedle pinyon	X		X	X	X	X	X	X	
	Pinus engelmannii Carr.	Apache pine	X			X	X	X	X	X	
	Pinus leiophylla var. chihuahuana (Engelm.) Shaw	Chihuahuan pine	X			X	X	X	X	X	
	Pinus ponderosa P.& C. Lawson	ponderosa pine	X								
	Pseudotsuga menziesii (Mirbel) Franco	Douglas-fir	X		X	X					
	Pseudotsuga menziesii var. glauca (Beissn.) Franco	Rocky Mountain Douglas-fir					X	X	X	X	
Plantaginaceae	*Plantago major* L.	common plantain				X	X	X	X	X	
	Plantago patagonica Jacq.	woolly plantain	X			X	X	X	X	X	
Platanaceae	*Platanus wrightii* S. Wats.	Arizona sycamore	X		X	X	X	X	X	X	
Poaceae	*Agrostis scabra* Willd.	rough bentgrass	X		X	X	X	X	X	X	
	Aristida adscensionis L.	sixweeks threeawn			X	X	X	X	X	X	
	Aristida divaricata Humb. & Bonpl. ex Willd.	poverty threeawn			X		X	X	X		
	Aristida havardii Vasey	Havard's threeawn					X	X	X	X	
	Aristida purpurea var. fendleriana (Steud.) Vasey	Fendler's threeawn					X	X	X		
	Aristida purpurea var. longiseta (Steud.) Vasey	Fendler threeawn			X	X	X	X	X	X	
	Aristida schiedeana Trin. & Rupr.	single threeawn	X								
	Aristida schiedeana var. orcuttiana (Vasey) Allred & Valdés-Reyna	Orcutt's threeawn			X	X	X	X	X	X	
	Aristida ternipes Cav.	spidergrass			X		X	X			
	Aristida ternipes var. gentilis (Henr.) Allred	spidergrass					X	X	X		
	Avena L.	oat									X
	Blepharoneuron tricholepis (Torr.) Nash	pine dropseed	X		X	X	X	X	X	X	
	Bothriochloa barbinodis (Lag.) Herter	cane bluestem	X		X	X	X	X	X	X	
	Bouteloua aristidoides (Kunth) Griseb.	needle grama					X	X	X	X	
	Bouteloua barbata Lag.	sixweeks grama					X	X	X		
	Bouteloua curtipendula (Michx.) Torr.	sideoats grama	X		X	X	X	X	X	X	
	Bouteloua eriopoda (Torr.) Torr.	black grama			X		X	X	X		
	Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths	blue grama	X				X	X	X	X	
	Bouteloua hirsuta Lag.	hairy grama	X		X	X	X	X		X	
	Bouteloua hirsuta Lag. *var. hirsuta*	hairy grama							X		
	Bouteloua radicosa (Fourn.) Griffiths	purple grama			X		X	X	X		
	Bouteloua repens (Kunth) Scribn. & Merr.	slender grama				X	X	X	X	X	
	Bouteloua rothrockii Vasey	Rothrock's grama				X	X	X	X	X	
	Bromus anomalus Rupr. ex Fourn.	nodding brome	X			X		X	X		
	Bromus carinatus Hook. & Arn.	California brome					X	X	X	X	
	***Bromus catharticus* Vahl**	**rescuegrass**	X								X
	Bromus ciliatus L.	fringed brome	X			X	X	X	X		

			Herbarium specimen			Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Poaceae	*Bromus ciliatus var. richardsonii* (Link) Boivin	fringed brome			X					X	
	***Bromus hordeaceus ssp. hordeaceus* L.**	**soft brome**					X	X	X		
	Bromus porteri (Coult.) Nash	Porter brome					X	X		X	
	***Bromus rubens* L.**	**red brome**									X
	Cenchrus spinifex Cav.	coastal sandbur	X				X	X	X		
	Chloris virgata Sw.	feather fingergrass			X	X	X	X	X	X	X
	***Cynodon dactylon* (L.) Pers.**	**Bermudagrass**					X	X	X	X	X
	Dasyochloa pulchella (Kunth) Willd. ex Rydb.	low woollygrass				X	X	X	X	X	
	Dichanthelium oligosanthes (J.A. Schultes) Gould *var. oligosanthes*	Heller's rosette grass					X	X			
	Dichanthelium oligosanthes var. scribnerianum (Nash) Gould	Scribner's rosette grass							X		
	Digitaria sanguinalis (L.) Scop.	hairy crabgrass	X		X	X	X	X	X	X	X
	***Echinochloa colona* (L.) Link**	**jungle rice**					X	X	X		
	***Echinochloa crus-galli* (L.) Beauv.**	**barnyardgrass**					X	X	X	X	
	Elymus arizonicus (Scribn. & J.G. Sm.) Gould	Arizona wheatgrass	X			X	X	X	X	X	
	Elymus elymoides (Raf.) Swezey	squirreltail	X		X			X	X		
	Elymus elymoides ssp. elymoides (Raf.) Swezey	squirreltail				X	X			X	
	Elyonurus barbiculmus Hack.						X	X	X	X	
	Enneapogon desvauxii Desv. ex Beauv.	nineawn pappusgrass					X	X	X		
	***Eragrostis cilianensis* (All.) Vign. ex Janchen**	**stinkgrass**	X		X		X	X	X	X	X
	***Eragrostis curvula* (Schrad.) Nees**	**weeping lovegrass**	X								X
	Eragrostis intermedia A.S. Hitchc.	plains lovegrass	X		X	X			X	X	
	***Eragrostis lehmanniana* Nees**	**Lehmann lovegrass**	X					X			X
	Eragrostis lugens Nees	mourning lovegrass					X	X	X		
	Eragrostis mexicana (Hornem.) Link	Mexican lovegrass	X		X	X	X	X		X	
	Eragrostis mexicana ssp. mexicana (Hornem.) Link	Mexican lovegrass					X	X	X		
	Eragrostis pectinacea (Michx.) Nees ex Steud.	tufted lovegrass					X	X		X	
	Eragrostis pectinacea var. miserrima (Fourn.) J. Reeder	desert lovegrass	X		X		X	X	X		
	Eragrostis pectinacea (Michx.) Nees ex Steud. *var. pectinacea*	tufted lovegrass				X			X	X	
	Eriochloa acuminata var. acuminata (J. Presl) Kunth	tapertip cupgrass					X	X			
	Eriochloa acuminata var. minor (Vasey) R.B. Shaw	tapertip cupgrass	X								
	Eriochloa lemmonii Vasey & Scribn.	canyon cupgrass							X		
	***Hackelochloa granularis* (L.) Kuntze**	**pitscale grass**					X	X	X	X	
	Heteropogon contortus (L.) Beauv. ex Roemer & J.A. Schultes	tanglehead	X		X		X	X	X	X	
	Hilaria belangeri (Steud.) Nash	curly-mesquite				X	X	X	X	X	
	***Hordeum murinum* L.**	**mouse barley**	X								
	***Hordeum murinum ssp. glaucum* (Steud.) Tzvelev**	**smooth barley**	X								
	***Hordeum murinum ssp. leporinum* (Link) Arcang.**	**leporinum barley**									X
	Koeleria macrantha (Ledeb.) J.A. Schultes	prairie Junegrass				X	X	X	X	X	
	Leptochloa dubia (Kunth) Nees	green sprangletop	X				X	X	X	X	
	***Lolium pratense* (Huds.) S.J. Darbyshire**	**meadow ryegrass**					X	X	X		
	Lycurus phleoides Kunth	common wolfstail				X	X	X		X	
	Lycurus setosus (Nutt.) C.G. Reeder	bristly wolfstail	X		X			X	X		
	Muhlenbergia arizonica Scribn.	Arizona muhly					X	X	X	X	
	Muhlenbergia asperifolia (Nees & Meyen ex Trin.) Parodi	scratchgrass	X				X	X	X	X	
	Muhlenbergia emersleyi Vasey	bullgrass	X		X	X	X	X	X	X	
	Muhlenbergia fragilis Swallen	delicate muhly			X		X	X	X	X	

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Poaceae	*Muhlenbergia glauca* (Nees) B.D. Jackson	desert muhly	X		X				X		
	Muhlenbergia longiligula A.S. Hitchc.	longtongue muhly			X		X	X	X	X	
	Muhlenbergia minutissima (Steud.) Swallen	annual muhly			X		X	X			
	Muhlenbergia pauciflora Buckl.	New Mexico muhly			X						
	Muhlenbergia polycaulis Scribn.	cliff muhly	X		X	X	X	X	X	X	
	Muhlenbergia repens (J. Presl) A.S. Hitchc.	creeping muhly	X								
	Muhlenbergia rigens (Benth.) A.S. Hitchc.	deergrass	X							X	
	Muhlenbergia rigida (Kunth) Trin.	purple muhly	X		X		X	X	X		
	Muhlenbergia sinuosa Swallen	marshland muhly	X			X			X		
	Muhlenbergia tenuifolia (Kunth) Trin.	slimflower muhly			X	X	X	X	X	X	
	Muhlenbergia texana Buckl.	Texas muhly	X								
	Muhlenbergia virescens (Kunth) Kunth	screwleaf muhly	X				X	X	X	X	
	Muhlenbergia wrightii Vasey ex Coult.	spike muhly	X		X		X	X	X		
	Panicum bulbosum Kunth	bulb panicgrass	X		X	X	X	X	X	X	
	Panicum capillare L.	witchgrass					X	X	X	X	
	Panicum hallii Vasey	Hall's panicgrass					X	X			
	Panicum hallii Vasey *var. hallii*	Hall's panicgrass							X		
	Panicum hirticaule J. Presl	Mexican panicgrass			X		X	X	X	X	
	Panicum hirticaule var. hirticaule J. Presl	Mexican panicgrass			X	X	X	X		X	
	***Panicum miliaceum* L.**	**broomcorn millet**					X	X	X	X	
	Panicum obtusum Kunth	vine mesquite			X	X	X	X	X	X	
	Piptochaetium fimbriatum (Kunth) A.S. Hitchc.	pinyon ricegrass	X		X	X	X	X	X	X	
	Piptochaetium pringlei (Beal) Parodi	Pringle's speargrass	X		X		X	X	X		
	Poa fendleriana (Steud.) Vasey	muttongrass	X				X	X		X	
	Poa fendleriana ssp. albescens (A.S. Hitchc.) Soreng	muttongrass			X						
	Poa fendleriana (Steud.) Vasey *ssp. fendleriana*	muttongrass							X		
	***Polypogon monspeliensis* (L.) Desf.**	**annual rabbitsfoot grass**				X	X	X	X	X	
	***Polypogon viridis* (Gouan) Breistr.**	**beardless rabbitsfoot grass**				X	X	X	X	X	
	Schizachyrium cirratum (Hack.) Woot. & Standl.	Texas bluestem	X				X	X	X	X	
	Schizachyrium sanguineum (Retz.) Alston	crimson bluestem	X		X						
	Schizachyrium sanguineum var. hirtiflorum (Nees) Hatch	crimson bluestem							X		
	Setaria grisebachii Fourn.	Grisebach's bristlegrass	X		X	X	X	X	X	X	
	Setaria leucopila (Scribn. & Merr.) K. Schum.	streambed bristlegrass	X								
	***Setaria viridis* (L.) Beauv.**	**green bristlegrass**			X	X	X	X	X	X	
	Setaria vulpiseta (Lam.) Roemer & J.A. Schultes	plains bristlegrass					X	X	X	X	
	Sorghastrum nutans (L.) Nash	Indiangrass	X		X		X	X	X		
	***Sorghum halepense* (L.) Pers.**	**Johnsongrass**					X	X	X	X	X
	Sphenopholis intermedia (Rydb.) Rydb.	slender wedgescale							X		
	Sphenopholis obtusata (Michx.) Scribn.	prairie wedgescale					X	X	X	X	
	Sporobolus airoides (Torr.) Torr.	alkali sacaton	X						X		
	Sporobolus contractus A.S. Hitchc.	spike dropseed	X								
	Sporobolus wrightii Munro ex Scribn.	big sacaton				X	X	X		X	
	Trachypogon spicatus (L.) Kuntze	spiked crinkleawn	X								
	Tragus berteronianus J.A. Schultes	spiked burr grass					X	X	X		
	Urochloa arizonica (Scribn. & Merr.) O. Morrone & F. Zuloaga	Arizona signalgrass	X				X	X	X	X	

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Poaceae	*Vulpia octoflora* (Walt.) Rydb.	sixweeks fescue	X				X	X		X	
	Vulpia octoflora var. octoflora (Walt.) Rydb.	sixweeks fescue							X		
Polemoniaceae	*Gilia mexicana* A.& V. Grant	El Paso gilia	X				X	X	X	X	
	Gilia sinuata Dougl. ex Benth.	rosy gilia				X		X		X	
	Ipomopsis macombii (Torr. ex Gray) V. Grant	Macomb's ipomopsis	X		X	X	X	X	X	X	
	Ipomopsis multiflora (Nutt.) V. Grant	manyflowered ipomopsis	X								
	Phlox gracilis ssp. gracilis (Hook.) Greene	slender phlox					X	X	X	X	
Polygalaceae	*Monnina wrightii* Gray	blue pygmyflower			X	X	X	X	X	X	
	Polygala alba Nutt.	white milkwort			X	X	X	X	X	X	
	Polygala barbeyana Chod.	blue milkwort			X						
	Polygala hemipterocarpa Gray	winged milkwort			X		X	X	X	X	
	Polygala obscura Benth.	velvetseed milkwort			X	X	X	X	X	X	
	Polygala scoparioides Chod.	broom milkwort				X		X		X	
Polygonaceae	*Eriogonum abertianum* Torr.	Abert's buckwheat			X	X	X	X		X	
	Eriogonum abertianum Torr. *var. abertianum*	Abert's buckwheat							X		
	Eriogonum alatum Torr.	winged buckwheat					X	X	X		
	Eriogonum corymbosum Benth.	crispleaf buckwheat				X					
	Eriogonum deserticola S. Wats.	Colorado Desert buckwheat				X					
	Eriogonum jamesii Benth.	James' buckwheat			X		X	X		X	
	Eriogonum jamesii var. undulatum (Benth.) S. Stokes ex M.E. Jones	James' buckwheat							X		
	Eriogonum pharnaceoides Torr. *var. pharnaceoides*	wirestem buckwheat							X		
	Eriogonum polycladon Benth.	sorrel buckwheat	X				X	X	X	X	
	Eriogonum racemosum Nutt.	redroot buckwheat						X			
	Eriogonum wrightii Torr. ex Benth.	bastardsage	X		X		X	X		X	
	Eriogonum wrightii var. wrightii Torr. ex Benth.	bastardsage							X		
	Polygonum aviculare L.	prostrate knotweed					X	X	X		X
	Polygonum douglasii ssp. johnstonii (Munz) Hickman	Johnston's knotweed					X	X	X		
	***Rumex crispus* L.**	**curly dock**			X	X	X	X		X	
	Rumex hymenosepalus Torr.	canaigre dock					X	X	X	X	
Portulacaceae	*Calandrinia ciliata* (Ruiz & Pavón) DC.	fringed redmaids					X	X	X	X	
	Portulaca halimoides L.	silkcotton purslane					X	X	X	X	
	Portulaca oleracea L.	little hogweed				X	X	X	X	X	
	Portulaca pilosa L.	kiss me quick					X	X	X	X	
	Portulaca suffrutescens Engelm.	shrubby purslane			X	X	X	X		X	
	Portulaca umbraticola Kunth	wingpod purslane					X	X	X	X	
	Portulaca umbraticola ssp. coronata (Small) Matthews & Ketron	wingpod purslane				X					
	Talinum aurantiacum Engelm.	orange fameflower			X		X	X	X	X	
	Talinum paniculatum (Jacq.) Gaertn.	jewels of Opar			X						
	Talinum parviflorum Nutt.	sunbright				X	X	X	X	X	
Primulaceae	***Anagallis arvensis* L.**	**scarlet pimpernel**				X	X	X	X	X	
	Androsace occidentalis Pursh	western rockjasmine					X	X	X	X	
Pteridaceae	*Adiantum capillus-veneris* L.	common maidenhair						X		X	
	Argyrochosma limitanea ssp. limitanea (Maxon) Windham	southwestern false cloakfern					X	X	X		
	Astrolepis cochisensis ssp. cochisensis (Goodding) Benham & Windham	Cochise scaly cloakfern					X	X	X	X	
	Astrolepis sinuata (Lag. ex Sw.) Benham & Windham *ssp. sinuata*	wavy scaly cloakfern					X	X	X	X	

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Pteridaceae	*Bommeria hispida* (Mett. ex Kuhn) Underwood	copper fern			X	X	X	X	X	X	
	Cheilanthes bonariensis (Willd.) Proctor	golden lipfern				X	X	X	X	X	
	Cheilanthes eatonii Baker	Eaton's lipfern			X	X	X	X	X	X	
	Cheilanthes feei T. Moore	slender lipfern				X	X	X	X	X	
	Cheilanthes fendleri Hook.	Fendler's lipfern			X	X	X	X	X	X	
	Cheilanthes lendigera (Cav.) Sw.	nitbearing lipfern					X	X	X		
	Cheilanthes lindheimeri Hook.	fairyswords					X	X	X	X	
	Cheilanthes wootonii Maxon	beaded lipfern					X	X	X	X	
	Cheilanthes wrightii Hook.	Wright's lipfern				X	X	X	X	X	
	Notholaena grayi Davenport	Gray's cloak fern					X	X			
	Notholaena grayi Davenport *ssp. grayi*	Gray's cloak fern							X		
	Notholaena standleyi Maxon	star cloak fern					X	X	X		
	Pellaea atropurpurea (L.) Link	purple cliffbrake	X			X	X	X	X	X	
	Pellaea intermedia Mett. ex Kuhn	intermediate cliffbrake				X	X	X	X	X	
	Pellaea truncata Goodding	spiny cliffbrake			X	X	X	X	X	X	
	Pellaea wrightiana Hook.	Wright's cliffbrake			X	X	X	X	X	X	
	Pteridium aquilinum (L.) Kuhn	western brackenfern			X	X		X			
	Pteridium aquilinum var. pubescens Underwood	hairy brackenfern					X		X	X	
	Selaginella underwoodii Hieron.	Underwood's spikemoss				X	X	X	X	X	
Ranunculaceae	*Aquilegia desertorum* (M.E. Jones) Cockerell ex Heller	desert columbine			X						
	Aquilegia triternata Payson	Chiricahua Mountain columbine	X			X	X	X	X	X	
	Clematis ligusticifolia Nutt.	western white clematis			X	X	X	X		X	
	Clematis ligusticifolia Nutt. *var. ligusticifolia*	western white clematis							X		
	Delphinium carolinianum ssp. virescens (Nutt.) Brooks	Carolina larkspur					X	X			
	Delphinium wootonii Rydb.	Organ Mountain larkspur							X		
	Myosurus cupulatus S. Wats.	Arizona mousetail					X	X	X	X	
	Thalictrum fendleri Engelm. ex Gray	Fendler's meadow-rue	X		X	X	X	X		X	
	Thalictrum fendleri var. wrightii (Gray) Trel.	Wright's meadow-rue							X		
Rhamnaceae	*Ceanothus fendleri* Gray	Fendler's ceanothus	X		X	X	X	X	X	X	
	Ceanothus greggii Gray	desert ceanothus			X	X	X	X		X	
	Ceanothus greggii var. vestitus (Greene) McMinn	Mojave ceanothus							X		
	Frangula betulifolia ssp. betulifolia (Greene) V. Grub.	beechleaf frangula	X		X	X	X	X	X	X	
	Frangula californica ssp. californica (Eschsch.) Gray	California buckthorn	X		X	X					
	Frangula californica ssp. ursina (Greene) Kartesz & Gandhi	California buckthorn					X	X	X	X	
	Rhamnus serrata Humb. & Bonpl. ex J.A. Schultes	sawleaf buckthorn					X	X	X		
Rhamnaceae	*Ziziphus obtusifolia var. canescens* (Gray) M.C. Johnston	lotebush							X		
Rosaceae	*Cercocarpus montanus* Raf.	alderleaf mountain mahogany	X								
	Cercocarpus montanus var. argenteus (Rydb.) F.L. Martin	silver mountain mahogany					X	X	X		
	Cercocarpus montanus var. paucidentatus (S. Wats.) F.L. Martin	hairy mountain mahogany			X	X	X	X	X	X	
	Fallugia paradoxa (D. Don) Endl. ex Torr.	Apache plume	X		X	X	X	X	X	X	
	Holodiscus discolor (Pursh) Maxim.	oceanspray			X						
	Holodiscus dumosus (Nutt. ex Hook.) Heller	rockspirea	X		X	X	X	X	X	X	
	Potentilla thurberi Gray	scarlet cinquefoil			X	X	X	X		X	
	Potentilla thurberi var. atrorubens (Rydb.) Kearney & Peebles	scarlet cinquefoil							X		

Family	Scientific name	Common name	UA	Herbarium specimen		Previous study/list					
				WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Rosaceae	*Prunus serotina* Ehrh.	black cherry			X						
	Prunus serotina var. rufula (Woot. & Standl.) McVaugh	black cherry							X		
	Prunus serotina var. virens (Woot. & Standl.) McVaugh	black cherry	X			X	X	X			
	***Pyracantha coccinea* M. Roemer**	**scarlet firethorn**						X			
	***Pyrus communis* L.**	**common pear**					X	X	X		
	Rosa woodsii Lindl.	Woods' rose					X	X			
	Rosa woodsii Lindl. *var. woodsii*	Woods' rose			X	X			X	X	
	Rubus neomexicanus Gray	New Mexico raspberry	X		X	X	X	X	X	X	
Rubiaceae	*Bouvardia ternifolia* (Cav.) Schlecht.	firecrackerbush			X	X	X	X	X	X	
	Crusea diversifolia (Kunth) W.A. Anderson	mountain saucerflower					X	X	X		
	Diodia teres Walt.	poorjoe			X	X	X	X		X	
	Diodia teres var. angustata Gray	poorjoe							X		
	Galium aparine L.	stickywilly				X		X		X	
	Galium coloradoense W. Wight	Colorado bedstraw				X		X		X	
	Galium fendleri Gray	Fendler's bedstraw			X	X	X	X	X	X	
	Galium mexicanum ssp. asperrimum (Gray) Dempster	Mexican bedstraw					X	X	X	X	
	Galium microphyllum Gray	bracted bedstraw	X		X	X	X	X	X	X	
	Galium wrightii Gray	Wright's bedstraw	X		X		X	X	X	X	
	Hedyotis greenei (Gray) W.H. Lewis	Greene's starviolet					X	X	X	X	
	Houstonia wrightii Gray	pygmy bluet	X			X	X	X	X	X	
Rutaceae	*Ptelea trifoliata var. angustifolia* (Benth.) V. Bailey	common hoptree				X	X	X	X	X	
Salicaceae	*Populus fremontii* S. Wats.	Fremont cottonwood					X				
	Populus fremontii S. Wats. *ssp. fremontii*	Fremont cottonwood	X		X	X		X	X	X	
	Salix gooddingii Ball	Goodding's willow			X	X	X	X	X	X	
	Salix irrorata Anderss.	dewystem willow				X	X	X	X	X	
	Salix lasiolepis Benth.	arroyo willow			X		X	X		X	
	Salix lasiolepis Benth. *var. lasiolepis*	arroyo willow							X		
	Salix taxifolia Kunth	yewleaf willow			X	X	X	X	X	X	
Santalaceae	*Comandra umbellata* (L.) Nutt.	bastard toadflax	X								
	Comandra umbellata ssp. pallida (A. DC.) Piehl	pale bastard toadflax	X		X	X	X	X	X	X	
Sapindaceae	*Sapindus saponaria* L.	wingleaf soapberry			X	X	X				
	Sapindus saponaria var. drummondii (Hook. & Arn.) L. Benson	western soapberry						X	X	X	
Saxfragiaceae	*Heuchera parviflora* Bartl.	littleflower alumroot				X	X	X		X	
	Heuchera sanguinea Engelm.	coralbells					X	X	X	X	
Scrophulariaceae	*Brachystigma wrightii* (Gray) Pennell	Arizona desert foxglove	X		X	X	X	X	X	X	
	Castilleja austromontana Standl. & Blumer	Rincon Mountain Indian paintbrush	X								
	Castilleja integra Gray	wholeleaf Indian paintbrush			X	X	X	X		X	
	Castilleja integra var. gloriosa (Britt.) Cockerell	wholeleaf Indian paintbrush							X		
	Castilleja lanata Gray	Sierra woolly Indian paintbrush			X	X	X	X	X	X	
	Castilleja tenuiflora Benth.	Santa Catalina Indian paintbrush	X		X		X	X	X		
	Cordylanthus wrightii Gray	Wright's bird's beak					X	X		X	
	Cordylanthus wrightii Gray *ssp. wrightii*	Wright's bird's beak							X		
	Maurandella antirrhiniflora (Humb. & Bonpl. ex Willd.) Rothm.	roving sailor			X	X	X	X	X	X	

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Scrophulariaceae	*Mimulus guttatus* DC.	seep monkeyflower					X	X	X	X	
	Mimulus rubellus Gray	little redstem monkeyflower					X	X	X		
	Penstemon barbatus (Cav.) Roth	beardlip penstemon			X	X	X	X		X	
	Penstemon barbatus ssp. torreyi (Benth.) Keck	Torrey's penstemon							X		
	Penstemon linarioides Gray	toadflax penstemon	X		X	X	X	X		X	
	Penstemon linarioides Gray *ssp. linarioides*	toadflax beardtongue							X		
	Penstemon pinifolius Greene	pineneedle beardtongue			X	X	X	X	X	X	
	Penstemon pseudospectabilis M.E. Jones	desert penstemon			X	X					
	Penstemon pseudospectabilis ssp. connatifolius (A. Nels.) Keck	desert beardtongue	X				X	X	X	X	
	Schistophragma intermedia (Gray) Pennell	harlequin spiralseed			X	X	X	X	X	X	
	Scrophularia parviflora Woot. & Standl.	pineland figwort	X		X		X	X	X	X	
	***Verbascum blattaria* L.**	**moth mullein**				X		X		X	
	***Verbascum thapsus* L.**	**common mullein**	X		X	X	X	X	X	X	X
	***Verbascum virgatum* Stokes**	**wand mullein**			X		X	X	X	X	
Solanaceae	*Chamaesaracha coronopus* (Dunal) Gray	greenleaf five eyes					X	X	X	X	
	***Datura inoxia* P. Mill.**	**pricklyburr**						X			
	Datura wrightii Regel	sacred thorn-apple			X	X	X		X		
	Lycium pallidum Miers	pale desert-thorn					X	X	X	X	
	Margaranthus solanaceus Schlecht.	netted globecherry			X		X	X	X	X	
	Nicotiana obtusifolia var. obtusifolia Mertens & Galeotti	desert tobacco				X	X	X	X	X	
	Physalis hederifolia var. fendleri (Gray) Cronq.	Fendler's groundcherry				X	X	X	X	X	
	Physalis hederifolia Gray	ivyleaf groundcherry			X						
	Physalis pubescens L.	husk tomato	X				X		X		
	Physalis pubescens var. integrifolia (Dunal) Waterfall	husk tomato						X			
	Solanum americanum P. Mill.	American black nightshade					X	X	X	X	
	Solanum douglasii Dunal	greenspot nightshade			X	X		X	X	X	
	Solanum elaeagnifolium Cav.	silverleaf nightshade				X	X	X	X	X	
	Solanum fendleri Gray ex Torr.	Fendler's horsenettle				X	X	X	X	X	
	Solanum heterodoxum Dunal	melonleaf nightshade				X	X			X	
	Solanum heterodoxum var. novomexicanum Bartlett	New Mexican nightshade						X	X		
	Solanum jamesii Torr.	wild potato			X	X		X		X	
	Solanum rostratum Dunal	buffalobur nightshade			X	X	X	X	X	X	
Typhaceae	*Typha domingensis* Pers.	southern cattail				X	X	X	X	X	
Ulmaceae	*Celtis laevigata var. reticulata* (Torr.) L. Benson	netleaf hackberry			X	X	X	X	X	X	
Verbenaceae	*Aloysia wrightii* Heller ex Abrams	Wright's beebrush					X	X	X	X	
	Glandularia bipinnatifida (Nutt.) Nutt.	Dakota mock vervain			X						
	Glandularia bipinnatifida var. bipinnatifida (Nutt.) Nutt.	Dakota mock vervain				X	X	X	X	X	
	Glandularia gooddingii (Briq.) Solbrig	southwestern mock vervain						X		X	
	Glandularia wrightii (Gray) Umber	Davis Mountain mock vervain	X				X	X	X	X	
	Verbena bracteata Lag. & Rodr.	bigbract verbena				X	X	X	X		
	Verbena carolina L.	Carolina vervain			X						
	Verbena gracilis Desf.	Fort Huachuca vervain				X	X	X	X	X	
	Verbena macdougalii Heller	MacDougal verbena				X	X	X	X	X	
	Verbena neomexicana (Gray) Small	hillside vervain			X	X	X	X	X	X	

				Herbarium specimen		Previous study/list					
Family	Scientific name	Common name	UA	WACC[a]	UAZ[b]	Clark[c]	Reeves[d]	Litzinger[e]	Bennett[f]	Hartman[g]	H&G[h]
Violaceae	*Hybanthus verticillatus* (Ortega) Baill.	babyslippers					X	X			
	Hybanthus verticillatus (Ortega) Baill. *var. verticillatus*	babyslippers							X		
	Viola canadensis L.	Canadian white violet			X	X	X	X	X	X	
Viscaceae	*Arceuthobium gillii* Hawksworth & Wiens	Huachuca Mountain dwarf mistletoe				X	X	X	X		
	Phoradendron bolleanum (Seem.) Eichl.	Bollean mistletoe			X		X	X		X	
	Phoradendron capitellatum Torr. ex Trel.	downy mistletoe				X			X		
	Phoradendron coryae Trel.	Cory's mistletoe			X	X	X	X	X	X	
	Phoradendron juniperinum Engelm. ex Gray	juniper mistletoe			X	X	X	X	X	X	
	Phoradendron leucarpum (Raf.) Reveal & M.C. Johnston	oak mistletoe			X						
	Phoradendron tomentosum (DC.) Engelm. ex Gray	Christmas mistletoe					X	X	X		
Vitaceae	*Parthenocissus quinquefolia* (L.) Planch.	Virginia creeper				X	X	X	X	X	
	Vitis arizonica Engelm.	canyon grape	X		X	X	X	X	X	X	
Zygophyllaceae	*Kallstroemia californica* (S. Wats.) Vail	California caltrop					X	X	X		
	Kallstroemia grandiflora Torr. ex Gray	Arizona poppy				X	X	X	X	X	
	Kallstroemia parviflora J.B.S. Norton	warty caltrop			X	X	X	X	X	X	
	***Tribulus terrestris* L.**	**puncturevine**			X	X	X		X	X	X

[a] Western Archaeological Conservation Center, Tucson.

[b] University of Arizona Herbarium.

[c] Clark (no date).

[d] Reeves (1976).

[e] Litzinger (1993).

[f] Bennett et al. (1996).

[g] Hartman et al. (1998).

[h] Halvorson and Guertin (2003).

Appendix B. Amphibian and reptile species observed in Chiricahua NM by University of Arizona Inventory personnel (UA) by survey type and other studies.

				UA survey method						Study			
Order	Family	Scientific name	Common name	Extensive	TAC plots	Line transect	Pitfall	Road	Inci-dental	Lowe and Holm (1987)	Prival and Schwalbe (2000)	Goode and Amarillo (2004)	Specimen or photograph voucher [a]
Caudata	Ambystomatidae	*Ambystoma tigrinum*	tiger salamander						X	X			X
Anura	Pelobatidae	*Spea multiplicata*	Mexican spadefoot				X	X		X	X		X
	Bufonidae	*Bufo cognatus*	Great Plains toad				X	X	X	X			X
		Bufo punctatus	red-spotted toad								X		
	Hylidae	*Hyla arenicolor*	canyon treefrog	X				X	X	X	X	X	X
Testudines	Emydidae	*Terrapene ornata*	western box turtle	X	X				X	X	X		X
Squamata	Crotaphytidae	*Crotaphytus collaris*	eastern collared lizard						X	X			X
		Sceloporus jarrovii	mountain spiny lizard	X	X			X	X	X	X	X	X
		Sceloporus clarkii	Clark's spiny lizard	X	X	X		X	X	X	X	X	X
		Sceloporus virgatus	striped plateau lizard	X	X	X			X	X	X	X	X
		Sceloporus undulatus	eastern fence lizard										X
		Urosaurus ornatus	ornate tree lizard	X	X	X			X	X	X	X	X
		Holbrookia maculata	lesser earless lizard										X
		Phrynosoma hernandesi	greater short-horned lizard	X			X		X	X			X
	Scincidae	*Eumeces obsoletus*	Great Plains skink				X		X	X	X		X
	Teiidae	*Cnemidophorus uniparens*	desert grassland whiptail				X		X	X			
		Cnemidophorus exsanguis	Chihuahuan spotted whiptail	X	X	X			X	X	X	X	X
		Cnemidophorus sonorae	Sonoran spotted whiptail	X	X	X			X		X	X	X
	Anguidae	*Elgaria kingii*	Madrean alligator lizard	X					X	X	X	X	X
	Leptotyphlopidae	*Leptotyphlops dulcis*	Texas blind snake					X					X
	Colubridae	*Masticophis flagellum*	coachwhip		X					X			
		Masticophis bilineatus	Sonoran whipsnake	X				X	X	X	X	X	X
		Salvadora hexalepis	western patch-nosed snake										X
		Salvadora grahamiae	mountain patch-nosed snake	X			X	X		X		X	X
		Senticolis triaspis	green rat snake							X	X		X
		Pituophis catenifer	gopher snake	X				X	X	X	X	X	X
		Lampropeltis pyromelana	Sonoran mountain kingsnake	X				X	X	X	X	X	X
		Thamnophis cyrtopsis	black-necked garter snake	X			X		X	X	X		X
		Sonora semiannulata	western ground snake										X
		Trimorphodon biscutatus	western lyre snake					X	X	X		X	X
		Hypsiglena torquata	night snake					X	X	X	X	X	X
	Viperidae	*Crotalus lepidus*	rock rattlesnake	X				X	X	X	X	X	X
		Crotalus molossus	black-tailed rattlesnake	X				X	X	X	X	X	X

[a] See Appendix G and H for additional information. All specimens or photographs were taken from within or just outside of the monument.

Appendix C. Bird species observed by University of Arizona (UA) Inventory personnel, by survey method, Chiricahua NM. Numbers of observations are not scaled by search effort and should not to be used for comparison among species. List also includes species reported in Fischer (2002) and the MAPS station (summarized in Martinez and Hubbard 2003). Underlined species are neotropical migrants (Rappole 1995).

				Number of observations by UA						Conservation designation				
Order	Family	Scientific name	Common name	VCP	Winter	Nocturnal	Incidental	Fischer	MAPS	ESA[a]	USFS[b]	AZ[c]	AZ APF[d]	USFWS[e]
Galliformes	Phasianidae	*Meleagris gallopavo*	wild turkey				2	X						
	Odontophoridae	*Callipepla squamata*	scaled quail					X						
		Callipepla gambelii	Gambel's quail	15	7		2	X						
		Cyrtonyx montezumae	Montezuma quail	4	1		8	X	X					
Ciconiiformes	Cathartidae	*Cathartes aura*	turkey vulture	18			2	X	X					
Falconiformes	Accipitridae	*Pandion haliaetus*	osprey					X				X		
		Haliaeetus leucocephalus	bald eagle					X		LT	X	X		
		Circus cyaneus	northern harrier		1			X						
		Accipiter striatus	sharp-shinned hawk				1	X			X			
		Accipiter cooperii	Cooper's hawk	10			2	X	X					
		Accipiter gentilis	northern goshawk					X		SC	X	X		
		Buteogallus anthracinus	common black-hawk					X			X	X	X	
		Buteo swainsoni	Swainson's hawk				1	X						
		Buteo albonotatus	zone-tailed hawk				5	X						
		Buteo jamaicensis	red-tailed hawk	1	4		3	X	X					
		Buteo regalis	ferruginous hawk					X		SC		X		
		Buteo lagopus	rough-legged hawk					X						
		Aquila chrysaetos	golden eagle		1		3	X	X					
	Falconidae	*Falco sparverius*	American kestrel				1	X						
		Falco peregrinus	peregrine falcon				1	X		SC		X		X
		Falco mexicanus	prairie falcon	1	1		2	X						
Gruiformes	Gruidae	*Grus canadensis*	sandhill crane				2	X						
Charadriiformes	Charadriidae	*Charadrius vociferus*	killdeer					X						
Columbiformes	Columbidae	*Patagioenas fasciata*	band-tailed pigeon	4			2	X	X					
		Zenaida asiatica	white-winged dove	76				X						
		Zenaida macroura	mourning dove	120	1			X	X					
		Columbina passerina	common ground-dove	1										
Cuculiformes	Cuculidae	*Geococcyx californianus*	greater roadrunner	2			5	X						
Strigiformes	Tytonidae	*Tyto alba*	barn owl			1								
	Strigidae	*Otus flammeolus*	flammulated owl					X						
		Megascops kennicottii	western screech-owl			9		X						
		Megascops trichopsis	whiskered screech-owl			14		X						
		Bubo virginianus	great horned owl					X						
		Glaucidium gnoma	northern pygmy-owl	17		6	2	X	X					
		Micrathene whitneyi	elf owl			33	1	X						X
		Strix occidentalis lucida	Mexican spotted owl				2	X		LT	X	X		
		Aegolius acadicus	northern saw-whet owl					X						
Caprimulgiformes	Caprimulgidae	*Chordeiles minor*	common nighthawk					X						
		Phalaenoptilus nuttallii	common poorwill	1		19	2	X						
		Caprimulgus vociferus	whip-poor-will			13		X						

				Number of observations by UA						Conservation designation				
Order	Family	Scientific name	Common name	VCP	Winter	Nocturnal	Incidental	Fischer	MAPS	ESA[a]	USFS[b]	AZ[c]	AZ APF[d]	USFWS[e]
Apodiformes	Apodidae	*Chaetura vauxi*	Vaux's swift					X						
		Aeronautes saxatalis	white-throated swift	45			2	X	X					
	Trochilidae	*Cynanthus latirostris*	broad-billed hummingbird	2										
		Hylocharis leucotis	white-eared hummingbird					X						
		Amazilia beryllina	Berylline hummingbird					X			X			
		Amazilia violiceps	violet-crowned hummingbird					X			X	X		
		Lampornis clemenciae	blue-throated hummingbird	1			2	X	X					
		Eugenes fulgens	magnificent hummingbird	3			1	X	X					
		Calothorax lucifer	Lucifer hummingbird						X					
		Archilochus alexandri	black-chinned hummingbird	13			5	X	X					
		Calypte anna	Anna's hummingbird					X						
		Stellula calliope	calliope hummingbird						X					
		Selasphorus platycercus	broad-tailed hummingbird	46			6	X	X					
		Selasphorus rufus	rufous hummingbird	2				X	X					
Trogoniformes	Trogonidae	*Trogon elegans*	elegant trogon					X				X		
		Euptilotis neoxenus	eared trogon					X			X			
Coraciiformes	Alcedinidae	*Ceryle alcyon*	belted kingfisher					X				X		
Piciformes	Picidae	*Melanerpes formicivorus*	acorn woodpecker	48	2		2	X	X					
		Melanerpes uropygialis	Gila woodpecker					X						X
		Sphyrapicus thyroideus	Williamson's sapsucker		1		1	X						
		Sphyrapicus nuchalis	red-naped sapsucker		4		3	X						
		Picoides scalaris	ladder-backed woodpecker	16	5		2	X						
		Picoides villosus	hairy woodpecker	7	1		1	X						
		Picoides arizonae	Arizona woodpecker	49	3		11	X	X					
		Colaptes auratus	northern flicker	57	11		1	X	X					
Passeriformes	Tyrannidae	*Camptostoma imberbe*	northern beardless-tyrannulet	8										
		Contopus cooperi	olive-sided flycatcher	1				X		SC				
		Contopus pertinax	greater pewee	3			1	X						
		Contopus sordidulus	western wood-pewee	103			2	X	X					
		Empidonax traillii	willow flycatcher					X				X		
		Empidonax hammondii	Hammond's flycatcher					X	X					
		Empidonax wrightii	gray flycatcher	3			1	X						
		Empidonax oberholseri	dusky flycatcher					X	X					
		Empidonax fulvifrons pygmaeus	buff-breasted flycatcher				1			SC		X		
		Empidonax occidentalis	cordilleran flycatcher	1				X	X					
		Sayornis nigricans	black phoebe					X	X					
		Sayornis saya	Say's phoebe	8	1		1	X						
		Pyrocephalus rubinus	vermilion flycatcher				1	X						
		Myiarchus tuberculifer	dusky-capped flycatcher	193			5	X	X					
		Myiarchus cinerascens	ash-throated flycatcher	118			4	X	X					
		Myiarchus tyrannulus	brown-crested flycatcher	2				X	X					
		Myiodynastes luteiventris	sulphur-bellied flycatcher	8				X	X					
		Tyrannus vociferans	Cassin's kingbird	129	4		3	X	X					
		Tyrannus verticalis	western kingbird					X						

				Number of observations by UA						Conservation designation				
Order	Family	Scientific name	Common name	VCP	Winter	Nocturnal	Incidental	Fischer	MAPS	ESA[a]	USFS[b]	AZ[c]	AZ APF[d]	USFWS[e]
Passeriformes	Laniidae	*Lanius ludovicianus*	loggerhead shrike				1	X		SC	X			
	Vireonidae	*Vireo vicinior*	gray vireo					X						
		Vireo plumbeus	plumbeous vireo	69			5	X	X					
		Vireo huttoni	Hutton's vireo	58	2		4	X	X					
		Vireo gilvus	warbling vireo	5			3	X	X					
	Corvidae	*Cyanocitta stelleri*	Steller's jay	10			4	X	X					
		Aphelocoma californica	western scrub-jay	6				X						
		Aphelocoma ultramarina	Mexican jay	178	14		6	X	X					
		Gymnorhinus cyanocephalus	pinyon jay				1	X						
		Nucifraga columbiana	Clark's nutcracker					X						
		Corvus sp.	unknown raven	19	2									
		Corvus cryptoleucus	Chihuahuan raven					X	X					
		Corvus corax	common raven					X	X					
	Alaudidae	*Eremophila alpestris*	horned lark					X						
	Hirundinidae	*Progne subis*	purple martin					X					X	
		Tachycineta thalassina	violet-green swallow	6			3	X						
		Stelgidopteryx serripennis	northern rough-winged swallow					X						
		Petrochelidon pyrrhonota	cliff swallow					X						
		Hirundo rustica	barn swallow					X						
	Paridae	*Poecile gambeli*	mountain chickadee	1	5									
		Poecile sclateri	Mexican chickadee	4			2	X						
		Baeolophus wollweberi	bridled titmouse	83	8		2	X	X					
		Baeolphus ridgwayi	juniper titmouse	10			3	X	X					
	Remizidae	*Auriparus flaviceps*	verdin	5	2		1							
	Aegithalidae	*Psaltriparus minimus*	bushtit	51	1		7	X	X					
	Sittidae	*Sitta canadensis*	red-breasted nuthatch	1	1		2	X						
		Sitta carolinensis	white-breasted nuthatch	47	3		4	X	X					
	Sittidae	*Sitta pygmaea*	pygmy nuthatch					X						
	Certhiidae	*Certhia americana*	brown creeper	31	1		3	X	X					
	Troglodytidae	*Campylorhynchus brunneicapillus*	cactus wren	31	7		2	X						
		Salpinctes obsoletus	rock wren	11	6			X						
		Catherpes mexicanus	canyon wren	56	1		3	X	X					
		Thryomanes bewickii	Bewick's wren	285	13		3	X	X					
		Troglodytes aedon	house wren	5	1			X						
	Regulidae	*Regulus calendula*	ruby-crowned kinglet	25	23			X	X					
	Sylviidae	*Polioptila caerulea*	blue-gray gnatcatcher	7			4	X	X					
	Turdidae	*Sialia sialis*	eastern bluebird				1	X						
		Sialia mexicana	western bluebird		6		2	X						
		Sialia currucoides	mountain bluebird				1	X						
		Myadestes townsendi	Townsend's solitaire	5	5		4	X	X					
		Catharus guttatus	hermit thrush	7			2	X	X					
		Turdus migratorius	American robin	70	5			X	X					
	Mimidae	*Mimus polyglottos*	northern mockingbird	37				X						

				Number of observations by UA						Conservation designation				
Order	Family	Scientific name	Common name	VCP	Winter	Nocturnal	Incidental	Fischer	MAPS	ESA[a]	USFS[b]	AZ[c]	AZ APF[d]	USFWS[e]
Passeriformes		*Toxostoma bendirei*	Bendire's thrasher	1										
		Toxostoma curvirostre	curve-billed thrasher				1	X						
		Toxostoma crissale	crissal thrasher	1	1		4		X					X
	Bombycillidae	*Bombycilla cedrorum*	cedar waxwing				1	X						
	Ptilogonatidae	*Phainopepla nitens*	phainopepla		3		1	X						
	Peucedramidae	*Peucedramus taeniatus*	olive warbler	1			1	X						
	Parulidae	*Vermivora celata*	orange-crowned warbler	1			1	X						
		Vermivora ruficapilla	Nashville warbler					X						
		Vermivora virginiae	Virginia's warbler	3			2	X	X					
		Vermivora luciae	Lucy's warbler	12									X	
		Dendroica petechia	yellow warbler	1										
		Dendroica coronata	yellow-rumped warbler	11				X	X					
		Dendroica coronata auduboni	Audubon's warbler	8			1							
		Dendroica nigrescens	black-throated gray warbler	175			5	X	X					
		Dendroica townsendi	Townsend's warbler	3			4	X	X					
		Dendroica occidentalis	hermit warbler	1				X	X					
		Dendroica graciae	Grace's warbler	24			4	X						
		Setophaga ruticilla	american redstart				1					X		
		Oporornis tolmiei	MacGillivray's warbler				1	X						
		Wilsonia pusilla	Wilson's warbler	5				X	X					
		Cardellina rubrifrons	red-faced warbler	9			1	X						
		Myioborus pictus	painted redstart	30			9	X	X					
	Thraupidae	*Piranga flava*	hepatic tanager	108	3		9	X	X					
		Piranga rubra	summer tanager	8										
		Piranga ludoviciana	western tanager	14			1	X	X					
	Emberizidae	*Pipilo chlorurus*	green-tailed towhee	2			2	X						
		Pipilo maculatus	spotted towhee	109	23			X	X					
		Pipilo fuscus	canyon towhee	48	19		2	X						
		Aimophila cassinii	Cassin's sparrow					X						
		Aimophila botterri	Botteri's sparrow					X						
		Aimophila ruficeps	rufous-crowned sparrow	39	12		1	X						
		Spizella passerina	chipping sparrow	8	25		2	X	X					
		Spizella breweri	Brewer's sparrow		3				X					
		Spizella atrogularis	black-chinned sparrow	3	1		1	X						
		Pooecetes gramineus	vesper sparrow		3			X						
		Chondestes grammacus	lark sparrow	1				X						
		Melospiza lincolnii	Lincoln's sparrow	1	2		2	X						
		Amphispiza bilineata	black-throated sparrow	21	6		1	X						
		Ammondramus savannarum	grasshopper sparrow					X						
		Passerella iliaca	fox sparrow					X						
		Zonotrichia leucophrys	white-crowned sparrow		3		2	X						
		Junco hyemalis	dark-eyed junco		9			X	X					
		Junco hyemalis mearnsi	pink-sided junco[f]	2	5		1							

Order	Family	Scientific name	Common name	Number of observations by UA						Conservation designation				
				VCP	Winter	Nocturnal	Incidental	Fischer	MAPS	ESA[a]	USFS[b]	AZ[c]	AZ APF[d]	USFWS[e]
Passeriformes		*Junco hyemalis dorsalis*	gray-headed junco[f]	4	4									
		Junco hyemalis oreganus	Oregon junco[f]	1	2		2							
		Junco phaeonotus	yellow-eyed junco	12			6	X						
	Cardinalidae	*Cardinalis cardinalis*	northern cardinal	6	1		1							
		Cardinalis sinuatus	pyrrhuloxia		1									
		Pheucticus ludovicianus	rose-breasted grosbeak					X						
		Pheucticus melanocephalus	black-headed grosbeak	111			5	X	X					
		Passerina caerulea	blue grosbeak	3				X						
		Passerina amoena	lazuli bunting	2			1	X	X					
		Passerina ciris	painted bunting					X						
	Icteridae	*Sturnella magna lilianae*	eastern meadowlark				1	X						
		Sturnella neglecta	western meadowlark		1			X						
		Quiscalus mexicanus	great-tailed grackle					X						
		Molothrus aeneus	bronzed cowbird					X						
		Molothrus ater	brown-headed cowbird	43				X	X					
		Icterus cucullatus	hooded oriole	1				X						
		Icterus bullockii	Bullock's oriole	14				X						
	Icteridae	*Icterus parisorum*	Scott's oriole	101			4	X	X					
	Fringillidae	*Carpodacus cassinii*	Cassin's finch		1		1	X						
		Carpodacus mexicanus	house finch	58	6			X	X					
		Loxia curvirostra	red crossbill					X						
		Carduelis pinus	pine siskin	1	2		1	X						
		Carduelis psaltria	lesser goldfinch	21	1			X	X					
		Carduelis tristis	American goldfinch					X						
		Coccothraustes vespertinus	evening grosbeak					X						

[a] "SC" = "Species of Concern"; "C" = Candidate for listing, "LT" = Listed as Threatened under the Endangered Species Act. U.S. Fish and Wildlife Service (HDMS 2004).

[b] "Sensitive species"; U.S.D.A. Forest Service (HDMS 2004).

[c] "Wildlife of Special Concern"; Arizona Game and Fish Department (HDMS 2004).

[d] "Priority species"; Arizona Partners in Flight (Latta et al. 1999).

[e] "Species of conservation concern"; U.S. Fish and Wildlife Service (HDMS 2004).

[f] We include observations of these subspecies in the appendix because field crew members occasionally made this distinction.

Appendix D. Mammal species observed by University of Arizona Inventory personnel (by survey method, 2002-2004) and those reported in other studies. For more information on specimen vouchers see Appendix H. Species in bold-faced type are non-native.

				Number of observations by UA						
Order	Family	Scientific name	Common name	Small-mammal trapping	Trailmaster	Incidental	Duncan (1990)[a]	Koprowski (2004)	Krebbs (2005)	Voucher specimen
Insectivora	Soricidae	*Notiosorex crawfordi*	Crawford's desert shrew				X			
		Notiosorex species	unknown desert shrew			6				
Chiroptera	Phyllostomidae	*Choeronycteris mexicana*	Mexican long-tongued bat						X	
		Leptonycteris curasoae yerbabuenae	southern long-nosed bat						X	
	Vespertilionidae	*Myotis occultus*	Arizona myotis						X	
		Myotis auriculus	southwestern myotis						X	
		Myotis velifer	cave myotis						X	
		Myotis thysanodes	fringed myotis						X	
		Myotis volans	long-legged myotis						X	
		Myotis californicus	California myotis			1			X	
		Myotis ciliolabrum	western small-footed myotis						X	
		Lasionycteris noctivagans	silver-haired bat						X	
		Pipistrellus hesperus	western pipistrelle				X		X	
		Eptesicus fuscus	big brown bat						X	
		Lasiurus blossevillii	western red bat						X	
		Lasiurus cinereus	hoary bat						X	
		Corynorhinus townsendii pallescens	Townsend's big-eared bat						X	X
		Idionycteris phyllotis	Allen's big-eared bat				X		X	
		Antrozous pallidus	pallid bat						X	X
	Molossidae	*Tadarida brasiliensis*	Brazilian free-tailed bat							
		Nyctinomops macrotis	big free-tailed bat							
Carnivora	Ursidae	*Ursus americanus*	American black bear			11	X	X		
	Procyonidae	*Procyon lotor*	northern raccoon				X	X		X
		Nasua narica	white-nosed coati			3	X	X		X
		Bassariscus astutus	ringtail		5	3	X	X		
	Mustelidae	*Taxidea taxus*	American badger				X			
	Mephitidae	*Mephitis mephitis*	striped skunk		11	2	X	X		
		Mephitis macroura	hooded skunk		2		X	X		
		Conepatus mesoleucus	white-backed hog-nosed skunk		2			X		
	Canidae	*Canis latrans*	coyote		2	4		X		
		Urocyon cinereoargenteus	common gray fox		38	7	X	X		
	Felidae	***Felis catus***	**feral cat**				X			
		Puma concolor	mountain lion		3	5	X	X		
		Lynx rufus	bobcat		2	1		X		
Rodentia	Sciuridae	*Spermophilus variegatus*	rock squirrel			6	X			X
		Spermophilus spilosoma	spotted ground squirrel							X
		Neotamias dorsalis	cliff chipmunk			3	X			X
		Sciurus nayaritensis	Mexican fox squirrel			3	X	X		X

				Number of observations by UA						
Order	Family	Scientific name	Common name	Small-mammal trapping	Trailmaster	Incidental	Duncan (1990)[a]	Koprowski (2004)	Krebbs (2005)	Voucher specimen
Rodentia	Geomyidae	*Thomomys bottae*	Botta's pocket gopher				X			X
	Heteromyidae	*Perognathus amplus*	Arizona pocket mouse							X
		Perognathus flavus	silky pocket mouse	11			X			X
		Chaetodipus intermedius	rock pocket mouse	7						
		Chaetodipus hispidus	hispid pocket mouse	43			X			
		Dipodomys ordii	Ord's kangaroo rat				X			
		Dipodomys merriami	Merriam's kangaroo rat	6			X			X
	Muridae	*Reithrodontomys montanus*	Plains harvest mouse	1			X			
		Reithrodontomys megalotis	western harvest mouse				X			X
		Reithrodontomys fulvescens	fulvous harvest mouse				X			
		Peromyscus eremicus	cactus mouse	2			X			X
		Peromyscus maniculatus	deer mouse	1[b]			X			X
		Peromyscus leucopus	white-footed mouse	[b]			X			X
		Peromyscus boylii	brush mouse	49			X			X
		Peromyscus truei	piñon mouse				X			
		Peromyscus nasutus	northern rock mouse	2			X			X
		Baiomys taylori	northern pygmy mouse	2						
		Onychomys leucogaster	northern grasshopper mouse				X			X
		Onychomys torridus	southern grasshopper mouse	10			X			
		Neotoma albigula	western white-throated woodrat	8			X			X
		Neotoma mexicana	Mexican woodrat				X			X
		Sigmodon hispidus	hispid cotton rat							X
		Sigmodon fulviventer	tawny-bellied cotton rat				X			X
		Sigmodon ochrognathus	yellow-nosed cotton rat	8			X			
		Sigmodon arizonae	Arizona cotton rat	20			X			X
		Mus musculus	**house mouse**	4						X
Lagomorpha	Leporidae	*Lepus californicus*	black-tailed jackrabbit				X			
		Sylvilagus floridanus	eastern cottontail		3		X			
		Sylvilagus audubonii	desert cottontail		23	2	X			
Artiodactyla	Tayassuidae	*Pecari tajacu*	collared peccary		4	5	X			X
	Cervidae	*Odocoileus virginianus*	white-tailed deer		2	10	X	X		

[a] Copies of Doug Duncan's original datasheets now resides at the I&M office in Tucson.

[b] Species trapped was either deer mouse or white-footed mouse. See text for more information.

Appendix E. Amphibian and reptile species that may occur at Chiricahua NM based on unconfirmed observations in the monument or listed as "hypothetical" by Lowe and Holm (1987), voucher specimen found within 5 km of the monument (Appendix H), or observations from the Sulphur Springs Valley (from Rosen et al. 1996).

Order	Family	Scientific name	Common name	Lowe and Holm	Appendix H	Rosen et al.[a]
Anura	Pelobatidae	*Spea bombifrons*	plains spadefoot	X		
		Scaphiopus couchii	Couch's spadefoot	X		
	Bufonidae	*Bufo debilis*	green toad	X		X
	Ranidae	*Rana chiricahuensis*	Chiricahua leopard frog	X		
		Rana catesbeiana	American bullfrog	X		
Squamata	Helodermatidae	*Heloderma suspectum*	Gila monster	X		
	Phrynosomatidae	*Sceloporus slevini*	Slevin's bunchgrass lizard	X		
		Phrynosoma cornutum	Texas horned lizard	X		X
		Cophosaurus texanus	greater earless lizard	X		X
	Colubridae	*Diadophis punctatus*	ring-necked snake	X	X	X
		Arizona elegans	glossy snake	X		
		Gyalopion canum	Chihuahuan hook-nosed snake	X	X	X
		Heterodon nasicus	western hog-nosed snake	X	X	
		Lampropeltis getula	common kingsnake	X		
		Thamnophis marcianus	checkered garter snake	X		X
		Micruroides euryxanthus	Sonoran coral snake	X		X
		Sistrurus catenatus	Desert massasauga			
		Crotalus scutulatus	Mojave rattlesnake	X	X	X
		Crotalus pricei	twin-spotted rattlesnake	X		

[a] Based on general habitat characteristics or geographic locations described in document.

Appendix F. Mammal species that were not recorded by University of Arizona personnel or others but that might occur or have been extirpated at Chiricahua NM. List based on detections by Hoffmeister (1986) and Swann et al. (2001): P = possible based on documentation near the monument, or E = documented but now known to be extirpated.

Order	Family	Scientific name	Common name	Possible/Extinct	Comments from Hoffmeister
Insectivora					
	Soricidae	*Sorex arizonae*	Arizona shrew	P	located just south of the monument in woodland of oak, walnut, maple, sycamore and Douglas fir
Carnivora					
	Canidae	*Canis lupus baileyi*	gray wolf	E	Chiricahua
	Ursidae	*Ursus arctos*	grizzly or brown bear	E	Chiricahua mountains
	Mustelidae	*Mustela frenata*	long-tailed weasel	P	Pinery Canyon (just south of monument), Chiricahua mountains
	Mephitidae	*Spilogale gracilis*	western spotted skunk	P	Pinery Canyon (just south of monument), Chiricahua Mountains
	Felidae	*Panthera onca*	Jaguar	P	Specimen taken in 1912 from Bonita Canyon (Cahalane 1939)
Rodentia					
	Sciuridae	*Ammospermophilus harrisii*	Harris's antelope squirrel	P	mouth of Pinery Canyon (just south of monument)
	Heteromyidae	*Chaetodipus penicillatus*	Sonoran Desert pocket mouse	P	
		Chaetodipus baileyi	Bailey's pocket mouse	P	
		Dipodomys spectabilis	banner-tailed kangaroo rat	P	
	Erethizontidae	*Erethizon dorsatum*	North American porcupine	P	
Artiodactyla					
	Cervidae	*Odocoileus hemionus*	mule deer	P	

Appendix G. Vertebrate voucher specimens and photographs collected by University of Arizona or monument personnel, Chiricahua NM, 2002–2005. All voucher specimens are located in respective University of Arizona (AZ) collections.

Voucher type	Taxon	Species	Collector(s)	Date of collection	AZ collection #	Specimen type
Specimen	Amphibian	canyon treefrog	Kevin E. Bonine	8/15/2002		whole
	Reptile	Clark's spiny lizard	Carrie Dennett		54123	whole
		unknown whiptail	Dan M. Bell	7/31/2003		whole
		unknown whiptail	Dan M. Bell	5/21/2003		whole
		Chihuahuan spotted whiptail	Dan M. Bell	5/19/2003	55457	whole
		Madrean alligator lizard	Ruth A. Olsen	3/24/2003		whole
		Texas blind snake	Kevin E. Bonine	8/13/2002		whole
		Sonoran whipsnake	Kevin E. Bonine	8/14/2002		whole
		western ground snake[a]	Ruth A. Olsen	5/05/2005		
		mountain patch-nosed snake	Kevin E. Bonine	8/13/2002	54445	whole
		black-necked garter snake	Dave B. Prival	7/7/1999		whole
		black-necked garter snake	Kevin E. Bonine	8/14/2002		whole
		night snake	Kevin E. Bonine	9/6/2002	54124	whole
		black-tailed rattlesnake	Kevin E. Bonine	8/13/2002	54443	whole
	Mammal	unknown desert shrew	Dan M. Bell	9/4/2003	26947	Skin and Skull
		American black bear	Ruth A. Olsen	7/19/2003	26944	Skull
		common gray fox	Neil D. Perry	9/7/2002	26779	Skull and Mandible
		silky pocket mouse	Neil D. Perry	10/10/2002	26897	Skin and Skull
		silky pocket mouse	Neil D. Perry	11/8/2002	26848	Skin and Skull
		rock pocket mouse	Neil D. Perry	10/10/2002	26885	Skin and Skull
		hispid pocket mouse	Neil D. Perry	10/9/2002	26884	Skin and Skull
		Plains harvest mouse	Neil D. Perry	11/10/2002	26851	Skin and Skull
		brush mouse	Neil D. Perry	10/9/2002	26922	Skull
		northern pygmy mouse	Neil D. Perry	11/10/2002	26850	Skin and Skull
Photograph	Amphibian	tiger salamander	Kevin E. Bonine	9/6/2002		
		Mexican spadefoot	Kevin E. Bonine	9/7/2002		
		Great Plains toad	Dan M. Bell	8/14/2002		
		canyon treefrog	Kevin E. Bonine	8/4/2003		
	Reptile	western box turtle	Dan M. Bell	8/14/2002		
		eastern collared lizard	Ruth A. Olsen	6/26/2004		
		mountain spiny lizard	Kevin E. Bonine	8/15/2002		
		Clark's spiny lizard	Kevin E. Bonine	8/16/2002		
		striped plateau lizard	Kevin E. Bonine	9/6/2002		
		ornate tree lizard	Kevin E. Bonine	8/16/2002		
		greater short-horned lizard	Kevin E. Bonine	8/14/2002		
		Great Plains skink	Kevin E. Bonine	7/31/2003		
		unknown whiptail	Kevin E. Bonine	8/16/2002		
		Chihuahuan spotted whiptail	Kevin E. Bonine	8/15/2002		
		Sonoran spotted whiptail	Dan M. Bell	7/31/2003		
		Madrean alligator lizard	Dan M. Bell	8/15/2002		
		Texas blind snake	Dan M. Bell	5/20/2003		
		Sonoran whipsnake	Kevin E. Bonine	5/6/2003		
		mountain patch-nosed snake	Kevin E. Bonine	6/4/2003		
		gopher snake	Kevin E. Bonine	9/7/2002		
		Sonoran mountain kingsnake	Kevin E. Bonine	8/16/2002		
		black-necked garter snake	Dan M. Bell	8/16/2002		
		western lyre snake	Dan M. Bell	8/13/2002		
		night snake	Kevin E. Bonine	8/14/2002		
		rock rattlesnake	Dan M. Bell	8/13/2002		
		black-tailed rattlesnake	Dan M. Bell	8/16/2002		
		Mexican spotted owl	Ruth A. Olsen	4/21/2004		
	Bird	magnificent hummingbird	Ruth A. Olsen			
		broad-tailed hummingbird	Ruth A. Olsen			
		Arizona woodpecker	Ruth A. Olsen			
		Mexican jay	Janine R. McCabe	5/6/2004		
		painted redstart	Ruth A. Olsen			
		black-headed grosbeak	Ruth A. Olsen			
		Scott's oriole	Janine R. McCabe	6/29/2004		

Voucher type	Taxon	Species	Collector(s)	Date of collection	AZ collection #	Specimen type
Photograph	Mammal	American black bear	Janine R. McCabe	5/4/2004		
		ringtail	Ruth A. Olsen	4/8/2003		
		striped skunk	Ruth A. Olsen	2/28/2003		
		hooded skunk	Ruth A. Olsen	4/2/2003		
		white-backed hog-nosed skunk	Ruth A. Olsen	9/10/2003		
		coyote	Ruth A. Olsen	4/7/2003		
		common gray fox	Ruth A. Olsen	12/5/2002		
		mountain lion	Ruth A. Olsen	4/6/2003		
		bobcat	Ruth A. Olsen	3/8/2003		
		cliff chipmunk	Ruth A. Olsen			
		eastern cottontail	Ruth A. Olsen	9/10/2003		
		desert cottontail	Ruth A. Olsen	3/13/2003		
		collared peccary	Ruth A. Olsen	3/13/2003		
		white-tailed deer	Ruth A. Olsen	1/16/2003		

[a] Found just prior to publishing of this report. At the time of this writing the specimen resides at the monument, though will likely be accessioned into the UA collection.

Appendix H. Voucher specimens that were not collected by University of Arizona personnel or by Chiricahua NM personnel, but were found in Chiricahua NM or within 5 km of the monument.

Taxon	Common name	Field collection number	Collection[a]	Date	Primary Collector
Amphibian	western spadefoot	7474–7479, 7481–7486, 8570–8572	INHS	6/25/1954	P. W. Smith
	red-spotted toad[b]	7491	INHS	6/25/1954	P. W. Smith
	Great Plains toad	HE.14025	MSU	7/25/1957	M. M. Hensley
		7506, 7507, 8553	INHS	6/25/1954	P. W. Smith
Reptile	lesser earless lizard	6457, 6458	INHS	6/16/1952	P. W. Smith
		41292–41295	UA	5/30/1953	Blackburn
	mountain spiny lizard	39664–39666	BYU	8/1/1987	Wilkinson, Jeff
		6463, 7536–540	INHS	6/15/1952, 6/17/1954	P.W. Smith
		42555	UCB	10/14/1945	M. Jollie
		115606–15610, 122480, 122481	NHMLA		
		1136, 11122, 11123	TTU	7/15/1959	Knopf
		27082–27085	TMNH	9/6/1966	W. B. Rhoten
		2564, 32574	UA	11/28/1952, 8/24/1970	V. J. Vance, J. K. Cross
		76024, 76025	UI	6/1/1955	D. M. Smith
	Clark's spiny lizard	6461	INHS	6/15/1952	P. W. Smith
		46328	UA	9/14/1985	P. A. Holm
	eastern fence lizard	6471, 7987	INHS	6/15/1952, 6/5/1955	P. W. Smith
	ornate tree lizard	6473, 7985	INHS	6/16/1952, 6/5/1955	P. W. Smith
	greater short-horned lizard	7550, 7551, 7939	INHS	6/25/1954	P. W. Smith
	Chihuahuan spotted whiptail	7556	INHS	6/17/1954	P. W. Smith
	Madrean alligator lizard	197996	USNM	8/1/1970	J. F. Watkins
		7552	INHS	6/17/1954	P. W. Smith
	Sonoran whipsnake	46850	UA	4/12/1986	J.E. Lowry
	western hog-nosed snake[b]	37758	UA	8/7/1969	S. F. Hale
	western patch-nosed snake	84173	UI		D. M. Smith
	mountain patch-nosed snake	18048	UCB	3/28/1935	A. E. Borell
		8005, 8291, 8292	INHS	6/5/1955, 6/7/1956	P. W. Smith
	Chihuahuan hook-nosed snake[b]	20738	UA	8/30/1963	L. F. Bronsor
	ring-necked snake[b]	46327	UA	10/5/1985	P. A. Holm
	green rat snake	29282	UI	6/15/1951	D. M. Smith
		8305	INHS	6/6/1956	P. W. Smith
	gopher snake	83970	UI	6/1/1951	D. M. Smith
		7580	INHS	6/24/1954	P. W. Smith
	Sonoran mountain kingsnake	6008	CAS	9/19/1937	P. C. Bowman
	black-necked garter snake	50758	UA	8/6/1969	W. R. Johnson
	western lyre snake	8634	INHS	6/27/1957	P. W. Smith
	rock rattlesnake	3584, 6010	CAS	8/16/1933, 9/19/1937	F. L. Fish, P. C. Bowman
	rock rattlesnake	8032, 8645	INHS	6/5/1955, 6/28/1957	P. W. Smith
		26596	MPM	8/19/1954	M. Leipzig
		42098, 42099	UA	4/21/1957	W. H. Woodin, Sherwin
	Mohave rattlesnake[b]	40083	UA	9/3/1972	B. Endres
		48821	UA	6/7/1986	P. A. Holm
	black-tailed rattlesnake	79328, 96878	UM	8/7/1932, 8/4/1936	R. H. Painter, F. L. Fish
		8033	INHS	6/19/1955	P. W. Smith
		8384, 8385	CAS	10/22/1936, 2/1/1944	F. L. Fish
Bird	red-winged blackbird	16103, 16104, 16105	UA		
Mammal	pallid bat	150291, 150292, 150293, 150294, 150295, 150296, 150297, 150298	UK	08/19/1954	A. Schwartz
	northern raccoon	9258	UA	04/02/1962	A. C. Risser
	rock squirrel	9294	UA	04/03/1962	A. C. Risser
	spotted ground squirrel	9262, 9271	UA	07/10/1962, 08/05/1962	A. C. Risser
	cliff chipmunk	9259, 26099	UA	05/06/1962, 09/14/1985	G. L. Dixon
	silky pocket mouse	26126	UA	05/22/1985	A. R. Shanks
	cactus mouse	26131, 26266	UA	09/14/1985	R. J. Fargo, G. L. Cordts

Taxon	Common name	Field collection number	Collection[a]	Date	Primary Collector
Mammal	deer mouse	9272, 9276	UA	08/06/1962, 08/25/1962	A. C. Risser
	brush mouse	25837, 25909, 25911, 25946, 26097, 26229, 26241, 26243, 26244, 26368, 26381, 26382, 26383	UA	09/14/1985, 09/15/1985	W. A. Rosenberg, M. Taborda, R. J. Fargo, J. G. Turner, M. S. Byerly, G. L. Dixon, G. L. Cordts, D. M Ragels
	northern rock mouse	26242	UA	09/14/1985	G. L. Dixon
	northern grasshopper mouse	26095,	UA	05/22/1985	A. R. Shanks
	Mexican woodrat	25573	UA	09/28/1986	D. Duncan
	hispid cotton rat	25952, 26245	UA	09/13/1985, 09/14/1985	T. L. Allen, R. Fargo
	Arizona cotton rat	26246	UA	09/19/1985	R. Garcia
	house mouse	9817	UA	07/18/1962	D. M. Smith
	collared peccary	665	INHS	06/24/1954	D. M. Smith

[a] BYU = Brigham Young University; CAS = Chicago Academy of Sciences; INHS = Illinois Natural History Survey; MSU = Michigan State University; MPM = Milwaukee Public Museum; NHMLA = Natural History Museum of Los Angeles County; TTU = Texas Tech University; TMNH = Tulane Museum of Natural History; UA = University of Arizona; UCB = University of California at Berkeley; UI = University of Illinois, Museum of Natural History; UK = Museum of Natural History, University of Kansas; USNM = U.S. National Museum.

[b] Based on the location description, these specimens were found outside of the monument (but within 5 km of the boundary).

Appendix I. Summary of vegetation characteristics measured at each VCP survey station for birds, Chiricahua NM, 2004. See Chapter 5 for category descriptions.

Transect Station	Category	Species	Mean density
Bonita			
1	Subshrub	rubber rabbitbrush	226.09
		catclaw mimosa	452.18
		Apache plume	1469.58
		pale desert-thorn	113.05
	Shrub	rubber rabbitbrush	172.80
		pointleaf manzanita	57.60
		catclaw mimosa	57.60
		velvet mesquite	57.60
		Apache plume	806.39
	Tree	Arizona cypress	5.62
		alligator juniper	16.86
		New Mexico locust	1.87
		Arizona walnut	11.24
		velvet ash	1.87
	Cavity	desert willow	1.67
		Arizona cypress	3.35
		alligator juniper	6.69
		Emory oak	0.84
		Arizona walnut	1.67
		velvet ash	0.84
2	Subshrub	Schott's yucca	13.34
		burroweed	20.02
		walkingstick cactus	20.02
		Arizona cypress	13.34
		velvet mesquite	13.34
		Emory oak	6.67
		common sotol	6.67
		Apache plume	33.36
		netleaf hackberry	6.67
	Shrub	eastern poison ivy	3.14
		skunkbush sumac	3.14
		turpentine bush	3.14
		Arizona cypress	6.28
		alligator juniper	6.28
		velvet mesquite	6.28
		velvet ash	3.14
		Apache plume	25.10
		netleaf hackberry	6.28
	Tree	Arizona cypress	1.07
		alligator juniper	10.70
		velvet mesquite	1.07
		Emory oak	2.14
		Arizona walnut	3.21
		velvet ash	2.14
		wingleaf soapberry	1.07
	Cavity	Arizona cypress	3.98
		alligator juniper	1.99
		Arizona white oak	1.99
		Emory oak	7.96
		Arizona walnut	3.98
Bonita 4		Wright's silktassel	5.22
		common sotol	5.22
		velvet ash	5.22
		Apache plume	10.44
	Tree	Arizona cypress	8.99
		alligator juniper	7.70
		Arizona white oak	1.28
		Emory oak	1.28
		Arizona walnut	2.57
		velvet ash	3.85
	Cavity	Arizona cypress	9.63
Bonita 2		velvet ash	7.96
		Arizona sycamore	5.97
3	Subshrub	Palmer's century plant	14.97
		Schott's yucca	44.91
		turpentine bush	29.94
		walkingstick cactus	14.97
		alligator juniper	14.97
		pointleaf manzanita	14.97
		catclaw mimosa	44.91
		Arizona white oak	29.94
		common sotol	44.91
		Apache plume	29.94
		netleaf hackberry	14.97
	Shrub	Palmer's century plant	11.28
		Schott's yucca	22.57
		skunkbush sumac	11.28
		Arizona cypress	11.28
		alligator juniper	11.28
		pointleaf manzanita	11.28
		catclaw mimosa	45.13
		Emory oak	22.57
		silverleaf oak	11.28
		Wright's silktassel	11.28
		common sotol	22.57
		sacahuista	22.57
	Tree	Arizona cypress	26.28
		alligator juniper	87.59
		Emory oak	26.28
		velvet ash	35.04
	Cavity	Arizona cypress	23.73
		alligator juniper	47.46
		Emory oak	11.86
		velvet ash	17.80
		Arizona sycamore	11.86
4	Subshrub	Schott's yucca	19.91
		smooth sumac	6.64
		skunkbush sumac	6.64
		walkingstick cactus	6.64
		alligator juniper	6.64
		pointleaf manzanita	13.27
		catclaw mimosa	33.18
		velvet mesquite	6.64
		Emory oak	6.64
		Apache plume	26.54
	Shrub	Schott's yucca	15.66
		smooth sumac	5.22
		Arizona cypress	10.44
		alligator juniper	10.44
		catclaw mimosa	15.66
		velvet mesquite	15.66
		Arizona white oak	5.22
Bonita 6		Emory oak	4.43
		sacahuista	13.28
		Apache plume	13.28
	Tree	Arizona cypress	24.44
		alligator juniper	109.96
		Arizona white oak	48.87
		Emory oak	61.09
	Cavity	alligator juniper	30.74
		Arizona white oak	13.66
		Emory oak	23.91
7	Subshrub	walkingstick cactus	63.11

Transect Station	Category	Species	Mean density
		alligator juniper	4.82
		Arizona white oak	0.96
		Arizona walnut	0.96
		velvet ash	2.89
5	Subshrub	Schott's yucca	8.02
		smooth sumac	8.02
		Arizona cypress	32.08
		alligator juniper	16.04
		pointleaf manzanita	16.04
		catclaw mimosa	40.11
		velvet mesquite	8.02
		Emory oak	8.02
		common sotol	8.02
		sacahuista	8.02
		pricklyburr	8.02
	Shrub	skunkbush sumac	29.38
		Arizona cypress	29.38
		alligator juniper	29.38
		pointleaf manzanita	36.72
		Wright's silktassel	14.69
		velvet ash	7.34
	Tree	Arizona cypress	9.28
		alligator juniper	111.40
		pointleaf manzanita	9.28
		Emory oak	55.70
	Cavity	Arizona cypress	7.78
		alligator juniper	11.67
		Emory oak	54.47
6	Subshrub	Schott's yucca	39.25
		Arizona cypress	5.61
		alligator juniper	16.82
		pointleaf manzanita	5.61
		catclaw mimosa	5.61
		Emory oak	5.61
		sacahuista	5.61
		Apache plume	28.04
	Shrub	Schott's yucca	4.43
		smooth sumac	8.86
		skunkbush sumac	13.28
		walkingstick cactus	4.43
		alligator juniper	22.14
		pointleaf manzanita	4.43
Bonita 8		Arizona cypress	11.71
		alligator juniper	11.71
		pointleaf manzanita	1.95
		Arizona white oak	1.95
		Emory oak	3.90
		Chihuahuan pine	1.95
		Apache plume	1.95
	Tree	Arizona cypress	46.24
		alligator juniper	73.98
		Arizona white oak	9.25
		Emory oak	46.24
		Arizona sycamore	9.25
	Cavity	Arizona cypress	10.11
		alligator juniper	8.67
		Arizona white oak	1.44
		Emory oak	2.89
		Arizona walnut	1.44
		velvet ash	2.89
		Arizona sycamore	1.44
Rhyolite			
1	Subshrub	Schott's yucca	10.06
		skunkbush sumac	10.06

Transect Station	Category	Species	Mean density
		alligator juniper	21.04
		pointleaf manzanita	21.04
		catclaw mimosa	42.07
		common sotol	10.52
		Apache plume	52.59
	Shrub	skunkbush sumac	9.69
		walkingstick cactus	6.46
		alligator juniper	9.69
		pointleaf manzanita	9.69
		catclaw mimosa	3.23
		velvet mesquite	3.23
		silverleaf oak	3.23
		sacahuista	3.23
		Apache plume	16.15
	Tree	Arizona cypress	46.70
		alligator juniper	65.38
		Arizona white oak	9.34
		Emory oak	37.36
		Arizona walnut	9.34
		velvet ash	9.34
		Arizona sycamore	9.34
	Cavity	Arizona cypress	17.23
		alligator juniper	10.34
		Arizona white oak	6.89
		Emory oak	17.23
		rush	3.45
		velvet ash	3.45
		Arizona sycamore	3.45
8	Subshrub	Palmer's century plant	3.34
		Schott's yucca	6.69
		aster	3.34
		walkingstick cactus	3.34
		Arizona cypress	23.41
		pointleaf manzanita	3.34
		velvet mesquite	3.34
		New Mexico locust	3.34
		Arizona white oak	3.34
		silverleaf oak	3.34
		common sotol	3.34
		Apache plume	6.69
	Shrub	Schott's yucca	1.95
		skunkbush sumac	1.95
Rhyolite 2	Shrub	Schott's yucca	12.06
		Arizona cypress	8.04
		pointleaf manzanita	16.08
		silverleaf oak	20.10
		sacahuista	16.08
		Chihuahuan pine	8.04
	Tree	Arizona cypress	35.86
		alligator juniper	35.86
		Arizona madrone	11.95
		Arizona white oak	71.71
		Emory oak	59.76
		silverleaf oak	11.95
		ponderosa pine	11.95
	Cavity	Arizona cypress	23.61
		alligator juniper	15.74
		Arizona white oak	31.48
		Emory oak	47.22
		oak	7.87
		ponderosa pine	31.48
3	Subshrub	Schott's yucca	20.18
		fragrant sumac	10.09
		skunkbush sumac	10.09

Transect Station	Category	Species	Mean density
		Arizona cypress	70.38
		pointleaf manzanita	50.27
		Arizona white oak	10.06
		silverleaf oak	30.16
		beechleaf frangula	20.11
	Shrub	smooth sumac	10.16
		skunkbush sumac	30.47
		Arizona cypress	91.40
		pointleaf manzanita	20.31
		Arizona white oak	10.16
		Emory oak	10.16
		Chihuahuan pine	20.32
		ponderosa pine	10.16
	Tree	Arizona cypress	137.84
		alligator juniper	103.38
		Arizona white oak	34.46
		Emory oak	68.92
	Cavity	Arizona cypress	45.30
		alligator juniper	60.40
		Arizona white oak	22.65
		Emory oak	7.55
		ponderosa pine	7.55
		Arizona sycamore	7.55
2	Subshrub	Schott's yucca	24.75
		Arizona cypress	8.25
		pointleaf manzanita	8.25
		Arizona white oak	8.25
		silverleaf oak	82.51
		sacahuista	16.50
		Chihuahuan pine	8.25
		ponderosa pine	8.25
Rhyolite 3		ponderosa pine	8.78
4	Subshrub	skunkbush sumac	32.87
		Arizona white oak	32.87
		Emory oak	65.74
		silverleaf oak	295.82
		sacahuista	65.74
		Chihuahuan pine	131.48
		ponderosa pine	32.87
	Shrub	Schott's yucca	11.72
		Arizona white oak	23.44
		silverleaf oak	82.05
		sacahuista	70.32
		Chihuahuan pine	46.88
	Tree	alligator juniper	335.99
		Arizona white oak	224.00
		Emory oak	168.00
		silverleaf oak	168.00
		Chihuahuan pine	168.00
		ponderosa pine	56.00
	Cavity	alligator juniper	22.94
		Arizona white oak	22.94
		Emory oak	15.29
		silverleaf oak	15.29
		Chihuahuan pine	68.81
		ponderosa pine	7.65
5	Subshrub	Schott's yucca	82.28
		fragrant sumac	27.43
		smooth sumac	27.43
		eastern poison ivy	54.86
		Arizona cypress	27.43
		Arizona white oak	27.43
		Emory oak	27.43
		silverleaf oak	137.14
		sacahuista	109.71

Transect Station	Category	Species	Mean density
		Arizona honeysuckle	10.09
		Arizona cypress	10.09
		pointleaf manzanita	10.09
		Arizona white oak	10.09
		silverleaf oak	100.88
		ponderosa pine	10.09
		beechleaf frangula	10.09
	Shrub	Schott's yucca	27.47
		fragrant sumac	18.31
		smooth sumac	9.16
		skunkbush sumac	36.63
		pointleaf manzanita	9.16
		Arizona white oak	9.16
		silverleaf oak	27.47
		sacahuista	9.16
		Chihuahuan pine	9.16
		ponderosa pine	9.16
		beechleaf frangula	18.31
	Tree	Arizona cypress	48.34
		alligator juniper	36.25
		Arizona madrone	12.08
		Arizona white oak	48.34
		Emory oak	12.08
		silverleaf oak	48.34
		Chihuahuan pine	36.25
	Cavity	Arizona cypress	17.57
		alligator juniper	4.39
		Arizona madrone	4.39
		Arizona white oak	17.57
		silverleaf oak	30.75
		Chihuahuan pine	4.39
Rhyolite 6		silverleaf oak	68.00
		ashy silktassel	7.56
		sacahuista	15.11
		Chihuahuan pine	15.11
		ponderosa pine	7.56
		beechleaf frangula	22.67
		black cherry	7.56
	Shrub	Schott's yucca	7.93
		silverleaf oak	39.66
		sacahuista	47.59
		Chihuahuan pine	7.93
		ponderosa pine	23.80
		beechleaf frangula	31.73
	Tree	Arizona white oak	284.98
		silverleaf oak	221.65
		Mexican pinyon	31.66
		Chihuahuan pine	63.33
		ponderosa pine	31.66
	Cavity	Arizona cypress	2.47
		alligator juniper	2.47
		Arizona madrone	4.94
		Arizona white oak	2.47
		silverleaf oak	9.87
		ponderosa pine	24.68
7	Subshrub	Schott's yucca	24.34
		eastern poison ivy	24.34
		Arizona cypress	24.34
		Arizona white oak	48.68
		silverleaf oak	267.71
		ashy silktassel	48.68
		sacahuista	24.34
		Chihuahuan pine	24.34
	Shrub	Schott's yucca	39.15
		eastern poison ivy	19.57

Transect Station	Category	Species	Mean density
		Chihuahuan pine	27.43
	Shrub	Schott's yucca	35.37
		fragrant sumac	35.37
		Arizona cypress	35.37
		Arizona white oak	70.74
		silverleaf oak	70.74
		sacahuista	424.41
		Chihuahuan pine	35.37
	Tree	Arizona madrone	114.11
		Arizona white oak	684.67
		silverleaf oak	456.44
		Chihuahuan pine	114.11
		ponderosa pine	912.89
	Cavity	Arizona cypress	7.29
		Arizona madrone	7.29
		silverleaf oak	43.75
		Chihuahuan pine	36.46
		ponderosa pine	51.04
6	Subshrub	Schott's yucca	7.56

Transect Station	Category	Species	Mean density
		Arizona cypress	19.57
		Arizona madrone	39.15
		Arizona white oak	19.57
		silverleaf oak	156.58
		sacahuista	78.29
		black cherry	19.57
	Tree	Arizona cypress	28.94
		Arizona madrone	57.88
		Arizona white oak	144.69
		silverleaf oak	318.31
		ponderosa pine	28.94
	Cavity	Arizona cypress	0.82
		Arizona madrone	1.64
		Arizona white oak	0.82
		silverleaf oak	4.93
		oak	0.82
		ponderosa pine	7.39
8	Subshrub	Schott's yucca	51.80
		Arizona cypress	25.90

Transect Station	Category	Species	Mean density
Rhyolite 8		pointleaf manzanita	51.80
		Arizona white oak	51.80
		silverleaf oak	233.11
		sacahuista	51.80
		Chihuahuan pine	25.90
		ponderosa pine	25.90
	Shrub	Arizona cypress	13.87
		Arizona madrone	13.87
		Arizona white oak	27.74
		silverleaf oak	138.71
		sacahuista	41.61
		Chihuahuan pine	41.61
	Tree	Arizona cypress	46.82
		Arizona white oak	46.82
		silverleaf oak	187.29
		Chihuahuan pine	31.22
	Cavity	Arizona cypress	6.18
		Arizona white oak	4.63
		silverleaf oak	3.09
		Chihuahuan pine	9.27
		ponderosa pine	6.18

		Litter		Bare Ground		Rock	
Transect	Station	Mean	SD	Mean	SD	Mean	SD
Bonita	1	59	24.7	39	26.3	3	4.7
	2	68	23.3	32	23.9	2	4.1
	3	69	29.4	15	20.9	17	19.5
	4	53	18.7	28	26.9	19	21.0
	5	52	40.6	18	23.8	27	35.6
	6	79	20.0	13	23.4	7	9.2
	7	62	22.8	23	17.4	16	15.0
	8	65	21.4	24	24.1	10	11.2
Rhyolite	1	71	10.2	12	11.5	20	14.5
	2	56	19.6	6	9.4	40	18.8
	3	56	27.8	13	17.4	32	24.6
	4	85	11.0	7	12.6	10	8.3
	5	78	15.1	2	4.1	18	13.7
	6	68	14.4	1	3.1	31	13.7
	7	60	20.0	5	7.6	38	18.8
	8	68	21.4	4	4.9	30	17.2

Appendix J. Number of individuals trapped (*n*) and relative abundance (RA) of small mammals, by community type and plot, Chiricahua NM, 2002. Data are summarized in Table 6.3. See Table 6.1 for information on trapping effort.

	Riparian[a]	
	01	
Species	*n*	RA
silky pocket mouse	1	1.2
brush mouse	6	7.0
western white-throated woodrat	1	1.2

[a] No animals trapped at 09 plot

	Rocky slope					
	02		10		11	
Species	*n*	RA	*n*	RA	*n*	RA
rock pocket mouse	4	4.9				
cactus mouse	1	1.2				
brush mouse	6	7.4	3	7.8		
northern rock mouse					2	13.8

	Semi-desert Grassland									
	03		05		06		07		08	
Species	*n*	RA	*n*	RA	*n*	RA	*n*	RA	*n*	RA
silky pocket mouse	4	4.6			2	1.4			2	2.5
hispid pocket mouse	7	8.0			14	10.1			3	3.8
Merriam's kangaroo rat	3	3.4	1	25.0						
Plains harvest mouse					1	0.7				
deer mouse	1	1.1								
brush mouse					11	7.9				
northern pygmy mouse					2	1.4				
southern grasshopper mouse					2	1.4	1	1.4	1	1.3
western white-throated woodrat					3	2.2				
yellow-nosed cotton rat					6	4.3			1	1.3
Arizona cotton rat					8	5.8			2	2.5
house mouse	1	1.1			3	2.2				

[a] No animals trapped at plot 04.

This page left intentionally blank.

U.S. Geological Survey
Southwest Biological Science Center
2255 N. Gemini Drive
Flagstaff, AZ 86001