Inventory of Amphibians and Reptiles at Hovenweep National Monument, 2001-2003

Final Report

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Horseshoe Ruins, Hovenweep National Monument, and Eastern Fence Lizard (inset).

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INTRODUCTION

In fiscal year 2000, the National Park Service (NPS) received a substantial budget increase for inventory and monitoring studies, and a nationwide program to inventory vertebrates and vascular plants within the national parks was begun in earnest. As part of this new inventory effort led by the NPS Inventory and Monitoring office, a total of 265 National Park units (parks, monuments, recreation areas, historic sites, etc.) were identified as having significant natural resources, and these were divided into 32 groups or "networks" based on geographical proximity and similar habitat types. The many NPS areas on the Colorado Plateau of Utah, northern Arizona, northwestern New Mexico, and western Colorado were divided into a northern and a southern network. Hovenweep National Monument (HOVE), located in extreme southwestern Colorado and southeastern Utah, was allocated to the Northern Colorado Plateau Network (NCPN). However, because of its close proximity to other NPS units in the Southern Colorado Plateau Network (SCPN), responsibility for conducting the amphibian and reptile (herpetofauna) inventory of HOVE was transferred to the SCPN.

Similar to the NCPN, an inventory plan was developed for the 19 park units in the SCPN (Stuart 2000), and the objectives of this plan were applied to the HOVE inventory. Long-term biological inventory goals are to provide: (1) complete bibliographies of studies pertinent to biological inventory of network parks; (2) detailed summaries of biological survey and natural history specimen data for the network parks; (3) species lists for each taxonomic group in relational database and hard copy format; (4) relative abundance estimates for selected species of concern in each vertebrate and vascular plant taxonomic group; (5) spatially located data for species of interest or concern; (6) spatial data on sampling site locations for GIS and a GIS data browser; (7) pertinent herbarium and museum vouchers databases; and, (8) recommendations for long-term monitoring within the network.

The overall goals of our herpetofauna inventory at HOVE were to: 1) provide HOVE with a baseline inventory of amphibians and reptiles in major habitats within the monument with the goal of documenting 90% of the species present; 2) identify park-specific species of special concern (which could become part of future "vital signs" monitoring); and 3) based on the inventory, provide recommendations for use in development of an effective monitoring program so that Resource Management staff can assess the condition of amphibian and reptile populations over time, and detect significant changes in those populations.

STUDY AREA DESCRIPTION

Hovenweep National Monument protects a number of ancient Puebloan ruins, and consists of six separate units straddling the Utah-Colorado state line, just north of the Four Corners region, in the heart of the Colorado Plateau (Figure 1). Two of the units are in San Juan County, Utah, the largest (about 160 Ha) being the Square Tower unit (the

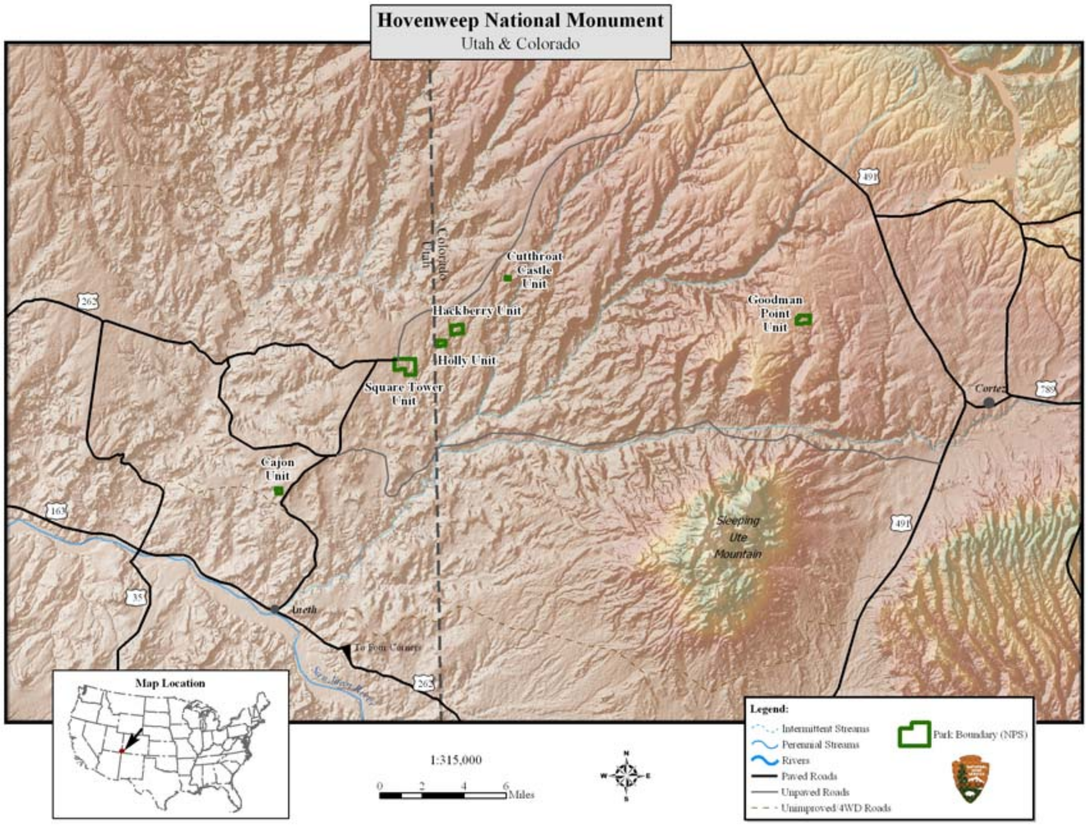

Figure 1. Location of the six units of Hovenweep National Monument in San Juan County, Utah and Montezuma County, Colorado.

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only unit with visitor facilities), and the small Cajon unit. In Montezuma County, Colorado, three units (Holly, Horseshoe/Hackberry, and Cutthroat Castle) are just to the northeast of the Square Tower unit, while the disjunct Goodman Point unit is located northwest of Cortez.

Elevations in the six units range from about 1545 m (5070 ft) and 1548 m (5080 ft) at the Square Tower and Cajon units, respectively, to about 2057 m (6750 ft) at the Goodman Point unit. Within the primary five units (not counting the disjunct Goodman Point unit), elevation generally increases from southwest to northeast, with the highest elevation being about 1789 m (5870 ft) at the Cuththroat Castle Unit. Similarly, habitats range from a shrubby and grassy desertscrub at the largely treeless Cajon unit, to well developed pinyon-juniper woodland at most of the other units. All of the units are bisected by one or more dry washes or small canyons, which provide rocky habitats for many reptiles. Additionally, all of the units contain spring or seep areas at the heads of these small canyons.

METHODS

We used a variety of methods to detect and document reptiles and amphibians at HOVE, including visual survey methods, nocturnal road driving, and data mining to document existing specimens already in museum collections.

Visual Survey Methods

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 each habitat within the sampling area for a specified amount of time, searching all reasonable areas within that habitat, and recording reptiles and amphibians encountered (Scott 1994). This method yields a number of individuals and species collected or observed per person-hour.

Because HOVE fell below the size threshold to qualify for a stratified random sampling design as was done in larger parks in the SCPN (Stuart 2000), we conducted our TACS surveys at non-randomly chosen sites. All TACS plots were one hectare (ha) in size, generally 100 meters square. In some areas, we were forced to move the plot center or change its shape to stay within a given habitat type or unit boundary. For each plot, we recorded the location of the center point in UTMs using a global positioning system (GPS) unit, as well as plot dimensions and orientation if different from cardinal bearings (N, S, E, W). We also photographed and described the topography, elevation, slope, aspect, vegetation, and non-vegetative cover of each plot using data sheets developed in conjunction with the database manager for the SCPN (Appendix A). We did a number of these TACS surveys in 2001, but due to their poor success we employed only other methods (below) in 2002 and 2003.

We conducted visual encounter surveys that were not time or area-limited. In these "general surveys," we sampled habitats that appeared to be of high quality for reptiles or amphibians, were otherwise unique, and/or not represented by TACS plots. The focus of this method was to search selected microhabitats opportunistically without necessarily covering a given area thoroughly. Most of these general surveys were conducted during the day, but we also conducted some at night. Nocturnal general surveys were used primarily to search amphibian breeding areas and document calling and/or larvae.

Amphibians and reptiles seen incidental to other fieldwork by us or seen by park staff were referred to as "random encounters." As with the amphibians and reptiles seen or captured by the different sampling methods described above, we recorded standard data on random encounters, including date, time, location, species, and size measurements and sex (if the animal was captured).

Nighttime Road Driving

Driving slowly on roads at night and carefully scanning the road in the headlights of the vehicle is recognized as an excellent method for surveying some groups of reptiles, particularly snakes (e.g., Klauber 1939, Mendelson and Jennings 1992, Rosen and Lowe

1994). This method is also effective for surveying amphibians (Shaffer and Juterbock 1994), particularly in the arid southwest where many anuran species are seldom active during daytime, but can often be found crossing roads on warm, rainy nights. Suitable paved or hard-packed dirt roads within HOVE were limited to the short stretch of road between the park entrance and the campground at the Square Tower unit. However, we also conducted surveys on the adjacent and nearby county roads, principally the paved section between the Square Tower unit and the Colorado state line, but also northeast towards the Cutthroat Castle unit and southwest in the area of the Cajon unit. We conducted these off-monument surveys in the hopes of finding rare or secretive species that would be nearly impossible to locate during walking surveys within the monument, and which we could then infer probably occur within the monument as well.

We standardized night driving surveys by driving a vehicle at slow speeds (30-40 km per hour), identifying all amphibians and reptiles encountered to species and recorded if they were either alive on the road (AOR) or dead on the road (DOR), sexing and aging all individuals, as possible, and recording locations to the nearest 0.1 mi using calibrated vehicle odometers.

Voucher Specimens

We attempted to document the presence of amphibians and reptiles at HOVE by collecting at least one individual of each species. Specimens 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 U.S. Geological Survey, Biological Survey Collection at the Museum of Southwestern Biology, University of New Mexico. Each specimen also has a National Park Service issue specimen tag containing information on species, collector, date of collection, collection site, and National Park Service (ANCS+) catalog numbers.

Literature and Museum Specimen Review

We reviewed specimen data from selected institutional collections in an effort to locate additional specimens previously collected at HOVE. We obtained records from San Juan county, Utah from Brigham Young University, the Museum of Southwestern Biology (University of New Mexico), the Museum of Vertebrate Zoology (University of California, Berkeley), the University of Kansas, and the University of Michigan Museum of Zoology. We also consulted the limited literature relevant to the HOVE region, as well as contacted individuals familiar with the HOVE herpetofauna. In particular, we followed up on collections made by Ted Rado, a ranger at Hovenweep during the 1970's.

Data Analysis and Estimation of Inventory Completeness

Locations of sampling sites and selected captures or observations of individual animals were recorded using either a Garmin® GPSIII Plus or Garmin 12 GPS unit in the North American Datum of 1927 (NAD 27).

All field data were entered into a Microsoft Access® database developed for the SCPN by the SCPN data manager. Metadata for the inventory was reported using Dataset Catalog. These databases have been delivered separately to the NCPN data manager.

The effectiveness of the different sampling methods was evaluated by determining overall species richness and capture rate per unit effort for each of the sampling methods. The number of species or individuals captured per unit effort was calculated by dividing the number captured or sighted by the total effort for that method or time period. The amount of sampling effort was measured as number of hours spent on each survey multiplied by the number of people per survey (person-hours).

To estimate inventory completeness, we developed a master list of potentially occurring species. Development of this master list was based on consultation of selected literature sources (Bury 1977, Cox and Tanner 1995, Hammerson 1999, Stebbins 1985, 2003), extensive personal knowledge of the distribution and habitats of southwestern amphibians and reptiles, specimen data from selected museum collections, personal communications with other herpetologists that have worked in or near HOVE (Geoff Hammerson, Ted Rado), and results of fieldwork from the 2001-2003 seasons. Probability of species occurrence was ranked as low, medium, or high, i.e. 0-33%, 34-67%, and 68-100%. In Appendix G these three rankings are coded as 1, 2, and 3, respectively. For quantitative analysis, these rankings were converted to the midpoint of their percentage range, i.e. 0.17, 0.50, and 0.83. These values were used as weighting factors for species not yet documented. For example, two species with rankings of medium probability of occurrence would combine to equal one full expected species (0.50 x 2=1.00 species), whereas six species of low probability of occurrence would be required to equal one full expected species (0.17 x 6=1.02 species). Species found by us during the inventory, or known from previously collected specimens or reliable observations, are weighted 1.00.

In addition to the master list, we generated a species accumulation curve (e.g. Scott 1994) to evaluate inventory completeness. This species accumulation curve was generated using Microsoft Excel®.

RESULTS AND DISCUSSION

Overview of Inventory Results

We detected 15 species of amphibians and reptiles at HOVE in 2001-2003 (Table 1). Of the species we consider documented (by voucher specimens or reliable observations) in Table 1, only the Common Kingsnake was not observed during this inventory. Details of abundance, habitat association, seasonal activity, and occurrence at the different units can be found in the species accounts (Appendix B). Scientific and common names generally follow Stebbins (2003). Scientific names for species mentioned throughout this report are found in Appendix C.

Table 1. Amphibian and reptile species known to occur (X) at each of the six units of Hovenweep National Monument. An asterisk (*) before the species name denotes a species represented by a voucher specimen, and an asterisk after an X signifies that a voucher specimen has been collected from that particular unit. The only species not recorded during the present inventory is the Common Kingsnake

	Cajon	**Cutthroat Castle**	**Goodman Point**	**Hackberry &Horseshoe**	**Holly**	**Square Tower**
*Tiger Salamander	X			X*		X*
*Mexican Spadefoot						X*
*Red-spotted Toad						X*
Woodhouse's Toad				X		X
*Eastern Collared Lzard	X	X	X			X*
*Longnose Leopard Lizard	X					X*
*Side-blotched Lizard	X	X		X	X	X*
*Tree Lizard	X	X		X	X	X*
*Sagebrush Lizard			X*			X*
*Desert Spiny Lizard	X*			X	X	X
*Eastern Fence Lizard	X	X	X*	X	X	X*
*Western Whiptail	X*	X*		X	X	X*
Striped Whipsnake	X					X
Common Kingsnake						X
*Gopher Snake						X*
Western Rattlesnake						X
TOTALS	**9**	**5**	**3**	**7**	**5**	**16**

We recorded 583 individual amphibians and reptiles within the boundaries of HOVE during this inventory. Of these observations, 529 (91%) were of lizards, 50 (9%) were of amphibians, and only four (<1%) were of snakes. The most abundant species was the Eastern Fence Lizard, accounting for 38% of all observations. The next most frequently observed species were the Side-blotched Lizard (18%), Tree Lizard (13%), and Western Whiptail (11%). Together, these four lizard species accounted for 80% of all observations, and 88% of all lizard observations. Except for the Tiger Salamander, found in permanent pools at the head of some canyons, all amphibians were found after the onset of summer monsoon rainfall. We observed relatively few amphibians, primary due to severe drought conditions in the region throughout the inventory period. Most of our amphibian observations were made on a few rainy nights in August of 2002. We recorded only four individual snakes within the HOVE monument boundaries in 2001-2003. While snakes are generally difficult to inventory due to their secretive habits and sometimes patchy distribution (Gibbons and Semlitsch 1986), the low numbers of even common species such as Striped Whipsnake, Gopher Snake, and Western Rattlesnake (the only three species we observed) were unexpected. The recent regional drought may have affected snake detections reducing aboveground activity and/or population numbers at

HOVE. Appendix D shows the number of individuals of each species we observed using each survey method.

Sixteen species have been documented from the Square Tower unit, almost twice as many as at any other unit (Table 1). In fact, every species recorded at HOVE has been found at the Square Tower unit. The reasons for greater species richness at the Square Tower unit are probably both ecological and sampling based. The Square Tower unit is by far the largest unit, containing the greatest variety of habitats, including permanent water for Tiger Salamanders and more extensive mesatop sagebrush communities that support Sagebrush Lizards, a species so far not found at the other four primary units. In addition, the Square Tower unit is low enough in elevation for desert species such as the Longnose Leopard Lizard and Desert Spiny Lizard, neither of which have been found at the highest elevation units (Cutthroat Castle, Goodman Point). However, equally important is the fact that park staff live and work primarily at the Square Tower unit, and the campground used by researchers is located there. As a result, more surveys were conducted at the Square Tower unit, and more random encounters have occurred there (e.g., the sole documented sighting of Common Kingsnake). Finally, some amphibian species (Mexican Spadefoot, Red-spotted Toad) likely occur at every primary unit, but we were able to detect them at the Square Tower unit during night driving surveys on the paved park road, a feature absent at the other units.

In contrast to the Square Tower unit, we recorded only three species at the Goodman Point unit. While this results in part from more limited survey time at this unit, ecological factors are important as well. Many lowland lizard species (e.g., Longnose Leopard Lizard, Side-blotched Lizard, Desert Spiny Lizard, Western Whiptail) common at all or most of the primary five units of HOVE are not found in the vicinity of the higher elevation Goodman Point unit.

We did not find five of the 19 species reported by Rado (1975) to occur at HOVE (Short-horned Lizard, Smooth Green Snake, Glossy Snake, Milk Snake, and Common Kingsnake). The only species we found that was not reported by Rado (1975) was the Side-blotched Lizard. This likely represents an omission during the production of Rado's checklist, since it is such a common species. We were surprised to find no Short-horned Lizards during this inventory, as the species is often common in habitats similar to those occurring at HOVE. Based on its inclusion on Rado's (1975) list, we feel confident it does occur at HOVE, however, without a specimen or verified observation we must regard it as hypothetical. We have included Common Kingsnake on the current documented species list because an individual was photographed eating a Gopher Snake within Hovenweep House Ruin (Square Tower unit), and species identity and exact location (based on characteristics of the ruin wall) in this photograph was verified by Ted Rado, former HOVE ranger (personal communication). However, the other three snake species listed were observed by others prior to Rado's tenure, and unless photographs or specimens emerge, we must consider them hypothetical. Written details of these previous observations resided at HOVE during Rado's tenure (Ted Rado, personal communication), but can no longer be found (Charlie Schelz, NPS Southeast Utah Group Biologist, personal communication). Glossy Snake undoubtedly occurs, as we observed a road-killed specimen in 2001 less than a mile from the Cajon unit, and Milk Snake likewise seems probable based on habitat and other records from the region (Hammerson 1999). However, it is unlikely that a population of Smooth Green Snake occurs at HOVE. The single record was reported from Ruin Canyon (Rado 1975, and personal communication), which seems much too xeric for this species, which elsewhere in southeastern Utah and southwestern Colorado is found in mesic foothill and mountain wet meadow habitats (Cox and Tanner 1995, Hammerson 1999). Other hypothetical species with a high probability of occurring are the Plains Spadefoot, Plateau Striped Whiptail (Goodman Point unit), Many-lined Skink (Goodman Point unit, possibly others), and Night Snake. Hammerson's (1999) checklist of species occurring in National Parks throughout the region includes Chorus Frog, Plateau Striped Whiptail, Racer, and Western Terrestrial Garter Snake as occurring at HOVE, but we cannot find documentation to support this (although we consider the whiptail and garter snake possible at the Goodman Point unit). Details of all hypothetical species are discussed in the species accounts (Appendix B).

Literature and Museum Specimen Review

The only written description of the herpetofauna of HOVE is a species list by Ted Rado (1975). This checklist is reproduced in Appendix E for reference. There are no comprehensive works on the herpetofauna of Utah, and the recent book on Utah snakes (Cox and Tanner 1995) is very general, and contains numerous errors in its depiction of species distributional ranges. Hammerson's (1999) excellent book on the amphibians and reptiles of Colorado contains detailed distribution, habitat, and status information, including dot distribution maps for all species. The Colorado Division of Wildlife maintains the specimen record database upon which those maps were based, which includes records from major museums throughout the country. We were able to search this database, and we uncovered a few records of specimens collected at HOVE (Colorado units).

Ted Rado (personal communication) collected specimens during his tenure at HOVE in the early 1970's, and many of these were deposited at San Jose State University. We located records for these specimens, now housed at the California Academy of Sciences. Apparently, a duplicate set of specimens collected by Rado was also housed at HOVE, but has since disappeared (Ted Rado, personal communication). None of the other institutions queried contained any specimens from HOVE. A complete list of all specimen records from the Colorado Division of Wildlife database and the California Academy of Sciences is found in Appendix F. All of these records are of common species already documented by us.

Sampling Effort and Efficacy of Methods

We spent approximately 157 person-hours (i.e., the number of people conducting any given survey multiplied by the number of hours per survey) on inventories for amphibians and reptiles at HOVE between April 2001 and August 2003. Most of this

Table 3. Survey effort (in person-hours) of each sampling method in each year during amphibian and reptile inventories at Hovenweep National Monument, 2001-2003. Most night driving survey time (about 90%) was spent outside monument boundaries.

Year	General Surveys	Nighttime General Surveys	Non Random TACS plot	Night Driving	Total
2001	40.02	12.26	25.15	10.13	**87.56**
2002	47.22	0.75		14.93	**62.90**
2003	5.72	0.72			**6.44**
Total	**92.96**	**13.73**	**25.15**	**25.06**	**156.90**

fieldwork was conducted in 2001 and 2002, with only two visits to the Goodman Point unit in 2003. The total amount of time, in person-hours, spent on each sampling method is summarized in Table 3.

We spent the most time conducting daytime general surveys, and these surveys produced both the greatest number of species of any method (12) and the greatest number of individuals per survey effort (4.7 individuals/person-hour). The next most productive method was the non-random TACS plot surveys, which recorded eight species, and 2.7 individuals per person-hour. Nocturnal General Surveys produced only three species (all amphibians), and our observation rate during these surveys was only 1.1 individuals per person-hour. However, these nocturnal surveys were valuable for targeting specific species or groups of species, despite their lower observation rate. Most night driving (about 90%) was conducted outside of monument boundaries so the number of species detected per person-hour is not comparable. Using this method within the monument we recorded only four species, and two of these were common diurnal lizard species observed at dusk.

Although the TACS plot surveys were second to general surveys both in terms of number of species and observation rate of individuals, they were in fact less efficient than these figures suggest. In the figures presented above, only actual survey time (generally 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. While we did not record the time spent on these tasks, we estimate that inclusion of this additional field time would reduce the observation rate for TACS plots to about half that of general surveys. For inventory purposes, general survey methods that maximize observation rate and allow for targeted, non-random searches for uncommon species are most appropriate. For these reasons, we abandoned TACS plot surveys at HOVE after the 2001 field season.

The lack of extensive roads within the boundaries of HOVE resulted in poor performance of night driving surveys in this inventory. Where extensive paved roads exist within park areas, night driving is by far the most efficient method to survey for both amphibians and snakes, and has elsewhere on the southern Colorado Plateau been used to document almost 100% of these taxa (Drost et al. 2001, Persons 2001).

Estimate of Inventory Completeness

Between our surveys at HOVE in 2001-2003 and previously documented species (Table 1), we estimate an overall inventory completeness of 66% for all six units combined (Appendix G). However, if we remove the disjunct Goodman Point unit from this analysis, the estimated inventory completeness of the five primary units rises to 71%. (Appendix G). This difference arises because many species are more likely to occur at the more easterly Goodman Point unit (e.g., Many-lined Skink, Plateau Striped Whiptail, Western Terrestrial Garter Snake) than any of the other five units.

Inventory Completeness of Different Taxa Groups

Using the same weighting methods and data from Appendix G, we calculated that our overall estimated inventory completeness is 80% for amphibians, 72% for lizards, and 48% for snakes. The relatively high success rate for lizards is likely because most lizard species are diurnal and conspicuous, and our efforts were biased towards daytime searches (both plots and general surveys) that easily detect such species. Many amphibians on the southern Colorado Plateau (especially spadefoot toads) breed during the summer monsoon season, and are often active on only a few nights a year, making them difficult to locate. The year 2001 had a poor monsoon season at HOVE, with no evidence of amphibian breeding, and 2002 was among the worst drought years on record in much of the southwest. However, we were at HOVE on a few rainy nights during the monsoon season in 2002, and documented the three anuran species most expected (Rado 1975). The high success rate for amphibians is primarily due to the low number of potential species. In contrast, our low estimate of inventory completeness for snakes results from a large number of potential species, combined with an overall low encounter rate for snakes (even common species) during this inventory. In addition, many snake species are primarily nocturnal and/or extremely secretive in their habits, making them difficult to locate even in the best of times (Gibbons and Semlitsch 1987). For snakes, therefore, the single most important factor limiting our success at HOVE was the lack of extensive networks of roads. Based on data from our own studies in the region (Drost et al. 2001, Persons 2001), nighttime road surveys are by far the most effective method for detecting both amphibians and snakes. At Petrified Forest National Park (Drost et al. 2001) the combination of general daytime foot surveys for lizards and nighttime road surveys for amphibians and snakes resulted in an overall estimated inventory completeness of >90%.

Evaluation of Inventory Completeness Through Species Accumulation

A species accumulation curve (plotted per survey day) for 2001-2003 HOVE data is shown in Figure 2. Only those species we observed during this inventory are included (i.e., Common Kingsnake is omitted). The asymptotic curve in Figure 2 suggests that we are close to detecting all the species present at HOVE. However, because our master list estimate of inventory completeness is only 68%, this false asymptote suggests only that we are close to detecting most of the common species using our current methods, and rare

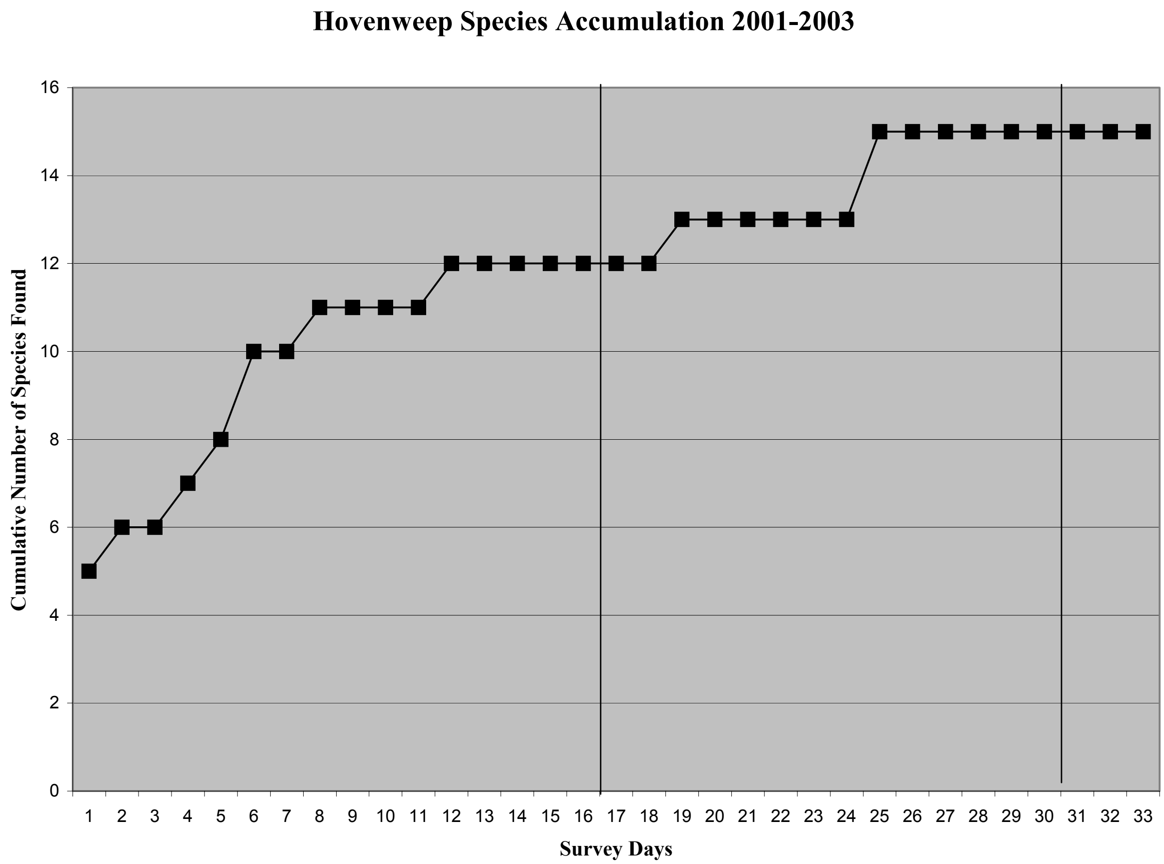

Figure 2. Species accumulation curve for amphibians and reptiles at Hovenweep National Monument, 2001-2003. Yearly survey days are separated by vertical lines through the data.

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species would require proportionately greater effort and/or different field methods to detect. Similarly, an asymptotic curve shown after two seasons at some SCPN parks (Nowak et al. 2003) is also misleading, as we were in fact not very close to detecting 90% of the species at most of these parks. Species accumulation curves can be valid estimators of inventory completeness in situations involving large numbers of species, extensive survey periods, and a wide variety of field methods (e.g., Scott 1994). However, at HOVE, given our small sample sizes, more limited and biased methods, and knowledge of the habitats and local distribution of potential species, we believe the master list approach provides a more precise estimate of inventory completeness.

Specimens Collected

We collected 15 amphibian and reptile specimens in 2001-2003 at HOVE (Appendix H). Of the 15 species we observed during this inventory, only the Woodhouse's Toad, Striped Whipsnake, and Western Rattlesnake were not collected. These 15 specimens are deposited in the U.S. Geological Survey, Biological Survey Collection at the Museum of Southwestern Biology, University of New Mexico, and are assigned both Biological Survey Collection (BS/FC) and National Park Service (ANCS+) catalog numbers.

CONSIDERATIONS FOR FUTURE INVENTORY WORK AND LONG-TERM MONITORING

Future Inventory Work

Given our level of effort and a resultant overall estimated inventory completeness of only 66%, reaching the goal of 90% inventory completeness by the end of this project would have required a shift in methodology and/or a substantial increase in the amount of time spent in the field. However, because this inventory was conducted during a severe drought period in the southwest, it is not surprising that we did not document many uncommon species. Additional fieldwork during a period of average or above average rainfall (and concomitant larger amphibian and reptile populations) would likely document species we did not find during this inventory.

The mediocre performance of the TACS surveys did not justify the labor involved in conducting them. These surveys by their nature detected primarily common, conspicuous species that are distributed across the landscape, such as many lizards. While some form of standardized methodology is required in a monitoring program, such methods are not necessary for species inventories, and their increased labor diverts available time away from more productive, targeted searches for rare species. As a result, targeted herpetological collecting techniques are far superior if compilation of a species list is the primary goal of a project (e.g., Campbell and Christman 1982, Karns 1986, Scott 1994, Turner et al. 1999).

Given the <90% completeness of the herpetofauna inventory at HOVE, the NCPN should consider funding additional inventory work with the goal of establishing a more complete baseline of species occurrence. It may be preferable to design a long-term monitoring program such that the percentage of effort allocated to inventory decreases over time, while the percentage of monitoring increases, until a solid baseline of species occurrence exists. It should be noted that inventory and monitoring are not mutually exclusive endeavors. In fact, many methods designed to monitor more inclusive subsets of the herpetofauna community (e.g., road driving surveys for snakes) are the same ones used for inventory. Thus, a well-rounded monitoring program that focuses on each major subset of the herpetofauna (i.e., amphibians, lizards, snakes) will monitor not only the population status of particular focal species within each group, but will simultaneously monitor the amphibian and reptile community as a whole, and in the process will document new species and lead toward a more complete baseline of species occurrence.

New species will also be documented opportunistically. Observations and/or collections by NPS staff can be invaluable in these efforts, especially for uncommon or secretive species that are generally undetected during periodic, short duration visits to the park by researchers. Now that solid baseline data exist on species occurrence at HOVE, help of interested staff and volunteers can more easily be directed towards documenting suspected species (or those known but not properly vouchered). Park staff must be trained by herpetologists in the identification of these species and the proper collection and initial storage of suitable specimens.

Road killed animals should be salvaged and placed in the freezer until they can be properly preserved. These specimens should be double or triple bagged in plastic zip-loc or similar bags, with an effort made to squeeze excess air out of the bags. Complete collection data (date, collector, precise location, preferably with UTM coordinates) should be included in the bags with the specimens. For rare or secretive species (e.g., Glossy Snake, Milk Snake, Smooth Green Snake) that represent important regional distribution and natural history data, animals could be captured alive and given to professional herpetologists for processing and documentation. At a minimum, high-quality, sharp focus, close-up photographs or (preferably) digital images should be taken of the animal while it is in captivity and shown to expert herpetologists to confirm identification before release. While not suitable for use as photographic vouchers, an advantage of digital images is that they can be quickly and easily e-mailed to experts.

Long-term Monitoring

Although we suggest additional inventory work at HOVE in order to reach a satisfactory level of inventory completeness, some results from this project can be used in guiding a monitoring program at HOVE. Based on our results, monitoring of amphibians or snakes would clearly be difficult. For snakes, initial work should focus on increased inventory efforts, in order to establish a baseline of species occurrence.

For most lizards this inventory has established a baseline of species occurrence, and has furthermore identified the dominant species and their general habitat associations within the different units at HOVE. We did not specifically analyze our data with respect to developing a monitoring program. However, Swann (1999), using transect methods of Rosen and Lowe (1996), used power analysis to evaluate the amount of effort required to detect changes in populations of common lizard species at Tonto National Monument, Arizona. He concluded that the effort needed to detect trends in even the most abundant species would be prohibitive for a small park like Tonto. For example, he determined that detecting a 2% annual decline over ten years in the two most common lizard species would require 120 person-days of fieldwork annually. Based on these results, he suggested that monitoring of species richness and related parameters (e.g., species diversity), which he determined would require much less effort, may be more appropriate for monitoring programs in national parks. However, common desert lizards have been successfully monitored for over a decade at Organ Pipe Cactus National Monument, Arizona (ORPI) using line transect methods with only about 40 person-days of fieldwork annually (Rosen 2000). Before implementation of a monitoring program at HOVE, a pilot study should be conducted in order to estimate the number of sites and surveys that will be needed to generate sample sizes adequate for statistical analysis of trends.

It is also clear from our data that monitoring of uncommon species, which are often of interest as potential “vital signs” of ecosystem health, would be extremely difficult in most cases, simply because they are so difficult to locate at all. Furthermore, while some uncommon or restricted species may be of interest to monitor for their own sake, it is unlikely these species can often be used as “vital signs” of ecosystem integrity. For these reasons, we propose that monitoring should encompass communities of species, and focus especially on the most common species (e.g., Side-blotched Lizard, Eastern Fence Lizard, Western Whiptail). Lizards, which are non-motile, usually respond quickly and drastically to fluctuations in precipitation and concomitant variation in primary productivity at a site. For this reason, common diurnal desert lizards have been the centerpiece of herpetofauna monitoring at ORPI for over a decade (Rosen 2000, Rosen and Lowe 1996). An exception at HOVE would be small, highly localized populations of some amphibian species, or known amphibian breeding areas (e.g., large mesatop potholes at Square Tower used by New Mexico Spadefoots and Red-spotted Toads, and permanent spring pools used by Tiger Salamanders at many units). For these species, some form of visual encounter survey could be conducted during appropriate weather conditions.

As part of a study of the Red-backed Whiptail in southern Arizona (Rosen et al. 2002), additional lizard line transects were established at ORPI. However, in an effort to detect greater numbers of lizards, and facilitate fieldwork in steep, rocky terrain, transects simply utilized existing backcountry hiking trails. Similarly, Swann (1999) placed lizard transects along foot trails at Tonto National Monument, which were infrequently used by visitors during the hours and seasons when field surveys were conducted. Although not random, such transects would be easy to establish and convenient to run. For example, establishing a series of such transects in Ruin Canyon at HOVE may provide adequate lizard sample sizes to facilitate data analysis. Because of their convenient location, such transects could be run many times a year at little expense, and this aspect would help insure such a monitoring program to be continued into the future.

In summary, we recommend a two-pronged approach to the initiation of long-term monitoring of amphibians and reptiles at HOVE. First, we recommend establishment of permanent lizard line transects (Rosen and Lowe 1995, 1996) to monitor the community of common, diurnal lizard species. Secondly, we recommend increased inventory work, directed at establishing a baseline of species occurrence, especially for snakes. Given the difficulty in detecting amphibians and snakes at HOVE, this may take several years. One approach, advanced by Swann (1999), would be to conduct periodic (e.g., every five years or more) complete species inventories, which would aid in the ultimate goal of completion or near completion of the species list, and simultaneously serve as a general monitoring of overall diversity. These repeated inventories could strike a balance between allocating effort to finding new species (inventory) and assessing diversity and abundance of common, widespread species (monitoring).

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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 at HOVE. 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. Species Accounts of amphibians and reptiles at Hovenweep National Monument, including all documented and hypothetical species. Because we do not have data on population sizes or density of species at HOVE, the use of the terms "common", "uncommon", and "rare" are necessarily somewhat subjective. They are designed to describe the relative abundance of a particular species, compared with other, similar species at HOVE, and also with the same species elsewhere throughout its range in the region. Complete NPSpecies checklist field assignments for all documented and hypothetical species are presented in a separate table (Appendix I).

Species Documented from Hovenweep National Monument

Tiger Salamander (*Ambystoma tigrinum*). We found Tiger Salamanders in the permanent spring-fed pools in Hackberry Canyon (Hackberry & Horseshoe unit) during this inventory, and Cindy Ramotnik and Mike Bogan (U.S. Geological Survey, University of New Mexico) found one at the head of the small canyon at the Cajon unit during a small mammal inventory in 2002. In addition, the species has been collected previously from the Square Tower unit. Tiger Salamanders probably occur in every unit of HOVE.

Mexican (New Mexico) Spadefoot *(Spea multiplicata*). Within HOVE we only recorded the Mexican Spadefoot from the Square Tower unit, and only on a few rainy nights in August 2002. We observed this species elsewhere outside the monument during night driving surveys, particularly northeast of the Square Tower unit, and it probably occurs at all of the units. Within HOVE, most of our observations were along the main park road, but we also found them breeding in potholes in slickrock on the mesatop. Although this species is seldom seen on the surface, it is probably common in the monument.

Red-spotted Toad (*Bufo punctatus*). Like the Mexican Spadefoot, we only found Red-spotted Toads within HOVE at the Square Tower unit during a few rainy nights in August 2002. We also found this species along roads outside the monument, and it may occur at every unit as well. Based on activity during the few optimal nights when we observed them, Red-spotted Toads are probably common at HOVE.

Woodhouse's Toad (*Bufo woodhousii*). We found only two individual Woodhouse's Toads during this inventory, one at the Square Tower unit campground and another in Hackberry Canyon (Hackberry & Horseshoe unit). We also found the species near the Utah-Colorado line northeast of the Square Tower unit during night driving surveys, and although apparently uncommon, it, too, probably occurs at every unit of HOVE.

Eastern (Common) Collared Lizard (*Crotaphytus collaris*). We found Eastern Collared Lizards at the Cajon, Cutthroat Castle, Goodman Point, and Square Tower units, and also observed them along roads in the area of the Holly and Hackberry & Horseshoe units, where they undoubtedly occur as well. This species is fond of rocks, a habitat element widespread at HOVE. Eastern Collared Lizards, while not abundant, were encountered more frequently than the closely related Longnose Leopard Lizard. The species should be considered common at HOVE.

Longnose Leopard Lizard (*Gambelia wislizenii*). We found only three individual Longnose Leopard Lizards during our surveys, and only at the Square Tower and Cajon units. This close relative of the Eastern Collared Lizard prefers more open habitats with scattered shrubs for cover, where individuals often sit concealed, waiting to ambush prey. Stebbins (2003) gives a maximum elevational range of about 6000 feet (1830 m) for the species. As such, Leopard Lizards probably do not occur at the Goodman Point unit (minimum 6600 ft/2012 m), and may not occur at the other three units northeast of Square Tower, where elevations are higher and woodland vegetation is denser.

Sagebrush Lizard (*Sceloporus graciosus*). In many areas of the Colorado Plateau the Sagebrush Lizard is abundant in shrublands and open woodlands with a well developed shrub (particularly sagebrush) understory. Despite an abundance of seemingly suitable habitat, we only found Sagebrush Lizards at the Square Tower and Goodman Point units. Although they could be reliably found by searching shrub areas with sandy soil on the Square Tower mesatop, they were uncommon. Although they were frequently seen at the Goodman Point unit, even there they were less common than the Eastern Fence Lizard.

Desert Spiny Lizard (*Sceloporus magister*). Although Desert Spiny Lizards were uncommon, we found them at the Cajon, Hackberry & Horseshoe, Holly, and Square Tower units. Stebbins (2003) gives an upper elevational range of around 5000 ft (1520 m), making their occurrence at the Hackberry & Horseshoe unit, with a minimum elevation of about 5350 ft (1630 m), possibly the upper elevation limit for the species. Given this, their occurrence at the Cutthroat Castle unit (minimum elevation about 5780 ft [1762 m]) seems unlikely, and they certainly do not occur at the Goodman Point unit. At HOVE they were usually observed in open rocky ledge habitats, such as along canyons and washes, although they were sometimes seen crossing open ground, even occassionaly attempting (through push-up displays) to defend the campground loop road.

Eastern Fence Lizard (*Sceloporus undulatus*). The Eastern Fence Lizard was the most frequently observed amphibian or reptile species at HOVE, accounting for 38% of all observations. It was also the only species recorded from all six units (although some other, less conspicuous species likely also occur at all six units). Eastern Fence Lizards at HOVE are referrable to the subspecies *elongatus*, although recent taxonomic studies recommend eliminating this taxon, and allocating HOVE lizards to the species *Sceloporus tristichus* (Leache and Reeder 2002).

Tree Lizard (*Urosaurus ornatus*). Tree Lizards were found at all five of the primary units, but were not found at Goodman Point, and they may not occur there. Despite their name, Tree Lizards at HOVE are almost exclusively found on rocks, and only rarely on trees. In particular, large boulders or rocky ledge habitats were preferred, and because these habitat elements are common at HOVE, Tree Lizards were also common, being the third most frequently observed species (after Eastern Fence Lizard and Side-blotched Lizard).

Side-blotched Lizard (*Uta stansburiana*). This was the second most frequently obsrerved species, and was common at all five of the primary HOVE units. It was not found at Goodman Point, and may not occur there. Like the Tree Lizard, the Side-blotched Lizard prefers rocky habitats, including boulders and rocky ledges, but was also found in more open areas such as slickrock with scattered shrubs.

Western Whiptail (*Cnemidophorus tigris*). Throughout much of the Colorado Plateau, as well as in the four true desert regions of the southwest (Chihuahuan, Sonoran, Mojave, and Great Basin deserts), the Western Whiptail occupies open desert areas with scattered shrubs. However, at HOVE this species also occurs in the more rugged pinyon-juniper woodland habitats, and is found in all five of the primary units (excluding Goodman Point, where it almost certainly does not occur). Many of the HOVE units, especially the higher elevation ones such as Cutthroat Castle, typify habitat often occupied on the Colorado Plateau by the all-female Plateau Striped Whiptail. Western Whiptails were fairly common at all five units where they were found, and were the fourth most common species overall. It has been proposed that the generic name for North American whiptail lizards be changed to *Aspidoscelis* (Reeder et al. 2002), but until this proposal is evaluated and more widely accepted, we prefer to retain the perfectly adequate *Cnemidophorus*.

Common Kingsnake (*Lampropeltis getula*). Of the 16 species we consider adquately documented, the Common Kingsnake was the only one not found by us during this inventory. To our knowledge, the only observation of this species at HOVE was an individual photographed eating a Gopher Snake within the walls of Hovenweep House Ruin (Square Tower unit), taken sometime prior to 1974 (Ted Rado, personal communication). Apparently this photo, as well as written accounts of observations of other species reported by Rado (1975), is no longer in the HOVE files (Charlie Schelz, personal communication). While we have no solid basis to evaluate the other reports, the identidy and location of the Common Kingsnake in the photograph was verified by Ted Rado (personal communication). Common Kingsnakes are at the edge of their range in the San Juan Basin of the Four Corners region (Hammerson 1999, Stebbins 2003), and are probably uncommon at all five of the primary HOVE units. It is unlikely they occur at the Goodman Point unit, which appears to be above their elevational range in this region.

Striped Whipsnake (*Masticophis taeniatus*). We observed one Striped Whipsnake at the Cajon unit, and found a positively identified shed skin of another at the Square Tower unit. This is a common species in the region, and is frequently observed due to its diurnal habits. We had expected to find this snake to be much more common, and as with other species, the current drought may have reduced its numbers in recent years. Striped Whipsnakes probably occur at all six HOVE units.

Gopher Snake (*Pituphis catenifer*). We only observed one Gopher Snake within HOVE during our inventory, a juvenile individual found at the Square Tower unit. Rado (1975) described the Gopher Snake as the "most commonly seen snake in the monument area", and we had expected to find many more of them at HOVE. As with other snakes, the persistent drought in the region may be responsible for our failure to locate many individuals of this species. The Gopher Snake is perhaps the most cosmopolitan snake in the western United States, and almost certainly occurs at every HOVE unit.

Western Rattlesnake (*Crotalus viridis*). Like the Gopher Snake, we only observed one Western Rattlesnake within the boundaries of HOVE, at the Square Tower unit, during this inventory. We observed a few additional individuals outside the monument during night driving surveys. Rado (1975) noted of the species that "although infequently sighted by park visitors, this is the most common snake in the area." As with other snakes, the current drought may have reduced rattlesnake populations or limited aboveground activity during our surveys, or both. Taxonomy of the Western Rattlesnake species complex has been the subject of recent study (Ashton and De Quieroz 2001, Douglas et al. 2002, Pook et al. 2000), and the most rigorous of these studies proposed elevating many current subspecies to full species status (Douglas et al. 2002). Although Rado (1975) regarded rattlesnakes at HOVE to be the Midget Faded subspecies, *Crotalus viridis concolor* (*Crotalus concolor* of Douglas et al. 2002), our impression of the the individuals we observed in or near HOVE was that, based on color pattern, they were probably Prairie Rattlesnakes (*Crotalus viridis viridis*, or simply *Crotalus viridis* of Douglas et al. 2002), which is what Douglas et al. (2002) regarded specimens analyzed from nearby in Montezuma County, Colorado.

Species That Possibly Occur at Hovenweep National Monument

Plains Spadefoot (*Spea bombifrons*). We found the Plains Spadefoot northeast of the Square Tower unit near the Utah-Colorado state line during night driving surveys. Its habits and habitats overlap that of the Mexican Spadefoot in this region, and the species almost certainly occurs in one or more of the HOVE units, although it is much less likely to occur at the higher elevation Goodman Point unit.

Canyon Treefrog (*Hyla arenicolor*). Although Canyon Treefrogs are widely distributed in the region, they usually prefer rocky canyons with permanent or semi-permanent tinajas. Although the habitat is marginal at some of the HOVE units, most notably at the heads of canyons with permanent seeps and pools, the fact that the species has not been recorded by us or previous observers suggests it is probably absent.

Striped Chorus Frog (*Pseudacris triseriata*). Although Hammerson (1999) included the Striped Chorus Frog as occuring at HOVE in his checklist of species occurring in National Parks in the region, we can find no recorded observations or specimens to substantiate this. There is a chance that the species occurs in the vicinity of the Goodman Point unit, as it is known from the Cortez, Colorado area. However, suitable breeding habitat of permanent or temorary water with emergent vegetation is not found within the monument boundaries.

Northern Leopard Frog (*Rana pipiens*). Rado (1975) included the Northern Leopard Frog in his list of species possibly occuring at HOVE. However, the lack of suitable permanent water (the pools at the heads of some canyons are much too small and densely shaded to accommodate this species) makes the occurrence of this species within the monument highly unlikely.

Lesser Earless Lizard (*Holbrookia maculata*). Hammerson (1999) includes on his dot distribution map for the species a location apparently just west of the Colorado line along McElmo Creek, to our knowledge the only record in Utah. Lesser Earless Lizards on the southern Colorado Plateau usually prefer sparse (even overgrazed) grassland habitats, such as those just to the south of the Square Tower unit. If the species occurs anywhere in the HOVE region, it would probably be in these habitats in the area of the Square Tower and Cajon units.

Short-horned Lizard (*Phrynosoma hernandesi*). Rado (1975) included the Short-horned Lizard on his checklist, stating that it was "the rarest lizard in the monument." Our failure to find this cosmopolitan species bears out his description. While it almost certainly does occur at HOVE, based on its inclusion on Rado's (1975) checklist, and probably at every unit, the lack of a specimen or verified observation requires that it be placed on the hypothetical list. The reason for the rarity of this often common species is unknown, but perhaps HOVE contains a depauperate or unsuitable ant fauna (the horned lizard's staple food).

Many-lined Skink (*Eumeces multivirgatus*). This lizard species, while found throughout the region, prefers more mesic habitats than are widely available at HOVE. However, there is a slight chance it occurs in the larger canyons at the primary five units (except probably the Cajon unit), and it probably does occur at the higher elevation Goodman Point unit, particularily in areas with extensive subsurface moisture (near seeps) with leaf litter and logs, rocks, or other cover objects.

Plateau Striped Whiptail (*Cnemidophorus velox*). This all-female species occurs widely on the Colorado Plateau, often in shrubland and woodland habitats such as those found at HOVE. While the Plateau Striped Whiptail may occur in small numbers at one or more of the five primary units, it probably does occur at the Goodman Point unit. We observed no whiptails of any species at Goodman Point, but the Plateau Striped Whiptail is known from the Cortez area (Hammerson 1999). While the Plateau Striped Whiptail actually represents a complex of species (Wright 1993), some undescribed, individuals we have observed in the region (Yucca House National Monument south of Cortez, and along McElmo Creek) appear to be *Cnemidophorus velox* proper (i.e., the same as those used in the original description of the species).

Desert Night Lizard (*Xantusia vigilis*). This small, secretive species has a spotty distribution in the region, with records from numerous localities in southeastern Utah (including Natural Bridges National Monument, Salt Creek in Canyonlands National Park, and near Moab). Many of these specimens were found in habitats similar to those found at HOVE. Due to its inconspicuous size and behavior (usually only found under or within logs or dead yucca plants, or sometimes under rocks), the species is likely more widely distributed than the spotty records indicate. As such, although there is no reason to believe the Desert Night Lizard must occur at HOVE, there is no good reason to believe it doesn't.

Glossy Snake (*Arizona elegans*). Rado (1975) included Glossy Snake on his checklist, and referred to it as being "uncommon," suggesting multiple observations. Since no specimens or photographs exist from within HOVE, and we did not find the species within the monument during this inventory, we have placed it on the hypothetical list. However, we did find a road-killed Glossy Snake on the dirt road about a mile north of the Cajon unit, so we feel confident it does indeed occur, at least at the southern units (Cajon, Square Tower). It probably does not occur at the higher elevation Goodman Point unit.

Racer (*Coluber constrictor*). Hammerson (1999) listed the Racer as occuring at HOVE in his checklist of species occurring in National Parks in the region, but we can find no evidence to support this. The species is not known from southeastern Utah, and the only southwestern Colorado record is along the Animas River just north of the New Mexico state line (Hammerson 1999).

Ringneck Snake (*Diadophis punctatus*). The Ringneck Snake is unknown from western Colorado or southeastern Utah, but relictual populations occur throughout its range in the southwest, and it seems plausable that isolated populations of this small, secretive species could persist in many areas of HOVE, particulary in larger, more mesic canyons, and at the Goodman Point unit. Although speculative, it seems possible that the single record of Smooth Green Snake from HOVE could actually have been of a Ringneck Snake (see the account for Smooth Green Snake, below).

Night Snake (*Hypsiglena torquata*). This strictly nocturnal species is widespread in many habitats on the Colorado Plateau, and probably occurs at all six HOVE units. Ted Rado (personal communication) recalled there being an observation from Ruin Canyon or a tributary, just outside the Square Tower unit boundaries. Details of this observation may have been in a wildlife observation file which existed at HOVE in the 1970's, but is apparently now lost (Charlie Schelz, personal communication).

Milk Snake (*Lampropeltis triangulum*). Rado (1975) included Milk Snake on his HOVE checklist, based on a single pre-1974 observation. Apparently the animal was found while night driving near the campground (Square Tower unit), and detailed written notes on the observation were in a wildlife observation file at HOVE (Ted Rado, personal communication). Unfortunately, the wherabouts of such a file is unknown (Charlie Schelz, personal communication). We do not doubt this observation, and although apparently uncommon, Milk Snakes likely occur at every HOVE unit. Hammerson (1999) plots a record near Cortez, suggesting the species probably occurs at the Goodman Point unit as well.

Smooth Green Snake (*Liochlorophis vernalis*). Rado (1975) included Smooth Green Snake on his HOVE checklist, based on a single pre-1974 observation from below Hovenweep House Ruin. Detailed written notes on the observation were in a wildlife observation file at HOVE (Ted Rado, personal communication). Unfortunately, the wherabouts of such a file is unknown (Charlie Schelz, personal communication). It seems unlikely that a population of Smooth Green Snake could occur at HOVE. The habitat, even in the seep area at the head of Ruin Canyon, seems much too xeric for this species, which elsewhere in southeastern Utah and southwestern Colorado is found in mesic foothill and mountain wet meadow habitats (Cox and Tanner 1995, Hammerson 1999). One possibility is that this observation could actually have been of a Ringneck Snake. Ringneck Snakes, while preferring mesic habitats, are nonetheless often found in drier situations than is the Smooth Green Snake. Although the belly of Ringneck Snakes are brightly colored with red and yellow, their dorsal surfaces are uniformly gray or greenish-gray, and in the southwest they often lack their namesake brightly colored neck ring, leading to possible misidentification as a Smooth Green Snake.

Long-nosed Snake (*Rhinocheilus lecontei*). Stebbins (2003) includes an area in extreme southeastern Utah, in the HOVE region, within the range of the Long-nosed Snake, and this is likely based on a locality plotted by Grogan and Tanner (1974) in south-central San Juan County, Utah (not very near HOVE, but rather along the San Juan River). We were unable to locate a specimen record for that locality dot, and in a later publication (Cox and Tanner 1975) that region is not included as within the range of the species, which terminates from the west and southwest in the vicinity of Lake Powell, suggesting Tanner perhaps reevaluated the validity of the Grogan and Tanner (1974) record. Nevertheless, in that same paper, Grogan and Tanner reported a valid record of the Long-nosed Snake from Carbon County, in east-central Utah. Based on biogeography, the species probably at least formerly occurred throughout the Colorado and Green River drainages of eastern Utah, suggesting populations could occur in the HOVE area as well.

Ground Snake (*Sonora semiannulata*). This small, secretive species has not been reported from the Four Corners area, but its occurrence at Wupatki National Monument in northern Arizona (Persons 1999), an extension up the Little Colorado River Valley from the Grand Canyon, suggests it could also oocur further upstream in the Colorado River drainage, and certainly could occur in the HOVE region.

Southwestern Black-headed Snake (*Tantilla hobartsmithi*). Like the Ground Snake, this small, secretive species could occur almost anywhere, and is more likely to occur at HOVE than is the Ground Snake. It is known from localities in southeastern Utah and west-central Colorado (Colorado River drainage), and Hammerson (1999) notes that "there is no apparent reason why this species should not occur in southwestern Colorado as well."

Black-necked Garter Snake (*Thamnophis cyrtopsis*). Although probably no garter snakes are found at the primary five units, they probably do occur at the Goodman Point unit. Although not as likely as the Western Terrestrial Garter Snake (below), the Black-necked Garter Snake does occur along the San Juan and Colorado Rivers in New Mexico and Utah, and could possibly occur at the Goodman Point unit.

Western Terrestrial Garter Snake (*Thamnophis elegans*). Although probably not occuring at the primary five units, which are too dry, the Western Terrestrial Garter Snake almost certainly occurs at the Goodman Point unit, which is wettter and cooler. Hammerson (1999) supports this idea, as he plotted numerous locality records in the Cortez area.

Appendix C. Scientific names of amphibians and reptiles used in the text.

Amphibians
Tiger Salamander *(Ambystoma tigrinum*)
Mexican (New Mexico) Spadefoot (*Spea multiplicata*)
Plains Spadefoot (*Spea bombifrons*)
Red-spotted Toad (*Bufo punctatus*)
Woodhouse's Toad (*Bufo woodhousii)*
Canyon Treefrog (*Hyla arenicolor*)
Striped Chorus Frog (*Pseudacris triseriata*)
Northern Leopard Frog *(Rana pipiens*)

Lizards
Eastern Collared Lizard (*Crotaphytus collaris*)
Longnose Leopard Lizard (*Gambelia wislizenii*)
Lesser Earless Lizard (*Holbrookia maculata*)
Short-horned Lizard (*Phrynosoma hernandesi*)
Sagebrush Lizard (*Sceloporus graciosus*)
Desert Spiny Lizard (*Sceloporus magister*)
Eastern Fence Lizard (*Sceloporus undulatus*)
Tree Lizard (*Urosaurus ornatus*)
Side-blotched Lizard (*Uta stansburiana*)
Many-lined Skink (*Eumeces multivirgatus*)
Western Whiptail (*Cnemidophorus tigris*)
Plateau Striped Whiptail (*Cnemidophorus velox*)
Desert Night Lizard (*Xantusia vigilis*)

Snakes
Glossy Snake (*Arizona elegans*)
Racer (*Coluber constrictor*)
Ringneck Snake (*Diadophis punctatus*)
Night Snake (*Hypsiglena torquata*)
Common Kingsnake (*Lampropeltis getula*)
Milk Snake (*Lampropeltis triangulum*)
Smooth Green Snake (*Liochlorophis vernalis*)
Striped Whipsnake (*Masticophis taeniatus*)
Gopher Snake (*Pituphis catenifer*)
Long-nosed Snake (*Rhinocheilus lecontei*)
Ground Snake (*Sonora semiannulata*)
Southwestern Black-headed Snake (*Tantilla hobartsmithi*)
Black-necked Garter Snake (*Thamnophis cyrtopsis*)
Western Terrestrial Garter Snake (*Thamnophis elegans*)
Western Rattlesnake (*Crotalus viridis*)

Appendix D. Total number of individuals of each species observed by each survey method during herpetofauna inventory of Hovenweep National Monument, 2001-2003. GS=General Survey, NGS=Nighttime General Survey, TACS=Non Random 1 Ha TACS plot, ND=Night Driving, and RE=Random Encounter. Although most night driving surveys were conducted outside monument boundaries, only those individuals found within the monument are included here.

Species	GS	NGS	TACS	ND	RE	Total
Tiger Salamander	5	5				**10**
Mexican Spadefoot		9		10		**19**
Red-spotted Toad		1		18		**19**
Woodhouse's Toad	1				1	**2**
Eastern Collared Lizard	17		2		2	**21**
Longnose Leopard Lizard	2		1			**3**
Sagebrush Lizard	6				1	**7**
Desert Spiny Lizard	4		2	2	2	**10**
Eastern Fence Lizard	198		17	2	7	**224**
Side-blotched Lizard	83		19		3	**105**
Tree Lizard	60		11		2	**73**
Western Whiptail	48		9		8	**65**
Unidentified Lizard	13		19		3	**21**
Striped Whipsnake	2					**2**
Gopher Snake	1					**1**
Western Rattlesnake			1			**1**
TOTAL	**440**	**15**	**69**	**32**	**27**	**583**

Appendix E. Copy of the field checklist "The Amphibians and Reptiles of Hovenweep National Monument" by Theodore Rado, published in 1975 by the Mesa Verde Museum Association.

AMPHIBIANS

Utah Tiger Salamander Ambystoma tigrinum utahensis
Found in seeps and stock ponds throughout the mesatop. Common; nocturnal.

Western Spadefoot Toad Scaphiopus hammondi
Mainly found in the sage community on the mesa. Spends much time underground, coming out after the first heavy summer rains. Common; nocturnal.

Rocky Mountain Toad Bufo w. woodhousei
Stock ponds on the mesatop. Uncommon; nocturnal.

Red-spotted Toad Bufo punctatus
Seeps, stock ponds, mammal burrows and arroyos throughout the area. Common; nocturnal.

LIZARDS

Yellow-headed Collared Lizard Crotaphytus collaris auriceps
Canyon rim and talus slope communities; anywhere rock outcroppings may be found. Common; diurnal.

Long-nosed Leopard Lizard Crotaphytus w. wislizenii
Open areas of sageland on the mesatop. Uncommon; diurnal.

Orange-headed Spiny Lizard Sceloporus magister Cephaloflavus
Canyon rim, talus slope and canyon bottom Communities. Rare; dirurnal.

Northern Plateau Lizard Sceloporus undulatus elongatus
Canyon rim, talus slope and canyon bottom Communities. Found where rock crevices, holes, dead wood or other suitable cover for protection exists. Common; diurnal.

Sagebrush Lizard Sceloporus graciosus
Sage community along the mesatop. Generally found where rodent burrows, a primary source of refuge, abound. Common; diurnal.

Tree Lizard Urosaurus ornatus
Usually found in association with large sandstone boulders in the canyon talus slopes. Seen in the canyon bottom and canyon rim communities to a lesser extent. Common; diurnal.

Mountain Short horned Lizard Phrynosoma douglassi hernandesi
This is the rarest lizard in the the monument. Known only from the sage community. Rare; diurnal.

Northern Whiptail Lizard Cnemidophorus tigris septrionalis
Found throughout the area, although most frequently encountered in the sagebrush. Common; diurnal.

SNAKES

Smooth Green Snake Opheodrys vernails
Known only from the head of Ruin Canyon. Rare; diurnal.

Striped Whipsnake Masticophis t. taeniatus
Found throught the monument, although most sightings occur in the sage community. Common; diurnal.

Painted Desert Glossy Snake Arizona elegans philipi
Sage community on the mesa. Uncommon; nocturnal.

Great Basin Gopher Snake Pituophis melanoleucus deserticola
This is the most commonly seen snake in the monument area. Found almost everywhere, although most often seen in the sage and canyon bottoms. Common; diurnal - nocturnal.

California Kingsnake Lampropeltis getulus californiae
Canyon rim, talus slope, and canyon bottom communities Rare; diurnal - nocurnal.

Milk Snake Lampropeltis triangulum subsp.
Sage and Canyon rim communities. Rare; nocturnal.

Midget-faded Rattlesnake Crotalus viridis concolor
Although infrequently sighted by park visitors, this is the most common snake in the area. Found throughout the mesatop. Common; diurnal during the spring and fall, nocturnal during the summer.

The following animals have either been seen in nearby areas or might be expected to occur here according to range maps in "A Field Guide to Western Reptiles and Amphibians" by Stebbins (1966). If you make positive identification of any of these the monument would appreciate learning of your findings.

Canyon Treefrog Hyla arenicolor
Leopard Frog Rana pipiens
Lesser Earless Lizard Holbrookia maculata
Southern Many-lined Skink Eumeces multivirgatus epipleurotus
Plateau Whiptail Lizard Cnemidophorus velox
Western Long-nosed Snake Rhinocheilus l. lecontei
Wandering Garter Snake Thamnophis elegans vagrans
Black-necked Garter Snake Thamnophis cyrtopsis
Mesa Verde Night Snake Hypsiglena torquata loreala

Appendix F. Amphibians and reptiles from Hovenweep National Monument located in institutional museum collections. CAS = California Academy of Sciences; KU = University of Kansas Museum of Natural History; UCM = University of Colorado Museum.

Species	Museum #	Date	Collector	Locality	Notes
Tiger Salamander	UCM 11845	6/7/1959	Laffan	Hackberry Canyon Spring, Hovenweep National Monument	From Colorodo DOW database
Tiger Salamander	UCM 11846	6/7/1959	Laffan	Hackberry Canyon Spring, Hovenweep National Monument	From Colorodo DOW database
Tiger Salamander	UCM 11847	6/7/1959	Laffan	Hackberry Canyon Spring, Hovenweep National Monument	From Colorodo DOW database
Tiger Salamander	CAS 187374	28 Jun 1976	T. Rado	Ruin Canyon, 5100' elev., Hovenweep Nat. Mon., San Juan Co., Utah	San Jose State University collection
Eastern Fence Lizard	KU 106109	unknown	unknown	Hovenweep National Monument	From Colorodo DOW database
Eastern Fence Lizard	CAS 189591	28 Jun 1976	T. Rado	Hovenweep National Monument, Ruins Trail, 5200' elev., San Juan Co., Utah	San Jose State University collection
Side-blotched Lizard	CAS 189934	29 Jun 1976	T. Rado	Hovenweep National Monument, Ruins Trail, 5200' elev., San Juan Co., Utah	San Jose State University collection
Tree Lizard	CAS 189134	29 Jun 1976	T. Rado	Hovenweep National Monument, Ruins Trail, 5200' elev., San Juan Co., Utah	San Jose State University collection
Western Whiptail	CAS 189032	29 Jun 1976	T. Rado	Campground at Hovenweep Nat. Mon., 5200' elev., San Juan Co., Utah	San Jose State University collection

Appendix G. All amphibian and reptile species found or expected to occur at HOVE. Ranking of probability of species occurrence is as follows: 1 = low probability, 2 = medium probability, and 3 = high probability. SX = specimen collected, this study. SP = specimen collected, previous study. OX = species observed, this study. OP = species observed previously (only included if observation(s) reliable). Although a species may be represented by multiple categories, only the "hardest" evidence is given, i.e., a specimen trumps an observation, and data from this study trumps previous data. Weighted total is equivalent to the total number of species expected to occur, and estimated inventory completeness is simply the number documented (SX, SP, OX, or OP) divided by the weighted total.

SPECIES	STATUS All Units Combined	STATUS All Units EXCEPT Goodman Point
Tiger Salamander	SX	SX
Mexican Spadefoot	SX	SX
Plains Spadefoot	3	3
Red-spotted Toad	SX	SX
Woodhouse's Toad	OX	OX
Canyon Treefrog	1	1
Eastern Collared Lizard	SX	SX
Longnose Leopard Lizard	SX	SX
Side-blotched Lizard	SX	SX
Tree Lizard	SX	SX
Lesser Earless Lizard	2	2
Short-horned Lizard	3	3
Desert Spiny Lizard	SX	SX
Eastern Fence Lizard	SX	SX
Sagebrush Lizard	SX	SX
Many-lined Skink	3	2
Plateau Striped Whiptail	3	1
Western Whiptail	SX	SX
Desert Night Lizard	1	1
Glossy Snake	3	3
Ringneck Snake	1	1
Night Snake	3	3
Common Kingsnake	OP	OP
Milk Snake	3	3
Striped Whipsnake	OX	OX
Smooth Green Snake	1	1
Gopher Snake	SX	SX
Long-nosed Snake	1	1
Ground Snake	1	1
Southwestern Black-headed Snake	1	1
Black-necked Garter Snake	1	
Western Terrestrial Garter Snake	3	
Western Rattlesnake	OX	OX
TOTAL RANK 1	**7**	**8**
TOTAL RANK 2	**1**	**2**
TOTAL RANK 3	**8**	**5**
TOTAL FOUND (SX, OX, SP, OP)	**16**	**16**
WEIGHTED TOTAL	**24.3**	**22.5**
ESTIMATED INVENTORY COMPLETENESS	**65.8%**	**71.1%**

Appendix H. Amphibians and reptiles collected at Hovenweep National Monument during herpetofauna inventory in 2001-2003. All specimens are deposited in the U.S. Geological Survey, Biological Survey Collection (BS/FC) at the Museum of Southwestern Biology, University of New Mexico, Albuquerque. Additionally, all specimens have been cataloged with the National Park Service (ANCS+). Abbreviations for collectors are Erika M. Nowak (EMN), Shawn C. Knox (SCK), and Trevor B. Persons (TBP). All specimens, regardless of collector, were assigned numbers in the field catalog of Trevor B. Persons.

Species	Field Number	NPS Catalog Number	BS/FC Catalog Number	Date	Collectors	UTM (NAD27)	Age/Sex	Locality
Tiger Salamander	TBP 110	HOVE 18449	BS/FC 7777	6/19/2001	TBP, SCK		adult	Hackberry unit, pool under ledge at head of main canyon
Mexican Spadefoot	TBP 230	HOVE 18458	BS/FC 7786	8/6/2002	TBP	670259 E, 4139547 N, EPE 7m	adult	Entrance road to Square Tower unit, ca. 10 m. s. of north boundary.
Red-spotted Toad	TBP 231	HOVE 18459	BS/FC 7787	8/6/2002	TBP	670440 E, 4139215 N, EPE 7m	Adult F	Square Tower unit, Visitor center patio
Eastern Collared Lizard	TBP 232	HOVE 18460	BS/FC 7788	8/7/2002	TBP	670967 E, 4138801N, EPE 4m	Adult F	Canyon east of campground, Square Tower unit
Longnose Leopard Lizard	TBP 139	HOVE 18456	BS/FC 7784	8/11/2001	TBP	671009 E, 4139424 N	Adult F	Square Tower unit, rim of "Campground Canyon"
Side-blotched Lizard	TBP 109	HOVE 18448	BS/FC 7776	6/19/2001	TBP, SCK	669944 E, 4139176 N	Adult F	Square Tower unit, head of Ruin Canyon
Tree Lizard	TBP 108	HOVE 18447	BS/FC 7775	6/19/2001	TBP, SCK	670277 E, 4138979 N	Adult M	Square Tower unit, Ruin Canyon
Desert Spiny Lizard	TBP 132	HOVE 18453	BS/FC 7781	7/6/2001	EMN	660969 E, 4129395 N	juvenile	Cajon unit
Eastern Fence Lizard	TBP 107	HOVE 18446	BS/FC 7774	6/19/2001	TBP, SCK	670709 E, 4138803 N	Adult F	Square Tower unit, Ruin Canyon
Eastern Fence Lizard	TBP 135	HOVE 18454	BS/FC 7782	8/9/2001	TBP		Adult F	Goodman Point unit, in wash ca. 20 m upstream of dropoff
Sagebrush Lizard	TBP 112	HOVE 18451	BS/FC 7779	6/20/2001	TBP, SCK	670885 E, 4138987 N	Adult M	Square Tower unit, campground
Sagebrush Lizard	TBP 136	HOVE 18455	BS/FC 7783	8/9/2001	TBP		Adult F	Goodman Point unit, along trail to rubble mounds, near wash
Western Whiptail	TBP 111	HOVE 18450	BS/FC 7778	6/20/2001	TBP, SCK	678571 E, 4145692 N	Adult F	Cutthroat Castle unit, upper end of small canyon
Western Whiptail	TBP 140	HOVE 18457	BS/FC 7785	8/12/2001	TBP		Adult F	Cajon unit, southeast corner of unit
Gopher Snake	TBP 113	HOVE 18452	BS/FC 7780	6/20/2001	SCK, TBP	670987 E, 4139038 N	juvenile	Square Tower unit, bouldery hillside of canyon east of campground

Appendix I. NPSpecies checklist field designations for all documented and hypothetical amphibian and reptile species at Hovenweep National Monument.

SPECIES	Park Status	Abundance	Residency	Nativity
Tiger Salamander	Present in Park	Common	Breeder	Native
Mexican Spadefoot	Present in Park	Common	Breeder	Native
Plains Spadefoot	Probably Present		Breeder	Native
Red-spotted Toad	Present in Park	Common	Breeder	Native
Woodhouse's Toad	Present in Park	Uncommon	Breeder	Native
Canyon Treefrog	Unconfirmed		Breeder	Native
Eastern Collared Lizard	Present in Park	Common	Breeder	Native
Longnose Leopard Lizard	Present in Park	Common	Breeder	Native
Side-blotched Lizard	Present in Park	Abundant	Breeder	Native
Tree Lizard	Present in Park	Abundant	Breeder	Native
Lesser Earless Lizard	Unconfirmed		Breeder	Native
Short-horned Lizard	Probably Present		Breeder	Native
Desert Spiny Lizard	Present in Park	Common	Breeder	Native
Eastern Fence Lizard	Present in Park	Abundant	Breeder	Native
Sagebrush Lizard	Present in Park	Common	Breeder	Native
Many-lined Skink	Probably Present		Breeder	Native
Plateau Striped Whiptail	Unconfirmed		Breeder	Native
Western Whiptail	Present in Park	Abundant	Breeder	Native
Desert Night Lizard	Unconfirmed		Breeder	Native
Glossy Snake	Probably Present		Breeder	Native
Ringneck Snake	Unconfirmed		Breeder	Native
Night Snake	Probably Present		Breeder	Native
Common Kingsnake	Present in Park	Rare	Breeder	Native
Milk Snake	Probably Present		Breeder	Native
Striped Whipsnake	Present in Park	Common	Breeder	Native
Smooth Green Snake	Unconfirmed		Breeder	Native
Gopher Snake	Present in Park	Common	Breeder	Native
Long-nosed Snake	Unconfirmed		Breeder	Native
Ground Snake	Unconfirmed		Breeder	Native
Southwestern Black-headed Snake	Unconfirmed		Breeder	Native
Black-necked Garter Snake	Unconfirmed		Breeder	Native
Western Terrestrial Garter Snake	Probably Present		Breeder	Native
Western Rattlesnake	Present in Park	Common	Breeder	Native