USGS
science for a changing world

In cooperation with the National Park Service

Distribution and Habitat Associations of the Little Striped Whiptail (*Cnemidophorus inornatus*) at Wupatki National Monument, Arizona

Southwest Biolological Science Center
USGS Open File Report OF 2005-1139 April 2005

U.S. Department of the Interior
U.S. Geological Survey

In cooperation with the National Park Service

Distribution and Habitat Association of the Little Striped Whiptail (*Cnemidophorus inornatus*) at Wupatki National Monument, Arizona

Final Report

By Trevor B. Persons

Open-File Report OF 2005-1139
April 2005

U.S. Department of the Interior
U.S. Geological Survey

USGS Southwest Biological Science Center
Colorado Plateau Research Station
Box 5614, Northern Arizona University
Flagstaff, Arizona 86011-5614

U.S. Department of the Interior
Gale A. Norton, Secretary

U.S. Geological Survey
Charles G. Groat, Director

U.S. Geological Survey, Reston, Virginia: 2005

Suggested Citation
Persons, T.B.. 2005. Distribution and Habitat Associations of the Little Striped Whiptail (Cnemidophorus inornatus) at Wupatki National Monument. USGS Open-File Report OF 2005-1139. U.S.Geological Survey, Southwest Biological Science Center, Flagstaff, AZ.

Cover Photo: Adult male *Cnemidophorus inornatus* from near FR 545, ca. 1.6 miles east of US Highway 89, 20 May 2003

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

The Little Striped Whiptail (*Cnemidophorus inornatus*) is a Southwestern grassland lizard species that has declined in parts of its range, likely due to the effects of overgrazing, expansion of woodlands, and competition with unisexual whiptail species. The species has a highly disjunct distribution in Arizona, including on the southern Colorado Plateau. In northern Arizona it is known primarily from grasslands north and east of Flagstaff, including at Wupatki National Monument. I surveyed for *C. inornatus* (bisexual) and the sympatric Plateau Striped Whiptail (*C. velox*; unisexual) in grassland and woodland habitats at Wupatki, as well as on grazed grasslands outside the monument, from 2001-2003. Although a severe regional drought was likely responsible for low observation rates during the study, I was able to determine geographic distribution of whiptails and other lizards within the monument, as well as relative abundance within and between major habitat types. Both *C. inornatus* and *C. velox* occurred throughout the study area, and overall *C. velox* outnumbered *C. inornatus* by a ratio of 4.4:1. *Cnemidophorus velox* also outnumbered *C. inornatus* within each habitat, and was roughly equally common in all major habitats (grassland, juniper savanna, and juniper woodland) found in the study area within the monument. In contrast, *C. inornatus* was only common in grassland, and was rare in both savanna and woodland habitats. The relative abundance of the two whiptails in grazed grassland just outside the monument was similar to ungrazed grassland within, but the absolute abundance of both species was reduced by about one half, possibly related to the presence of large numbers of the Lesser Earless Lizard (*Holbrookia maculata*) in the more open habitat on the grazed sites. The relative rarity of *C. inornatus* in savanna and woodland habitats suggests that the increase of these habitats through juniper encroachment of grasslands has probably reduced populations of this species at Wupatki. Reduction of juniper in grassland habitats and transfer of adjacent ranch land to the monument would probably enhance conservation of *C. inornatus* at Wupatki. Long-term monitoring studies have the opportunity to address questions about the roles of drought, livestock grazing, and woodland expansion on the comparative abilities of bisexual and unisexual whiptail species to flourish in many areas of the Southwest.

INTRODUCTION

Whiptail lizards (genus *Cnemidophorus*) belong to the New World family Teiidae, and occur throughout much of North and South America, primarily in arid and semi-arid habitats (Wright 1993). Of the approximately 50 described species of *Cnemidophorus*, over one third are unisexual (all-female) species (Wright 1993), and many more unisexual taxa remain to be formally described. Unisexual *Cnemidophorus* are of hybrid origin, and reproduce by parthenogenesis (Wright 1993). Recently, it has been proposed that North American whiptail lizards be placed in the genus *Aspidoscelis* (Reeder at al. 2002), but since this change has not been universally accepted (e.g., Stebbins 2003), in this report I will use the more familiar *Cnemidophorus*.

The Little Striped Whiptail (*Cnemidophorus inornatus*) is found only in parts of Arizona, New Mexico, Texas, and northern Mexico (Wright and Lowe 1993), and chiefly inhabits grasslands (e.g., Stebbins 1985, 2003). On the southern Colorado Plateau, *C. inornatus* has a disjunct, relictual distribution (Degenhardt et al. 1996, Persons and Wright 1999, Wright and Lowe 1993), and was described by Wright and Lowe (1993) as the subspecies *C. inornatus pai* (Pai Striped Whiptail), one of eight subspecies they summarized. These taxa, including *C. i. pai*, are considered by some to be full, distinct species (e.g., Collins and Taggart 2002, Crother 2000). Much of the known distribution of *C. inornatus* in Arizona consists of a relatively small area of grassland north and east of Flagstaff, in Coconino County, Arizona, including Wupatki National Monument. *Cnemidophorus inornatus* has declined in parts of its range, due to habitat loss and from competition with disturbance-adapted unisexual whiptail species (Wright and Lowe 1965, Wright 1968, Wright and Lowe 1968, Behler and King 1979, Loftin et al. 1995, Bogan et al. 1998). In northern Arizona, *C. inornatus* faces competition from *C. velox*, a unisexual species adapted to disturbed and ecotonal habitats such as degraded grasslands and juniper woodland/grassland ecotones (Wright 1968). *Cnemidophorus velox* is a triploid species, sharing two of its three sets of chromosomes with *C. inornatus* (Wright 1993), and is morphologically and ecologically similar to *C. inornatus*. Although *C. velox* may be a complex of mostly undescribed species (*sensu* Frost and Wright 1988; Wright 1993), the species occurring at Wupatki would be *C. velox* proper. At most known localities for *C. inornatus* in the region, *C. velox* is also present, and is generally more abundant (personal observation).

Grassland habitats in the Southwest, including in the region of the southern Colorado Plateau, have declined (e.g., Brown 1994, Dick-Peddie 1993, Kearney and Peebles 1960, Lowe 1964). Causes for the decline or degradation of grasslands include livestock grazing (Abruzzi 1995, Cole 1997, Lockett and Snow 1939, Wright and Lowe 1968), conversion to desert grassland (Loftin et al 1995, Wright 1968), and encroachment of juniper woodlands (Bogan et al. 1998, Dick-Peddie 1993, Johnson 1962). Encroachment of one-seed juniper (*Juniperus monosperma*) into grassland areas at Wupatki within the past century has been documented (Cinnamon 1988). Recent studies of grassland birds at Wupatki have demonstrated that encroachment of juniper into grassland habitats is affecting avian community structure there (Rosenstock 1999, Rosenstock and van Riper 2001). Given this, *C. inornatus* might be negatively affected by juniper encroachment at Wupatki, either directly through loss of habitat or by competition with *C. velox*, which is adapted to a variety of habitats, including both grassland and woodland.

The primary goals of this study were to: 1) determine the current distribution of *C. inornatus* and *C. velox* at Wupatki; 2) analyze distribution and abundance in relation to habitat, including grazed and ungrazed habitats; and 3) evaluate distribution and habitat data in relation to grassland decline and management of the grassland community. Other objectives of this project were to compare current and past relative abundance of the whiptail species at Wupatki, and to design a cost-effective monitoring protocol for these species for potential future use.

STUDY AREA DESCRIPTION

Wupatki National Monument is located approximately 55 km NNE of Flagstaff, Coconino County, Arizona, on the northeastern edge of the San Francisco volcanic field (Duffield 1997). The monument encompasses 14,341 hectares (National Park Service 2002), and is bordered on the southwest by the Coconino National Forest, and on the northeast by the Navajo Indian Reservation. The remainder of the surrounding land is a mixture of state trust and private lands, used primarily as grazing land for cattle.

Geology at Wupatki is dominated by exposed limestone and sandstone, extensively overlain by volcanic basalt lava flows and cinder deposits (Breed 1976). Soils range from clay-loam, especially in the Wupatki Basin, to sand-cinder, especially in the western half of the monument. Vegetation includes Great Basin desertscrub, grassland, and juniper savanna communities (Green and Rominger 1976). Although Brown (1994) and Brown and Lowe (1980) lump juniper habitats in the Wupatki area into their Great Basin conifer woodland biotic community, they are more properly a juniper savanna (Dick-Peddie 1993).

Because *C. inornatus* was not known or expected from desertscrub habitats of Wupatki Basin in the eastern half of the monument, I limited the present study to grassland and juniper habitats in the western half of the monument, where both *C. inornatus* and *C. velox* were known to occur. The study area was defined as the portion of the monument west of the Doney Cliffs, a prominent northeast trending monocline that sharply divides desertscrub habitats of Wupatki Basin to the east and grassland and juniper habitats of Antelope Prairie to the west. The study area included Antelope Wash, a large, deep dry wash cut into Antelope Prairie and the Doney Cliffs. Desertscrub vegetation of Wupatki Basin extends up into Antelope Wash, where it mingles with grassland elements characteristic of Antelope Prairie above. In addition to the Wupatki portion of the study area (ca. 6,500 hectares), I also included ca. 2,300 hectares of adjacent CO Bar Ranch land bordering the monument west of Doney Cliffs, and extending 1.6 km north of the monument's northern boundary. The CO Bar Ranch land consisted entirely of grassland, and was actively grazed by cattle. The management of the CO Bar Ranch granted permission to survey on their land.

METHODS

Whiptail lizards are active, conspicuous, and range widely while foraging (Pianka 1986), and visual searches are often effective for studying them (e.g., Mitchell 1979, Paulissen 1988, 1994, Schall 1993). Whiptail lizards in the Wupatki area are primarily active from April to September, with most activity of adults occurring from May through August (personal observation). For this study, I used different types of visual encounter surveys (Crump and Scott 1994), including time-area constrained searches, general surveys, and lizard line transects to search for whiptail lizards. In addition, I conducted a literature review and compiled data from numerous museums on specimens collected previously in the vicinity of Wupatki.

Habitat Stratification and Generation of Random Points

Using ArcView GIS® version 3.1, I used digitized aerial photographs (digital ortho quarter quads, or DOQQs) of the study area as a base to delimit four habitat strata: (1) grassland, (2) juniper savanna, (3) juniper woodland, and (4) grazed grassland (refer to Figure 6). Although I did not use a specific tree density as criteria for delimiting strata, I attempted to be consistent with the three strata recognized at Wupatki by Rosenstock (1999) in his investigation of the effects of juniper density on composition of the breeding bird community at Antelope Prairie. Rosenstock's uninvaded grassland, early establishment woodland, and developing woodland are equivalent to my grassland, savanna, and woodland, respectively. Rosenstock (1999) provided representative photographs of these three habitats at Wupatki, and reported mean juniper densities of 0, 10.6, and 41.9 trees per hectare within each.

Because I had not yet decided upon a plot size or lizard line transect length when generating random points, I chose a buffer zone of 566 m between points and 283 m from the edge of the strata, which would have allowed for non-overlapping 16 hectare square plot areas. Because of the small size of the woodland strata, only seven such points could be located there, and I chose to limit the number of points to seven in the other three strata as well, for ease of comparison. As a result of ultimately deciding to survey one-hectare plot areas, the effective buffer between edges of any two plots was at least 424 m. The locations of the 28 random points are shown in Figure 1.

The broad habitat categories (grassland, savanna, woodland, grazed grassland) were used throughout the study, and the initial stratification was useful in on-the-ground assignment of habitat during general surveys. Representative photographs of the different habitat types are shown in Figures 2-5.

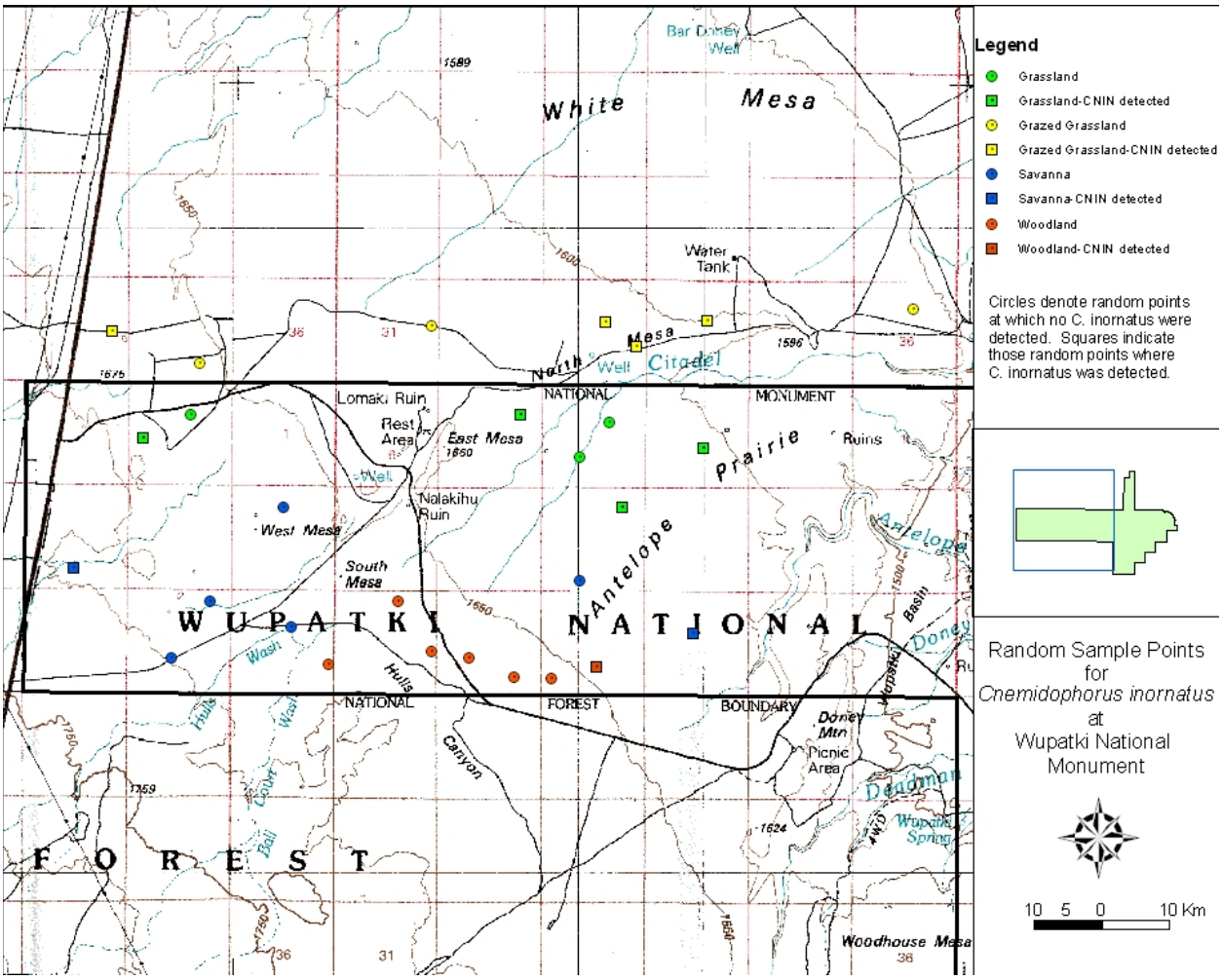

Figure 1. Location of the random sample points used in 2001 for time-area constrained searches for *Cnemidophorus inornatus* at Wupatki National Monument. UTM coordinates for these sample points can be found in Appendix B.

Figure 2. Typical grassland habitat (grassland #8) at Wupatki National Monument, Arizona. Photographed on 16 July 2001.

Figure 3. Typical juniper savanna habitat (savanna #5) at Wupatki National Monument, Arizona. Photographed on 21 July 2001.

Figure 4. Typical juniper woodland habitat (woodland #7) at Wupatki National Monument, Arizona. Photographed on 3 July 2001.

Figure 5. Typical grazed grassland habitat (grazed #2) just north of Wupatki National Monument, Arizona. Photographed on 28 June 2001.

Time-Area Constrained Searches

Time-area constrained searches (TACS) are a version of visual encounter surveys defined by Crump and Scott (1994) in which not only the amount of time spent searching, but also the area covered, are standardized. TACS consist of walking systematically through the habitat within the sampling area for a specified amount of time, and recording all lizards encountered, yielding a number of individuals and species observed per person-hour. For this study, I adopted the TACS methodology of a concurrent NPS herpetofauna inventory of parks in the Southern Colorado Plateau Inventory & Monitoring Network (SCPN), including Wupatki (Persons and Nowak unpublished data). Specifically, TACS plot locations were randomly chosen (see above), and consisted of a one hectare square area (100 m x 100 m) centered on the random point, thoroughly searched for whiptail lizards for exactly one hour. Plot corners were located using GPS, and marked with flagging to facilitate staying within the plot during the survey. I systematically searched each plot by walking slowly back and forth across the length of the plot, with each pass being ~10 m away from the previous one, until the entire plot was searched. Often, this procedure resulted in full coverage of the plot in less than an hour, in which case I resurveyed the entire plot, usually with similar but more widely spaced passes of the plot. Locations, sizes, and other features such as broken or regenerated tails of all lizards were noted, in an attempt to identify individual lizards so as to avoid double-counting them. All TACS were conducted in the morning (ending before 12:00 noon local time), and all 28 plots were surveyed once in 2001. All surveys were conducted during optimal weather conditions for whiptail lizard activity, i.e., warm, sunny, and not too windy. At each survey, I photographed the site from the plot center (usually facing all four cardinal directions) and described the topography, elevation, slope, aspect, vegetation, and non-vegetative cover using data sheets developed for use in the SCPN inventories (Appendix A). Unlike most general surveys in 2003, individual lizard habitat association data were limited to the habitat of the plot. Random sampling points (UTMs) were located in the field using GPS.

General Surveys

In all years, I conducted non-random visual encounter surveys that were not time or area-limited. These "general surveys" were designed to maximize lizard detections in promising habitats, and allowed me to survey throughout the study area in an attempt to determine geographic distribution of both whiptail species. Like TACS, general surveys yielded a number of individuals of each species observed per person-hour. All surveys, and thus all individual lizard observations, were assigned to one of the four major habitat categories. Additionally in 2003, microhabitat data were recorded for each individual lizard observation, which described the habitat of a 10 m^2 circle (visually estimated), centered on the location where the lizard was first sighted. The nine microhabitat categories used were: shrub patch, sparse grass/weeds, medium dense grass/weeds, dense grass/weeds, rocky habitats, under a tree, open cinder, grass/snakeweed, and road edge weeds. During surveys in 2003, I also estimated the distance from each lizard (when first sighted) to the closest shrub or tree, as these habitat features were suspected of being important to both whiptail species in their ability to occupy otherwise relatively open grassy habitats. This "distance to shrub" (DTS) was visually estimated to the closest meter. Most general surveys were conducted during optimal weather conditions (i.e., warm, sunny), although moderately strong winds may have curtailed lizard activity during some surveys.

Lizard Line Transects

I had initially considered using lizard line transects ("lizard lines;" Rosen and Lowe 1995, 1996) to survey at each of the 28 random points, but after a trial run at the first grassland point I decided to adopt the TACS methodology for those points, fearing lizard lines would be too time-intensive and yield too few observations of whiptails. As developed by Rosen and Lowe (1995, 1996), lizard lines consist of repeatedly walking an established transect over the course of the morning activity period, and recording the number of each lizard species observed on each walk of the transect. The metric of interest in this method is the greatest number of each species observed on any single transect walk, which is termed the peak value. Use of the peak value in analysis corrects for variation in activity patterns of different species over the course of the survey, and lizard lines are therefore of potential value in a long-term monitoring program, as they have been at Organ Pipe Cactus National Monument (Rosen 2000, Rosen and Lowe 1996). However, because of limited time available for this study, and because I was primarily focused on determining the distribution and habitat associations of whiptails over the entire study area, I decided that using TACS at the random point locations would be both more efficient in terms of geographical coverage of the monument (I was sometimes able to conduct two surveys per morning) and in yielding the maximum number of unique lizard observations.

Random Encounters

In addition to the three primary survey methods (above), I sometimes opportunistically recorded animals while traveling between plot locations, while driving, or otherwise not conducting a formal survey. Data associated with these "random encounters" included major habitat type, as well as date, time and location. Because time and effort spent surveying was not recorded for random encounters, these observations are not included in analyses of observation rates, efficacy of different survey methods, or relative abundance by habitat type.

Museum Specimen Review

As part of a concurrent herpetofauna inventory of NPS areas across the southern Colorado Plateau, including Wupatki (Persons and Nowak in preparation), I obtained data on amphibian and reptile specimens from Coconino County, Arizona (and often all of northern Arizona) housed in a number of institutional museum collections. These included the American Museum of Natural History (AMNH), Arizona State University (ASU), Brigham Young University (BYU), California Academy of Sciences (CAS), Carnegie Museum (CM), University of Colorado Museum (CU), University of Kansas Museum of Natural History (KU), Los Angeles County Museum (LACM), Museum of Comparative Zoology, Harvard University (MCZ), Museum of Northern Arizona (MNA), Museum of Southwestern Biology, University of New Mexico (MSB), Museum of Vertebrate Zoology, UC Berkeley (MVZ), Northern Arizona University (NAU), United States National Museum, Smithsonian Institution (USNM), University of Arizona (UAZ), University of Michigan Museum of Zoology (UMMZ), University of Texas at El Paso (UTEP), and the Flagstaff Area National Monuments vertebrate collection (SUCR, WACA, WUPA). I searched data from these museums for records of *C. inornatus* and *C. velox*, in an effort to characterize the distribution and habitat association of the species throughout the Wupatki region.

Comparison of Past and Present Relative Abundance
Prior to initiation of this study, I was aware that limited collections of *C. inornatus* and *C. velox* had been made from Wupatki in the 1960's, in the far western part of the monument near US Highway 89, based on specimens in the collection of the Museum of Northern Arizona. I reviewed museum collection data (see above) in search of additional specimens, or associated field notes or reports that would allow me to compare past and present relative abundance of the two species. I also contacted Clay May and John Wright, herpetologists who collected in the area previously. To compare past and present relative abundance of *C. inornatus* and *C. velox*, I used survey results from this study specifically from the area of Wupatki where collections were made in the 1960's, i.e., near the north entrance at US Highway 89 and along the park road (FR 545) up to one mile east of US Highway 89.

Voucher Specimen Collection
Specimens collected during this study were humanely euthanized, injected with and immersed in 10% formalin for fixing, then transferred to 55% isopropyl alcohol for preservation, using standard techniques (e.g., Pisani 1973). These specimens have been deposited in the vertebrate collection of the Flagstaff Area National Monuments (NPS) in Flagstaff, Arizona. In addition to a collector field tag and data tag, each specimen has a National Park Service issue specimen tag containing information on species, collector, date of collection, collection site, and National Park Service (ANCS+) accession and catalog number. Specimens were collected under NPS research permit numbers WUPA-2001-SCI-0014, WUPA-2002-SCI-0002, and WUPA-2003-SCI-005.

Data Recording and Analysis
UTM coordinates (NAD27 datum) were recorded for all observations of *C. inornatus* in the study area using a hand held Garmin 12 GPS receiver. For most observations of *C. inornatus* (and other species) made during TACS surveys, I used the randomly generated point coordinates, located at the center of each one-hectare plot. These coordinates were therefore at most 71 meters from the actual observation, a distance well within a lizard's normal home range (personal observation). TACS field data were recorded on data sheets developed for use in the SCPN herpetofauna inventories (Appendix A), and all other survey data were recorded in a field notebook. Species observation and survey data were entered in Microsoft FoxPro® and imported into Microsoft Word® to create the tables presented in the Appendices.

Most analyses, including efficacy of different survey methods, relative abundance of different species by habitat type, and comparison of daily activity times, used the metric of mean number of lizard observations per person-hour of surveying. Because time and effort spent surveying was not recorded for random encounters, these observations are not included in analyses. To analyze microhabitat niche overlap, from general survey data in 2003, I used Pianka's (1973) formula, which produces a value ranging from 0 (no overlap) to 1 (complete overlap). Also from the 2003 general surveys, mean distance to shrub (DTS) data was calculated for each species, and the means were compared using a Student's t-test (Sokal and Rohlf 1987).

RESULTS AND DISCUSSION

Overview of Results and Efficacy of Different Survey Methods

I surveyed for a total of 83.1 hours between May 2001 and August 2003, conducting 59 discrete surveys (Table 1). These included 28 TACS plot surveys (28.0 hours), 30 general surveys (52.9 hours), and one lizard line transect survey (2.2 hours). Most effort in 2001 was directed towards TACS surveys, while all effort in 2003 consisted of general surveys. Only one formal survey was conducted in 2002, due to budget limitations. A complete list of all surveys, including dates, times, location, and weather conditions is presented in Appendix B. Vegetation data for the 28 TACS plot surveys are presented in Appendix C.

Table 1. Total number of survey hours by each method and in each distinct habitat type present in the study area, during surveys for whiptail lizards at Wupatki National Monument in 2001-2003.

Survey Type	Grassland	Savanna	Woodland	Grazed Grassland	Antelope Wash	TOTAL
General Surveys	24.9	15.1	6.8	0.4	5.7	52.9
TACS	7.0	7.0	7.0	7.0		28.0
Lizard Line Transect	2.2					2.2
TOTAL	**34.1**	**22.1**	**13.8**	**7.4**	**5.7**	**83.1**

I recorded a total of 609 reptile observations during these surveys, including 606 lizards, two Striped Whipsnakes (*Masticophis taeniatus*), and one Western Rattlesnake (*Crotalus viridis*) (Appendix D). Of the 606 lizards, 297 (49%) were whiptails, including 55 *C. inornatus*, 220 *C. velox*, five Western Whiptails (*C. tigris*), and 17 unidentified whiptails (either *C. inornatus* or *C. velox*). Observations of other lizard species included 13 Eastern Collared Lizards (*Crotaphytus collaris*), 6 Long-nosed Leopard Lizards (*Gambelia wislizenii*), 89 Lesser Earless Lizards (*Holbrookia maculata*), 3 Greater Short-horned Lizards (*Phrynosoma hernandesi*), 5 Desert Spiny Lizards (*Sceloporus magister*), 112 Eastern Fence Lizards (*Sceloporus undulatus*), 28 Tree Lizards (*Urosaurus ornatus*), 32 Side-blotched Lizards (*Uta stansburiana*), and 21 unidentified lizards. *Cnemidophorus tigris* and *Sceloporus magister* are desert species found throughout Wupatki Basin, but within the study area were only recorded within Antelope Wash and at the base of Doney Mountain.

Overall observation rate for all species of whiptails (including unidentified individuals) over all methods (excluding random encounters) was 3.2 lizards/hour. Counting only individuals identified to species, this rate declines to 3.1 lizards/hour. General surveys recorded 3.4 identified whiptails/hour, while TACS surveys recorded only 2.4 identified whiptails/hour. The single lizard line transect survey recorded only 5 whiptails (all during off-transect surveys), for an observation rate of 2.3 whiptails/hour. These observation rates are summarized in Table 2. Although observation rates have not generally been reported in most whiptail field studies, the figures in the present study are low. Although they did not note it in their report, Sullivan et al. (2001) recorded as many as 28 *C. inornatus* during a half-hour of transect surveying in the

Willcox, Arizona area (Brian Sullivan, personal communication), and I have recorded similar observation rates for *C. sonorae* in riparian habitat (Arivaca Creek) in southern Arizona. Rates such as these would not be expected in the less productive grassland and juniper habitats at Wupatki. However, based on past experience in the region I would have expected to observe three or four times the number I did. The low observation rate during the present study was possibly due to the effects of a persistent regional drought (see below).

Table 2. Observation rate (lizards/hour) for selected lizard species using different survey methods at Wupatki National Monument in 2001-2003.

Species	General Survey	TACS	Lizard Line	Overall
Cnemidophorus inornatus	0.55	0.50	1.36	0.55
Cnemidophorus velox	2.80	1.89	0.91	2.44
Both whiptails combined	3.35	2.39	2.27	2.99
Holbrookia maculata	0.55	1.93	0.45	2.44

General Surveys recorded the greatest number of whiptails per person-hour, and provided the most information about distribution and relative abundance of whiptails in different habitat types throughout the study area at Wupatki.

Observation rates of whiptails during TACS plots were lower than on general surveys. In addition, only actual survey time (one hour for a TACS plot survey) was used to calculate observation rate, but these more standardized plot surveys required additional time to map and flag plot corners and record detailed site characterization and habitat data, making them even less efficient. While I did not record the time spent on these tasks, I estimate that inclusion of this additional field time would reduce the observation rate for TACS plots to about two whiptails per person-hour of field effort. However, because they were more standardized than general surveys, and were chosen randomly, they have potentially greater statistical strength, in that inferences can be made to the entire study area based on their results.

Lizard line transects are a potentially useful long-term monitoring tool for whiptails at Wupatki (see Considerations for Long-term Monitoring, below). However, because of their low observation rate, particularly of unique individuals (i.e., many lizards are seen more than once within a survey period), and the time required to conduct them (all morning for each survey), I decided that it would be a better use of limited available time to survey more sites, and attempt to observe as many whiptails as possible throughout the study area.

Geographic Distribution of *Cnemidophorus inornatus*

At Wupatki, *C. inornatus* is distributed throughout the study area, i.e., in the grassland and juniper habitats west of the Doney Cliffs (55 observations total, Figure 6; see also Appendix D). Throughout the study area, *C. inornatus* was found with *C. velox*, and at one locality (Antelope Wash) *C. tigris* was also present. Although this study was limited to the area west of the Doney Cliffs, results of a concurrent amphibian and reptile inventory at Wupatki (Persons and Nowak unpublished data) indicate that *C. inornatus* does not occur elsewhere in the monument. Of particular note, Persons and Nowak (unpublished data) surveyed a prominent grassland bench atop a lava flow in section 22, east of Wukoki Ruin, and found only *C. velox*. *Cnemidophorus tigris* dominated throughout the desertscrub habitats in Wupatki Basin, although *C. velox* was also found in the upper elevations within the basin, i.e., directly east of the study area and in the southern part of the monument. However, in the lowest elevation areas of Wupatki near the Little Colorado River, *C. tigris* was the only whiptail species observed.

Many published maps (e.g., Stebbins 1985, 2003, Wright and Lowe 1993) depict a fairly widespread distribution for *C. inornatus* in parts of northern Arizona, especially in the region from Wupatki west across the Coconino Plateau. However, a review of the literature on the distribution of *C. inornatus* in Arizona (Drost et al. 2001, Hahn and May 1972, Persons and Wright 1999, Rosen et al. 1998, Stevens 1983, Sullivan et al. 2001, Wright and Lowe 1993) reveals that most of this mapped range is not supported with specimen records. By including all localities cited in the aforementioned literature, as well as other museum specimen records and observations (unpublished data), I have produced a more accurate map of the known distribution of *C. inornatus* in Arizona (Figure 7). In addition to including a very large, mostly unoccupied range in the Grand Canyon region, Stebbins (2003) includes a locality dot in northeastern Arizona described in the text as representing a specimen from Chinle, Apache County. However, I examined this specimen, which is in the herpetology collection at the University of Arizona, and it is a misidentified *C. velox*. While there are undoubtedly additional undiscovered populations of *C. inornatus* in northern Arizona, Figure 7 shows that the bulk of the known distribution of the species in Arizona is in the Wupatki region. More generally, Figure 7 paints a very different picture of the possible threats facing this lizard, which may be more pronounced than would be inferred from earlier maps.

Habitat Association of Whiptails at Wupatki

Total numbers and observation rates for *C. inornatus* and *C. velox* in different habitats are presented in Tables 3 and 4. In addition, I analyzed results for *Holbrookia maculata*, a common species sympatric with both *C. inornatus* and *C. velox* throughout the study area, and numbers and observation rates for this species are presented in Table 5. Although *Sceloporus undulatus*, *Urosaurus ornatus*, and *Uta stansburiana* were also common in many parts of the study area, these species generally occupy different microhabitats than the ground-dwelling whiptails and *Holbrookia*, instead utilizing trees (*Sceloporus undulatus*) and rocky habitats (all three species).

Overall, *C. velox* outnumbered *C. inornatus* at Wupatki by a ratio of 4.4:1, and it also outnumbered *C. inornatus* in each habitat type by at least 2:1. Abundance of *C. velox* was similar in all three major habitat types (grassland, savanna, and woodland) surveyed within the

monument (Table 4). In contrast, *C. inornatus* was only relatively common in grassland, and was rare in both savanna and woodland (Table 3). The rarity of *C. inornatus* in woodland was not surprising, where the structure and composition of the habitat was different from the "grassy" habitat types (grassland and savanna). In particular, the woodland TACS sites had a significant amount of tree cover (about 12%, often over 100 trees/hectare), and much more unvegetated ground than the other habitats (Table 6). The increased bare ground at the woodland sites was likely responsible for the greater numbers of *Holbrookia* in that habitat (Table 5). Surprising, however, was the rarity of *C. inornatus* in the savanna habitat (Table 3), because this habitat differed little from the grassland areas. At the TACS sites surveyed in 2001, which are representative of the habitat types throughout the study area, grassland and savanna were similar in percent cover of trees, shrubs, grass, and bare ground (Table 6). Although there were more trees on savanna sites, mean percent cover was still less than two percent. Because the savanna habitat in this study contained an intermediate tree density, and presumably represents an intermediate stage of woodland encroachment ("early establishment woodland" of Rosenstock 1999), I had originally expected observation rates for *C. inornatus* to also be intermediate between grassland and woodland. The rarity of the species in both savanna and woodland suggests a relatively low "threshold" of juniper density that affects the abundance of *C. inornatus* at Wupatki.

The relative abundance of the two whiptails (relative to each other) in grazed grassland on CO Bar Ranch land just north of Wupatki was similar to ungrazed grassland within the monument, but the absolute abundance of both species was reduced by about one half, possibly related to the presence of large numbers of *Holbrookia maculata* in the more open habitat on the grazed sites (Tables 3-5), and to the reduction in forage and cover attributable to grass utilization by cattle. A similar abundance reduction in actively foraging lizard species (especially whiptails) was reported by Jones (1981). *Holbrookia* is often associated with open, modified habitats such as grazed grasslands (Ballinger and Watts 1995) and prairie dog colonies (Davis and Theimer 2003). Livestock grazing has had profound ecological effects across the western United States (e.g., Fleischner 1994), and may be at least partly responsible for the current limited distribution of *C. inornatus* in many areas of the southwest (Wright and Lowe 1968). Prior to livestock grazing in the Wupatki region, it is likely that *Holbrookia* was much less common, occurring in large numbers primarily in disturbed, open habitats such as prairie dog towns and recently burned areas, perhaps with concomitantly greater numbers of whiptails in the grasslands.

Much of the ranch land north of Wupatki may eventually be transferred to the NPS in the near future (National Park Service 2002), and a release from livestock grazing should facilitate a reversal in lizard abundances, with whiptails becoming more abundant and *Holbrookia* declining. These surveys can be used as baseline data in efforts to monitor the changes in the population of *C. inornatus* as livestock grazing is eliminated. In addition, future studies could be designed to examine the differential response of *C. inornatus* and *C. velox* as the habitat is released from grazing, in order to address the question of whether past overgrazing may have contributed to the current dominance of unisexual whiptails in many areas of the Southwest. In particular, this hypothesis would predict parthenogenetic *C. velox* to initially increase much more rapidly than *C. inornatus*, and then maintain this initial dominance even as the habitat recovers.

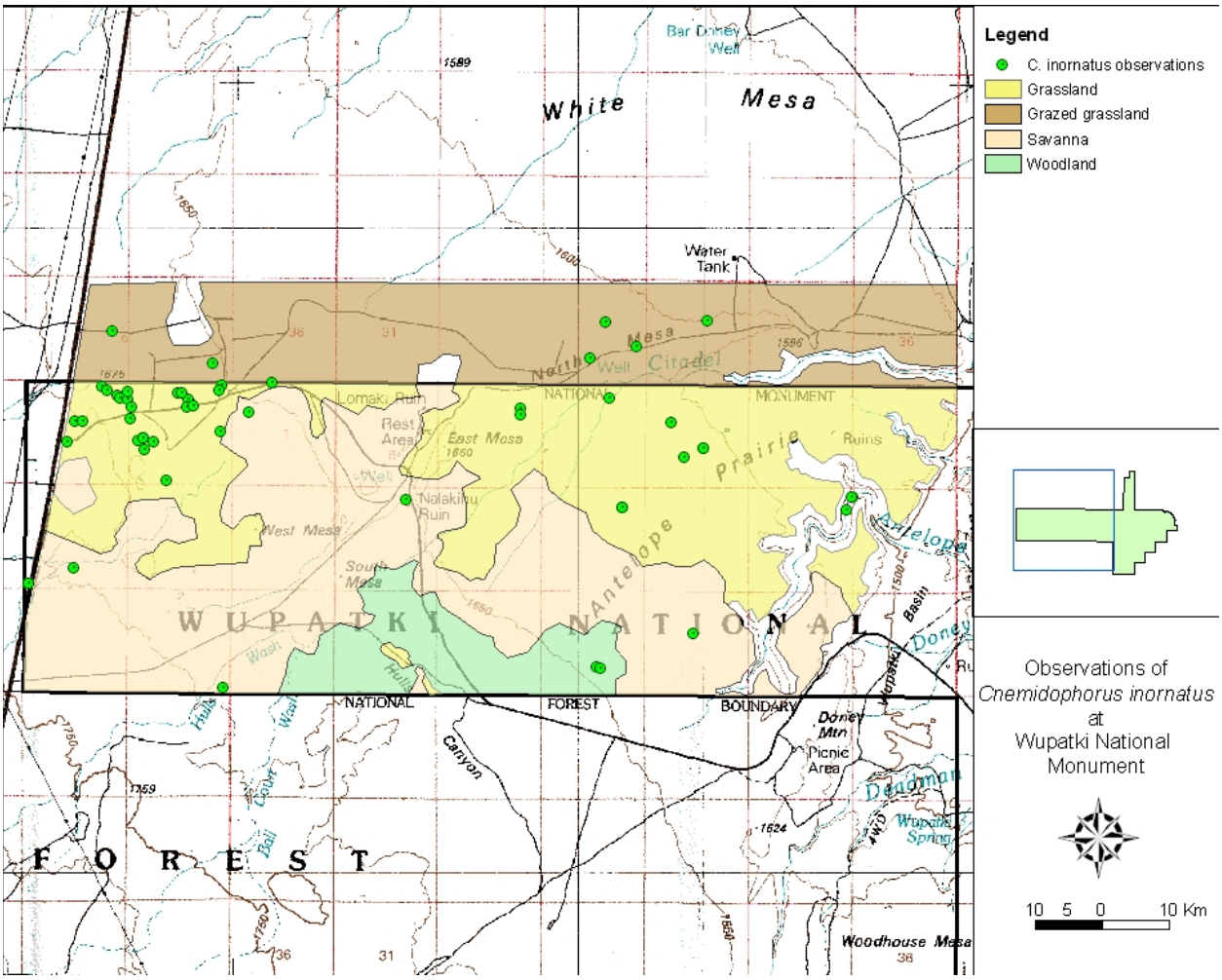

Figure 6. Locations of all 55 sightings of *Cnemidophorus inornatus* within the study area at and near Wupatki National Monument, Arizona, 2001-2003.

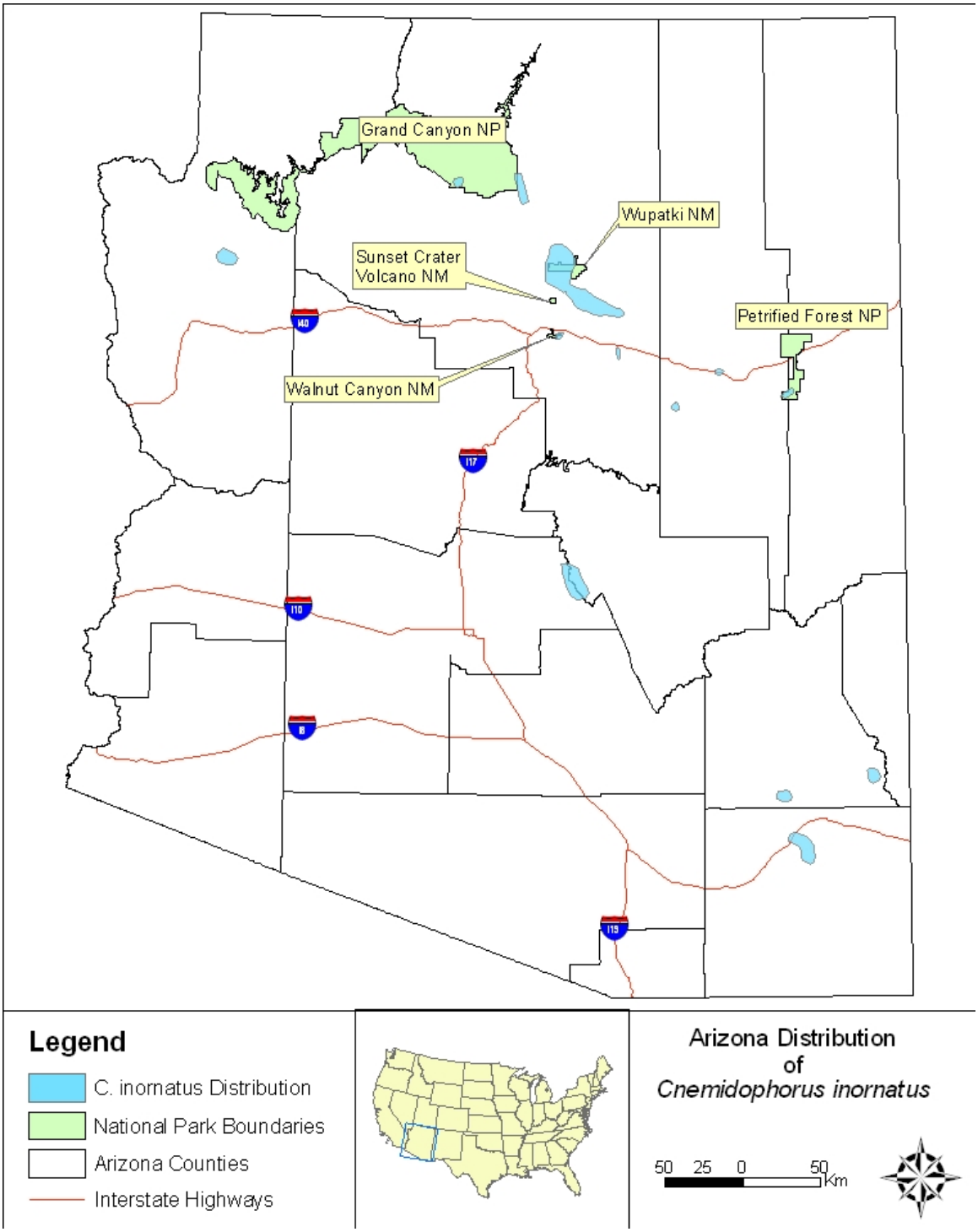

Figure 7. Approximate known distribution of *Cnemidophorus inornatus* in Arizona.

Table 3. Total numbers and observation rates for *Cnemidophorus inornatus* in different habitats at Wupatki National Monument, 2001-2003. Calculation of observation rate does not include random encounters.

Habitat	General Survey	Random Encounter	TACS	Lizard Line	TOTAL	Lizards/hour
Grassland	24	6	7	3	**40**	**1.00**
Savanna	1		2		**3**	**0.14**
Woodland	1	1	1		**3**	**0.15**
Grazed Grassland		2	4		**6**	**0.54**
Antelope Wash	3				**3**	**0.53**
TOTAL	**29**	**9**	**14**	**3**	**55**	**0.55**

Table 4. Total numbers and observation rates for *Cnemidophorus velox* in different habitats at Wupatki National Monument, 2001-2003. Calculation of observation rate does not include random encounters.

Habitat	General Survey	Random Encounter	TACS	Lizard Line	TOTAL	Lizards/hour
Grassland	78	1	17	2	**98**	**2.85**
Savanna	37	8	21		**66**	**2.62**
Woodland	24	8	6		**38**	**2.17**
Grazed Grassland			9		**9**	**1.21**
Antelope Wash	9				**9**	**1.58**
TOTAL	**148**	**17**	**53**	**2**	**220**	**2.44**

Table 5. Total numbers and observation rates for *Holbrookia maculata* in different habitats at Wupatki National Monument, 2001-2003. Calculation of observation rate does not include random encounters.

Habitat	General Survey	Random Encounter	TACS	Lizard Line	TOTAL	Lizards/hour
Grassland	13		3	1	**17**	**0.50**
Savanna	6	2	3		**11**	**0.41**
Woodland	5	1	7		**13**	**0.87**
Grazed Grassland	2		41		**43**	**5.79**
Antelope Wash	3				**3**	**0.53**
Woodland or Savanna		2			**2**	**N/A**
TOTAL	**29**	**5**	**54**	**1**	**89**	**2.44**

Table 6. Mean percent cover of trees, shrubs, grass, and bare ground on 1-hectare TACS plots surveyed for lizards in 2001 at Wupatki National Monument, Arizona. Figures are presented ± one standard deviation.

	Grassland	Savanna	Woodland	Grazed Grassland
% Tree Cover	0.1 ± 0.4	1.6 ± 2.1	11.7 ± 5.0	0
% Shrub Cover	4.4 ± 3.5	2.7 ± 2.0	1.7 ± 2.0	2.5 ± 3.3
% Grass Cover	46.1 ± 4.8	42.9 ±9.2	18.7 ± 10.1	36.4 ± 10.8
% Bare Ground	49.3 ± 1.9	53.6 ± 9.5	67.9 ± 9.5	62.0 ± 7.0

Cnemidophorus inornatus is largely restricted to grassland habitats at Wupatki, and is generally considered to be a grassland species throughout its range (e.g., Christiansen 1971, Christiansen et al. 1971, Degenhardt 1996, Harris 1963, Medica 1967, Mitchell 1979, Stebbins 1985, 2003). However, some isolated populations in Arizona occur in other habitats, including chaparral, pinyon-juniper woodland, and ponderosa pine parkland (Stevens 1983, Wright and Lowe 1993). For example, the newly discovered population of *C. inornatus* at Walnut Canyon National Monument east of Flagstaff (Persons and Nowak unpublished data) occurs in shrub-dominated habitats in pinyon-juniper woodland, and is apparently isolated from the more extensive grassland population to the northeast, which includes Wupatki (Figure 7). It is possible that these isolated non-grassland populations are more ancient relicts, and may have diverged genetically to the degree that they prefer different habitats. This hypothesis is perhaps strengthened by the fact that *C. inornatus* in these populations attain larger body sizes than those in grassland (Stevens 1983, and personal observation), an idea suggested by John Wright (personal communication). However, it is also possible that larger body sizes simply reflect greater food availability in these habitats, which for the most part occur at higher elevations and receive greater precipitation than the grasslands. Ecological and phylogeographic studies throughout the range of the species are needed to elucidate the factors contributing to the current ecological and geographic distribution of *C. inornatus*.

Coexistence of Whiptails at Wupatki

Sympatric bisexual whiptail species are often segregated locally by their choice of habitat (e.g., Schall 1993), or when they do occur together are often of different body sizes (Case 1983). However, coexistence between ecologically similar bisexual and unisexual *Cnemidophorus* is common (e.g., Paulissen et al. 1992). Pianka (1973) outlined the three primary dimensions of a lizard's ecological niche, namely time, food, and place. Classical ecological theory suggests that coexisting species must differ in at least one of these niche dimensions, unless none of these resources is limiting (e.g., Ricklefs 1990). These niche dimensions (microhabitat, daily activity times, diet) are discussed below, as well as other considerations for the coexistence of *Cnemidophorus* at Wupatki.

Microhabitat Use and Niche Overlap. In 2003, data on individual lizard observations included not only macrohabitat, but also microhabitat each lizard was first sighted in. Most lizards were assigned to one of a few common microhabitat classes (e.g., medium dense grass/weeds, shrub

patch, etc.), and others were assigned to uncommon or unique microhabitats (e.g., open cinder, under tree, etc.). Raw data used for calculation of microhabitat niche overlap are presented in Table 7. Microhabitat niche overlap between *C. inornatus* and *C. velox* was 0.95, between *C. velox* and *Holbrookia* was 0.87, and between *C. inornatus* and *Holbrookia maculata* was 0.79.

Table 7. Microhabitats of three lizard species observed during surveys at Wupatki National Monument in 2003. Numbers are percentage of observations in each category, with total number of observations in parentheses.

Microhabitat	***Cnemidophorus inornatus***	***Cnemidophorus velox***	***Holbrookia maculata***
Shrub Patch	0.21 (4)	0.28 (33)	0.32 (8)
Sparse Grass/Weeds	0.16 (3)	0.18 (21)	0.36 (9)
Medium Dense Grass/Weeds	0.26 (5)	0.23 (27)	0.12 (3)
Dense Grass/Weeds	0.05 (1)	0.08 (10)	
Rocky Habitats	0.21 (4)	0.11 (13)	0.08 (2)
Under Tree	0.05 (1)	0.06 (7)	
Open Cinder		0.01 (1)	0.08 (2)
Grass/Snakeweed		0.01 (1)	
Road Edge Weeds	0.05 (1)	0.05 (6)	0.04 (1)
TOTAL	**N = 19**	**N = 119**	**N = 25**

In other studies, microhabitat niche overlap has generally been found to be high among sympatric whiptails. Mitchell (1979) studied four species, including *C. inornatus*, in southeastern Arizona, and the average overlap between species pairs was 0.86, (range = 0.81-0.92). Paulissen (1994) calculated a microhabitat niche overlap of 0.99 for two sympatric unisexual species in the *C. laredoensis* complex in Texas. Schall (1993) calculated overlaps for five species in Texas, and most overlap pairs were high (0.83-0.95), but some pairs involving *C. tigris*, the most desert adapted species, were lower. Although small sample sizes for *C. inornatus* caution against placing too much significance on these results, my calculated value of 0.95 for *C. inornatus* and *C. velox* is among the highest microhabitat niche overlap values for coexisting whiptails. This result is consistent with the notion that these two species use markedly similar microhabitats where they occur together in the study area.

Another microhabitat feature recorded in 2003 was a visual estimate of the distance each lizard was from the nearest shrub. Usually, the shrub species was also recorded, and these data are included in Appendix D. I analyzed these "distance to shrub" (DTS) data only for *C. inornatus* (N=14) and *C. velox* (N=107). Across all habitats, mean DTS (± SD) was 1.86 ± 1.66 meters for *C. inornatus*, and was 2.21 ± 2.57 meters for *C. velox*. A Student's t-test (Sokal and Rohlf 1987) showed no significant difference between these two means ($p > 0.5$). More meaningful, however, is a comparison of these DTS values within habitat types, because the different habitats differ in the distribution and abundance of shrubs and trees. Because DTS data were recorded for only a

single *C. inornatus* in savanna, and none in woodland, a within habitat comparison is only possible for the grassland. Within grassland, mean DTS (± SD) was 2.08 ± 1.61 meters for *C. inornatus* (N=13) and was 2.51 ± 2.49 meters for *C. velox* (N=63). Again, a Student's t-test showed no significant difference between these two means ($p > 0.2$).

During the present study, I focused primarily on the place niche dimension in examining the distribution and abundance of sympatric whiptails at Wupatki. As discussed above, *C. inornatus* and *C. velox* overlapped in microhabitat use, but I did find a clear difference in the abundance of *C. inornatus* in different major habitat types at Wupatki, with the species being rare except in grassland habitats. In contrast, *C. velox* was found to be equally abundant in all habitats. Schall (1993), Mitchell (1979), and Wright and Lowe (1968) all noted that unisexual whiptails tend to have broader macrohabitat niches than bisexual species, a pattern evident during the present study. At Wupatki, *C. tigris* is restricted to desert habitats and *C. inornatus* is largely restricted to grassland habitats, while *C. velox* occurs throughout the monument, with the exception that it appears to be absent from the lowest desert areas. In addition, *C. velox* occurs throughout higher elevation pinyon-juniper woodlands outside the monument, up into ponderosa pine habitats, as at Sunset Crater Volcano National Monument south of Wupatki (Persons and Nowak, unpublished data).

Daily Activity Times. Whiptail lizards often display a bimodal daily activity pattern, avoiding surface activity during the heat of midday (e.g., Mitchell 1979), although in some areas the same or similar species exhibit a more unimodal activity pattern (e.g., Schall 1993). A number of researchers studying whiptail communities have investigated whether coexisting species are active at different times of the day, with activity times of most species, including *C. inornatus*, overlapping almost completely (e.g., Echternacht 1967, Mitchell 1979, Paulissen 2001, Schall 1993). Mitchell (1979) calculated daily activity time overlap in southeastern Arizona between *C. inornatus* and *C. uniparens*, a unisexual species similar to *C. velox*, to be 0.88. This similarity in activity time is the result of similar foraging tactics, diet, and thermoregulatory needs among whiptail species (Schall 1993).

In contrast, John W. Wright (personal communication) has suggested that *C. inornatus*, at least in Arizona and New Mexico, may have a tendency toward greater afternoon activity, when compared with other, sympatric whiptail species. Casual observations of both *C. inornatus* and *C. velox* in Alpine Ranches, southeast of Wupatki, lend support to this notion (personal observation). However, I spent limited time surveying in the afternoon during this study, because whiptail activity was generally greatly reduced after the initial morning activity period. This may have been due to frequent sub-optimal environmental conditions (overheated substrates, lack of shade, high winds) in the afternoon. This situation was likely made worse by drought conditions that prevailed during the study period. Ninenty-two percent (76.6 person-hours) of all survey time was in the morning (before 12:00 noon local time), with only 8% (6.5 person-hours) from 12:00 noon or later. Overall observation rate for all whiptails (including those not identified to species, but not including random encounters) before noon was 3.4 lizards per person-hour (N=258 lizards), and from noon or after was 2.0 lizards per person-hour (N=13 lizards). However, of those 13 whiptails observed at or after 12:00 noon, six were *C. inornatus*, six were *C. velox*, and one was *C. tigris*. Although sample sizes are small, these results support the idea that *C. inornatus* may be more active in the afternoon, relative to *C. velox*. This aspect of the

ecology of *C. inornatus* at Wupatki would be worth investigating as part of any future studies or long-term monitoring efforts.

Diet. The only niche dimension not investigated at Wupatki was food. However, whiptails have similar foraging tactics, and foods eaten by coexisting species are usually similar, with the exception that smaller species tend to eat smaller prey (Price et al. 1993). Although most whiptails are generalist insectivores (e.g., Price et al. 1993), termites are eaten in large quantities when they are available (e.g., Echternact 1967, Milstead 1957, Schall 1993). Schall (1993) found no differences among prey items of five sympatric species is southern Texas, except that *C. inornatus*, which was smaller than the other four species, ate smaller prey. At the mark-recapture study site southeast of Wupatki, the upper decile snout-vent length (e.g., Case 1983) was 63 mm for *C. inornatus* (N=85) and 74 mm for *C. velox* (N=587) (unpublished data). Although *C. inornatus* is somewhat smaller than *C. velox* at Wupatki, results of other studies suggest that diet overlap is probably high. Perhaps more important in a grassland environment would be the ability of the smaller *C. inornatus* to navigate tight spaces within grass clumps or escape into smaller holes at the base of bunch grasses (Phil Rosen, personal communication).

Other Considertations for Coexistence of Whiptails at Wupatki. Wright and Lowe (1968), noting that unisexual whiptails often occur in disturbed or ecotonal habitats, advanced the idea that these species are essentially animal "weeds," an idea which has come to be known as the "weed hypothesis." They pointed to the broad-scale climatic and habitat shifts that occurred in the southwest during the Pleistocene and Holocene, creating numerous large-scale ecotones between major habitat types, as a critical factor in the formation and persistence of unisexual whiptail species. Wright and Lowe (1968) also noted that, like botanical weeds, many unisexual whiptails occur widely in habitats largely unoccupied by bisexuals, and that the more stable habitats in the region (thornscrub, desertscrub, and grassland) are primarily occupied by bisexual species. While the weed hypothesis is widely accepted as a general explanation for the formation of so many unisexual species in the region (e.g., Price et al. 1993), it does not explain the coexistence of ecologically similar bisexual and unisexual species, such as *C. inornatus* and *C. velox* at Wupatki.

Some authors have suggested that unisexual whiptails are ecologically inferior to their bisexual congeners, based on decreased predator avoidance ability (Paulissen 1998, Price 1992, Price et al. 1993) and decreased prey capture rates (Paulissen 2001). These authors suggest that unisexual whiptails are able to coexist with bisexual species only in ecotonal areas where selective forces are relaxed, i.e., where competition is reduced or eliminated. However, demonstrating interspecific competition (or the lack thereof) can be extremely difficult (e.g., Strong et al. 1984), and more intense studies would need to be undertaken to adequately address this issue for *Cnemidophorus* at Wupatki.

The ecotonal nature of the habitat at Wupatki likely plays some role in whiptail coexistence there. Grassland and juniper habitats at Wupatki do not appear disturbed, when compared with, for example, a weedy, vacant lot or a flood plain habitat along a large river. However, vegetation changes associated with livestock grazing can be severe (e.g., Fleischner 1994), and vegetation structure of the habitat at Wupatki is probably very different today than it was a few decades ago, when moderate grazing occurred within the monument, as well as a century ago during the

period of severe overgrazing in the region (Abruzzi 1995). In particular, the presumed expansion of juniper into grassland represents an expansion of the ecotone between woodland and grassland. Considering broadly that unisexual whiptails often occupy different (i.e., higher elevation) or intermediate environments, compared to the core biotic communities occupied by their bisexual progenitors (Wright and Lowe 1968), the juniper expansion, like woody vegetation invasion in other Southwestern desert grasslands, likely favors the unisexuals (i.e., *C. velox, C. uniparens*) due to specific performance parameters not yet identified. These ecological performance parameters may be the strongest approach to understanding the conservation status of *C. inornatus*.

The occurrence of droughts such as the one during this study may repeatedly reduce population sizes of both whiptails. Even if *C. velox* is ecologically "inferior" (*sensu* Price et al. 1993) to *C. inornatus*, frequent population crashes of both species would give *C. velox* opportunities to recolonize the habitat quickly due to its parthenogenetic reproductive mode (e.g., Walker 1987b). Finally, while Wupatki does contain a relatively large expanse of grassland habitat, primarily on Antelope Prairie, this habitat is small on a regional scale, and is wedged between much larger expanses of savanna and woodland habitats to the west and desert habitats to the east. The grassland itself, therefore, is probably subject to pressure from the larger and expanding population of *C. velox* in adjoining ecotonal areas. This may help account for the presence of *C. velox* throughout the grasslands at Wupatki.

Short-term studies are probably insufficient in addressing these questions, as species composition and relative abundance in whiptail lizard communities sometimes change drastically in a decade or less (Milstead 1965, Paulissen et al. 2001, Walker 1987a) suggesting that long-term studies will be necessary to adequately investigate some aspects of whiptail community ecology. Wupatki offers an excellent opportunity for such long-term studies, as there now exists a baseline of data on distribution and relative abundance of two bisexual and one unisexual species occurring in various combinations of sympatry at different sites. In addition, the known past land uses at Wupatki (i.e., grazing until the 1980's), the relatively stable nature of protected habitats within the monument, and the probable future changes (release from grazing) of CO Bar Ranch land habitats north of the monument combine to make a varied, relatively controlled study system where changes in the whiptail communities at various sites could be tracked through time.

OTHER RESULTS AND OBSERVATIONS

Effect of Drought on Lizard Populations at Wupatki.
The low observation rate of whiptails during the present study was likely due to the effects of a persistent regional drought. Although the western part of Wupatki, which is higher in elevation, receives slightly more precipitation than the official monument weather station (located at the visitor center near Wupatki Pueblo), these data are adequate for monthly or annual comparisons (Table 8).

The 30-year mean (1971-2000) for annual precipitation at Wupatki is 9.02 inches, with 44%

coming during the monsoon season months of July, August, and September. This period is preceded by the three driest months (April, May, and June), which together account for only 13% of the annual total. Although 2000, the year prior to commencement of this study, recorded near average annual precipitation, all three years of the study were below normal. In 2001, winter and early spring (January-March) precipitation was 36% above average, but the annual total was only 7.25 inches, due in part to below average totals for the months of September through December. The dry fall of 2001 continued into winter and spring of 2002, with the first six months of 2002 recording only 0.87 inches, only 30% of average. Although the 2002 field season for this project was mostly curtailed due to an NPS budget problem, it was perhaps to the benefit of the study, as lizard activity was low at Wupatki, as well as the surrounding region (Persons and Nowak unpublished data). The 2002 season was made worse by the delayed onset of monsoon rains. The only substantial rains occurred in September, well after the reproductive season. In fact, almost no lizard reproduction was noted in the Wupatki area in 2002, either in limited surveys within the study area or in more extensive surveys in the desert habitats within the monument (Persons and Nowak unpublished data). Similarly, at a long-term lizard mark-recapture study site in nearby grassland habitat southeast of Wupatki, no reproduction was recorded in 2002 for *C. inornatus*, *C. velox*, or *Holbrookia*, and only a very few early season hatchling *Sceloporus undulatus* and *Uta stansburiana* were noted (personal observation). This apparent lack of reproduction in 2002 was further confirmed by the conspicuous absence of young of the previous year lizards in 2003 both at Wupatki and at the study site southeast of Wupatki. Although monsoon rains arrived earlier in 2003, and whiptails did successfully reproduce, activity (and presumably population size) was again low. It seems likely that many adult lizards died during the prolonged drought of 2002. More importantly, the lack of recruitment would be expected to reduce further the population sizes of both whiptails, as annual population turnover is fairly high for these species (unpublished data).

Table 8. Monthly and annual precipitation totals (in inches) for the three years (2001-2003) of whiptail lizard surveys at Wupatki National Monument, Arizona, plus for the year (2000) preceding the study, and the 30 year mean (1971-2000).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2000	0.04	0.23	2.67	0.21	0.15	0.10	0.73	1.18	0.25	2.02	0.64	0.11	**8.33**
2001	1.07	0.40	0.86	0.53	0.26	0.10	0.90	1.67	0.17	0.77	0.22	0.21	**7.25**
2002	0.45	0	0	0.35	0	0.02	0.53	0.16	3.08	0.39	0.38	0.05	**5.41**
2003	0.07	0.09	0.20	0.06	0	0	0.88	1.32	0.61	0.31	1.11	0.63	**5.28**
Mean	0.53	0.54	0.70	0.48	0.40	0.32	1.32	1.56	1.06	0.88	0.62	0.60	**9.02**

While low observation rates of whiptails, and especially of *C. inornatus*, frustrated attempts at gathering large sample sizes for habitat analyses, data from this study could be valuable as a baseline in measuring the response of the two whiptail species to drought-induced population reductions. Parthenogenetic species are likely at a disadvantage compared with sexually reproducing species in the long term, due to their inability to adapt to changes in their environment (i.e., evolve) through natural selection (Pianka and Vitt 2003). It is not surprising, therefore, that estimated ages of parthenogenetic whiptail lineages are evolutionarily young (Wright 1993). However, the widespread occurrence and probable rapid colonization of large

areas by many unisexual species can be attributed to their parthenogenetic mode of reproduction. In unisexual whiptails, including *C. velox*, all individuals are female, and therefore the reproductive potential of any species is twice as great, each generation, as similar bisexual species. As an example, Pianka and Vitt (2003) calculate that, if unchecked, a single female bisexual lizard that produces four young over its lifetime would increase its population size to 256 individuals after seven years, and an identical parthenogenetic individual would over the same time increase its population to 16,384 individuals.

This theoretical exponential population growth of unisexual species has implications for the distribution and abundance of whiptails at Wupatki. Although other factors (competition, habitat preferences) likely work to allow coexistence of *C. inornatus* and *C. velox* at Wupatki, it is obvious that *C. velox* has (at least theoretically) a short-term advantage in repopulating a habitat after a period of population reduction. It may well be that past events, such as drought or severe overgrazing, may have allowed *C. velox* to become dominant at Wupatki, through rapid population growth to fill most of the available "whiptail niche" once conditions improved. If this were correct, we would expect a ratcheting down of *C. inornatus* after each drought. Monitoring of whiptail relative abundance during and after the current drought may provide insight into whether this may be one of the mechanisms by which *C. velox* has gained numerical dominance over *C. inornatus* at Wupatki. This could be particularly evident in the suboptimal non-grassland population areas for *C. inornatus*, where stepwise reductions might be observed after each drought, with final extirpations probably occurring during drought-related population minima.

Museum Specimen Review and Comparison of Past and Present Relative Abundance

A review of data from numerous institutional collections with holdings from Coconino County, Arizona revealed only seven specimen records for *C. inornatus* from the immediate vicinity of Wupatki (Appendix E). Of these, three (LACM 137269-71) are probably from just north of the monument, near Hank's Trading Post on US Highway 89, and one older specimen (LACM 14679), labeled "Wupatki Ruins," is probably from elsewhere in the monument, or may even represent a misidentified *C. velox* (which does occur at the ruins). The remaining three specimens represent two localities, in close proximity to each other: along FR 545, 0.8 and 1.0 miles east of US Highway 89. Even for *C. velox*, only 15 specimen records could be found from within or near the study area (Appendix E): 14 from just north of the north entrance at US Highway 89 (near Hank's Trading Post), and one from one mile east of US Highway 89 on FR 545.

The only previous data on whiptails in the study area are from the few museum specimens (above) and from limited herpetofauna surveys during a general biological inventory of Wupatki by Bateman (1976, 1980). Bateman (1980) never mentioned *C. inornatus*, and for all methods combined (can traps and visual surveys) recorded a total of 27 *C. velox*, including 16 in grassland, eight in savanna, and three in desert habitats. The lack of *C. inornatus* detections is probably the result of misidentification or lack of recognition, at least in the grassland areas. Based only on the limited museum specimens known, the ratio of *C. velox* to *C. inornatus* in that area (i.e., from near the north entrance along US Highway 89 to ca. one mile east of US Highway 89 along FR 545) was 2.5 to 1, compared to my observed ratio throughout the study area of 4.4 to 1. However, data from my surveys in the same areas where the museum specimens originated,

which included the lizard line and grassland TACS #1 and general surveys 19, 36, 62, 69, and 72-76, included 49 *C. velox* and 16 *C. inornatus*, for a ratio of 3.1 to 1. Although sample sizes are small, especially for the earlier museum specimens, these data suggest but are insufficient to demonstrate a decline in the relative abundance of *C. inornatus* over the past few decades in this small area. The absence of a large change in relative abundance of whiptails at Wupatki over the recent decades for which data are available is perhaps not surprising, as habitat in this area has probably not changed much in the past few decades. Instead, with the exclusion of grazing from the monument, grasses are likely more dense as the area has recovered from grazing, making the habitat more favorable for whiptails, perhaps especially for *C. inornatus*.

It has been documented that grassland areas at Wupatki have been invaded by juniper over the past century (Cinnamon 1988), and it would be more interesting to have prior knowledge of the relative abundance of whiptails in these areas. In Cedar Canyon, the area investigated by Cinnamon (1988), I found only *C. velox*, although *C. inornatus* was found nearby. Based on the habitat associations I recorded for the two species during this study, it seems likely that *C. inornatus* occurred previously in Cedar Canyon, which was largely grassland less than a century ago, and the species has probably similarly declined in other areas throughout the monument wherever grasslands have been converted to juniper savanna or woodland.

Sullivan et al. (2001) found essentially no change (since the 1960's and 1970's) in the distribution and relative abundance of *C. inornatus* and the unisexual *C. uniparens* in the Willcox, Arizona area, the location of a relict race (*C. i. arizonae*) of *C. inornatus*. They suggested that because populations of *C. inornatus* appear to be persisting, even in grazed areas in close proximity to sites dominated by *C. uniparens*, *C. uniparens* may not have the competitive edge often attributed to it and other unisexual species in such habitats (e.g., Wright and Lowe 1968). However, Rosen et al. (1998) noted an increase in *C. uniparens* at some of Mitchell's (1979) study sites in the Willcox area, and found *C. uniparens* in Willcox at some sites with many museum records for just *C. inornatus*. However, it is clear that that the distribution of *C. inornatus* is not currently rapidly contracting near Willcox, which is also the result seen at Wupatki.

Even if populations of unisexuals versus *C. inornatus* have remained stable over the past few decades, the extremely limited occurrence of *C. inornatus* in southeastern Arizona suggests a relictual distribution, and the species only occurs in "relict grassland communities" in the region (Mitchell 1979). It is well established that drastic habitat changes took place in the grasslands of Arizona and New Mexico in the late 1800's, during a period of intense overgrazing and drought (e.g., Abruzzi 1995, Hastings and Turner 1965), and it seems reasonable that rapid, drastic changes in whiptail lizard communities may have occurred then, possibly leading to the frequently observed dominance of unisexual species seen today. Prior to the 1960's, *C. inornatus* was largely unknown in the Wupatki region, and we may never know if such changes took place there. However, the documented effects of the overgrazing period of the late 1800's in the Little Colorado River basin (Abruzzi 1995), combined with the relictual distribution of *C. inornatus* in the region (Figure 7), suggest the species may have declined and its distribution become more restricted during that period. As at Willcox, careful quantitative monitoring of relative abundances, along with studies of ecological performance relevant to coexistence of the similar species, will be required to understand current trends in the status of *C. inornatus*.

Voucher Specimen Collection

I collected nine whiptail lizard specimens as part of this study (i.e., within the study area) in 2001-2003, including four *C. inornatus*, four *C. velox*, and one *C. tigris* (Appendix F). Additional specimens of *C. tigris* and *C. velox* were collected outside the study area as part of a concurrent general herpetofauna inventory (Persons and Nowak unpublished data). All of these specimens have been deposited in the vertebrate collection maintained by the Museum and Archive Curation Program of the Flagstaff Area National Monuments (NPS) in Flagstaff, Arizona.

Data and Other Products

I took photographs (35 mm color slides) of most TACS plots, taken from the plot center and usually facing all four cardinal directions. These photographs may be useful for future long-term monitoring efforts, and can be used as points for repeat photography studies of habitat change, relating to whiptails or otherwise. These slides have been delivered to the NPS in a separate binder. Electronic data consists of Microsoft Excel® spreadsheets (converted from Microsoft FoxPro® databases) of lizard observation and survey data, as well as the GIS map products used in this report. Hard copy data consists of field notes and field data sheets for TACS surveys. Both hard copy and electronic data have been delivered to the Natural Resource Program at Wupatki, and metadata is being developed for this project in cooperation with monument staff.

CONSIDERATIONS FOR LONG-TERM MONITORING AND CONSERVATION OF *CNEMIDOPHORUS INORNATUS* AT WUPATKI

Long-term Monitoring

One of the original goals of this project was to design a long-term monitoring strategy for *C. inornatus* at Wupatki. That I recorded only 55 individuals of *C. inornatus* in over two years of targeted surveys suggests that an effective monitoring program for this species may be difficult to achieve, at least during drought years. In a recent workshop, the NPS Southern Colorado Plateau Inventory & Monitoring Network (SCPN) identified “diurnal lizards” as a faunal group that received a high priority for monitoring across the network, and whiptails would be among the primary species targeted in such monitoring at all SCPN parks. Considering the difficulty in obtaining large sample sizes of *C. inornatus*, it makes sense to include the species in a broader scale monitoring of lizard communities at Wupatki, which hopefully will be funded through the SCPN. However, this monitoring could be tailored to maximize collection of important data on *C. inornatus*, including locating monitoring sites across the grassland-savanna-woodland gradient, as well as including adjacent CO Bar Ranch land north of the monument, in anticipation of this land being added to Wupatki in the future (see below).

Because the present study was largely focused on obtaining a baseline of distribution and relative abundance of the two whiptails throughout Wupatki, I chose to spend the majority of survey effort on more productive general surveys. However, for long-term lizard monitoring it may be preferable to use a more standardized approach such as lizard line transects (Rosen and Lowe 1995, 1996). Although pilot studies would be needed to determine the number and nature (length, straightness, speed of transit along the line) of such transects for statistically sound data

for trend analysis, a preliminary recommendation is 20 transects run twice a year (e.g., Rosen 2000). Because whiptail abundances are relatively low at Wupatki, it may be preferable to locate long-term monitoring sites non-randomly in areas with ready access, good observability, and good lizard abundance. Although this approach would reduce the statistical simplicity of extrapolation to the whole landscape, more important is the ability to make repeatable observations at exactly the same sites and infer trends from those data. Substantial savings in effort per data point would be realized using this approach.

Although not currently part of the monument, the NPS might consider including the CO Bar Ranch land north of Wupatki in any future lizard monitoring programs. The Preferred Managment Alternative in the Final Environmental Impact Statement and General Management Plan for Wupatki (NPS 2002) proposes to expand the boundary of the monument to incorporate as much as 24 sections of private and Arizona State Trust Land. Additional surveys, whether general surveys or long-term monitoring plots or transects, could be conducted to gather a more detailed baseline on distribution and relative abundance of *Cnemidophorus*, as well as *Holbrookia*, on the currently grazed land. Solid survey data both before and after release from grazing, if coupled with concurrent "control" data from unchanged habitats within the current monument, and sites with similar habitat with continued grazing, would provide a robust and ideal sampling framework to test hypotheses related to the differential response of bisexual and unisexual whiptails as the available "whiptail niche" increases. In addition, the current drought may also be acting to decrease populations of both species, providing an additional variable that must be understood if we are to properly interpret long-term ecological study results for lizard communities at Wupatki. In particular, it may be possible to examine the synergistic effects of precipitation patterns and land use practices, both factors that may have contributed to the drastic ecological changes that took place in the region in the late 1800's (e.g. Abruzzi 1995, Hastings and Turner 1965).

Conservation of *Cnemidophorus inornatus* at Wupatki

Based on the results of this study, the two primary factors that appear to be affecting the distribution and abundance of *C. inornatus* in the grasslands in the Wupatki area are juniper encroachment and livestock grazing, respectively. Juniper encroachment appears to drastically reduce the numbers of *C. inornatus*, even in relatively open, savanna habitats, while favoring the "weedy" unisexual *C. velox*. In contrast, livestock grazing on the CO Bar Ranch reduces the abundance of both whiptails, in favor of large populations of *Holbrookia maculata*. Given this, the two most effective means of increasing populations of *C. inornatus* would probably be to reduce the amount of juniper in grasslands within the current monument, and to release the CO Bar Ranch land from grazing after this land is transferred to the NPS. As recommended by Rosenstock (1999) and Rosenstock and Van Riper (2001) in relation to grassland birds at Wupatki, juniper eradication efforts should be targeted to those areas of early establishment woodland (analogous to my savanna) where tree density is low and perennial grass cover is high, and relatively large areas can be reverted to grassland with minimal effort. Presumably, juniper invasion is related to subtle environmental conditions that differ at least slightly from conditions in uninvaded grassland. Thus, while we would predict recovery of grassland species after juniper eradication, it would be essential to carefully evaluate monitoring results following such drastic management action.

Acquisition and protection of CO Bar Ranch land may be even more effective. With removal from grazing, most of this area would probably revert to dense grassland, and abundance of both whiptails would likely increase (and the abundance of *Holbrookia* would likely drastically decrease). The addition of this land to the monument would more than double the amount of habitat suitable for *C. inornatus* at Wupatki. Given the species' limited distribution elsewhere in northern Arizona, this could be important to the long-term survival of the species in the region.

ACKNOWLEDGEMENTS

This study was made possible by a grant from the National Park Service's Natural Resource Preservation Program, and was facilitated by Flagstaff Area National Monuments resource management specialists Paul Whitefield and Steve Mitchelson. Staff at Wupatki were always helpful and encouraging, especially Mary Blasing, Bill Hudson, and Rex Vanderford. Billy Cordasco kindly granted permission to survey on CO Bar Ranch land north of the monument. Charles Drost, Erika Nowak, and Phil Rosen all made valuable suggestions on study design, and Phil in particular was always willing to discuss the problems of whiptail lizard coexistence. Royce Ballinger, Joe Schall, and Jim Stuart also kindly answered queries on study design and whiptail ecology. Nicole Tancreto, GIS whiz previously with the Flagstaff Area National Monuments, now with the Southern Colorado Plateau Inventory & Monitoring Network, generated the random TACS points, helped me delineate the original habitat strata, and produced the maps in this report. Museum specimen data was provided by curators and collection managers at numerous institutions, including George Bradley (UAZ), Jay Cole, Linda Ford, and Chris Raxworthy (AMNH), Ron Crombie (USNM), Tom Giermakowski (MSB), Janet Gillette and Deb Hill (MNA), Andy Holycross (ASU), Cindy Ramotnik (USGS BS/FC), Steve Rogers (CM), Greg Schneider (UMMZ), Jeff Seigel and John Wright (LACM), and Skip Skidmore (BYU). Charles Drost, Phil Rosen, Mark Sogge, and Paul Whitefield made many valuable comments on earlier versions of this report. Finally, I thank John Wright, who has helped guide my thinking on the ecology and systematics of whiptails, and through collaboration with him I have become both a better observer and a more critical thinker.

LITERATURE CITED

Abruzzi, W.S. 1995. The social and ecological impacts of early cattle grazing in the Little Colorado River Basin. Human Ecology 23: 75-99.

Ballinger, R.E., and K.S. Watts. 1995. Path to extinction: impact of vegetational change on lizard populations on Arapaho Prairie in the Nebraska sandhills. American Midland Naturalist 134: 413-417.

Bateman, G.C. 1976. Natural resource survey and analysis of Sunset Crater and Wupatki National Monuments, final report. Report to National Park Service. Department of Biological Sciences, Northern Arizona University, Flagstaff.

Bateman, G.C. 1980. Natural resource survey and analysis of Sunset Crater and Wupatki National Monuments, final report (phase III). Report to National Park Service. Department of Biological Sciences, Northern Arizona University, Flagstaff.

Behler, J.L., and F.W. King. 1979. Audubon Society Field Guide to North American Reptiles and Amphibians. Alfred A. Knopf, New York.

Bogen, M.A., C.D. Allen, E.H. Muldavin, S.P. Platania, J.N. Stuart, G.H. Farley, P. Mehlhop, and J. Belnap. 1998. Southwest grassland herpetofauna. Page 572 *In* M.J. Mac et al., editor. Status and Trends of the Nation's Biological Resources. U.S. Department of the Interior, U.S. Geological Survey, Reston, Virginia.

Breed, W.J. 1976. Molten rock and trembling earth: the story of a landscape evolving. Plateau 49: 2-13.

Brown, D.E. 1994. Cold-temperate grasslands. Pages 112-121 *In* D.E. Brown, editor. Biotic Communities, Southwestern United States and Northwestern Mexico. University of Utah Press, Salt Lake City.

Brown, D.E., and C.H. Lowe. 1980. Biotic communities of the southwest. USDA Forest Service General Technical Report RM-78. 1 page map. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Christensen, J.L. 1971. Reproduction of *Cnemidophorus inornatus* and *Cnemidophorus neomexicanus* (Sauria, Teiidae) in northern New Mexico. American Museum Novitates 2442: 1-48.

Christiansen, J.L., W.G. Degenhardt, and J.E. White. 1971. Habitat preferences of *Cnemidophorus inornatus* and *C. neomexicanus* with reference to conditions contributing to their hybridization. Copeia 1971(2): 357-359.

Cinnamon, S.K. 1988. The Vegetation Community of Cedar Canyon, Wupatki National Monument as Influenced by Prehistoric and Historic Environmental Change. Unpublished Master's Thesis, Northern Arizona University, Flagstaff.

Cole, K.L. 1997. Holocene vegetation and historic grazing impacts at Capitol Reef National Park reconstructed using packrat middens. Great Basin Naturalist 57(4): 315-326.

Collins, J.T., ans T.W. Taggart. 2002. Standard Common and Current Scientific Names for North American Amphibians, Turtles, Reptiles, & Crocodilians, Fifth Edition. Center for North American Herpetology, Lawrence, Kansas.

Crother, B.I., chair. 2000. Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in our Understanding. Herpetological Circular No. 29, Society for the Study of Amphibians and Reptiles.

Crump, M.L., and N.J. Scott. 1994. Visual encounter surveys. Pages 84-92 *In* Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, and M.S. Foster. Measuring and Monitoring Biodiversity: Standard Methods for Amphibians. Smithsonian Institution Press, Washington, D.C.

Davis, J.R., and T.C. Theimer. 2003. Increased lesser earless lizard (*Holbrookia maculata*) abundance on Gunnison's prairie dog colonies and short term responses to artificial prairie dog burrows. American Midland Naturalist 150: 282-290.

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

Dick-Peddie, W.A. 1993. New Mexico Vegetation, Past, Present, and Future. University of New Mexico Press, Albuquerque.

Drost, C.A., T.B. Persons, and E.M. Nowak. 2001. Herpetofauna survey of Petrified Forest National Park, Arizona. Pages 83-102 *In* C. van Riper, III, K.A. Thomas, and M.A. Stuart, editors. Proceedings of the Fifth Biennial Conference of Research on the Colorado Plateau. U.S. Geological Survey/FRESC Report Series USGSFRESC/COPL/2001/24.

Duffield, W.A. 1997. Volcanoes of Northern Arizona. Grand Canyon Association, Grand Canyon, Arizona.

Echternacht, A.C. 1967. Ecological relationships of two species of the lizard genus *Cnemidophorus* in the Santa Rita Mountains of Arizona. American Midland Naturalist 78(2): 448-459.

Fleischner, T.L. 1994. Ecological costs of livestock grazing in western North America. Conservation Biology 8(3): 629-644.

Frost, D.R. and J.W. Wright. 1988. The taxonomy of uniparental species, with special reference to parthenogenetic *Cnemidophorus* (Squamata: Teiidae). Systematic Zoology 37: 200-209.

Gould, F.W. 1951. Grasses of the Southwestern United States. University of Arizona Press, Tucson.

Green, L.T., III, and J.M. Rominger. 1976. Plant communities at Sunset Crater and Wupatki National Monuments. In G.C. Bateman, director. Natural Resource Survey and Analysis of Sunset Crater and Wupatki National Monuments. Report to National Park Service. Department of Biological Sciences, Northern Arizona University, Flagstaff.

Hahn, D.E., and C.J. May. 1972. Noteworthy Arizona herpetofaunal records. Herpetological Review 4: 91-92.

Harris, A.H. 1963. Ecological distribution of some vertebrates in the San Juan Basin, New Mexico. Museum of New Mexico Papers in Anthropology 8:1-64.

Hastings, J.R., and R.M. Turner. 1965. The Changing Mile. University of Arizona Press, Tucson.

Johnson, T.N. 1962. One-seed juniper invasion of northern Arizona grasslands. Ecological Monographs 32: 187-207.

Jones, K.B. 1981. Effects of grazing on lizard abundance and diversity in western Arizona. Southwestern Naturalist 26: 107-115.

Kearney, T.H. and R.H. Peebles, and collaborators. 1960. Arizona Flora with Supplement by J.Y. Howell, S. McClintock, and collaborators. University of California Press, Berkeley.

Lockett, H.C., and M. Snow. 1939. Along the Beale Trail: A Photographic Account of Wasted Range Land. Education Division, U.S. Office of Indian Affairs.

Loftin, S.R., R. Aguilar, A.L. Chung-MacCoubrey, and W.A. Robbie. 1995. Desert grassland and shrubland ecosystems. Pages 80-94 *In* D.M. Finch and J.A. Turner, editors. Ecology, Diversity, and Sustainability of the Middle Rio Grande Basin. USDA Forest Service, General Technical Report RM-GTR-268.

Lowe, C.H. 1964. Arizona landscapes and habitats. Pages 1-132 *In* C.H. Lowe, editor. The Vertebrates of Arizona. University of Arizona Press, Tucson.

Medica, P.A. 1967. Food habits, habitat preference, reproduction, and diurnal activity in four sympatric species of whiptail lizards (*Cnemidophorus*) in south central New Mexico. Bulletin of the Southern California Academy of Sciences 66(4): 251-276.

Milstead, W.W. 1965. Changes in competeing populations of whiptail lizards (*Cnemidophorus*) in southwestern Texas. American Midland Naturalist 73: 75-80.

Mitchell, J.C. 1979. Ecology of southeastern Arizona whiptail lizards (*Cnemidophorus*: Teiidae): population densities, resource partitioning, and niche overlap. Canadian Journal of Zoology 57: 1487-1499.

National Park Service. 2002. Wupatki National Monument Final Environmental Impact Statement and General Management Plan.

Paulissen, M.A. 1988. Ontogenetic and seasonal shifts in microhabitat use by the lizard *Cnemidophorus sexlineatus*. Copeia 1988(4): 1021-1029.

Paulissen, M.A. 1994. Microhabitat use and escape behavior of syntopic clonal complexes of the parthenogenetic whiptail lizard *Cnemidophorus laredoensis*. American Midland Naturalist 132: 10-18.

Paulissen, M.A. 1998. Laboratory study of escape tactics of parthenogenetic and gonochoristic *Cnemidophorus* from southern Texas. Copeia 1998(1): 240-243.

Paulissen, M.A. 2001. Ecology and behavior of lizards of the parthenogenetic *Cnemidophorus laredoensis* complex and their gonochoristic relative *Cnemidophorus gularis*: implications for coexistence. Journal of Herpetology 35(2): 282-292.

Paulissen, M.A., J.M. Walker, and J.E. Cordes. 1992. Can parthenogenetic *Cnemidophorus laredoensis* (Teiidae) coexist with its bisexual congeners? Journal of Herpetology 26(2): 153-158.

Paulissen, M.A., J.M. Walker, and J.E. Cordes. 2001 Status of the parthenogenetic lizards of the *Cnemidophorus laredoensis* complex in Texas: Re-survey after eleven years. Texas Journal of Science 53(2): 121-138.

Persons, T., and J.W. Wright. 1999. *Cnemidophorus inornatus* geographic distribution. Herpetological Review 30(2): 109.

Pianka, E.R. 1973. The structure of lizard communities. Annual Review of Ecology and Systematics 4: 53-74.

Pianka, E.R. 1986. Ecology and Natural History of Desert Lizards. Princeton University Press, Princeton, New Jersey.

Pianka, E.R., and L.J. Vitt. 2002. Lizards: Windows to the Evolution of Diversity. University of California Press, Berkeley.

Pisani, G.R. 1973. A guide to preservation techniques for amphibians and reptiles. Society for the Study of Amphibians and Reptiles Herpetological Circular No. 1.

Price, A.H. 1992. Comparative behavior in lizards of the genus *Cnemidophorus* (Teiidae), with comments on the evolution of parthenogenesis in reptiles. Copeia 1992(2): 323-331.

Price, A.H., J.L. LaPointe, and J.W Atmar. 1993. The ecology and evolutionary implications of competition and parthenogenesis in Cmemidophorus. Pages 371-410 *In* J.W. Wright and L.J. Vitt, editors. Biology of Whiptail Lizards (Genus *Cnemidophorus*). Oklahoma Museum of Natural History, Norman.

Reeder, T.W., C.J. Cole, and H.C. Dessauer. 2002. Phylogenetic relationships of whiptail lizards of the genus *Cnemidophorus* (Squamata: Teiidae): A test of monophyly, reevaluation of karyotypic evolution, and a review of hybrid origins. American Museum Novitates 3365: 1-61.

Ricklefs, R.E. 1990. Ecology, Third Edition. W.H. Freeman and Co., New York.

Rosen, P.C. 2000. A Monitoring Study of Vertebrate Community Ecology in the Northern Sonoran Desert, Arizona. Unpublished Ph.D Dissertation, University of Arizona, Tucson.

Rosen, P.C., and C.H. Lowe. 1995. Lizard Monitoring Protocol for the Ecological Monitoring Program in Organ Pipe Cactus National Monument, Arizona. Section 4 of the Organ Pipe

Cactus National Monument Ecological Monitoring Program Monitoring Protocol Manual. Special Report No. 11, National Biological Service, Cooperative Park Studies Unit, University of Arizona, Tucson.

Rosen, P.C., and C.H. Lowe. 1996. Ecology of the Amphibians and Reptiles at Organ Pipe Cactus National Monument, Arizona. Technical Report No. 53, Cooperative Park Studies Unit, University of Arizona, Tucson.

Rosen, P.C. S.S. Sartorius, C.R. Schwalbe, P.A. Holm, and C.H. Lowe. 1998. Herpetology of the Sulphur Springs Valley, Cochise County, Arizona. Pagers 65-80 In B. Tellman, D.M Finch, C Edminster, and R. Hamre, editors. The future of arid grasslands: identifying issues, seeking solutions. Proceedings RMRS-P-3, US Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado.

Rosenstock, S.S. 1999. Effects of juniper woodland expansion on breeding birds in grasslands of northern Arizona. Technical Guidance Bulletin No. 1, Arizona Game and Fish Department, Phoenix.

Rosenstock, S.S., and C. Van Riper, III. 2001. Breeding bird responses to juniper woodland expansion. Journal of Range Management 54: 226-232.

Schall, J.J. 1977. Thermal ecology of five sympatric species of *Cnemidophorus* (Sauria: Teiidae). Herpetologica 33(3): 261-272.

Schall, J.J. 1978. Reproductive strategies in sympatric whiptail lizards (*Cnemidophorus*): two parthenogenetic and three bisexual species. Copeia 1978(1): 108-116.

Schall, J.J. 1993. Community ecology of *Cnemidophorus* lizards in southwestern Texas: A test of the weed hypothesis. Pages 319-344 *In* J.W. Wright and L.J. Vitt, editors. Biology of Whiptail Lizards (Genus *Cnemidophorus*). Oklahoma Museum of Natural History, Norman.

Sokal, R.R., and F.J. Rohlf. 1987. Introduction to Biostatistics, Second Edition. W.H. Freeman and Company, New York.

Stebbins, R.C. 1985. A Field Guide to Western Reptiles and Amphibians, Second Edition. Houghton Mifflin Co., Boston.

Stebbins, R.C. 2003. A Field Guide to Western Reptiles and Amphibians, Third Edition. Houghton Mifflin Co., Boston.

Stevens, T.P. 1983. Reproduction of an upper elevation population of *Cnemidophorus inornatus* (Reptilia, Teiidae). Southwestern Naturalist 28(1): 9-20.

Strong, D.R., Jr., D. Simberloff, L.G. Abele, and A.B. Thistle. 1984. Ecological Communities, Conceptual Issues and the Evidence. Princeton University Press, Princeton, New Jersey.

Sullivan, B.K., P.S Hamilton, and M.A. Flowers. 2001. A survey of the Arizona whiptail, *Cnemidophorus arizonae* (=*C. inornatus arizonae*), in southeastern Arizona. Report to Arizona Game and Fish Department and US Fish and Wildlife Service. Arizona State University, Phoenix.

Walker, J.M. 1987a. Habitat and population destruction and recovery in the parthenogenetic whiptail lizard, *Cnemidophorus laredoensis* (Sauria: Teiidae), in southern Texas. Texas Journal of Science 39(1): 81-88.

Walker, J.M. 1987b. Distribution and habitat of the parthenogenetic whiptail lizard, *Cnemidophorus laredoensis* (Sauria: Teiidae). American Midland Naturalist 117(2): 319-332.

Wright, J.W. 1968. Variation in three sympatric sibling species of whiptail lizards, genus *Cnemidophorus*. Journal of Herpetology 1: 1-20.

Wright, J.W. 1993. Evolution of the lizards in the genus *Cnemidophorus*. Pages 27-81 *In* J.W. Wright and L.J. Vitt, editors. Biology of Whiptail Lizards (Genus *Cnemidophorus*). Oklahoma Museum of Natural History, Norman.

Wright, J.W., and C.H. Lowe. 1965. The rediscovery of *Cnemidophorus arizonae* Van Denburgh. Journal of the Arizona Academy of Science 3(3): 164-168.

Wright, J.W., and C.H. Lowe. 1968. Weeds, polyploids, parthenogenesis, and the geographical and ecological distribution of all-female species of *Cnemidophorus*. Copeia 1968: 128-138.

Wright, J.W., and C.H. Lowe. 1993. Synopsis of the subspecies of the little striped whiptail lizard, *Cnemidophorus inornatus* Baird. Journal of the Arizona-Nevada Academy of Science 27(1): 129-157.

Appendix A. Data form (following two pages) used for herpetofauna TACS 1-ha plots in the Southern Colorado Plateau I&M Network, and also used for whiptail TACS surveys at WUPA in 2001. There are two pages, meant to be photocopied back to back.

Park Code _____ Pg. ____ of ____

Southern Colorado Plateau Herpetofauna Surveys

Date _____ Observers _____ Location _____

GPS Unit _____ Datum / Zone _____ Survey Type (circle): 1 Ha TACS Plot ~10 Ha TCS survey

UTMs: Easting _____ Northing _____ EPE _____

Elevation _____ USGS Quad _____ Slope _____ Aspect _____

Description of Plot _____

_____

Photo #s _____ Description of Photo Shots _____

Landform Class _____ Soil Type _____ Surface Water Type _____

Cover Stratum	Species	% Cover	Height
Tree Total %			
Shrub Total %			
Herbaceous Total %			
Unvegetated Total %	Bedrock		
	Large Rocks (>10 cm)		
	Small Rocks (0.2 - 10 cm)		
	Sand / Bare Soil		
	Litter / Duff		
	Woody Debris (> 1 cm)		
	Biotic Crust		

Park Code _____ Pg. _____ of _____

Southern Colorado Plateau Herpetofauna Surveys

Date _____ Observers _____ Location _____

	Time	% Cloud Cover	Sun Condition	Ta °C	Ts °C	Wind Max. (mph)	Wind Avg. (mph)	rH %
Begin								
End								

HERPETOFAUNA OBSERVATIONS

Species	Time	Sex	Age Class	Notes

Notes _____

Appendix B. Summary of all whiptail surveys within the study area at Wupatki National Monument, Arizona, 2001-2003. In the survey column, GS = General Survey, LL = Lizard Line, and habitat-based surveys with a # refer to random TACS surveys. General survey numbers are the same as those used in a concurrent SCPN inventory (Persons and Nowak, unpublished data). Abbreviations for weather conditions are CC = cloud cover, Ta = ambient temperature (C), Ts = substrate temperature (C), wind is in mph, and rH = percent relative humidity. Total time for each survey is given in minutes.

Survey	Date	Locality	UTM E	UTM N	Habitat	Habitat Notes
WUPA-GS-005	5/9/2001	Antelope Wash and vicinity			grassland, desertscrub in wash	grassland on top of Antelope Prairie, both grassland and desertscub in Antelope Wash
WUPA-GS-006	5/11/2001	Hull's Canyon area			juniper woodland	open juniper woodland, cinder soil, and lots of basalt outcrops along and SW of Hull's Canyon
Grassland #1 LL	5/15/2001	Near blowhole at milepost 1	453272	3936760	grassland	see TACS habitat data for this point
WUPA-GS-007	5/15/2001	Citadel Ruin, Citadel Sink			juniper savanna	focused on rocky areas around ruins and sink
WUPA-GS-008	5/15/2001	Rockpile N of 545 across from Citadel parking lot			juniper savanna	targeted basalt rockpiles
WUPA-GS-011	5/29/2001	Grassy area below Doney Mtn, S of FR 545			grassland	grassland patch with basalt rockpiles, surrounded by desert (below Doney Cliffs, SW of FR 545)
WUPA-GS-014	6/12/2001	Lomaki area, W of Lomaki road			grassland	rocky areas (basalt, limestone) W of Lomaki road
WUPA-GS-015	6/12/2001	Lomaki area			grassland	Surveyed basalt rockpiles, Box Canyon, limestone areas of Lomaki Wash
WUPA-GS-019	6/14/2001	Rocks N & S of FR 545 at milepost 1			grassland	basalt rockpiles in grassland
WUPA-GS-021	6/15/2001	Between Savanna #1 and Citadel Ruin area			juniper savanna	included basalt outcops along South Mesa
WUPA-GS-023	7/8/2001	Just N Grassland #4 plot, ca. 1 mile E Lomaki			grassland	basalt rockpile N of plot ("ruins" on 7.5' topo)
Grassland #1	6/14/2001	near blowhole, milepost 1	453272	3936767	grassland	
Grassland #2	6/28/2001	Near N boundary, below North Mesa	460501	3936999	grassland	
Grassland #4	7/8/2001	Near ruins ca. 1 mile E Lomaki	459127	3937121	grassland	
Grassland #5	8/5/2001	Middle of Antelope Prairie	460709	3935681	grassland	
Grassland #7	7/6/2001	Just S FR 545, ca. milepost 1.4	454010	3937119	grassland	previoulsy burned area
Grassland #8	7/8/2001	Antelope Prairie, E Citadel Wash, ca. 1 mi. S Mesa Well	460044	3936456	grassland	
Grassland #9	8/5/2001	Middle of Antelope Prairie	461952	3936595	grassland	
Grazed #1	6/14/2001	Just E Hank's Trading Post	452792	3938416	grazed grassland	
Grazed #2	6/28/2001	N of Citadel Wash, W of abandoned ranch house	465215	3938757	grazed grassland	~15-20 abandoned prairie dog burrows on plot
Grazed #3	8/14/2001	Along road E of Mesa Well	460924	3938169	grazed grassland	lots of cow shit
Grazed #4	7/16/2001	Just N road, North Mesa, ca. 1.5 mi. E Mesa Well	462022	3938585	grazed grassland	
Grazed #7	8/14/2001	Along road NE of Mesa Well	460439	3938560	grazed grassland	
Grazed #8	7/16/2001	Along road ca 1 mile W Mesa Well	457742	3938492	grazed grassland	old cow shit, no rodent burrows
Grazed #9	7/26/2001	Just N Wupatki boundary, ca. 1.5 mi E US 89	454138	3937918	grazed grassland	
Savanna #1	6/15/2001	SW area of monument	454302	3934226	juniper savanna	really grassland, few trees
Savanna #4	6/29/2001	Middle of Antelope Prairie, in section 9	460048	3934544	juniper savanna	
Savanna #5	7/21/2001	Antelope Prairie, W of Antelope Wash	461807	3933719	juniper savanna	21 junipers on plot
Savanna #6	8/6/2001	E of West Mesa, W of Citadel Ruin area	455451	3935679	juniper savanna	22 junipers
Savanna #7	7/19/2001	ca. 1.5 mi. ENE Sinagua Trading Post	453700	3933344	juniper savanna	sandy loam covered with thin layer of cinders
Savanna #8	7/29/2001	N Hull's Wash, SW of South Mesa	455571	3933828	juniper savanna	

Appendix B, continued.

Survey	Date	Locality	UTM E	UTM N	Habitat	Habitat Notes
Savanna #9	7/19/2001	Just E US 89, halfway between N & S boundaries	452182	3934748	juniper savanna	really grassland (only 1 juniper)
Woodland #1	6/25/2001	NNE Doney Fissure area, N of FR 545	459611	3933027	juniper woodland	
Woodland #2	7/29/2001	N of Arrowhead Sink	456149	3933248	juniper woodland	maybe 120-140 junipers
Woodland #3	7/26/2001	ENE Doney Fissure area	459030	3933052	juniper woodland	50 junipers on plot
Woodland #4	7/6/2001	W of milepost 5 of FR 545	457215	3934225	juniper woodland	
Woodland #5	7/3/2001	Just E FR 545, ca. half mile N Doney Fissure area	458323	3933340	juniper woodland	Based on other plots, the 9% juniper cover probably represents ~100 trees
Woodland #6	7/21/2001	Antelope Prairie, N of FR 150 area	460306	3933206	juniper woodland	45 junipers
Woodland #7	7/3/2001	Just W FR 545, ca. half mile N Doney Fissure area	457741	3933440	juniper woodland	~150 junipers
WUPA-GS-036	5/23/2002	Rockpiles at milepost 1 of FR 545			grassland	basalt rockpiles
WUPA-GS-059	5/20/2003	N of FR 545 at mp 1.6 rd			grassland	some rabbitbrush, few scattered junipers, a few low limestone outcrops.
WUPA-GS-060	5/21/2003	Lomaki area, Box Canyon, grassland, rocky areas			juniper savanna	
WUPA-GS-061	5/22/2003	Doney Fissure area, woodland within WUPA to NW, and Hull's Canyon			juniper woodland	
WUPA-GS-063	5/23/2003	Savanna N of FR 545 at Citadel Ruin			juniper savanna	
WUPA-GS-062	5/29/2003	Grassland N of FR 545, just E US 89 to ca. mp 1			grassland	incl. Roadside near US 89
WUPA-GS-064	6/2/2003	N of FR 545, across from Citadel Ruin			juniper savanna	
WUPA-GS-065	6/3/2003	Near mp 2 of FR 545, where road nearly touches N boundary fence; S of rd, limestone outcrops, savanna			juniper savanna	savanna mostly due to limestone bedrock at/near surface
Grazed Gen Surv	6/3/2003	Just across (N) fence from FR 545 near mp 2			grazed grassland	choked with short stature (<0.5m) rabbitbrush
WUPA-GS-066	6/4/2003	Hull's Wash along S boundary (1.9 rd mi. E US 89 on Arrowheard Sink Road), including Antelope Fire burn			juniper woodland	some borderline savanna, but overall it's woodland
WUPA-GS-067	6/5/2003	S of FR 545 near mp 1.6 road, open burned grassland			grassland	burned years back, a few juniper "snags"
WUPA-GS-068	6/25/2003	Cedar Canyon			juniper savanna	
WUPA-GS-069	6/30/2003	W half of old burned grassland S of FR 545, E of mp 1 blowhole outcrops			grassland	previously burned area
WUPA-GS-070	7/1/2003	Citadel area, along West Mesa, savanna in valley to W			juniper savanna	
WUPA-GS-071	7/12/2003	Just N of FR 545 at mp 1.6 area			grassland	some areas w/ lots rabbitbrush, a few small junipers scattered about
WUPA-GS-072	7/16/2003	S of FR 545, W of mp 1/blowhole rockpile			grassland	
WUPA-GS-073	7/22/2003	N of FR 545 at mp 1 area; E of outcrops, W of Jack and Laurie's driveway road			grassland	mostly surveyed rockpiles before it warmed up
WUPA-GS-074	7/30/2003	mp 1 area, N of FR 545, W of outcrops, and S of 545 W of outcrops			grassland	
WUPA-GS-075	8/3/2003	S of FR 545, just E of US 89			juniper savanna	trees sometimes 50-100 m apart, but sometimes only 20-30 m apart
WUPA-GS-076	8/22/2003	N of FR 545, just E of US 89			grassland	soil damp, grass greening up here

Appendix B, continued.

Survey	Time Start	Time End	Total Time	CC % Start	CC % End	Sun Start	Sun End	Ta Start	Ta End	Ts Start	Ts End	Wind Start	Wind End	rH Start	rH End
WUPA-GS-005	0812	1354	342	30	80	sunny		20.6	29.4			1-3	4-7 (gusts 8-12)		
WUPA-GS-006	0824	1119	175	0	10	sunny	sunny	24.6	30.3			<1	1-3		
Grassland #1 LIZARD LINE	0859	1112	133	40	10	sunny	sunny	23.3	26.9	33.4	42.7	4-7 (gusts 8-12)	8-12 (gusts 13-18)		
WUPA-GS-007	1131	1238	67			suuny	sunny					8-12	8-12		
WUPA-GS-008	1244	1311	27		20				30.2				4-7		
WUPA-GS-011	0740	1029	169	0	5	sunny	sunny	23.3	27.7			4-7	4-7		
WUPA-GS-014	0930	0953	23									windy	windy		
WUPA-GS-015	1015	1125	70									windy	windy		
WUPA-GS-019	1405	1530	85	0	0	sunny	sunny					1-3	1-3		
WUPA-GS-021	1020	1240	140	0		sunny						2			
WUPA-GS-023			10												
Grassland #1	0906	1006	60	0	0	sunny	sunny	14.9	16.3	29.4	38.3	4	1		
Grassland #2	0800	0900	60	0	0	sunny	sunny	24.7	27.8	34.4	42.2	1.3	2.2	14	11
Grassland #4	0800	0900	60	30	90	mostly sunny	partly sunny	26.1	27.4	37.2	40.2	4.5	3.4	32	27
Grassland #5	0827	0927	60	20	5	sunny	sunny	24.8	25.7	31.7	42.8	1.7	2.7	46	39
Grassland #7	0805	0905	60	30	60	partly sunny	partly sunny	25.6	25.8	32.4	33.5	9.3	6.6	40	37
Grassland #8	0948	1048	60	85	40	partly cloudy	partly cloudy	28.7	29.8	44.3		2.3	1.6	24	22
Grassland #9	1010	1110	60	5	10	sunny	sunny	27.7	30.1			1.4	1.0	34	28
Grazed #1	1050	1150	60			sunny	sunny	17.4	19.9	41.2		3	4		
Grazed #2	0956	1056	60	0	0	sunny	sunny	30.3	31.6	45.8		1.7	2.1	9	7
Grazed #3	0845	0945	60	10	15	sunny	sunny	22.8	22.9	27.1	32.5	2.6	2.4	66	65
Grazed #4	0946	1046	60	0	0	sunny	sunny	28.7	28.9	42.3	46.7	2.7	7.2	8	6
Grazed #7	1011	1111	60	10	10	sunny	sunny	23.9	25.4	34.2	37.5	1.1	2.4	58	57
Grazed #8	0812	0912	60	0	0	sunny	sunny	21.8	25.8	28.6	38.9	1.4	3.1	18	15
Grazed #9	0837	0937	60	15	80	sunny	cloudy	21.8	24.4	27.3	34.6	2.2	4.1	45	37
Savanna #1	0900	1000	60	0	0	sunny	sunny	20.9	25.3	41.3	48.5	3	2		
Savanna #4	0827	0927	60	0	0	sunny	sunny	28.3	30.4	40.4	47.7	2.5	2.2	5	3
Savanna #5	0759	0859	60	10	10	sunny	sunny	23.7	25.3	32.6	44.7	0.9	1.1	34	30
Savanna #6	0835	0935	60	1	10	sunny	sunny	23.4	26.4	29.3	33.7	0.6	2.0	48	44
Savanna #7	0743	0843	60	10	0	sunny	sunny	24.2	26.8	28.1	36.6	1.7	1.5	25	21
Savanna #8	0830	0930	60	5	1	sunny	sunny	28.8	30.7	37.2	44.6	8.2	6.1	20	18
Savanna #9	0937	1037	60	5	60	sunny	partly sunny	28.3	28.5	48.3	44.3	4.6	2.5	17	19

Appendix B, continued.

Survey	Time Start	Time End	Total Time	CC % Start	CC % End	Sun Start	Sun End	Ta Start	Ta End	Ts Start	Ts End	Wind Start	Wind End	rH Start	rH End
Woodland #1	0810	0910	60	95	99	cloudy	cloudy	21.3	23.7	25.5	29.3	1.0	0.7	28	24
Woodland #2	1009	1109	60	1	5	sunny	sunny	32.1	33.8	48.6		2.3	2.2	20	13
Woodland #3	1035	1135	60	5	30	sunny	sunny	25.5	27.3	41.6	45.3	3.1	2.4	29	29
Woodland #4	1008	1108	60	10	60	sunny	partly sunny	30.2	29.4	48.3	45.7	1.1	0.8	29	28
Woodland #5	0743	0843	60	10	5	sunny	sunny	23.6	26.3	31.8	42.3	0	1.2	40	35
Woodland #6	0954	1054	60	15	20	sunny	sunny	25.9	30.4	42.9		1.4	1.4	36	22
Woodland #7	0923	1023	60	0	5	sunny	sunny	28.4	31.5	45.3		1.1	1.7	31	23
WUPA-GS-036	1300	1425	85												
WUPA-GS-059	0812	1054	162	40	20	sunny	sunny	21.7	26.3	26.3	42.8	slight breeze	very slight breeze	14	
WUPA-GS-060	0837	1116	159	0	0	sunny	sunny	22.8	26.4	33.4		1-3 or less	1-3		
WUPA-GS-061	0821	1028	127	20	70	high, thin clouds	sun in/out last half hour	23.5	28.4	34.4		<1	<1		
WUPA-GS-063	0850	0910	20	90	90	some hazy sun	cloudy	25.4		36.0		1-3		18	
WUPA-GS-062	0837	1135	178	80	10	mostly cloudy	sunny	25.3	32.8	30.8		<1	1-3		
WUPA-GS-064	0805	0956	111	20	10		sunny	28.1	31.7	39.0		<1	<1		
WUPA-GS-065	0822	0940	78	5	1	sunny	sunny	27.7	31.4	36.5		8-12	8-12 +		
Grazed General Survey	0950	1016	26		1		sunny		31.4			8-12+	8-12+		
WUPA-GS-066	0818	1005	107	20	5	sunny	sunny	27.7	29.4	39.2	46.9	4-7	8-12		
WUPA-GS-067	0805	1027	142	10	10	sunny	small clouds sometimes block sun	23.5	26.5	32.2	46.3	4-7	1-3		
WUPA-GS-068	0907	1116	129	0	0	sunny	sunny	19.7	24.7	38.3		1-3	1-3		
WUPA-GS-069	0759	1001	122	0	0	sunny	sunny	26.9	33.0	34.1		1-3	1-3		
WUPA-GS-070	0812	0945	93	0	0	sunny	sunny	28.3	30.2	38.5	48.4	4-7	8-12		
WUPA-GS-071	0748	0849	61	10	5	sunny	sunny	31.5	33.3	35.3	40.7	8-12	8-12+		
WUPA-GS-072	0749	0925	96	30	10	partly behind clouds	still hazy sun	27.2	31.0	28.6	47.3	1-3	1-3		
WUPA-GS-073	0817	1009	112	80	80	mostly cloudy	mostly cloudy	25.5	29.3	26.7	39.4	1-3	<1		
WUPA-GS-074	0855	0959	64	60	30	partly cloudy	sunny	24.8	28.7	30.9	42.1	4-7	4-7		
WUPA-GS-075	0843	1006	83	20	40	sunny	mostly sunny	27.0	29.8	34.5	46.1	1-3	<1		
WUPA-GS-076	0838	1031	113	50	15	sun in	sunny	22.4	28.2	20.2	32.5	<1	8-12		

Appendix B, continued.

Survey	Notes
WUPA-GS-005	Covered grassland E of Antelope Wash, W of Doney Cliffs, then from mouth to head of Antelope Wash
WUPA-GS-006	Focused on rocky basalt areas along and SW of Hull's Canyon Graben
Grassland #1 LIZARD LINE	Did 4 walks, and searched off-line inbetween walks. High, thin clouds at start.
WUPA-GS-007	Brief survey of rim of Citadel Sink and Citadel Ruin
WUPA-GS-008	Surveyed rockpiles E of Lomaki road
WUPA-GS-011	This is direcly E of E base of Doney Mountain, has habitat (and herp) elements of both basalt/grassland and desertscrub
WUPA-GS-014	
WUPA-GS-015	
WUPA-GS-019	warm, surveyed both N and S of FR 545, incl. rocky wash N of rocks N of FR 545
WUPA-GS-021	Walked along unnamed wash N of Hull's Wash, leading to W side of South Mesa, and along South Mesa; also Citadel Ruin.
WUPA-GS-023	Quick (ca. 10 minute) survey for tree lizards
Grassland #1	Grassy plot, dominated by *Hilaria*
Grassland #2	wind <1 overall. One juniper, dominated by *Stipa* grass
Grassland #4	Five junipers; dominated by *Stipa*, some *Hilaria*
Grassland #5	Top cinder layer dry, soil below slightly damp to 1.5 inch, then dry again; dominated by *Stipa*
Grassland #7	Lots of bare soil, rodent burrows/mounds (K-rat); burned previously, charred rabbitbrush "trunks"
Grassland #8	Ts >50 at end. No herps seen! Dominated by *Stipa*.
Grassland #9	Ts >50 both start and end. Dominated by *Stipa*.
Grazed #1	Ts >50 at end. *Hilaria* only grass, lots of snakeweed, some rabbitbrush
Grazed #2	Ts >50 at end, wind 1-3 overall; dominated by *Hilaria*
Grazed #3	Ground damp. Dominated by *Hilaria*
Grazed #4	Dominated by *Hilaria*
Grazed #7	Ground damp. Dominated by *Hilaria*.
Grazed #8	Wind 1-3 overall. Dominated by *Hilaria*.
Grazed #9	Wind 1-3 overall. Sunny ~20% of survey. Top cinder layer dry, damp below to at least 5 cm
Savanna #1	Dense, flowering *Stipa* (dominant grass), hard to see far in grass. Only 4 junipers.
Savanna #4	Largely unvegetated, co-dominated by *Stipa* and *Hilaria*, only 10 junipers on plot
Savanna #5	Dominated by *Hilaria*
SAvanna #6	Dominated by *Hilaria*
Savanna #7	17 adult, 6 tiny junipers; Dominated by *Hilaria*
Savanna #8	breezy (4-7) entire survey. 35 junipers, dominated by *Hilaria*, some *Stipa* and others
Savanna #9	Wind 1-3 during survey overall. Only 1 juniper, dominated by *Stipa*
Woodland #1	Based on other counts, this 13% juniper cover is probably ~100+ trees
Woodland #2	Wind 4-7 overall during survey. Ts at end >50.
Woodland #3	Wind <1 overall during survey. Soil dry on top, slightly damp ~1 cm below, to a few cm deep

Appendix B, continued.

Survey	Notes
Woodland #4	Based on other plots, the 12% tree cover probably represents >100 junipers
Woodland #5	Otherwise dominated by *Hilaria*
Woodland #6	Ts >50 at end of survey. Dominated by *Hilaria*.
Woodland #7	Ts >50 at end of survey. Dominated otherwise by *Hilaria*.
WUPA-GS-036	Surveyed rocks both N and S of FR 545
WUPA-GS-059	soil sandy dirt (loam?) mixed with cinders, cinder layer on top; area bounded by FR 545 to S, N boundary fence to N, mp 1.6 dirt road to E, and mp 1.0 dirt road to W
WUPA-GS-060	Ts barely >50 at end of survey
WUPA-GS-061	Ts >50 at end
WUPA-GS-063	Quick, aborted survey, due to clouds not going anywhere, too cool for many whiptails
WUPA-GS-062	Ts >50 at end of survey.
WUPA-GS-064	Ts >50 at end. Never cooled down last night, low of 70 F at home. Surveyed N of 545, E of outcrops.
WUPA-GS-065	Ts >50 at end. Ending temps taken at 1016 (after brief survey N of fence)
Grazed General Survey	Ts >50. Almost no rodent burrows, no large shrubs. Active grazing (cows nearby)
WUPA-GS-066	walked upwash ca. half mile, covered woodland either side, some burned, some not
WUPA-GS-067	did E half of the grassly flat between mp 1 rockpiles to W and low rocky ridge to E
WUPA-GS-068	Ts >50 at end. Overall habitat is diverse, lots of shrubs, good soft soil, lots of larger animal burrows
WUPA-GS-069	Ts barely >50 at end. Although grass has recovered from burn, you can tell rabbitbrush got knocked back, there's LOTS of it, all only 1 foot tall or so
WUPA-GS-070	Accompanied by Wupatki SCA Julia
WUPA-GS-071	sucks! the few wary lizards were gone during last half hour of survey
WUPA-GS-072	Recently 8 straight 100 F+ days at home; poor results possible drought-induced, pre-monsoon activity lull?
WUPA-GS-073	included outcrops S of road at start.
WUPA-GS-074	crossed road at 0933, to survey S of 545.
WUPA-GS-075	
WUPA-GS-076	

Appendix C. Site characterization data for the 28 random Time Area Constrained Search (TACS) plots surveyed for lizards in 2001 at and near Wupatki National Monument, Arizona. Under grass species, "*Stipa*" represents either *Stipa neomexicana* or *Stipa comata*. Scientific names of grasses follow Gould (1951).

Grassland #1

Slope: 3 degrees Aspect: 78 degrees Soil Type: fine sandy loam, covered by cobble

Tree Cover 0%			Shrub Cover 2%			Grass Cover 48%			Unvegetated Cover 50%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
			Chrysothamnus nauseosus	100	0.75	*Hilaria jamesii*	80	0.15	Cobble	90
						Bouteloua eriopoda	15	0.15	Bare ground	10
						Stipa	5	0.30		

Notes:

Grassland #2

Slope: 0 degrees Aspect: N/A Soil Type: sandy loam, with cinders on top

Tree Cover <1%			Shrub Cover 3%			Grass Cover 47%			Unvegetated Cover 50%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	1	*Chrysothamnus nauseosus*	100	0.4	*Stipa*	95	0.40	Cinders	95
						Hilaria jamesii	5	0.15	Large rocks	5

Notes: One juniper.

Grassland #4

Slope: 0.5 degrees Aspect: 180 degrees Soil Type: fine sandy loam, with cinder layer

Tree Cover 1%			Shrub Cover 3%			Grass Cover 46%			Unvegetated Cover 50%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	1	*Chrysothamnus nauseosus*	100	0.5	*Stipa*	80	0.35	Cinders	90
						Hilaria jamesii	15	0.10	Bare ground	10
						Bouteloua erioopda	5	0.20		

Notes: Five junipers.

Grassland #5

Slope: 0 degrees Aspect: N/A Soil Type: sandy loam with cinders

Tree Cover <1%			Shrub Cover 5%			Grass Cover 45%			Unvegetated Cover 50%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	1.8	*Chrysothamnus nauseosus*	90	0.6	*Stipa*	85	0.40	Cinders	80
			Atriplex canescens	10	1	*Bouteloua eriopoda*	5	0.20	Bare ground	20
						Hilaria jamesii	10	0.15	Large rocks	<1
						Bouteloua gracilis	<1	0.05		
						Sporobolis airoides	<1	0.40		

Notes: Two junipers.

Appendix C, continued.

Grassland #7										
Slope: 1 degree Aspect: 20 degrees Soil Type: fine sandy loam with cinder layer <1 cm deep										
Tree Cover <1%			Shrub Cover 10%			Grass Cover 40%			Unvegetated Cover 50%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	2	*Chrysothamnus nauseosus*	100	0.40	*Stipa*	50	0.40	Cinders	70
						Bouteloua eriopoda	35	0.30	Bare ground	30
						Hilaria jamesii	15	0.05		
Notes: One juniper. Lots of bare soil exposed, lots of rodent burrows/mounds (K-rat). Burned sometime (charred rabbitbrush "trunks")										

Grassland #8										
Slope: 1 degree Aspect: 38 degrees Soil Type: fine sandy loam with cinder layer										
Tree Cover <1%			Shrub Cover 8%			Grass Cover 42%			Unvegetated Cover 50%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	1	*Chrysothamnus nauseosus*	100	0.50	*Stipa*	85	0.35	Cinders	100
						Hilaria jamesii	15	0.10		
Notes: Three junipers.										

Grassland #9										
Slope: 0 degrees Aspect: N/A Soil Type: sandy loam, with cinders and small rocks										
Tree Cover 0%			Shrub Cover <1%			Grass Cover 55%			Unvegetated Cover 45%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
			Atriplex canescens	90	1	*Stipa*	80	0.30	Cinders and small rocks	85
			Chrysothamnus nauseosus	10	0.40	*Hilaria jamesii*	15	0.08	Bare ground	14
						Bouteloua eriopoda	4	0.20	Large rocks	1
						Sporobolis airoides	1	0.30		
Notes:										

Grazed #1										
Slope: 2 degrees Aspect: 295 degrees Soil Type: fine sandy loam with cinders										
Tree Cover 0%			Shrub Cover 9%			Grass Cover 21%			Unvegetated Cover 70%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
			Gutierrezia sarothrae	80	0.20	*Hilaria jamesii*	100	0.05	Cinder layer	80
			Chrysothamnus nauseosus	20	0.80				Bare ground	20
Notes: Lots of old cow shit, old prairie dog burrows.										

Appendix C, continued.

Grazed #2										
Slope: 1 degree Aspect: 30 degrees Soil Type: sandy loam with cinders and limestone pieces										
Tree Cover 0%			Shrub Cover 2%			Grass Cover 28%			Unvegetated Cover 70%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
			Gutierrezia sarothrae	85	0.30	*Hilaria jamesii*	95	0.05	Cinders and small rocks	50
			Atriplex confertifolia	15	0.5	*Sporobolis airoides*	5	0.5	Bare ground	50
Notes: ~15-20 abandoned prairie dog burrows.										

Grazed #3										
Slope: 1 degree Aspect: 295 degrees Soil Type: sandy loam with cinder top layer										
Tree Cover 0%			Shrub Cover <1%			Grass Cover 50%			Unvegetated Cover 50%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
			Chrysothamnus nauseosus	75	0.30	*Hilaria jamesii*	100	0.08	Cinders	100
			Senecio douglasii	25	0.40				Large rocks	<1
Notes:										

Grazed #4										
Slope: 3 degrees Aspect: 300 degrees Soil Type: sandy loam with cinders										
Tree Cover 0%			Shrub Cover 1%			Grass Cover 49%			Unvegetated Cover 50%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
			Chrysothamnus nauseosus	90	0.30	*Hilaria jamesii*	99	0.08	Cinders	80
			Atriplex confertifolia	5	0.15	*Sporobolis airoides*	1	0.40	Large rocks (basalt chunks)	10
			Gutierrezia sarothrae	5	0.25				Bare ground	10
Notes:										

Grazed #7										
Slope: 0.5 degrees Aspect: 340 degrees Soil Type: sandy loam with cinders										
Tree Cover <1%			Shrub Cover <1%			Grass Cover 40%			Unvegetated Cover 60%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	0.25	*Chrysothamnus nauseosus*	few	0.20	*Hilaria jamesii*	95	0.08	Cinders	90
			Senecio douglasii	lots	0.35	*Bouteloua eriopoda*	5	0.20	Bare ground	8
									Large rocks	1
									Bedrock	1
Notes: Only two small junipers										

Appendix C, continued.

Grazed #8										
Slope: 0 degrees Aspect: N/A Soil Type: sandy loam?										
Tree Cover 0%			Shrub Cover 4%			Grass Cover 36%			Unvegetated Cover 60%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
			Gutierrezia sarothrae	99	0.30	*Hilaria jamesii*	99	0.07	Cinder layer	60
			Senecio douglasii	1	0.30	*Sporobolis airoides*	1	0.40	Bare ground	40
									Large rocks (limestone chunks)	<1
Notes: Old cow shit, no rodent burrows.										

Grazed #9										
Slope: 0 degrees Aspect: N/A Soil Type: sandy loam, covered with cinders										
Tree Cover 0%			Shrub Cover 4%			Grass Cover 31%			Unvegetated Cover 65%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
			Chrysothamnus nauseosus	50	0.35	*Hilaria jamesii*	70	0.08	Cinders	85
			Gutierrezia sarothrae	50	0.25	*Stipa*	30	0.15	Bare ground	10
									Large rocks	5
Notes: Lots of cow shit.										

Savanna #1										
Slope: 2 degrees Aspect: 136 degrees Soil Type: fine sandy loam with cinders										
Tree Cover <1%			Shrub Cover 1%			Grass Cover 49%			Unvegetated Cover 50%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	2	*Chrysothamnus nauseosus*	100	0.5	*Stipa*	80	0.30	Cinders	100
						Hilaria jamesii	10	0.20		
						Bouteloua eriopoda	9	0.15		
						Weeds	1	0.10		
Notes: Really grassland, few trees (only four junipers); dense, hard to see far (dense, flowering *Stipa*)										

Savanna #2										
Slope: 0.5 degrees Aspect: 58 degrees Soil Type: clay loam?										
Tree Cover 1%			Shrub Cover 1%			Grass Cover 28%			Unvegetated Cover 70%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	2.5	*Gutierrezia sarothrae*	70	0.15	*Stipa*	50	0.40	Bare ground	80
			Atriplex canescens	30	1	*Hilaria jamesii*	40	0.15	Large rocks	20
						Bouteloua eriopoda	10	0.20		
Notes: Nine adult junipers, plus one 40 cm tall one										

Appendix C, continued.

Savanna #5

Slope: 0.5 degrees Aspect: 360 degrees Soil Type: fine sandy loam with cinders

Tree Cover 2%			Shrub Cover 4%			Grass Cover 34%			Unvegetated Cover 60%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	3	*Gutierrezia sarothrae*	40	0.25	*Hilaria jamesii*	90	0.25	Cinders	75
			Chrysothamnus nauseosus	40	0.5	*Bouteloua eriopoda*	10	0.25	Large rocks	5
			Atriplex canescens	10	1	*Sporobolis airoides*	<1	0.30	Bare ground	10
									Litter/duff under trees	10

Notes: 21 junipers. Field estimation error for shrub species, as they don't add up to 100% for percent cover.

Savanna #6

Slope: 1 degree Aspect: 60 degrees Soil Type: sandy loam with cinders

Tree Cover 1%			Shrub Cover 4%			Grass Cover 40%			Unvegetated Cover 55%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	2.2	*Chrysothamnus nauseosus*	100	0.5	*Hilaria jamesii*	90	0.12	Cinders	95
						Stipa	9	0.30	Litter/duff under trees	5
						Bouteloua eriopoda	1	0.20		
						B. gracilis	<1	0.05		

Notes: 21 adult junipers, plus one 0.5 m baby.

Savanna #7

Slope: 1 degree Aspect: 60 degrees Soil Type: sandy loam with cinders

Tree Cover 1%			Shrub Cover 2%			Grass Cover 47%			Unvegetated Cover 50%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	2.0	*Chrysothamnus nauseosus*	50	0.40	*Hilaria jamesii*	80	0.15	Cinders	80
			Gutierrezia sarothrae	50	0.30	*Stipa*	10	0.40	Bare ground	20
						Bouteloua eriopoda	5	0.20		
						Aristida	5	0.20		

Notes: 17 adult junipers, 6 tiny ones.

Savanna #8

Slope: 1.5 degrees Aspect: 40 degrees Soil Type: sandy loam with cinders

Tree Cover 6%			Shrub Cover 1%			Grass Cover 53%			Unvegetated Cover 40%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	2.5	*Chrysothamnus nauseosus*	80	0.40	*Hilaria jamesii*	62	0.10	Cinders	85
			Gutierrezia sarothrae	20	0.25	*Stipa*	25	0.30	Litter/duff under trees	15
						Bouteloua eriopoda	10	0.20		
						B. gracilis	1	0.08		
						Oryzopsis hymenoides	1	0.40		
						Aristida	1	0.25		

Notes: 35 junipers

Appendix C, continued.

Savanna #9										
Slope: 1 degree Aspect: 20 degrees Soil Type: sandy loam										
Tree Cover <1%			Shrub Cover 1%			Grass Cover 49%			Unvegetated Cover 50%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	2	*Chrysothamnus nauseosus*	90	0.5	*Stipa*	75	0.40	Cinders	90
			Gutierrezia sarothrae	10	0.30	*Hilaria jamesii*	15	0.10	Bare ground	10
						Bouteloua eriopoda	10	0.20	Large rocks	<1
Notes: One juniper.										

Woodland #1										
Slope: 0 degrees Aspect: N/A Soil Type: fine sandy loam with cinders										
Tree Cover 13%			Shrub Cover 1%			Grass Cover 11%			Unvegetated Cover 75%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	2.5	*Gutierrezia sarothrae*	100	0.25	*Stipa*	75	0.40	Cinders	90
			Opuntia whipplei	<1		*Hilaria jamesii*	15	0.10	Bare ground	10
			Chrysothamnus nauseosus	<1		*Bouteloua eriopoda*	10	0.20	Large rocks	<1
Notes: Based on other counts, this 13% juniper cover is probably ~100+ trees										

Woodland #2										
Slope: 0 degrees Aspect: N/A Soil Type: sandy loam overlain by black cinders										
Tree Cover 15%			Shrub Cover 0%			Grass Cover 10%			Unvegetated Cover 75%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	3.5				*Hilaria jamesii*	100	0.08	Cinders	90
									Litter/duff under trees	7
									Woody debris	2
									Large rocks	1
Notes: Maybe 120-140 junipers.										

Woodland #3										
Slope: 0 degrees Aspect: N/A Soil Type: sandy loam with cinders										
Tree Cover 8%			Shrub Cover <1%			Grass Cover 17%			Unvegetated Cover 75%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	3	*Gutierrezia sarothrae*	few		*Hilaria jamesii*	65	0.15	Cinders	95
			Chrysothamnus nauseosus	few		*Bouteloua eriopoda*	35	0.20	Litter/duff under trees	5
									Woody debris	<1
Notes: 50 junipers, all big except one 1m tall tree										

Appendix C, continued.

Woodland #4										
Slope: 0 degrees Aspect: N/A Soil Type: black cinder with some sandy loam within and below										
Tree Cover 12%			Shrub Cover 3%			Grass Cover 15%			Unvegetated Cover 70%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	2.5	*Chrysothamnus nauseosus*	100	0.40	*Hilaria jamesii*	100	0.08	Cinders	93
									Litter/duff under trees	5
									Woody debris	1
									Large rocks	1
Notes: Based on other plots, the 12% tree cover probably represents >100 junipers. Large rocks are rockpiles of archaeological sites, and woody debris is downed junipers										

Woodland #5										
Slope: 0 degrees Aspect: N/A Soil Type: clay loam (?) overlain by cinders										
Tree Cover 9%			Shrub Cover 3%			Grass Cover 18%			Unvegetated Cover 70%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	3.5	*Gutierrezia sarothrae*	95	0.25	*Hilaria jamesii*	100	0.20	Cinders	70
			Yucca angustissima	5	0.50				Bare ground	20
									Large rocks	10
									Litter/duff under trees	<1
Notes: Based on other plots, the 9% tree cover probably represents ~80-100 junipers										

Woodland #6										
Slope: 1 degree Aspect: 305 degrees Soil Type: clay loam(?) with black cinders										
Tree Cover 5%			Shrub Cover 5%			Grass Cover 40%			Unvegetated Cover 50%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	3	*Chrysothamnus nauseosus*	70	0.5	*Hilaria jamesii*	90	0.10	Cinders	50
			Gutierrezia sarothrae	20	0.30	*Stipa*	5	0.30	Bare ground	35
			Ephedra torryana	10	0.5	*Boutloua gracilis*	4	0.02	Small rocks (limestone)	10
						Sporobolis aoroides	1	0.5	Litter/duff under trees	4
									Large rocks (sandstone)	1
Notes: 45 junipers										

Woodland #7										
Slope: 1 degree Aspect: 340 degrees Soil Type: fine sandy loam overlain with cinders										
Tree Cover 20%			Shrub Cover 0%			Grass Cover 20%			Unvegetated Cover 60%	
Tree species	% cover	Height (m)	Shrub Species	% cover	Height (m)	Grass species	% cover	Height (m)	Unvegetated Category	% Cover
Juniperus monosperma	100	3.5				*Hilaria jamesii*	100	0.10	Cinders	80
									Litter/duff under trees	10
									Large rocks	5
									Woody debris	5
Notes: ~150 junipers, all adults										

Appendix D. Complete list of all reptile observations made during surveys within the study area at and near Wupatki National Monument, Arizona 2001-2003. Species codes are the first 2 letters of the genus and species name, i.e., CNIN = *Cnemidophorus inornatus*, CNSP = *Cnemidophorus* species (unidentified), CNTI = *C. tigris*, CNVE = *C. velox*, CRCO = *Crotaphytus collaris*, CRVI = *Crotalus viridis*, GAWI = *Gambelia wislizenii*, HOMA = *Holbrookia maculata*, MATA = *Masticophis taeniatus*, PHHE = *Phrynosoma hernandesi*, SCMA = *Sceloporus magister*, SCUN = *S. undulatus*, UROR = *Urosaurus ornatus*, and UTST = *Uta stansburiana*. UIL = unidentified lizard. Likewise, shrub species codes are the first 2 letters of the genus and species name, i.e., AMPE = *Amsonia peeblesiana*, ATCA = *Atriplex canescens*, CHNA = *Chrysothamnus nauseosus*, FAPA = *Fallugia paradoxia*, GUSA = *Gutierrezia sarothre*, JUMO = *Juniperus monosperma*, and LYPA = *Lycium pallidum*. Observations are first organized alphabetically by species, then by date and time. Survey numbers are the same as those in Appendix B, and "RE" referes to a random encounter.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub	Notes
CNIN	WUPA-GS-005	5/9/2001	1110	adult	F	464266	3935834	22	Edge of gentle, mostly grassy slope in wash bottom	under an *Ephedra viridis*			TBP 059. Lots of *Ephedra*, *Lycium andersonii*, apache plume; rocky, limestome soil
CNIN	WUPA-GS-005	5/9/2001	1115	adult	F	464265	3935835		wash bottom				Time approximate. UTM approximate "Saw another F inornatus very near the first"
CNIN	WUPA-GS-005	5/9/2001	1143	immature		464179	3935640	23	up on grassy slope				for UTM northing, last number not recorded, so I put a zero.
CNIN	Grassland #1 LIZARD LINE	5/15/2001	910	adult	F	453189	3936723		grassland				ran to rabbitbrush; off-walk observation
CNIN	Grassland #1 LIZARD LINE	5/15/2001	918	adult	M	453424	3936692	17	grassland	base of rockpile			ran into Rhus; off-walk observation
CNIN	Grassland #1 LIZARD LINE	5/15/2001	1020	adult	M	453290	3936586	14	grassland				off-walk observation, pure black gramma grass area, TBP 067
CNIN	Grassland #1	6/14/2001	925	adult		453272	3936767		grassland	bare ground next to 0.5m rabbitbrush			Basking in sun. UTM is center of plot.
CNIN	Grassland #1	6/14/2001	936	adult	F	453272	3936767		grassland	under rabbitbrush			UTM is center of plot. Near SE corner, may be same as 0925 individual.
CNIN	Grassland #1	6/14/2001	945	adult	F	453272	3936767		grassland	under rabbitbrush			UTM is center of plot. Near SE corner, probably same one again!.
CNIN	Grassland #1	6/14/2001	1003	adult	F	453272	3936767		grassland				UTM is center of plot. Near SE corner, same lizard!!! (only 1 inornatus this plot).
CNIN	Grazed #1	6/14/2001	1112	adult	M	452792	3938416		grazed grassland	open snakeweed area			UTM is center of plot. small adult, near E line
CNIN	WUPA-GS-019	6/14/2001	1410	adult	M	453067	3937061	13	rockpile, grassland	rocky/grassy apache plume area on top of outcrop			Rocks S of FR 545
CNIN	WUPA-GS-019	6/14/2001	1450	adult	F	452871	3937423	15	rockpile, grassland	rocky/grassy slope of rockpile			Rocks N of FR 545

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
CNIN	WUPA-GS-019	6/14/2001	1516	adult	F	452899	3937380	12	rockpile, grassland	rocky/grassy slope of rockpile			Rocks N of FR 545
CNIN	Random encounter	6/28/2001	914	adult	M	460496	3937371	14	grassland				on walk back after plot, halfway to N boundary fence, ca. 300 m N of Grassland #2
CNIN	WUPA-GS-023	7/8/2001	730	juvenile		459122	3937220		grassland	Rabbitbrush, *Hilaria* area just N plot			last year's hatchling. Time approximate
CNIN	Grassland #4	7/8/2001	805	adult		459127	3937121		grassland	Ran to Rabbitbrush, then to *Stipa* clump			UTM is center of plot
CNIN	Grazed #4	7/16/2001	1023	hatchling		462022	3938585		grazed grassland	under snakeweed near SE corner of plot			UTM is center of plot.
CNIN	RE	7/16/2001	1125	adult	F	460200	3938000		grazed grassland	At Mesa Well			Mesa Well. TBP 126. Gravid. UTM estimated from topo map.
CNIN	Savanna #9	7/19/2001	1030	adult		452182	3934748		savanna (really grassland)				UTM is center of plot. Small adult, wavy paravertebrals, TBP 130.
CNIN	Savanna #5	7/21/2001	816	adult	F	461807	3933719		savanna	near juniper (see notes)			UTM is center of plot. Headed into tangle of dead branches beneath mostly live juniper
CNIN	Woodland #6	7/21/2001	1031	adult	F	460306	3933206		woodland	under a juniper			UTM is center of plot. Regenerated tail. Small adult.
CNIN	RE	7/21/2001	1120	adult	M	460353	3933189	12	woodland				Antelope Prairie, just SE of Woodland #6
CNIN	RE	7/26/2001	815	adult		454340	3937920		grazed grassland				Babbitt land, ca. 200 m E Grazed #9. Time approximate. UTM estimated.
CNIN	Grassland #5	8/5/2001	853	adult	M	460709	3935681		grassland	near middle of plot			UTM is center of plot.
CNIN	Grassland #5	8/5/2001	905	adult	F	460709	3935681		grassland	ca. 20 m E middle			UTM is center of plot.
CNIN	Grassland #5	8/5/2001	916	adult		460709	3935681		grassland	by SW corner of plot			UTM is center of plot. Small adult.
CNIN	RE	8/5/2001	1000			461650	3936450		grassland				Middle of Antelope Prairie, NE grassland #5. UTM is very approximate ("ca. 400 m WSW of point #9")

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
CNIN	RE	8/5/2001	1005			461952	3936595		grassland				Grassland #9, NE part of Antelope Prairie. UTM is center of plot. Seen on plot pre-survey.
CNIN	Grassland #9	8/5/2001	1045	adult	M	461952	3936595		grassland				UTM is center of plot. Regenerated tail.
CNIN	Grassland #9	8/5/2001	1103	adult		461952	3936595		grassland				Along N line. UTM is center of plot.
CNIN	RE	8/5/2001	1130	adult	F	461454	3937001		grassland				N part of Antelope Prairie, NW of Grassland #9. On walk back from grassland #9 to Mesa Well. TBP 134.
CNIN	RE	8/6/2001	1018	adult		457343	3935799		grassland	grassy area			Near Citadel Ruins
CNIN	Grazed #3	8/14/2001	914	adult	M	460924	3938169		grazed grassland	under a rabbitbrush			UTM is center of plot. Small adult. TBP 141.
CNIN	Grazed #7	8/14/2001	1055	adult	F	460439	3938560		grazed grassland				UTM is center of plot.
CNIN	WUPA-GS-036	5/23/2002	1350	adult		453024	3937348	12	grassland	grassy area			small adult
CNIN	WUPA-GS-036	5/23/2002	1400	adult		453090	3937243	15	grassland	grassy area			small adult
CNIN	WUPA-RE-015	8/15/2002	1200	adult	M	451500	3934500		grassland	road edge weeds, shrubs, E side US 89			WUPA-GS-015, US 89, ca. 1 mile N Sinagua Trading Post, UTM is VERY approximate (estimated from topo)
CNIN	WUPA-GS-059	5/20/2003	830	adult	F	454487	3937580	16	grassland	rocks/shrub		ATCA	DTS not officially recorded this survey. Under 4 wing on rocky limestone ridge just SW of N boundary
CNIN	WUPA-GS-059	5/20/2003	841	adult	F	454439	3937507	24	grassland	sparse grass		ATCA	DTS not officially recorded this survey. Under edge of large 4 wing, isolated shrub in grassy open p
CNIN	WUPA-GS-059	5/20/2003	910	adult		453994	3937321	14	grassland	med dense grass	2	CHNA	DTS not officially recorded this survey. Ran into the rabbitbrush, spooked another inornatus
CNIN	WUPA-GS-059	5/20/2003	910	adult		453993	3937319	14	grassland	shrub patch		CHNA	DTS not officially recorded this survey. Spooked by other 0910 inornatus!
CNIN	WUPA-GS-059	5/20/2003	914	adult	F	453970	3937349	14	grassland	open rocky shrub			No DTS this survey. In open, cinder/sparse grass at edge of outcrop, ran to rocks/snakeweed.
CNIN	WUPA-GS-059	5/20/2003	951	adult	M	453813	3937453	14	grassland	med dense grass	3		DTS now in effect. Photod this lizard basking.
CNIN	WUPA-GS-059	5/20/2003	1002	adult	M	453875	3937465	14	grassland	sparse grass	4		DTS now in effect.

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
CNIN	WUPA-GS-059	5/20/2003	1040	adult		453953	3937248	19	grassland	open weeds (mallow) in disturbed road edge	3	CHNA	DTS now in effect. Ran to nearest (3m) shrub.
CNIN	WUPA-GS-059	5/20/2003	1046	immature		454046	3937262	16	grassland	dense weed patch of disturbed road edge	1		DTS now in effect. Ran in a mammal burrow.
CNIN	WUPA-GS-062	5/29/2003	845	adult		452201	3937009	17	grassland	rockpile			rock pile dumped by NPS to block old road, in open grassland
CNIN	WUPA-GS-062	5/29/2003	919	adult	M	452620	3937567	16	grassland	shrub patch	0	CHNA	Under a rabbitbrush, in patch of rabbitbrush, in small "arroyo" near N boundary
CNIN	WUPA-GS-062	5/29/2003	926	adult	F	452718	3937488	19	grassland	shrub patch	1	CHNA	in floor of rocky wash
CNIN	WUPA-GS-062	5/29/2003	947	adult	M	453019	3937468	19	grassland	med dense grass	3	JUMO	near lone 1.5 m juniper
CNIN	WUPA-GS-062	5/29/2003	1045	adult	F	452336	3937028	20	grassland	shrub patch	0	GUSA	in very small rocky wash a little N of FR 545
CNIN	WUPA-GS-062	5/29/2003	1118	adult	F	452096	3936699	24	grassland	disturbed road edge weeds	5		In mustards, along edge of paved pullout by US 89
CNIN	WUPA-GS-065	6/3/2003	852	adult	M	454907	3937158	21	savanna	med dense grass	1	ATCA	
CNIN	WUPA-GS-066	6/4/2003	953	adult	F	454497	3932881	14	woodland	under edge of large juniper	0	JUMO	
CNIN	WUPA-GS-067	6/5/2003	821	adult	F	454469	3936866	16	grassland	dense grass/rocky patch	2		Along rocky limestone ridge
CNIN	WUPA-GS-069	6/30/2003	836	adult	F	453636	3936091	21	grassland	in sun under juniper, by trunk/exposed roots	0	JUMO	small adult
CNIN	WUPA-GS-071	7/12/2003	818	adult		455265	3937615	15	grassland	med dense grass	3	ATCA	near where road and N boundary fence converge
CNSP	Savanna #1	6/15/2001	901	adult		454302	3934226		savanna	in grass near center of plot			UTM is center of plot; probably a velox.
CNSP	Grassland #7	7/6/2001	903			454010	3937119		grassland	Ran into a hole.			UTM is center of plot.
CNSP	RE	8/5/2001	1000						grassland				Middle of Antelope Prairie, NE grassland #5. 1 of 2 UNK whiptails seen between grassland plots 5 and 9. Time approximate
CNSP	RE	8/5/2001	1000						grassland				Middle of Antelope Prairie, NE grassland #5. 2 of 2 UNK whiptails seen between grassland plots 5 and 9. Time approximate

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
CNSP	Grassland #9	8/5/2001	1054			461952	3936595		grassland				UTM is center of plot. Didn't look blue (i.e. maybe velox)
CNSP	WUPA-GS-059	5/20/2003	859	immature					grassland	grass/rocks			DTS not officially recorded this survey. Ran into lone rabbitbrush on grassy rocky ridge.
CNSP	WUPA-GS-059	5/20/2003	949	adult					grassland	med dense grass			DTS not officially recorded this survey.
CNSP	WUPA-GS-061	5/22/2003	912						woodland	shrub patch	0	ATCA	4 wing shrub patch with med dense grass
CNSP	WUPA-GS-062	5/29/2003	901						grassland	sparse grass	2	GUSA	2 m to snakeweed, 4 m to rabbitbrush
CNSP	WUPA-GS-062	5/29/2003	950						grassland	med dense grass	0		darted into small burrow
CNSP	WUPA-GS-062	5/29/2003	1030						grassland	shrub patch	0	CHNA	
CNSP	WUPA-GS-067	6/5/2003	908	adult					grassland	med dense grass	2	CHNA	
CNSP	WUPA-GS-067	6/5/2003	920						grassland	sparse grass	4	CHNA	Small, ran away and vanished
CNSP	WUPA-GS-067	6/5/2003	1000	adult					grassland	med dense grass/weeds	12	CHNA	probably velox, but can't rule out female inornatus
CNSP	WUPA-GS-071	7/12/2003	802						grassland	med dense grass	5	CHNA	darted into hole, prodded out, but darted in another hole!
CNSP	WUPA-GS-074	7/30/2003	921						grassland	med dense grass with rocks	4	RHTR	disappeared into an invisible hole; N of 545
CNSP	WUPA-GS-076	8/22/2003	958	hatchling					grassland	sparse grass	15	CHNA	tiny hatchling
CNTI	WUPA-GS-005	5/9/2001	1007	juvenile		464785	3935047	17	limestone rocky slope halfway to bottom of wash				Time approximate, seen along canyon rim before dropping into Antelope Wash, by lone juniper
CNTI	WUPA-GS-005	5/9/2001	1007	juvenile		464785	3935047	17	limestone rocky slope halfway to bottom of wash				
CNTI	WUPA-GS-005	5/9/2001	1220	adult		464067	3935225	17	rocky area at edge of wash				TBP 061.
CNTI	WUPA-GS-011	5/29/2001	929	adult	F	464412	3933577	20	in "desert edge" (shrubs, cinder)	in *Ephedra viridis*			right where grassy area abruptly transitions to open cinder, shrubs. gravid.
CNTI	WUPA-GS-011	5/29/2001	936	subadult		464355	3933523	21	grassy area, lots of *Ephedra viridis*				30 m from edge of grassy area
CNVE	WUPA-GS-005	5/9/2001	825	adult		463557	3933387	22	savanna				TBP 057; near *Ephedra viridis*, *Lycium*, *Hilaria*, lots bare ground. Open juniper woodland
CNVE	WUPA-GS-005	5/9/2001	837	adult					savanna				open savanna
CNVE	WUPA-GS-005	5/9/2001	900						grassland				Time approximate, between 0837-0915. Grassland, but with shrubs.

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
CNVE	WUPA-GS-005	5/9/2001	900						grassland				Time approximate, between 0837-0915. Grassland, but with shrubs. 2 of 2 seen this interval.
CNVE	WUPA-GS-005	5/9/2001	1129	adult		464263	3935765	19	midway up slope, rocky, grassy.				TBP 060
CNVE	WUPA-GS-005	5/9/2001	1200	adult					on grassy slope				Time approximate
CNVE	WUPA-GS-005	5/9/2001	1200	adult					wash bottom				Time approximate
CNVE	WUPA-GS-005	5/9/2001	1240	adult						wash bottom, cinder, shrubs			Time approximate, 1 of 2 seen ca. 1220-1250
CNVE	WUPA-GS-005	5/9/2001	1240	adult						wash bottom, cinder, shrubs			Time approximate, 2 of 2 seen ca. 1220-1250
CNVE	WUPA-GS-006	5/11/2001	830	immature					rocky/grassy area of junipers above wash				Time approximate, near Doney Fissure (survey start)
CNVE	WUPA-GS-006	5/11/2001	930	adult					head of Hull's Canyon graben	basalt rocks			Time approximate, seen ca. 0905-0947. 1 of 2 seen.
CNVE	WUPA-GS-006	5/11/2001	930	adult					head of Hull's Canyon graben	basalt rocks			Time approximate, seen ca. 0905-0947. 2 of 2 seen.
CNVE	WUPA-GS-006	5/11/2001	930	juvenile					head of Hull's Canyon graben	basalt rocks			Time approximate, seen ca. 0905-0947. 1 of 2 seen.
CNVE	WUPA-GS-006	5/11/2001	930	juvenile					head of Hull's Canyon graben	basalt rocks			Time approximate, seen ca. 0905-0947. 2 of 2 seen.
CNVE	WUPA-GS-006	5/11/2001	1020	adult					basalt ridge south of Hull's Canyon, near WS 952				Time approximate, 1 of 3 seen here
CNVE	WUPA-GS-006	5/11/2001	1020	adult					basalt ridge south of Hull's Canyon, near WS 952				Time approximate, 2 of 3 seen here
CNVE	WUPA-GS-006	5/11/2001	1020	adult					basalt ridge south of Hull's Canyon, near WS 952				Time approximate, 3 of 3 seen here
CNVE	Grassland #1 LIZARD LINE	5/15/2001	1020						grassland				off-walk observation, grass area, probable velox
CNVE	Grassland #1 LIZARD LINE	5/15/2001	1045	adult					grassland				off-walk observation, time approx, 5 m W of line, ran to rabbitbrush
CNVE	WUPA-GS-007	5/15/2001	1220	adult					rubble at base of Citadel Ruin				time approx
CNVE	WUPA-GS-007	5/15/2001	1300	juvenile					in grass near rocks				time approximate
CNVE	WUPA-GS-011	5/29/2001	842	adult		464500	3933247	15	open *Hilaria* area				ran to *E. viridis* shrub.
CNVE	WUPA-GS-011	5/29/2001	940	subadult		464326	3933508	22	grassy area				ran to rockpile/*Ephedra viridis* clump
CNVE	WUPA-GS-011	5/29/2001	952	adult		464464	3933255	24	grassland				ran to *Ephedra viridis*

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
CNVE	WUPA-GS-014	6/12/2001	945	adult					under 4-wing saltbush at base of rocks				time approx. Small adult.
CNVE	WUPA-GS-015	6/12/2001	1100	adult					Box Canyon, disturbed canyon bottom				time approximate. Lots of 4-wing saltbush, *Lycium pallidum* here.
CNVE	Grassland #1	6/14/2001	948	adult		453272	3936767		grassland	open grass			UTM is center of plot.
CNVE	Grazed #1	6/14/2001	1144	adult		452792	3938416		grazed grassland				UTM is center of plot.
CNVE	Savanna #1	6/15/2001	914	adult		454302	3934226		savanna	basking in open between grass			UTM is center of plot
CNVE	WUPA-GS-021	6/15/2001	1030	adult		454800	3934235		grassland				UTM is approximate (ca. 100 m W of TBP 094 *Holbrookia*), time is approximate
CNVE	Grassland #2	6/28/2001	803	adult		460501	3936999		grassland				UTM is center of plot. Small adult.
CNVE	Grassland #2	6/28/2001	836	adult		460501	3936999		grassland				UTM is center of plot.
CNVE	Grassland #2	6/28/2001	844	juvenile		460501	3936999		grassland				UTM is center of plot. Missing tail (no regen yet)
CNVE	Grassland #2	6/28/2001	857	adult		460492	3937050	18	grassland				Captured (TBP 115).
CNVE	Grazed #2	6/28/2001	1050	adult		465215	3938757		grazed grassland				UTM is center of plot. Ran into burrow.
CNVE	RE	6/29/2001	815	adult					woodland, ca. 100 m E FR 545				time approximate
CNVE	RE	6/29/2001	815	adult					savanna, E of FR 545 (further E than woodland sighting)				time approximate; 1 of 3 seen in savanna
CNVE	RE	6/29/2001	815	adult					savanna, E of FR 545 (further E than woodland sighting)				time approximate; 2 of 3 seen in savanna
CNVE	RE	6/29/2001	815	adult					savanna, E of FR 545 (further E than woodland sighting)				time approximate; 3 of 3 seen in savanna
CNVE	Woodland #5	7/3/2001	820	adult		458323	3933340		woodland	under 3 m tall juniper along S edge of plot			UTM is center of plot
CNVE	Woodland #5	7/3/2001	827	juvenile		458323	3933340		woodland	beneath 4 m tall dead juniper			UTM is center of plot; among juniper twig pile (*Neotoma* nest). Last year's hatchling.
CNVE	Woodland #5	7/3/2001	832	adult		458323	3933340		woodland	under 3 m juniper near NE corner of plot			UTM is center of plot; small adult.

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
CNVE	RE	7/3/2001	915	adult					woodland	open cinder area, ran to a juniper			On walk between woodland #5 and #7, Just W FR 545, ca. half mile N Doney Fissure area
CNVE	RE	7/6/2001	800	adult					grassland				on walk from FR 545 to plot, Near Grassland #7, just S FR 545, ca. milepost 1.4
CNVE	Grassland #7	7/6/2001	826	adult		454010	3937119		grassland	sitting in sun under a rabbitbrush			UTM is center of plot
CNVE	Grassland #7	7/6/2001	842	adult		454010	3937119		grassland	walked into a burrow			UTM is center of plot
CNVE	Grassland #7	7/6/2001	847	adult		454010	3937119		grassland				UTM is center of plot
CNVE	Grassland #7	7/6/2001	855	adult		454010	3937119		grassland				UTM is center of plot. PROBABLY SAME AS AT 0847
CNVE	Grassland #7	7/6/2001	859	subadult		454010	3937119		grassland				UTM is center of plot. Near SE corner.
CNVE	Grassland #4	7/8/2001	824	juvenile		459127	3937121		grassland	Ran to 0.6 m juniper			UTM is center of plot; last year's hatchling.
CNVE	Grassland #4	7/8/2001	851	adult		459127	3937121		grassland	near (ran to) 1 m juniper			UTM is center of plot.
CNVE	Grazed #8	7/16/2001	821	subadult		457742	3938492		grazed grassland	very open, ran to *Senecio douglassii*			UTM is center of plot.
CNVE	Grazed #8	7/16/2001	855	subadult		457742	3938492		grazed grassland				UTM is center of plot. SAME INDIVIDUAL AS AT 0821
CNVE	Savanna #7	7/19/2001	820	juvenile		453700	3933344		savanna	snakeweed area			UTM is center of plot. Probably a 1 year old.
CNVE	Savanna #7	7/19/2001	832	juvenile		453700	3933344		savanna	snakeweed area			UTM is center of plot.
CNVE	Savanna #7	7/19/2001	839	adult		453700	3933344		savanna	under a juniper			UTM is center of plot.
CNVE	RE	7/19/2001	930	adult					grassland				Between US 89 and Savanna #9 (E of US 89)
CNVE	Savanna #5	7/21/2001	821	adult		461807	3933719		savanna	area of rodent (K rat? burrows			UTM is center of plot. Ran in a hole.
CNVE	Savanna #5	7/21/2001	825	subadalt		461807	3933719		savanna	heading under big juniper			UTM is center of plot. Probably last year's hatchling.
CNVE	Savanna #5	7/21/2001	842	juvenile		461807	3933719		savanna	Ran into a rabbitbrush			UTM is center of plot. Probably last year's hatchling.
CNVE	Savanna #5	7/21/2001	852	adult		461807	3933719		savanna	heading to tree			UTM is center of plot. Small adult (or subadult).
CNVE	Savanna #5	7/21/2001	856	subadult		461807	3933719		savanna				UTM is center of plot.

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
CNVE	Savanna #5	7/21/2001	857	Adult		461807	3933719		savanna	under tree			UTM is center of plot. Small adult.
CNVE	RE	7/21/2001	945	adult					savanna				Antelope Prairie, W of Savanna #5. On walk to Woodland #6. 1 of 2 adults seen. Time approximate.
CNVE	RE	7/21/2001	945	adult					savanna				Antelope Prairie, W of Savanna #5. On walk to Woodland #6. 2 of 2 adults seen. Time approximate.
CNVE	RE	7/21/2001	945	subadult					savanna				Antelope Prairie, W of Savanna #5. On walk to Woodland #6. Time approximate.
CNVE	RE	7/21/2001	945	juvenile					savanna				Antelope Prairie, W of Savanna #5. On walk to Woodland #6. Time approximate.
CNVE	Woodland #6	7/21/2001	956	adult		460306	3933206		woodland	under huge old juniper			UTM is center of plot.
CNVE	Woodland #6	7/21/2001	1017	adult		460306	3933206		woodland				UTM center of plot. Near 0956 *velox*, could be same one...
CNVE	Woodland #6	7/21/2001	1035	adult		460306	3933206		woodland	under juniper			UTM center of plot. Same area---all 3 *velox* so far may be same individual!
CNVE	Woodland #6	7/21/2001	1044	juvenile		460306	3933206		woodland	under a juniper, sandstone "knoll"			UTM center of plot. Same area, near middle of plot.
CNVE	Grazed #9	7/26/2001	845	adult		454138	3937918		grazed grassland				UTM is center of plot
CNVE	Grazed #9	7/26/2001	914	subadult		454138	3937918		grazed grassland	under a cow pie			UTM is center of plot. Ran out when I lifted cow pie!
CNVE	Grazed #9	7/26/2001	921	adult		454138	3937918		grazed grassland	ran into a hole			UTM is center of plot.
CNVE	Grazed #9	7/26/2001	935	adult		454138	3937918		grazed grassland	under a cow pie!			UTM is center of plot.
CNVE	Woodland #3	7/26/2001	1111	adult		459030	3933052		juniper woodland	under a juniper			UTM is center of plot.
CNVE	RE	7/29/2001	750	adult					woodland	saltbush flat			Along road just N Hull's Canyon graben, on walk out toward Savanna #8. 1 of 2 adults seen here.
CNVE	RE	7/29/2001	750	adult					woodland	saltbush flat			Along road just N Hull's Canyon graben, on walk out toward Savanna #8. 2 of 2 adults seen here.
CNVE	RE	7/29/2001	750	juvenile					woodland	saltbush flat			Along road just N Hull's Canyon graben, on walk out toward Savanna #8.
CNVE	RE	7/29/2001	810	adult					woodland	woodland area			Along road ca. 300 m E Savanna #8. Along walk out toward Savanna #8.
CNVE	Savanna #8	7/29/2001	835	adult		455571	3933828		savanna	ran under a juniper			UTM is center of plot.

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
CNVE	Savanna #8	7/29/2001	842	juvenile		455571	3933828		savanna	ran into rocks near SW corner			UTM is center of plot.
CNVE	Savanna #8	7/29/2001	909	juvenile		455571	3933828		savanna				UTM is center of plot. Near SW corner, may be same as 0842 individual!
CNVE	Savanna #8	7/29/2001	913	juvenile		455571	3933828		savanna	in grass, headed to big tree			UTM is center of plot.
CNVE	Savanna #8	7/29/2001	922	adult		455571	3933828		savanna	basking at edge of juniper			UTM is center of plot.
CNVE	Grassland #5	8/5/2001	835	adult		460709	3935681		grassland				UTM is center of plot. Regenerated tail.
CNVE	Grassland #5	8/5/2001	839	adult		460709	3935681		grassland				UTM is center of plot.
CNVE	Grassland #5	8/5/2001	854	adult		460709	3935681		grassland	near middle of plot			UTM is center of plot. Small adult.
CNVE	Grassland #5	8/5/2001	905	adult		460709	3935681		grassland	ca. 20 m E middle			UTM is center of plot.
CNVE	Grassland #5	8/5/2001	919	adult		460709	3935681		grassland				UTM is center of plot. PROBABLY SAME AS AT 0839!
CNVE	Grassland #9	8/5/2001	1024	adult		461952	3936595		grassland				UTM is center of plot.
CNVE	Grassland #9	8/5/2001	1101	adult		461952	3936595		grassland				UTM is center of plot.
CNVE	Savanna #6	8/6/2001	847	subadult		455451	3935679		savanna	under rabbitbrush			UTM is center of plot. Last year's hatchling.
CNVE	RE	8/6/2001	853	adult		455451	3935679		savanna				Savanna #6, E of West Mesa, W of Citadel Ruin area. UTM is center of plot. large adult, seen OFF PLOT!
CNVE	Savanna #6	8/6/2001	858	adult		455451	3935679		savanna				UTM is center of plot.
CNVE	Savanna #6	8/6/2001	902	subadult		455451	3935679		savanna				UTM is center of plot. Last year's hatchling.
CNVE	Savanna #6	8/6/2001	902	juvenile		455451	3935679		savanna	ran to a tree			UTM is center of plot. Last year's hatchling.
CNVE	Savanna #6	8/6/2001	923	adult		455451	3935679		savanna				UTM is center of plot.
CNVE	Savanna #6	8/6/2001	929	adult		455451	3935679		savanna				UTM is center of plot.
CNVE	RE	8/6/2001	953	adult					woodland	cinder soil area			Ca. 300 m E Savanna #6, W of Citadel area
CNVE	RE	8/6/2001	1004	adult					woodland	cinder/rabbitbrush/tree area			Ca. 200 m E Kaibab House Ruin, Cedar Canyon
CNVE	Grazed #3	8/14/2001	906	subadult		460924	3938169		grazed grassland	under rabbitbrush			UTM is center of plot. Same shrub as the UNK lizard---so that's what it was!
CNVE	Grazed #7	8/14/2001	1052	adult		460439	3938560		grazed grassland				UTM is center of plot. TBP 142.

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
CNVE	WUPA-GS-036	5/23/2002		Juvenile					grassland	grassy area			small adult, 1300-1425 hrs
CNVE	WUPA-GS-036	5/23/2002		adult					grassland	along dirt road to blowhole			1300-1425 hrs
CNVE	WUPA-GS-059	5/20/2003	815	adult					grassland	shrub patch	1	CHNA	DTS not officially recorded this survey. In area of med dense grass, 3 rabbitbrush w/in 1 m
CNVE	WUPA-GS-059	5/20/2003	842	adult					grassland	sparse grass			DTS not officially recorded this survey. In open, in open grassy patch
CNVE	WUPA-GS-059	5/20/2003	848	adult					grassland	sparse grass	1	CHNA	DTS not officially recorded this survey. In open within 1 m to 2 small rabbitbrush
CNVE	WUPA-GS-059	5/20/2003	852	immature					grassland	grass/rocks	1	GUSA	DTS not officially recorded this survey. In open at edge of limestone ridge, near a snakeweed
CNVE	WUPA-GS-059	5/20/2003	854	adult					grassland	grass/rocks			DTS not officially recorded this survey. Moving in open through grass
CNVE	WUPA-GS-059	5/20/2003	903	adult					grassland	med dense grass			DTS not officially recorded this survey. moving through med dense grass patch (no shrubs nearby)
CNVE	WUPA-GS-059	5/20/2003	909	adult					grassland	med dense grass			DTS not officially recorded this survey. Adjacent to rocky ridge.
CNVE	WUPA-GS-059	5/20/2003	928	adult					grassland	med dense grass			DTS not officially recorded this survey. Ran to rabbitbrush patch, then to 15 m distant lone tree.
CNVE	WUPA-GS-059	5/20/2003	940	immature					grassland	med dense grass			DTS not officially recorded this survey. In large (>1 ha) almost pure grass area
CNVE	WUPA-GS-059	5/20/2003	1027	subadult					grassland	shrub patch	2	CHNA	DTS now in effect. Open grassy rabbitbrush shrub patch.
CNVE	WUPA-GS-059	5/20/2003	1031	adult					grassland	shrub patch	0	CHNA	DTS now in effect. Dense rabbitbrush shrub patch 15 m N of FR 545
CNVE	WUPA-GS-059	5/20/2003	1035	adult					grassland	shrub patch in disturbed road edge	1		DTS now in effect.
CNVE	WUPA-GS-060	5/21/2003	907	subadult					savanna	sparse grass	3	CHNA	Ran to further (6 m) rabbitbrush
CNVE	WUPA-GS-060	5/21/2003	910	adult					savanna	shrub patch	0	FAPA	Under isolated *Fallugia* patch
CNVE	WUPA-GS-060	5/21/2003	918	adult					savanna	grass and snakeweed patch	6	JUMO	
CNVE	WUPA-GS-060	5/21/2003	922	adult					savanna	sparse grass/snakeweed	3	JUMO	Ran to tree 12 m away

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
CNVE	WUPA-GS-060	5/21/2003	933	adult					savanna	sparse grass	2	JUMO	"Open cinder/grass patch", 2 m from big juniper
CNVE	WUPA-GS-060	5/21/2003	937	adult					savanna	med dense grass	15	JUMO	some snakewwed, but hardley any diff than a big grass clump
CNVE	WUPA-GS-060	5/21/2003	940	immature					savanna	sparse grass	2	GUSA	Lots snakeweed w/in 10 m radius. Open cinder/sparse grass patch
CNVE	WUPA-GS-060	5/21/2003	1034	adult					savanna	boulders in Lomaki side wash	0		
CNVE	WUPA-GS-060	5/21/2003	1109	adult					savanna	on rocks on Box Canyon rim	0		
CNVE	WUPA-GS-061	5/22/2003	830	adult					woodland	rockpile patch of ruin	6	JUMO	
CNVE	WUPA-GS-061	5/22/2003	836	adult					woodland	open cinder rock patch	2	JUMO	Along old dirt road
CNVE	WUPA-GS-061	5/22/2003	900	adult					woodland	shrub patch	1	ATCA	Open, cinder area, but 4 wing shrub patch, 3 m from a tree. 1 of 2 here.
CNVE	WUPA-GS-061	5/22/2003	900	adult					woodland	shrub patch	1	ATCA	Open, cinder area, but 4 wing shrub patch, 3 m from a tree. 2 of 2 here.
CNVE	WUPA-GS-061	5/22/2003	918	adult					woodland	shrub patch	0	ATCA	bare ground 4 wing patch
CNVE	WUPA-GS-061	5/22/2003	920	adult					woodland	shrub patch	0	ATCA	under a 4 wing
CNVE	WUPA-GS-061	5/22/2003	921	adult					woodland	shrub patch	0	ATCA	ran through 4 wing patch
CNVE	WUPA-GS-061	5/22/2003	958	immature					woodland	sparse grass	2	JUMO	2 m from big tree. Cinder sparse grass area
CNVE	WUPA-GS-061	5/22/2003	1006	immature					woodland	shrub patch	0	ATCA, CHNA	Big shrub patch (CHNA, ATCA) in sandstone/red clay borrow pit near road
CNVE	WUPA-GS-061	5/22/2003	1024	adult					woodland	sparse grass	3	JUMO	sparse grass/cinder patch
CNVE	WUPA-GS-063	5/23/2003	905	adult					savanna	shrub patch	1	CHNA	Ran into rabbitbrush, grassy shrub patch by rockpile
CNVE	WUPA-GS-062	5/29/2003	914	adult					grassland	shrub patch	1	ATCA	
CNVE	WUPA-GS-062	5/29/2003	942	adult					grassland	sparse grass/weeds	2		open cinder portion of basalt rocky wash
CNVE	WUPA-GS-062	5/29/2003	952	adult					grassland	dense grass	5		
CNVE	WUPA-GS-062	5/29/2003	1045	adult					grassland	disturbed road edge weeds	3		On N side of FR 545
CNVE	WUPA-GS-062	5/29/2003	1054	adult					grassland	disturbed road edge weeds	10		On S side of FR 545
CNVE	WUPA-GS-062	5/29/2003	1117	adult					grassland	disturbed road edge weeds	5		Along FR 545 near US 89, 1 of 3 seen here now

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
CNVE	WUPA-GS-062	5/29/2003	1117	adult					grassland	disturbed road edge weeds	5		Along FR 545 near US 89, 2 of 3 seen here now
CNVE	WUPA-GS-062	5/29/2003	1117	adult					grassland	disturbed road edge weeds	5		Along FR 545 near US 89, 3 of 3 seen here now
CNVE	WUPA-GS-062	5/29/2003	1125	adult					grassland	disturbed road edge weeds	5		along edge of paved pullout by US 89
CNVE	WUPA-GS-064	6/2/2003	909	adult					savanna	dense grass	3		
CNVE	WUPA-GS-064	6/2/2003	933	adult					savanna	dense grass	1	CHNA	
CNVE	WUPA-GS-064	6/2/2003	939	adult					savanna	shrub patch	1	CHNA	rabbitbrush shrub patch. 2 m to a tree. Gravid, large.
CNVE	RE	6/2/2003	1003	adult					savanna	near large four wing saltbush	0		Citadel Ruin parking lot
CNVE	WUPA-GS-065	6/3/2003	823	subadult					savanna	med dense grass	3	GUSA	2 year old?
CNVE	WUPA-GS-065	6/3/2003	841	adult					savanna	cinder/limestone/ shrub patch	2		four wing and snakewwed shrub patch
CNVE	WUPA-GS-065	6/3/2003	845	adult					savanna	rocky bedrock patch	1	JUMO	
CNVE	WUPA-GS-065	6/3/2003	910	adult					savanna	med dense grass	2	JUMO	2 m tall tree nearby
CNVE	WUPA-GS-065	6/3/2003	912	adult					savanna	under large juniper	0	JUMO	
CNVE	WUPA-GS-065	6/3/2003	925	immature					savanna	shrub patch, with rocks	0	GUSA	
CNVE	WUPA-GS-066	6/4/2003	823	adult					woodland	under juniper by wash	0	JUMO	Antelope fire area, unburned section
CNVE	WUPA-GS-066	6/4/2003	825	adult					woodland	med dense weed patch	6	JUMO	Antelope fire area, burned area
CNVE	WUPA-GS-066	6/4/2003	832	adult					woodland	dege of juniper	0	JUMO	Antelope fire area, unburned section
CNVE	WUPA-GS-066	6/4/2003	835	subadult					woodland	under juniper	0	JUMO	Antelope fire area, unburned section
CNVE	WUPA-GS-066	6/4/2003	843	adult					woodland	sparse grass/weed patch	1	JUMO	Antelope fire area, burned section
CNVE	WUPA-GS-066	6/4/2003	856	subadult					woodland	under edge of large juniper	0	JUMO	Antelope fire area, unburned section
CNVE	WUPA-GS-067	6/5/2003	809	adult					grassland	rocky patch, on limestone ridge	0		
CNVE	WUPA-GS-067	6/5/2003	812	adult					grassland	med dense grass/rocky soil patch	2	ATCA	Along rocky limestone ridge
CNVE	WUPA-GS-067	6/5/2003	829	subadult					grassland	shrub patch	1	CHNA	Along rocky limestone ridge
CNVE	WUPA-GS-067	6/5/2003	831	subadult					grassland	rock/shrub patch	1	RHTR	Along rocky limestone ridge

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
CNVE	WUPA-GS-067	6/5/2003	843	adult					grassland	shrub patch	1	CHNA	2 m from a juniper snag
CNVE	WUPA-GS-067	6/5/2003	845	adult					grassland	shrub patch	0	CHNA	
CNVE	WUPA-GS-067	6/5/2003	846	adult					grassland	sparse grass	3	JUMO	3 m from juniper snag
CNVE	WUPA-GS-067	6/5/2003	849	adult					grassland	med dense grass	2	CHNA	gravid
CNVE	WUPA-GS-067	6/5/2003	854	juvenile					grassland	med dense grass	1	CHNA	
CNVE	WUPA-GS-067	6/5/2003	854	adult					grassland	med dense grass	1	CHNA	gravid
CNVE	WUPA-GS-067	6/5/2003	900	adult					grassland	med dense grass	3	CHNA	
CNVE	WUPA-GS-067	6/5/2003	911	adult					grassland	sparse grass	7	CHNA	Basking in sun at edge of 1.3m diam. anthill
CNVE	WUPA-GS-067	6/5/2003	911	adult					grassland	sparse grass	7	CHNA	Basking in partial shade of grass clump at edge of 1.3m diam. anthill
CNVE	WUPA-GS-067	6/5/2003	927	adult					grassland	med dense grass	2		
CNVE	WUPA-GS-067	6/5/2003	933	subadult					grassland	shrub patch	0	CHNA	ran down a hole
CNVE	WUPA-GS-067	6/5/2003	936	adult					grassland	med dense grass	6	CHNA	
CNVE	WUPA-GS-067	6/5/2003	937	adult					grassland	shrub patch	0	CHNA	
CNVE	WUPA-GS-067	6/5/2003	940	adult					grassland	dense grass/weeds	2	JUMO	2 m to a half alive juniper snag
CNVE	WUPA-GS-067	6/5/2003	948	adult					grassland	shrub/weed patch	4	AMPE	Amsonia patch along sort of flat wash. 4 m to nearest rabbitbrush (true shrub)
CNVE	WUPA-GS-067	6/5/2003	952	adult					grassland	dense grass/weeds	2	CHNA	Amsonia patch along sort of flat wash. 2 m to nearest rabbitbrush (true shrub)
CNVE	WUPA-GS-068	6/25/2003	922	adult					savanna	med dense grass	2	GUSA	rocky W edge of Cedar Canyon
CNVE	WUPA-GS-068	6/25/2003	932	adult					savanna	rock/shrub patch	0	GUSA	head backed down a hole, W edge Cedar Canyon, chased it out for ID
CNVE	WUPA-GS-068	6/25/2003	943	adult					savanna	rocky patch	1	JUMO	At edge of large juniper, W edge Cedar Canyon
CNVE	WUPA-GS-068	6/25/2003	1001	adult					savanna	shrub patch	0	CHNA, ATCA	Some rocks in patch, W edge Cedar Canyon
CNVE	WUPA-GS-068	6/25/2003	1007	adult					savanna	rocky shrub patch	0	CHNA, ATCA	Some rocks in patch, W edge Cedar Canyon
CNVE	WUPA-GS-068	6/25/2003	1041	adult					savanna	open cinder/shrub patch	1	CHNA	Along E edge Cedar Canyon
CNVE	WUPA-GS-069	6/30/2003	806	adult					grassland	sparse grass	2	CHNA	
CNVE	WUPA-GS-069	6/30/2003	812	subadult					grassland	med dense grass	1	CHNA	probably a 2 year old
CNVE	WUPA-GS-069	6/30/2003	829	adult					grassland	sparse grass	2	JUMO	small adult
CNVE	WUPA-GS-069	6/30/2003	835	juvenile					grassland	rocky, weedy patch along limestone ridge	3	JUMO	normally I'd say yearling, but probably 2 year old. 3 m to large tree.

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
CNVE	WUPA-GS-069	6/30/2003	842	adult					grassland	under a juniper	0	JUMO	
CNVE	WUPA-GS-069	6/30/2003	859	adult					grassland	med dense grass	2	CHNA	
CNVE	WUPA-GS-069	6/30/2003	933	adult					grassland	med dense grass	2	CHNA	warm and fast
CNVE	WUPA-GS-069	6/30/2003	937	adult					grassland	dense grass (tall Stipa)	6	CHNA	
CNVE	WUPA-GS-069	6/30/2003	945	adult					grassland	shrub patch	0	CHNA	
CNVE	WUPA-GS-069	6/30/2003	953	adult					grassland	shrub patch	0	CHNA	Use of shrubs may now be influenced by temperature? (later in the day, hotter out)
CNVE	WUPA-GS-071	7/12/2003	755	adult					grassland	shrub patch	0	CHNA	along two-track (abandoned easternmost road)
CNVE	WUPA-GS-072	7/16/2003	915	adult					grassland	sparse grass	1	CHNA	near the mp 1 outcrop, small adult
CNVE	WUPA-GS-073	7/22/2003	825	subadult					grassland	sparse grass, open cinder patch	3	CHNA	
CNVE	WUPA-GS-073	7/22/2003	942	subadult					grassland	sparse grass/weed patch	10		N side of road.
CNVE	WUPA-GS-074	7/30/2003	900	adult					grassland	shrub patch	1	CHNA	ran away crazy like they do in the wind; N of 545
CNVE	WUPA-GS-074	7/30/2003	905	adult					grassland	sparse grass patch	3	CHNA	ran away crazy; N of 545
CNVE	WUPA-GS-074	7/30/2003	907	subadult					grassland	shrub patch	0	CHNA	N of 545
CNVE	WUPA-GS-074	7/30/2003	927	subadult					grassland	med dense grass weed patch	3	CHNA	N of 545
CNVE	WUPA-GS-074	7/30/2003	937	adult					grassland	med dense grass	5		S of 545, valley W of blowhole outcrop
CNVE	WUPA-GS-074	7/30/2003	939	adult					grassland	open cinder patch	1	CHNA	S of 545, valley W of blowhole outcrop
CNVE	WUPA-GS-075	8/3/2003	856	adult					savanna	sparse grass patch	4	ATCA	But ran to tree 7 m away, not closest shrub
CNVE	WUPA-GS-075	8/3/2003	901	adult					savanna	under a juniper	0	JUMO	small adult
CNVE	WUPA-GS-075	8/3/2003	930	adult					savanna	med dense grass	1	CHNA	
CNVE	WUPA-GS-075	8/3/2003	932	adult					savanna	shrub patch	1	CHNA	
CNVE	WUPA-GS-075	8/3/2003	945	adult					savanna	med dense grass	2	CHNA	ran to tree 8 m away. small adult
CNVE	WUPA-GS-075	8/3/2003	949	subadult					savanna	shrub patch	0	CHNA	
CNVE	WUPA-GS-075	8/3/2003	950	subadult					savanna	shrub patch	0	CHNA	small adult
CNVE	WUPA-GS-075	8/3/2003	953	adult					savanna	sparse grass	3	CHNA	good adult
CNVE	WUPA-GS-076	8/22/2003	1004	hatchling					grassland	med dense grass/weeds	2	CHNA	
CNVE	WUPA-GS-076	8/22/2003	1013	hatchling					grassland	med dense grass	2	CHNA	disturbed road edge along FR 545

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
CNVE	WUPA-GS-076	8/22/2003	1016	hatchling					grassland	med dense weeds	3	CHNA	disturbed road edge along FR 545
CNVE	WUPA-GS-076	8/22/2003	1019	adult					grassland	dense weed patch	10	CHNA	disturbed road edge along FR 545. 2 year old?
CNVE	WUPA-GS-076	8/22/2003	1025	adult					grassland	med dense weed	2	CHNA, GUSA	disturbed road edge along FR 545. 6 m from road
CNVE	WUPA-GS-076	8/22/2003	1027	adult					grassland	dense weed patch	0		disturbed road edge along FR 545. DTS = infinity (functionally), weeds are so dense and extensive
CNVE	WUPA-GS-076	8/22/2003	1029	adult					grassland	dense weed patch	0		disturbed road edge along FR 545. DTS = infinity (functionally), weeds are so dense and extensive
CNVE	WUPA-GS-076	8/22/2003	1030	hatchling					grassland	dense grass/weed patch	2	CHNA	disturbed road edge along FR 545.
CRCO	WUPA-GS-007	5/15/2001	1230	adult	M				rubble below Citadel Ruin				time approx. Photod.
CRCO	WUPA-GS-011	5/29/2001	830	adult					base of Doney Mtn				time approx
CRCO	WUPA-GS-011	5/29/2001	1000	adult					rocks near E edge grassland area				time approx
CRCO	WUPA-GS-014	6/12/2001	945	adult	F				rocky slope				time approx. Post partum
CRCO	WUPA-GS-019	6/14/2001		adult	F				rockpile, grassland	rocks			Rocks along wash N of FR 545, gravid.
CRCO	WUPA-GS-021	6/15/2001	1230	adult	M				rocks along S rim Citadel Sink				time approximate
CRCO	WUPA-GS-021	6/15/2001	1230	adult	F				Basalt rockpile by trail of Citadel ruin				Post partum? Time approximate
CRCO	WUPA-GS-060	5/21/2003	922	adult	M				savanna	tree	0	JUMO	Climbing on lower branches/trunk of tree velox ran to!
CRCO	WUPA-GS-060	5/21/2003	1004	adult	M				savanna	under a juniper	0	JUMO	Ran in burrow at base of trunk.
CRCO	WUPA-GS-061	5/22/2003	1010	adult	M				woodland	open sandstone			At borrow pit. Photod.
CRCO	WUPA-GS-062	5/29/2003	1020	adult	M				grassland	shrub/rock patch	0		in wash bottom of rocky wash
CRCO	WUPA-GS-065	6/3/2003	922	adult	M				savanna	rocky ground near tree	1	JUMO	
CRCO	WUPA-GS-070	7/1/2003	940	adult	M				savanna	On rocks along trail up to Citadel Ruin			
CRVI	Grazed #9	7/26/2001	900	adult		454138	3937918		grazed grassland				UTM is center of plot. Coiled under 40 cm rabbitbrush.
GAWI	WUPA-GS-005	5/9/2001	1335	adult					in middle of wash bottom	grass clump			almost stepped on it! Ca. 80 m upwash large juniper
GAWI	WUPA-GS-011	5/29/2001	730	adult						under Ephedra			time approx

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
GAWI	Grazed #2	6/28/2001	1034	adult	M	465215	3938757		grazed grassland				UTM is center of plot. Ran into old burrow.
GAWI	WUPA-GS-059	5/20/2003	1008	adult	F				grassland	shrub patch	0	ATCA	DTS now in effect. Gravid, in partial shade of ATCA.
GAWI	WUPA-GS-059	5/20/2003	1038	adult					grassland	open weeds of disturbed road edge	3	CHNA	DTS now in effect. Ran to 3 m distant rabbitbrush
GAWI	WUPA-GS-060	5/21/2003	1113	adult					savanna	under 4 wing just W parking lot	0	ATCA	
HOMA	WUPA-GS-005	5/9/2001	915	adult	F	464353	3935199	12	grassland				*Hilaria/Stipa* grassland, some shadscale and snakeweed; TBP 058;
HOMA	WUPA-GS-005	5/9/2001	930										Time approximate, 1 of 2 seen along canyon rim before dropping into Antelope Wash
HOMA	WUPA-GS-005	5/9/2001	930										Time approximate, 2 of 2 seen along canyon rim before dropping into Antelope Wash
HOMA	Grassland #1 LIZARD LINE	5/15/2001	1042	adult	M				grassland				on-walk observation
HOMA	Grazed #1	6/14/2001	1055	adult	M	452792	3938416		grazed grassland				UTM is center of plot.
HOMA	Grazed #1	6/14/2001	1100	adult	F	452792	3938416		grazed grassland	ran into prairie dog burrow			UTM is center of plot.
HOMA	Grazed #1	6/14/2001	1106	adult	F	452792	3938416		grazed grassland	by prairie dog burrow			UTM is center of plot. gravid.
HOMA	Grazed #1	6/14/2001	1108	adult	M	452792	3938416		grazed grassland	by prairie dog burrow			UTM is center of plot.
HOMA	Grazed #1	6/14/2001	1110	adult	M	452792	3938416		grazed grassland	by prairie dog burrow			UTM is center of plot.
HOMA	Grazed #1	6/14/2001	1110	adult	F	452792	3938416		grazed grassland	by prairie dog burrow			UTM is center of plot. post-partum.
HOMA	Grazed #1	6/14/2001	1117	adult	M	452792	3938416		grazed grassland	in open			UTM is center of plot.
HOMA	Grazed #1	6/14/2001	1130	adult		452792	3938416		grazed grassland	darted into burrow			UTM is center of plot.
HOMA	Grazed #1	6/14/2001	1133			452792	3938416		grazed grassland	burrow complex area			UTM is center of plot. 1 of 3 seen together, may be same same as ones seen earlier.
HOMA	Grazed #1	6/14/2001	1133			452792	3938416		grazed grassland	burrow complex area			UTM is center of plot. 2 of 3 seen together, may be same same as ones seen earlier.

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub	Notes
HOMA	Grazed #1	6/14/2001	1133			452792	3938416		grazed grassland	burrow complex area			UTM is center of plot. 3 of 3 seen together, may be same same as ones seen earlier.
HOMA	Grazed #1	6/14/2001	1136	adult	F	452792	3938416		grazed grassland	darted into burrow			UTM is center of plot. Gravid. May be same same as ones seen earlier.
HOMA	WUPA-GS-021	6/15/2001	1040	adult	M	454918	3934235		grassland				TBP 094
HOMA	Woodland #1	6/25/2001	854	adult	M	459611	3933027		woodland	open cinder area, ran to grassy area			UTM is center of plot
HOMA	Grazed #2	6/28/2001	1000	adult	F	465215	3938757		grazed grassland				UTM is center of plot
HOMA	Grazed #2	6/28/2001	1003	adult	F	465215	3938757		grazed grassland				UTM is center of plot. Gravid.
HOMA	Grazed #2	6/28/2001	1024	adult	M	465215	3938757		grazed grassland				UTM is center of plot.
HOMA	Grazed #2	6/28/2001	1025	adult	M	465215	3938757		grazed grassland				UTM is center of plot.
HOMA	Grazed #2	6/28/2001	1029	adult	M	465215	3938757		grazed grassland				UTM is center of plot. Missing end of tail.
HOMA	Grazed #2	6/28/2001	1031	adult	M	465215	3938757		grazed grassland				UTM is center of plot.
HOMA	Grazed #2	6/28/2001	1047	adult		465215	3938757		grazed grassland				UTM is center of plot. Ran into burrow.
HOMA	RE	6/29/2001	815	adult					woodland or savanna				time approximate; 1 of 2 seen on walk to point
HOMA	RE	6/29/2001	815	adult					woodland or savanna				time approximate; 2 of 2 seen on walk to point
HOMA	Savanna #4	6/29/2001	858	adult	F	460048	3934544		savanna				UTM is center of plot; gravid, or recently so (saw orange color)
HOMA	Woodland #5	7/3/2001	747	adult	M	458323	3933340		woodland	basking on small rock			UTM is center of plot
HOMA	Woodland #5	7/3/2001	834	adult	M	458323	3933340		woodland	ran off plot, along E edge			UTM is center of plot
HOMA	Woodland #4	7/6/2001	1058	adult	M	457215	3934225		woodland	ran to a juniper			UTM is center of plot.
HOMA	Grassland #4	7/8/2001	833	adult	M	459127	3937121		grassland				UTM is center of plot
HOMA	Grassland #4	7/8/2001	841	adult	F	459127	3937121		grassland	by small burrow			UTM is center of plot. Orange, not super fat
HOMA	Grassland #4	7/8/2001	851	adult	M	459127	3937121		grassland	near 1 m juniper			UTM is center of plot.
HOMA	Grazed #8	7/16/2001	812	adult	M	457742	3938492		grazed grassland				UTM is center of plot.
HOMA	Grazed #8	7/16/2001	824	adult	M	457742	3938492		grazed grassland	Along road (cuts through plot)			UTM is center of plot. Only 1 m from female at same time
HOMA	Grazed #8	7/16/2001	824	adult	F	457742	3938492		grazed grassland	Along road (cuts through plot)			UTM is center of plot. Only 1 m from male at same time
HOMA	Grazed #8	7/16/2001	830	adult	M	457742	3938492		grazed grassland				UTM is center of plot.
HOMA	Grazed #8	7/16/2001	833	adult	M	457742	3938492		grazed grassland				UTM is center of plot.

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
HOMA	Grazed #8	7/16/2001	855	adult	M	457742	3938492		grazed grassland				UTM is center of plot.
HOMA	Grazed #8	7/16/2001	909	adult	M	457742	3938492		grazed grassland				UTM is center of plot.
HOMA	Grazed #4	7/16/2001	953	adult	M	462022	3938585		grazed grassland				UTM is center of plot.
HOMA	Grazed #4	7/16/2001	1009	adult	M	462022	3938585		grazed grassland	ran and perched on cow pie			UTM is center of plot.
HOMA	Grazed #4	7/16/2001	1013	adult	F	462022	3938585		grazed grassland				UTM is center of plot. Looks gravid.
HOMA	Grazed #4	7/16/2001	1017	adult	F	462022	3938585		grazed grassland				UTM is center of plot. Post partum? (orange sides, skinny)
HOMA	Grazed #4	7/16/2001	1030	adult	F	462022	3938585		grazed grassland				UTM is center of plot. Eating ca 1 cm long grasshopper. Orange, skin folds on sides (post-partum?)
HOMA	Savanna #7	7/19/2001	807	adult		453700	3933344		savanna	ran into snakeweed along old 2 track			UTM is center of plot
HOMA	Savanna #5	7/21/2001	801	adult		461807	3933719		savanna	ran into a rabbitbrush			UTM is center of plot
HOMA	RE	7/21/2001	945						savanna				Antelope Prairie, W of Savanna #5. On walk to Woodland #6. Time approximate. 1 of 2 seen along way
HOMA	RE	7/21/2001	945						savanna				Antelope Prairie, W of Savanna #5. On walk to Woodland #6. Time approximate. 2 of 2 seen along way
HOMA	Grazed #9	7/26/2001	928	adult	F	454138	3937918		grazed grassland				UTM is center of plot. A little plump (gravid?)
HOMA	RE	7/26/2001	1030	adult	F	459030	3933052		woodland				Woodland #3, ENE Doney Fissure area. UTM is center of plot. Saw before survey started.
HOMA	Woodland #3	7/26/2001	1051	adult	M	459030	3933052		woodland	open cinder area			UTM is center of plot.
HOMA	Woodland #3	7/26/2001	1107	adult	F	459030	3933052		woodland				UTM is center of plot. Small adult, but gravid (orange)
HOMA	Woodland #2	7/29/2001	1057	adult		456149	3933248		woodland	under a tree			UTM is center of plot. Small adult (last year's hatchling)
HOMA	Grazed #3	8/14/2001	854	adult	M	460924	3938169		grazed grassland	under old rabbitbrush			UTM is center of plot.
HOMA	Grazed #3	8/14/2001	858	adult	M	460924	3938169		grazed grassland				UTM is center of plot.
HOMA	Grazed #3	8/14/2001	930	adult		460924	3938169		grazed grassland				UTM is center of plot.
HOMA	Grazed #3	8/14/2001	931	adult	M	460924	3938169		grazed grassland				UTM is center of plot.
HOMA	Grazed #3	8/14/2001	934	adult	M	460924	3938169		grazed grassland				UTM is center of plot.
HOMA	Grazed #3	8/14/2001	938	adult	F	460924	3938169		grazed grassland				UTM is center of plot.

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
HOMA	Grazed #3	8/14/2001	939	adult	F	460924	3938169		grazed grassland				UTM is center of plot.
HOMA	Grazed #7	8/14/2001	1017	adult	M	460439	3938560		grazed grassland				UTM is center of plot.
HOMA	Grazed #7	8/14/2001	1018	adult	M	460439	3938560		grazed grassland				UTM is center of plot. Small adult.
HOMA	Grazed #7	8/14/2001	1020	adult	M	460439	3938560		grazed grassland				UTM is center of plot.
HOMA	Grazed #7	8/14/2001	1033	adult	M	460439	3938560		grazed grassland				UTM is center of plot.
HOMA	Grazed #7	8/14/2001	1051	adult		460439	3938560		grazed grassland				UTM is center of plot.
HOMA	Grazed #7	8/14/2001	1102	adult		460439	3938560		grazed grassland				UTM is center of plot. Small adult.
HOMA	WUPA-GS-059	5/20/2003	907	adult	F				grassland	sparse grass			DTS not officially recorded this survey. Open grassy patch.
HOMA	WUPA-GS-060	5/21/2003	916	adult	F				savanna		1	ATCA	Ran 1 m to 4-wing
HOMA	WUPA-GS-060	5/21/2003	958	adult	M				savanna	sparse grass	1	CHNA	
HOMA	WUPA-GS-060	5/21/2003	1100	adult					savanna	Floor of Box Canyon, on small rock			Photod on rock.
HOMA	WUPA-GS-061	5/22/2003	927	adult	M				woodland	open cinder patch	3	JUMO	on rock in open cinder patch
HOMA	WUPA-GS-061	5/22/2003	950	adult	F				woodland	sparse grass/limestone chunk patch	3	JUMO	Gravid
HOMA	WUPA-GS-062	5/29/2003	903	adult					grassland	under large snakeweed	0	GUSA	darted to prairie dog burrow beneath the snakeweed
HOMA	WUPA-GS-062	5/29/2003	906	adult					grassland	sparse grass/weeds	3		
HOMA	WUPA-GS-062	5/29/2003	913	adult	M				grassland	shrub patch	0	ATCA	under edge of large four wing
HOMA	WUPA-GS-064	6/2/2003	845	adult					savanna	sparse grass	1		
HOMA	WUPA-GS-064	6/2/2003	956	adult	M				savanna	roadside dense grass			
HOMA	WUPA-GS-065	6/3/2003	831	adult	M				savanna	rocky patch	2	JUMO	
HOMA	Grazed land adjacent to Wupatki	6/3/2003	955	adult	M				grazed grassland	sparse grass/rabbitbrush			Whole area is sparse, short (grazed) grass choked with short (<0.5m) rabbitbrush
HOMA	Grazed land adjacent to Wupatki	6/3/2003	1000	adult	M				grazed grassland	sparse grass/rabbitbrush			Whole area is sparse, short (grazed) grass choked with short (<0.5m) rabbitbrush
HOMA	WUPA-GS-066	6/4/2003	856	adult	F				woodland	sparse grass/weed patch by wash	2	JUMO	
HOMA	WUPA-GS-066	6/4/2003	930	adult	M				woodland	open cinder patch	4	JUMO	
HOMA	WUPA-GS-066	6/4/2003	942	adult	M				woodland	sparse grass	3	JUMO	
HOMA	WUPA-GS-067	6/5/2003	923	adult	F				grassland	shrub patch	0	CHNA	orange color

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
HOMA	WUPA-GS-067	6/5/2003	1005	adult	M				grassland	med dense grass	2	CHNA	
HOMA	WUPA-GS-068	6/25/2003	911	adult					savanna	shrub patch	0	LYPA	*Lycium pallidum* patch
HOMA	WUPA-GS-069	6/30/2003	939	adult					grassland	med dense grass with 1 shrub	0	CHNA	
HOMA	WUPA-GS-074	7/30/2003	925	adult	F				grassland	shrub patch	0	CHNA	N of 545
HOMA	WUPA-GS-076	8/22/2003	852	adult	M				grassland	med dense grass	2	CHNA	soil damp
HOMA	WUPA-GS-076	8/22/2003	857	adult	F				grassland	shrub patch (snakeweed)	0	GUSA	soil damp
HOMA	WUPA-GS-076	8/22/2003	903	hatchling					grassland	shrub patch (snakeweed)	0	GUSA	soil damp
HOMA	WUPA-GS-076	8/22/2003	946	adult					grassland	shrub patch	1	CHNA	
MATA	WUPA-GS-064	6/2/2003	825	adult					savanna	shrub patch	0	CHNA	Outstretched half under a rabbitbrush. Photod. Ca. 2.5 feet long TL.
MATA	WUPA-GS-067	6/5/2003	944	adult					grassland	shrub patch	0	CHNA	BIG adult in rabbitbrush patch, vanished down a pretty small hole!
PHHE	WUPA-GS-005	5/9/2001	915	adult	F	464353	3935199	12	grassland				2 m from HOMA seen at same time. Photographed.
PHHE	WUPA-GS-064	6/2/2003	810	adult	F				savanna	sparse grass/snakeweed patch			In open, ran away and when caught, squirted blood on me! Photod. Ca 200 m N Citadel.
PHHE	WUPA-GS-072	7/16/2003	839	adult	M				grassland	resting in shade of rabbitbrush, shrub patch	0	CHNA	
SCMA	WUPA-GS-005	5/9/2001	1032	juvenile		464603	3935466	32	bottom of wash	limestone boulder at wash edge			
SCMA	WUPA-GS-005	5/9/2001	1040	adult	M	464559	3935567	27	rocky ledge in wash bottom				
SCMA	WUPA-GS-005	5/9/2001	1140	adult		464177	3935677	26	rock ledge at edge of wash bottom				
SCMA	WUPA-GS-011	5/29/2001	752	adult		464396	3933304	18	Ephedra-Hilaria grassland	lava rockpile			
SCMA	WUPA-GS-011	5/29/2001	908	adult	M	464364	3933184	20	S edge grassland terrace area	lava rockpile			
SCUN	WUPA-GS-005	5/9/2001	930						along canyon rim	by lone juniper			Time approximate; before dropping into Antelope Wash
SCUN	WUPA-GS-005	5/9/2001	1030	adult					rocky areas in wash bottom				Time approximate. 1 of 3 seen around this time
SCUN	WUPA-GS-005	5/9/2001	1030	adult					rocky areas in wash bottom				Time approximate. 2 of 3 seen around this time

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
SCUN	WUPA-GS-005	5/9/2001	1030	adult					rocky areas in wash bottom				Time approximate. 3 of 3 seen around this time
SCUN	WUPA-GS-005	5/9/2001	1140	adult									Nearby to 1140 SCMA
SCUN	WUPA-GS-005	5/9/2001	1240	adult						large rock			Time approximate, 1 of 5 seen ca. 1220-1250
SCUN	WUPA-GS-005	5/9/2001	1240	adult						large rock			Time approximate, 2 of 5 seen ca. 1220-1250
SCUN	WUPA-GS-005	5/9/2001	1240	adult						large rock			Time approximate, 3 of 5 seen ca. 1220-1250
SCUN	WUPA-GS-005	5/9/2001	1240	adult						large rock			Time approximate, 4 of 5 seen ca. 1220-1250
SCUN	WUPA-GS-005	5/9/2001	1240	adult						large rock			Time approximate, 5 of 5 seen ca. 1220-1250
SCUN	WUPA-GS-005	5/9/2001	1300						rocks at edge of wash				Time approximate. 1 of 2 seen ca. 1250-1330
SCUN	WUPA-GS-005	5/9/2001	1300						rocks at edge of wash				Time approximate. 2 of 2 seen ca. 1250-1330
SCUN	WUPA-GS-005	5/9/2001	1328	adult		462921	3933776	18	in wash bottom	large juniper			
SCUN	WUPA-GS-005	5/9/2001	1350	adult						small rock under a bush			Time approximate
SCUN	WUPA-GS-006	5/11/2001	900	adult						basalt rocks			Time approximate
SCUN	WUPA-GS-006	5/11/2001	900	adult						juniper snag			Time approximate
SCUN	WUPA-GS-006	5/11/2001	930	adult					head of Hull's Canyon graben	Basalt rocks			Time approximate, seen ca. 0905-0947. 1 of 5 seen.
SCUN	WUPA-GS-006	5/11/2001	930	adult					head of Hull's Canyon graben	Basalt rocks			Time approximate, ca. 0905-0947. 2 of 5 seen.
SCUN	WUPA-GS-006	5/11/2001	930	adult					head of Hull's Canyon graben	Basalt rocks			Time approximate, ca. 0905-0947. 3 of 5 seen.
SCUN	WUPA-GS-006	5/11/2001	930	adult					head of Hull's Canyon graben	Basalt rocks			Time approximate, ca. 0905-0947. 4 of 5 seen.
SCUN	WUPA-GS-006	5/11/2001	930	adult					head of Hull's Canyon graben	Basalt rocks			Time approximate, ca. 0905-0947. 5 of 5 seen.
SCUN	WUPA-GS-006	5/11/2001	930	juvenile					head of Hull's Canyon graben	Basalt rocks			Time approximate, ca. 0905-0947. 1 of 2 seen.
SCUN	WUPA-GS-006	5/11/2001	930	juvenile					head of Hull's Canyon graben	Basalt rocks			Time approximate, ca. 0905-0947. 2 of 2 seen.
SCUN	WUPA-GS-006	5/11/2001	1005						basalt ridge south of Hull's Canyon				Time approximate, same area as 1011 tree lizard

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
SCUN	WUPA-GS-006	5/11/2001	1020	juvenile					basalt ridge south of Hull's Canyon, near WS 952				Time approximate
SCUN	WUPA-GS-006	5/11/2001	1030						basalt ridge south of Hull's Canyon				Time approximate; near boundary
SCUN	Grassland #1 LIZARD LINE	5/15/2001	920	adult					grassland	rockpile			off-walk observation
SCUN	Grassland #1 LIZARD LINE	5/15/2001	950						grassland	rockpile			off-walk observation, 1 of 2 seen W of line
SCUN	Grassland #1 LIZARD LINE	5/15/2001	950						grassland	rockpile			off-walk observation, 2 of 2 seen W of line
SCUN	Grassland #1 LIZARD LINE	5/15/2001	1100						grassland	Rockpile; on rocks just S of blowhole			off-walk observation, time approx, 1 of 2 seen
SCUN	Grassland #1 LIZARD LINE	5/15/2001	1100						grassland	Rockpile; on rocks just S of blowhole			off-walk observation, time approx, 2 of 2 seen
SCUN	WUPA-GS-007	5/15/2001	1145	adult					rocks				time approx
SCUN	WUPA-GS-007	5/15/2001	1145	juvenile					rocks				time approx
SCUN	WUPA-GS-007	5/15/2001	1220						base of Citadel Ruin				time approx. 1 of 4 seen here
SCUN	WUPA-GS-007	5/15/2001	1220						base of Citadel Ruin				time approx. 2 of 4 seen here
SCUN	WUPA-GS-007	5/15/2001	1220						base of Citadel Ruin				time approx. 3 of 4 seen here
SCUN	WUPA-GS-007	5/15/2001	1220						base of Citadel Ruin				time approx. 4 of 4 seen here
SCUN	WUPA-GS-007	5/15/2001	1220						Nalakihu Ruin				time approx
SCUN	WUPA-GS-007	5/15/2001	1300										1 of 3 seen this survey
SCUN	WUPA-GS-007	5/15/2001	1300										2 of 3 seen this survey
SCUN	WUPA-GS-007	5/15/2001	1300										3 of 3 seen this survey
SCUN	WUPA-GS-011	5/29/2001	1010	adult					in middle of grassy area	rockpile			
SCUN	WUPA-GS-015	6/12/2001											1 of 5 seen this survey
SCUN	WUPA-GS-015	6/12/2001											2 of 5 seen this brief survey
SCUN	WUPA-GS-015	6/12/2001											3 of 5 seen this brief survey
SCUN	WUPA-GS-015	6/12/2001											4 of 5 seen this brief survey
SCUN	WUPA-GS-015	6/12/2001											5 of 5 seen this brief survey
SCUN	WUPA-GS-014	6/12/2001	945	adult									time approx. 1 of 2 seen this survey
SCUN	WUPA-GS-014	6/12/2001	945	adult									time approx. 2 of 2 seen this survey
SCUN	WUPA-GS-019	6/14/2001		adult					grassland	rockpile			Rockpile just S of FR 545, 1 of 4 here
SCUN	WUPA-GS-019	6/14/2001		adult					grassland	rocks			Rockpile just S of FR 545, 2 of 4 here
SCUN	WUPA-GS-019	6/14/2001		adult					grassland	rocks			Rockpile just S of FR 545, 3 of 4 here

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
SCUN	WUPA-GS-019	6/14/2001		adult					grassland	rocks			Rockpile just S of FR 545, 4 of 4 here
SCUN	WUPA-GS-019	6/14/2001							grassland	rocks			1 of 11 seen on Rockpiles along wash N of FR 545
SCUN	WUPA-GS-019	6/14/2001							Grassland	rocks			2 of 11 seen on Rockpiles along wash N of FR 545
SCUN	WUPA-GS-019	6/14/2001							Grassland	rocks			3 of 11 seen on Rockpiles along wash N of FR 545
SCUN	WUPA-GS-019	6/14/2001							Grassland	rocks			4 of 11 seen on Rockpiles along wash N of FR 545
SCUN	WUPA-GS-019	6/14/2001							Grassland	rocks			5 of 11 seen on Rockpiles along wash N of FR 545
SCUN	WUPA-GS-019	6/14/2001							Grassland	rocks			6 of 11 seen on Rockpiles along wash N of FR 545
SCUN	WUPA-GS-019	6/14/2001							Grassland	rocks			7 of 11 seen on Rockpiles along wash N of FR 545
SCUN	WUPA-GS-019	6/14/2001							Grassland	rocks			8 of 11 seen on Rockpiles along wash N of FR 545
SCUN	WUPA-GS-019	6/14/2001							Grassland	rocks			9 of 11 seen on Rockpiles along wash N of FR 545
SCUN	WUPA-GS-019	6/14/2001							grassland	rocks			10 of 11 seen on Rockpiles along wash N of FR 545
SCUN	WUPA-GS-019	6/14/2001							grassland	rocks			11 of 11 seen on Rockpiles along wash N of FR 545
SCUN	WUPA-GS-021	6/15/2001							rocks on W side of South Mesa				1 of 6 seen along this section
SCUN	WUPA-GS-021	6/15/2001							rocks on W side of South Mesa				2 of 6 seen along this section
SCUN	WUPA-GS-021	6/15/2001							rocks on W side of South Mesa				3 of 6 seen along this section
SCUN	WUPA-GS-021	6/15/2001							rocks on W side of South Mesa				4 of 6 seen along this section
SCUN	WUPA-GS-021	6/15/2001							rocks on W side of South Mesa				5 of 6 seen along this section
SCUN	WUPA-GS-021	6/15/2001							rocks on W side of South Mesa				6 of 6 seen along this section
SCUN	Woodland #1	6/25/2001	825	adult	F	459611	3933027		juniper woodland	debris mound of packrat nest at juniper base			UTM is center of plot

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
SCUN	Woodland #5	7/3/2001	832	adult		458323	3933340		juniper woodland	under 3 m juniper near NE corner of plot			UTM is center of plot
SCUN	Woodland #7	7/3/2001	938	adult		457741	3933440		woodland	perched on juniper stump			UTM is center of plot
SCUN	WUPA-GS-023	7/8/2001	740						grassland	basalt rockpile near ruins			Time approximate
SCUN	Savanna #5	7/21/2001	807	adult		461807	3933719		savanna	at base of tree			UTM is center of plot
SCUN	WUPA-GS-036	5/23/2002							grassland	rockpile S of FR 545			1 of 5 seen here this survey, 1300-1425 hrs
SCUN	WUPA-GS-036	5/23/2002							grassland	rockpile S of FR 545			2 of 5 seen here this survey, 1300-1425 hrs
SCUN	WUPA-GS-036	5/23/2002							grassland	rockpile S of FR 545			3 of 5 seen here this survey, 1300-1425 hrs
SCUN	WUPA-GS-036	5/23/2002							grassland	rockpile S of FR 545			4 of 5 seen here this survey, 1300-1425 hrs
SCUN	WUPA-GS-036	5/23/2002							grassland	rockpile S of FR 545			5 of 5 seen here this survey, 1300-1425 hrs
SCUN	WUPA-GS-059	5/20/2003	919	adult					grassland	on small rockpile			DTS not officially recorded this survey.
SCUN	WUPA-GS-059	5/20/2003	921	adult					grassland	shrub patch			DTS not officially recorded this survey. No rocks here.
SCUN	WUPA-GS-060	5/21/2003	1026	adult					savanna	rocky ledge in Lomaki Wash			
SCUN	WUPA-GS-060	5/21/2003	1037	adult					savanna	on rocks in Lomaki Wash			
SCUN	WUPA-GS-060	5/21/2003	1102	adult					savanna	on ground in Box Canyon			
SCUN	WUPA-GS-061	5/22/2003	845	adult					woodland	Rocky ledge			Upper Hull's Canyon
SCUN	WUPA-GS-061	5/22/2003	847	immature					woodland	rock outcrop			Upper Hull's Canyon
SCUN	WUPA-GS-061	5/22/2003	849	subadult					woodland	under juniper	0	JUMO	Upper Hull's Canyon
SCUN	WUPA-GS-062	5/29/2003	923	adult					grassland	rocks in rocky wash			
SCUN	WUPA-GS-062	5/29/2003	925	adult					grassland	under rabbitbrush in rocky wash	0	CHNA	
SCUN	WUPA-GS-062	5/29/2003	930	adult	M				grassland	on rocks, in rocky wash			
SCUN	WUPA-GS-062	5/29/2003	1021	adult					grassland	rock wall			in rocky wash
SCUN	WUPA-GS-062	5/29/2003	1027	adult					grassland	on boulder in wash			in rocky wash, 1 of 2 seen on boulder

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub	Notes
SCUN	WUPA-GS-062	5/29/2003	1027	adult					grassland	on boulder in wash			in rocky wash, 2 of 2 seen on boulder
SCUN	WUPA-GS-062	5/29/2003	1042	adult					grassland	on rocks			in very small rocky "wash" N of FR 545
SCUN	WUPA-GS-064	6/2/2003	822	adult					savanna	sparse grass/cinder	1		in (self-made?) burrow
SCUN	WUPA-GS-067	6/5/2003	824	adult	M				grassland	on rocks	2		Along rocky limestone ridge
SCUN	WUPA-GS-069	6/30/2003	835	adult					grassland	juniper	0	JUMO	on the big tree
SCUN	WUPA-GS-070	7/1/2003	849	adult	M				savanna	on rocks along West Mesa			
SCUN	WUPA-GS-072	7/16/2003	753	adult					grassland	on rock at base of outcrop			
SCUN	WUPA-GS-072	7/16/2003	806	adult					grassland	on outcrop, near S end ca 1/2 mi. S FR 545			
SCUN	WUPA-GS-073	7/22/2003	836	adult	M				grassland	on rocks in wash			N side of road
SCUN	WUPA-GS-073	7/22/2003	839	adult					grassland	on rockpile			N side of road
SCUN	WUPA-GS-073	7/22/2003	843	subadult					grassland	on rockpile			N side of road
SCUN	WUPA-GS-073	7/22/2003	903	adult					grassland	on rocks			S side of road
SCUN	WUPA-GS-073	7/22/2003	906	adult					grassland	on rocks			S side of road
SCUN	WUPA-GS-073	7/22/2003	907	adult					grassland	on rocks			S side of road; 1 of 2 this time/place
SCUN	WUPA-GS-073	7/22/2003	907	adult					grassland	on rocks			S side of road; 2 of 2 this time/place
SCUN	WUPA-GS-073	7/22/2003	931	adult	M				grassland	on rocks			S side of road.
SCUN	WUPA-GS-076	8/22/2003	909	adult					grassland	packrat nest			in rocks in the 'gorge' near N boundary
SCUN	WUPA-GS-076	8/22/2003	915	adult					grassland	on rocks in 'gorge'			on rocks in the 'gorge' near N boundary
SCUN	WUPA-GS-076	8/22/2003	958	adult					grassland	on rockpile			
UIL	Grassland #7	7/6/2001	821			454010	3937119		grassland				possible *Holbrookia*, disappeared! UTM is center of plot
UIL	Grassland #4	7/8/2001	815			459127	3937121		grassland	ran into mostly dead rabbitbrush, wouldn't emerge			UTM is center of plot. PROBABLY A *HOLBROOKIA*.
UIL	Grazed #3	8/14/2001	852			460924	3938169		grazed grassland	under rabbitbrush			UTM is center of plot. Disappeared under shrub!
UIL	WUPA-GS-059	5/20/2003	1033						grassland	disturbed road edge grass			DTS now in effect.
UIL	WUPA-GS-061	5/22/2003	824						woodland	sandstone rockpile ruins			Just N of boundary fence along old road

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub Species	Notes
UIL	WUPA-GS-063	5/23/2003	858						savanna	basalt boulder pile			Saw blue tail, but could have been *Uta*??? (Otherwise, probably *velox*)
UIL	WUPA-GS-062	5/29/2003	856						grassland	ran into prairie dog burrow			
UIL	WUPA-GS-064	6/2/2003	916						savanna	dense grass	2		possible *Holbrookia*
UIL	WUPA-GS-065	6/3/2003	838						savanna	sparse grass	5	JUMO	probably *Holbrookia*
UIL	WUPA-GS-065	6/3/2003	918						savanna	ran under tree	0	JUMO	
UIL	WUPA-GS-066	6/4/2003	932						woodland	shrub patch	1	CHNA	ran to tree and vanished
UIL	WUPA-GS-067	6/5/2003	817						grassland	ran into rocks on ridge			Along rocky limestone ridge, probably cnemi or undulatus
UIL	WUPA-GS-067	6/5/2003	929						grassland	med dense grass	5	CHNA	possible whiptail
UIL	WUPA-GS-067	6/5/2003	931						grassland		0	CHNA	ran down hole below a rabbitbrush
UIL	WUPA-GS-069	6/30/2003	942						grassland	shrub patch	1	CHNA	blur ran away
UIL	WUPA-GS-071	7/12/2003	758						grassland	med dense grass	2	CHNA	ran away, skittery in wind
UIL	WUPA-GS-071	7/12/2003	814						grassland	sparse grass	4	ATCA	ran to big patch of 4-wing by road, near where road and N boundary fence converge
UIL	WUPA-GS-072	7/16/2003	827						grassland	disappeared in crack in outcrop			almost certainly an *undulatus*
UIL	WUPA-GS-073	7/22/2003	909						grassland	on rocks			S side of road; probably *undulatus*
UIL	WUPA-GS-074	7/30/2003	858						grassland	med dense grass	2	CHNA	ran in hole; N of 545
UIL	WUPA-GS-076	8/22/2003	940						grassland	med dense grass	0		ran in shrub, maybe *Holbrookia*?
UROR	WUPA-GS-006	5/11/2001	910	adult	M	457483	3933190	15	basalt rocks at head of graben				Time approximate. TBP 065
UROR	WUPA-GS-006	5/11/2001	910	adult	M	457468	3933189	20	basalt rocks at head of graben				Time approximate. TBP 066
UROR	WUPA-GS-006	5/11/2001	930	adult	M				head of Hull's Canyon graben (basalt rocks)				Time approximate, seen ca. 0905-0947. Photod this one (not collected)
UROR	WUPA-GS-006	5/11/2001	1011	adult	F	457504	3932829	29	basalt ridge south of Hull's Canyon				
UROR	WUPA-GS-006	5/11/2001	1020						basalt ridge south of Hull's Canyon, near WS 952				Time approximate, seen same area as tree lizard at 1011. 1 of 2 more seen
UROR	WUPA-GS-006	5/11/2001	1020						basalt ridge south of Hull's Canyon, near WS 952				Time approximate, seen same area as tree lizard at 1011. 2 of 2 more seen

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Microhabitat	DTS (m)	Shrub	Notes
UROR	WUPA-GS-006	5/11/2001	1030	adult	M	457312	3932766	33	6 m S NPS boundary, on basalt ridge by wash				Time approximate
UROR	WUPA-GS-007	5/15/2001	1210	adult	M	457169	3935619		basalt outcrop on W side Citadel Sink				
UROR	WUPA-GS-007	5/15/2001	1220	adult	M				basalt at base of Citadel Ruin				time approx
UROR	WUPA-GS-007	5/15/2001	1257	adult	M	457685	3936234	68	basalt outcrop E of Lomaki road				
UROR	WUPA-GS-007	5/15/2001	1300	adult					rocks just N of 545, near Citadel				time approximate
UROR	WUPA-GS-019	6/14/2001		adult	F				rockpile, grassland	rocks			Rockpile S of FR 545. Gravid.
UROR	WUPA-GS-019	6/14/2001		adult	M				rockpile, grassland	rocks			Rockpile S of FR 545. 1 of 4 seen here.
UROR	WUPA-GS-019	6/14/2001		adult	M				rockpile, grassland	rocks			Rockpile S of FR 545. 2 of 4 seen here.
UROR	WUPA-GS-019	6/14/2001		adult	M				rockpile, grassland	rocks			Rockpile S of FR 545. 3 of 4 seen here.
UROR	WUPA-GS-019	6/14/2001		adult	M				rockpile, grassland	rocks			Rockpile S of FR 545. 4 of 4 seen here.
UROR	WUPA-GS-019	6/14/2001		adult					rockpile, grassland	rocks			Rockpile just N of FR 545
UROR	WUPA-GS-021	6/15/2001		adult	M				rocks on W side of South Mesa				
UROR	WUPA-GS-021	6/15/2001	1230	adult	M				Limestone below Citadel Ruin				Time approximate
UROR	WUPA-GS-023	7/8/2001	740	adult		459237	3937275	16	grassland	basalt rockpile near ruins			TBP 123. Time approximate
UROR	WUPA-GS-023	7/8/2001	740	adult					grassland	basalt rockpile near ruins			Time approximate
UROR	WUPA-GS-036	5/23/2002							grassland	rockpile S of FR 545			1300-1425 hrs
UROR	WUPA-GS-060	5/21/2003	1048	adult		457556	3936727	300	savanna	On wall in Box Canyon			Photod. First sighting in Box Canyon.
UROR	WUPA-GS-073	7/22/2003	913	adult					grassland	on rocks			S side of road
UROR	WUPA-GS-073	7/22/2003	915	adult	M				grassland	on rocks			S side of road.
UROR	WUPA-GS-073	7/22/2003	925	adult	M				grassland	on rocks			S side of road.
UROR	WUPA-GS-073	7/22/2003	931	adult	M				grassland	on rocks			S side of road. 1 of 2 adult males seen here now.
UROR	WUPA-GS-073	7/22/2003	931	adult	M				grassland	on rocks			S side of road. 2 of 2 adult males seen here now.

Appendix D, continued.

Species	Survey	Date	Time	Age	Sex	UTM E	UTM N	EPE (ft)	Habitat	Micro-habitat	DTS (m)	Shrub Species	Notes
UTST	WUPA-GS-005	5/9/2001	1020	adult	M				on slope of wash				Time approximate
UTST	WUPA-GS-005	5/9/2001	1100						wash bottom				Time approximate. 1 of 4 1055-1130.
UTST	WUPA-GS-005	5/9/2001	1100						wash bottom				Time approximate. 2 of 4 seen 1055-1130.
UTST	WUPA-GS-005	5/9/2001	1100						wash bottom				Time approximate. 3 of 4 1055-1130.
UTST	WUPA-GS-005	5/9/2001	1100						wash bottom				Time approximate. 4 of 4 1055-1130.
UTST	WUPA-GS-005	5/9/2001	1140	adult									Nearby to 1140 magister
UTST	WUPA-GS-005	5/9/2001	1240	adult						rock			Time approximate, seen ca. 1220-1250
UTST	WUPA-GS-005	5/9/2001	1300						rocks at edge of wash				Time approximate. 1 of 3 ca. 1250-1330
UTST	WUPA-GS-005	5/9/2001	1300						rocks at edge of wash				Time approximate. 2 of 3 ca. 1250-1330
UTST	WUPA-GS-005	5/9/2001	1300						rocks at edge of wash				Time approximate. 3 of 3 ca. 1250-1330
UTST	WUPA-GS-011	5/29/2001	0										1 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										2 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										3 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										4 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										5 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										6 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										7 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										8 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										9 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										10 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										11 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										12 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										13 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										14 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										15 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										16 of 17 seen entire survey
UTST	WUPA-GS-011	5/29/2001	0										17 of 17 seen entire survey
UTST	WUPA-GS-015	6/12/2001	0						Lomaki Ruin graben				1 of 2 seen in this graben
UTST	WUPA-GS-015	6/12/2001	0						Lomaki Ruin graben				2 of 2 seen in this graben
UTST	WUPA-GS-014	6/12/2001	945	adult	M				on rocks				time approx. Area is N of 545, W of Lomaki rd (Uta here, Urosaurus E of Lomaki rd!)
UTST	WUPA-GS-060	5/21/2003	1107	adult	M				savanna				Box Canyon, near upper end. Sympatry of Uta and Urosaurus in Box Canyon!
UTST	WUPA-GS-060	5/21/2003	1107	adult	F				savanna				Box Canyon, near upper end. Sympatry of Uta and Urosaurus in Box Canyon!

Appendix E. Specimens of *Cnemidophorus inornatus* and *C. velox* in institutional museum collections from the vicinity of Wupatki National Monument, Arizona.

Species	Museum No.	Date Collected	Collectors	Locality
C. inornatus	LACM 137269-71	(June?) 1986	JW Wright	Wupatki, Hwy 89 (trading post)
C. inornatus	LACM 14679	8/9/1931	Bogert	Wupatki Ruins
C. inornatus	MNA Z7.1014	5/3/1969	CJ May	1 mi. E on Wupatki Nat'l Mon. rd from US 89
C. inornatus	MNA Z7.1038	7/30/1972	CJ May	0.8 mi. E on Wupatki Nat'l Mon. rd from US 89
C. inornatus	MNA Z7.2845	7/20/1966	CJ May	1 mi. E on Wupatki Nat'l Mon, rd. from US 89
C. velox	LACM 137272-85	(June?) 1986	JW Wright	Wupatki, Hwy 89 (trading post)
C. velox	MNA Z7.2548	5/31/1967	RS Funk and CJ May	1 mi. E on Wupatki Nat'l Mon. rd from US 89
C. velox	WUPA 16983	9/2/2000	Trevor B Persons	FR 454, milepost 4.6
C. velox	MNA Z7. 127	8/18/1933	CW Quaintance	Wupatki
C. velox	BYU 32087	6/10/1969	McMorris	Wupatki National Monument
C. velox	UAZ 5362	8/2/1951	CH Lowe	Wupatki Nat'l Mon, 1.2 mi. W The Citadel
C. velox	UAZ 5374	8/2/1951	CH Lowe	Wupatki Nat'l Mon, 1.2 mi. W The Citadel
C. velox	WUPA 1770	July 1976	Richard V Harris	Wupatki Residence Area
C. velox	MNA Z7.128	8/19/1933	CW Quaintance	Wupatki, on cinder hill slope

Appendix F. Whiptail lizard specimens collected within the study area at Wupatki National Monument, Arizona 2001-2003. Specimens are housed in the vertebrate collections of the Flagstaff Area National Monuments, and are cataloged under accession number WUPA-412.

Species	Field No.	NPS Catalog No.	Date	UTM E	UTM N	Age	Locality	Notes
Cnemidophorus velox	TBP 057	WUPA 24700	5/9/2001	463557	3933387	adult	East of Antelope Wash	SVL 83, VT 182
Cnemidophorus inornatus	TBP 059	WUPA 24702	5/9/2001	464266	3935834	adult	Bottom of Antelope Wash	Female, SVL 56, VT 123
Cnemidophorus velox	TBP 060	WUPA 24703	5/9/2001	464263	3935765	adult	Bottom of Antelope Wash, same area as TBP 059	SVL 78, VT 167
Cnemidophorus tigris	TBP 061	WUPA 24704	5/9/2001	464067	3935225	adult	Bottom of Antelope Wash	Female, SVL 84, VT 173 (91 of it regenerated); just up canyon from TBP 059-060
Cnemidophorus inornatus	TBP 067	WUPA 24707	5/15/2001	453290	3936586	adult	South of blowhole, s. of FR 545 ca. 1 mile east of US 89, near whiptail study grassland point #1	Male, SVL 58, VT 106 (39 of it regenerated)
Cnemidophorus velox	TBP 114	WUPA 24710	6/28/2001	460544	3937515	adult	Below Mesa Well, just s. of n. Wupatki bdy.	
Cnemidophorus velox	TBP 115	WUPA 24711	6/28/2001	460492	3937050	adult	Below Mesa Well, just s. of n. Wupatki boundary	On 1 ha TACS plot, just south of TBP 114
Cnemidophorus inornatus	TBP 130	WUPA 24713	7/19/2001	452182	3934748		Ca. 1/4 mi. e. of US 89	On 1 ha TACS plot, UTM is center of plot. Wavy paravertebrals (otherwise looks 100% inornatus)
Cnemidophorus inornatus	TBP 134	WUPA 24714	8/5/2001	461454	3937001	adult	South of Mesa Well, Antelope Prairie	Female

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