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Inventory of Amphibians and Reptiles at Death Valley National Park

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By Trevor B. Persons and Erika M. Nowak

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Inventory of Amphibians and Reptiles at Death Valley National Park

By Trevor B. Persons and Erika M. Nowak

Abstract

As part of the National Park Service Inventory and Monitoring Program in the Mojave Network, we conducted an inventory of amphibians and reptiles at Death Valley National Park in 2002–04. Objectives for this inventory were to: 1) Inventory and document the occurrence of reptile and amphibian species occurring at DEVA, primarily within priority sampling areas, with the goal of documenting at least 90% of the species present; 2) document (through collection or museum specimen and literature review) one voucher specimen for each species identified; 3) provide a GIS-referenced list of sensitive species that are federally or state listed, rare, or worthy of special consideration that occur within priority sampling locations; 4) describe park-wide distribution of federally- or state-listed, rare, or special concern species; 5) enter all species data into the National Park Service NPSpecies database; and 6) provide all deliverables as outlined in the Mojave Network Biological Inventory Study Plan. Methods included daytime and nighttime visual encounter surveys, road driving, and pitfall trapping. Survey effort was concentrated in predetermined priority sampling areas, as well as in areas with a high potential for detecting undocumented species. We recorded 37 species during our surveys, including two species new to the park. During literature review and museum specimen database searches, we recorded three additional species from DEVA, elevating the documented species list to 40 (four amphibians and 36 reptiles). Based on our surveys, as well as literature and museum specimen review, we estimate an overall inventory completeness of 92% for Death Valley and an inventory completeness of 73% for amphibians and 95% for reptiles.

Key Words: Amphibians, reptiles, Death Valley National Park, Inyo County, San Bernardino County, Esmeralda County, Nye County, California, Nevada, Mojave Desert, Great Basin Desert, inventory, NPSpecies.

Introduction

In fiscal year 2000, the National Park Service (NPS) received a substantial budget increase for inventory and monitoring studies. At that time, a nationwide program to inventory vertebrates and vascular plants within the National Parks was initiated. As part of this new inventory effort led by the NPS Inventory and Monitoring program, a total of 265 National Park units (e.g., parks, monuments, recreation areas, historic sites) 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 Mojave Network consists of six NPS units in the Mojave and Great Basin biomes: Death Valley National Park (DEVA), Great Basin National Park (GRBA), Joshua Tree National Park (JOTR), Lake Mead National Recreation Area (LAME), Manzanar National Historic Site (MANZ) and Mojave National Preserve (MOJA). A biological inventory study plan was developed for the Mojave Network (NPS 2001), and DEVA identified inventory of amphibians and reptiles as a high priority. A preliminary NPS assessment of inventory completeness indicated that 74% (35 of 47) of the potentially occurring reptile species and 44-50% (4 of 8 or 9) of the potentially occurring amphibian species had been verified from DEVA. Reptile and amphibian inventories were funded as two separate projects, with inventory work for reptiles beginning in spring of 2002 and amphibians in spring of 2003. Although both inventories were originally planned as two-year efforts, deadlines for deliverables have been adjusted so that results can be combined into a single report.

Park managers and local experts identified priority sampling areas for both amphibians and reptiles, representing areas that lacked adequate baseline information on species occurrence, had a high potential for increasing the park species list, or were of special management concern. Many of these areas are within lands recently added to the park as part of the

1994 California Desert Protection Act, including the Greenwater Range and Greenwater Valley, Owlshead Mountains, Argus Range and Darwin Plateau, springs in the Cottonwood and Panamint Mountains, and the Last Chance Range (Figure 1).

Objectives for this inventory were to: 1) Inventory and document the occurrence of reptile and amphibian species occurring at DEVA, primarily within priority sampling locations, with the goal of documenting at least 90% of the species potentially present; 2) document (through collection or museum specimen and literature review) one voucher specimen for each species identified; 3) provide a GIS-referenced list of sensitive species that are known to be federally or state listed, rare, or worthy of special consideration that occur within priority sampling locations; 4) describe park-wide distribution of federally- or state-listed, rare, or special concern species; 5) enter all species data into the National Park Service NPSpecies database; and 6) provide all deliverables as outlined in the Mojave Network Biological Inventory Study Plan.

Study Area Description

Death Valley National Park encompasses over 1.37 million hectares, primarily in Inyo County, California, but extends

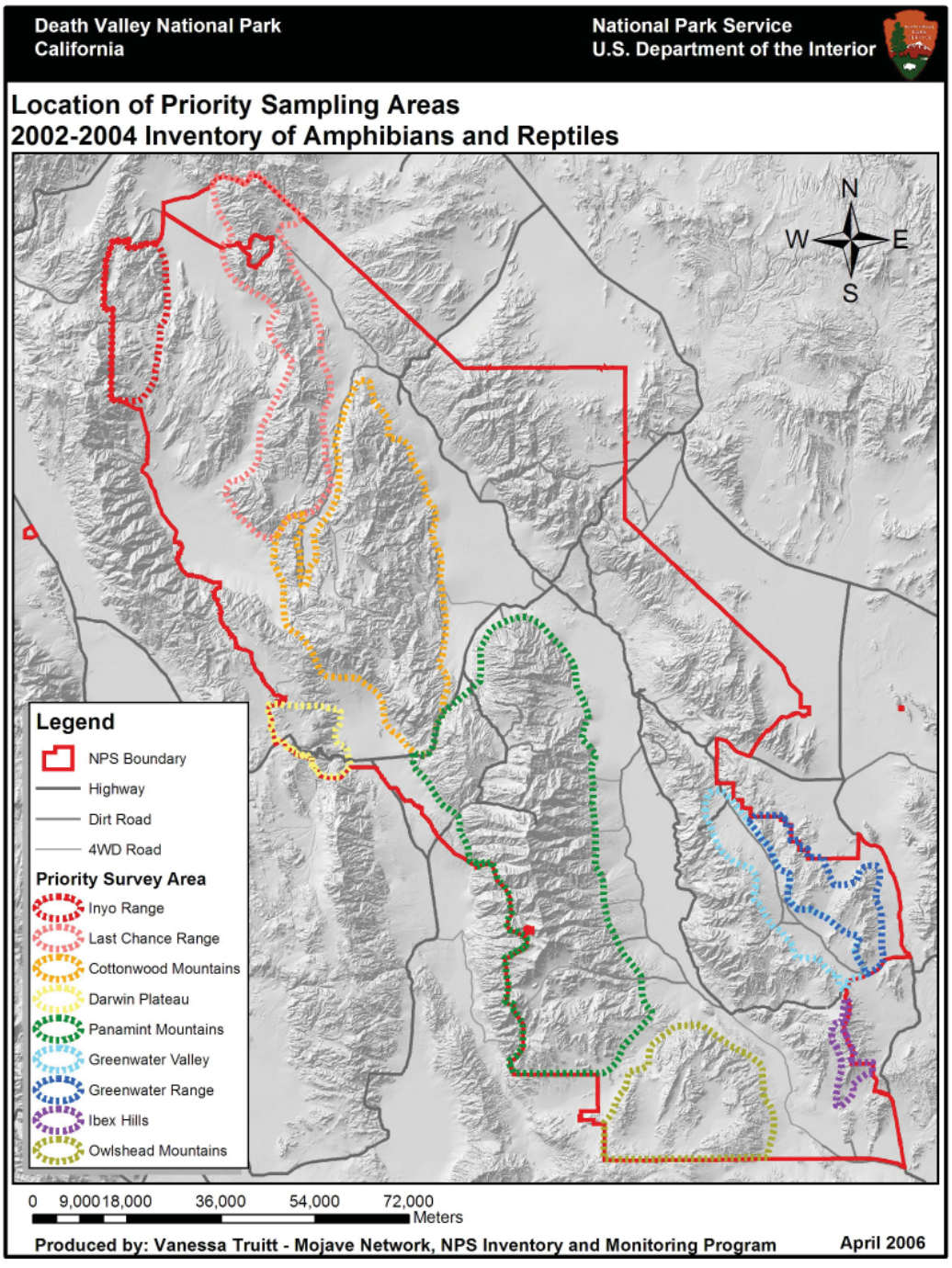

Figure 1. Map of Death Valley National Park showing the location of priority sampling areas during an inventory of amphibians and reptiles in 2002–04.

into San Bernardino County, California, and Esmeralda and Nye counties, Nevada (Figure 1). Elevation ranges from 86 m below sea level (the lowest point in North America) to 3368 m on Telescope Peak in the Panamint Mountains, for a total elevation range of over 3450 m. DEVA is physiographically and hydrologically part of the Great Basin, but lies floristically within the Mojave Desert (Grayson 1993). While summer temperatures are moderate at higher elevations, they can be extremely hot in the lowest valleys. Furnace Creek has an average high temperature of 47 ºC for July, and holds the record for the hottest temperature ever recorded in North America, 57 ºC. The average high and low temperatures at Furnace Creek in January are18 ºC and 4 ºC, respectively. Rainfall at the lowest point in Death Valley averages only 4.19 cm per year, but increases at higher elevations. Habitats range from barren salt flats and alkaline Mojave Desertscrub communities at the lowest elevations within the valleys, to bristlecone pine (*Pinus aristida*) woodlands in the highest elevations of the Panamint Mountains (Turner and Wauer 1963). On the extensive alluvial fans, creosote bush (*Larrea tridentata*) is the dominant plant, and big sagebrush (*Artemisia tridentata*) and blackbrush (*Coleogyne ramosissima*) flats and pinyon-juniper (*Pinus monophylla* and *Juniperus osteosperma*) woodlands are common at intermediate elevations (Turner and Wauer 1963). Microhabitats important to some amphibians and reptiles at DEVA include rocky canyons, sand dunes, and aquatic habitats. Natural aquatic habitats include Saratoga Spring, a large (ca. 1 ha) pond in the southern part of the park, a perennial stream at Darwin Falls, spring-fed washes along the margins of Death Valley and elsewhere, a large salt lake and nearby flowing wells in Saline Valley, stagnant pools along the lower Amargosa River, and numerous springs in the Panamint Range (i.e., Panamint and Cottonwood Mountains). These latter springs occur between ca. 1067-1372 m elevation, and often contain heavy stands of willow (*Salix*), rabbitbrush (*Crysothamnus*), seep willow (*Baccharis*), and desert grape (*Vitis girdiana*; Turner and Wauer 1963). Artificial ponds around the golf course at Furnace Creek contribute to the diversity of aquatic habitats available to amphibians within the park.

Methods

Sampling Design

The focus of the present DEVA amphibian and reptile inventory was very specific: to survey relatively unknown or sensitive areas of the park and to document the presence of suspected species. Given this, and based on results from previous herpetological inventories (e.g., Drost et al. 2001, Nowak et al. 2003), we used non-random, targeted sampling methods rather than randomized plots or transects. It is well known that unconstrained, targeted surveys are superior to randomized methods when trying to compile a herpetofauna species list (e.g., Campbell and Christman 1982, Karns 1986, Scott 1994, Turner et al. 1999). Much of our effort was focused in the previously identified priority sampling areas (above), but we also targeted other areas of the park with a high likelihood of harboring new species, especially the lower Amargosa River valley (including Ibex Dunes).

Field Methods

For this inventory, we used a combination of diurnal and nocturnal time-recorded visual encounter surveys ("general surveys"), road driving (primarily at night), and limited pitfall trapping. These methods are outlined below.

Daytime General Surveys

General surveys are a form of time-recorded visual encounter survey described by Crump and Scott (1994). During daytime general surveys we recorded the area searched (either with GPS points or written route descriptions, or both), start and stop times, weather conditions (temperature, cloud cover, wind, relative humidity) at the beginning and end of each survey, and observations of all amphibians or reptiles encountered during the survey. Habitat data included descriptions of dominant vegetation and physiographic features of the area (soil type, slope, drainages, etc.). A copy of the field data sheet used for most general surveys is reproduced in Appendix A. These surveys varied from short duration searches of specific habitats (e.g., springs, sand dunes) to all-day hikes over extensive areas (e.g., long, large canyons).

Nocturnal General Surveys

Nocturnal general surveys were conducted in the same manner as daytime general surveys, except that they occurred at night with the aid of flashlights. During these surveys, we primarily targeted aquatic habitats used by amphibians. These surveys included an aural component (i.e. listening at potential breeding locations for calling amphibians), as well as visual searches of pools and streams for tadpoles and egg masses. We also surveyed some dry washes and sand dunes at night in search of snakes.

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.

We standardized these surveys by driving a vehicle at slow speeds (20-30 km per hour) on both paved and good dirt roads within DEVA, identifying all amphibians and reptiles encountered to species and recording if they were either alive on the road (AOR) or dead on the road (DOR). We sexed and aged all individuals, as possible, and recorded locations to the nearest 0.1 mi using calibrated vehicle odometers. Locations of selected observations were also recorded using a GPS unit.

Day Driving

During some daytime driving we actively searched for reptiles on or near the road, usually between survey areas. However, most commuter driving was generally done at higher speeds (over 40 km per hour), and any reptiles observed opportunistically (usually larger species, especially snakes) were recorded as random encounters (below).

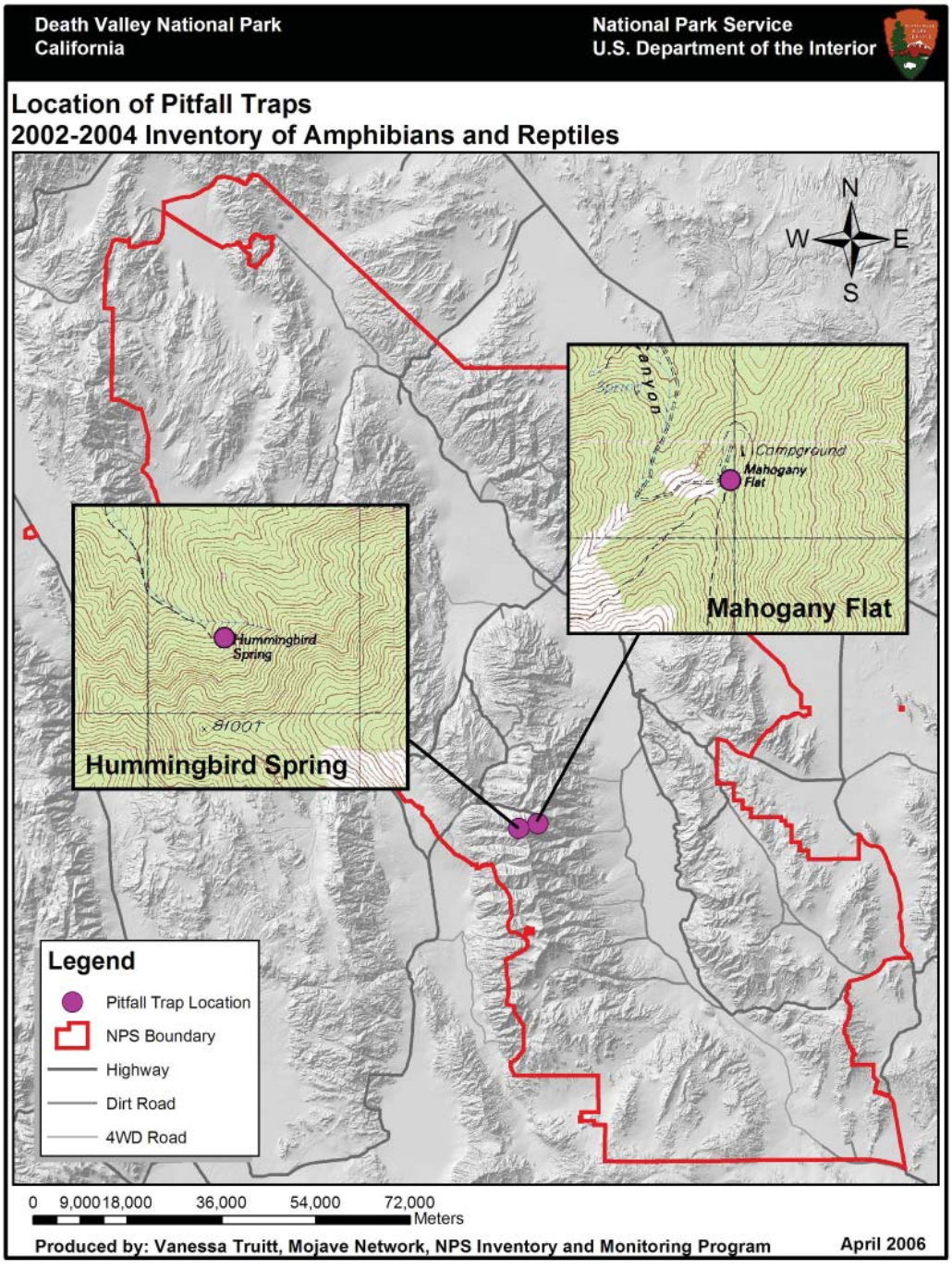

Figure 2. Location of pitfall traps operated in 2003–04 at Mahogany Flat and Hummingbird Spring, Panamint Mountains, during an inventory of amphibians and reptiles at Death Valley National Park.

Pitfall Traps

In 2003 and 2004 we operated 35 pitfall traps in the Panamint Mountains (16 at Mahogany Flat and 19 at Hummingbird Spring), targeting salamanders. Location of these two trapping sites is shown in Figure 2. At each location, trap arrays consisted of 15 cm diameter and 46 cm deep pitfall traps constructed of plastic piping, buried flush with the ground surface. Traps were arranged non-systematically within a small area at each site in likely looking microhabitats (leaf litter and nearby cover objects, subsurface soil moisture), and were connected by a series of drift fences, designed to direct moving animals into the traps. These drift fences were constructed of flexible fiberglass window screen material tied to tent stakes to keep the fence upright, and were buried below the ground surface and extended up to a height of approximately 20 cm. When open, traps were covered with small boards raised off the ground 2-5 cm, in order to keep traps shaded from the sun, as well as attract animals seeking cover. Wet sponges were placed in each trap, in order to provide moisture for any captured animals (especially amphibians). All captured animals were identified and released.

Random Encounters

Amphibians and reptiles seen during other than formal surveys (e.g., during daytime when driving between survey areas) 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, size or age class, and sex, as possible.

Spatial Data Collection

Survey area locations were recorded using Garmin® hand-held GPS units (GPSIII Plus or Garmin 12), usually with an accuracy of 4-5 m. In addition, we recorded individual capture locations of some uncommon species. Although the Mojave I&M Network is trying to standardize all spatial data in the NAD83 datum, we used NAD27 in order to match the USGS topographic maps of DEVA. As with other field data, all spatial data were originally recorded on field data sheets (Appendix A) or in field notebooks before being entered into the Microsoft Access® database.

Voucher Specimens

We documented new species at DEVA by collecting one individual of each. In addition, we salvaged several road-killed animals found in good condition. Collection locations for most specimens were recorded using GPS. Specimens were injected with and immersed in 10% formalin for fixing, then transferred to either 55% isopropyl alcohol (Trevor B. Persons field series) or 70% ethanol (Bryan T. Hamilton field series) for preservation, using standard techniques (e.g., Simmons 2002). These specimens have been deposited in the natural history collection facility at Death Valley National Park. Each specimen has a field series tag, a data tag, and an NPS issue specimen tag containing information on species, collector, date of collection, collection site, and NPS (ANCS+) accession and catalog number. Information for each specimen was entered into the online version of NPSpecies.

Literature and Museum Specimen Review

In addition to more general references such as Stebbins (1985, 2003), the primary references used for herpetofauna of the DEVA area were Banta (1962), Stejneger (1893), and Turner and Wauer (1963). In addition, we reviewed species-specific distribution literature (e.g. Emmerich and Cunningham 2003, Norris 1958; Turner 1959b, 1959c) and ecological literature (e.g., Kay 1970, 1972; Kay et al. 1970, Turner 1959a) relating to amphibians and reptiles within the park. We also reviewed unpublished reports on amphibians and reptiles at DEVA (Boland and Goodlett 1997, Marlow 1996, Threloff 1996), and also consulted with experts familiar with aspects of the herpetofauna in the DEVA region. These experts included Alex Heindl, David Morafka, Jonathan Richmond, and Eric Simandle. Contact information for these experts is presented in Appendix B.

We reviewed museum specimen records previously entered into NPSpecies. These records were obtained from the online collection databases at the California Academy of Sciences (CAS) and the Museum of Vertebrate Zoology, University of California at Berkeley (MVZ), as well as the DEVA natural history collection. Although we did not verify species identifications for specimens from CAS and MVZ, we reviewed collection data for uncommon species, in order to verify that specimens were collected within the current boundaries of DEVA. We did examine specimens in the DEVA natural history collection facility, as we suspected some might have been misidentified.

Data Analysis

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. We measured sampling effort for general surveys and nocturnal general surveys in person-hours, i.e., the number of hours spent surveying multiplied by the number of observers for any given survey. For night driving and day driving we measured effort both in person-hours and in total miles driven. We measured pitfall trapping effort in trap days, i.e., the number of individual traps multiplied by the number of days traps were open. Random encounters are not quantifiable in terms of effort, but they added important

information for the development of the species accounts on the distribution and abundance of species within the park.

To estimate inventory completeness, we developed a master list of species documented and potentially occurring at DEVA. Development of this master list was based on consultation of selected literature sources (e.g., Banta 1962, Stebbins 1985, 2003, Turner and Wauer 1963), review of the NPSpecies database, personal knowledge of the distribution and habitats of southwestern amphibians and reptiles, data from selected museum collections, personal communications with other herpetologists that have worked in the DEVA region, and results of fieldwork from the 2002 through 2004 seasons. Based on our expert opinion, probability of species occurrence was ranked as low (0-33%), medium (34-67%), or high (68-100%). In Table 4 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 are weighted 1.0. Such weighting of categorical probability data is generally not recommended for statistical applications; however, we feel it justifiable because we are not using the resulting inventory completeness estimates for statistical probability or hypothesis testing. Instead, we are generating a locally-specific estimate of percent inventory completeness as mandated by the NPS I&M program, in a manner that integrates a range of information including inventory results, pre-existing information, and professional knowledge. These considerations should be kept in mind when interpreting the inventory completeness estimates, and underscore the need to focus on the more detailed discussions in the species accounts - especially for undocumented species.

In addition to the master list, we produced a species accumulation curve (e.g., Scott 1994) to evaluate inventory completeness. This curve is simply a graphical representation of the rate at which we added to the species list over the course of the entire inventory period.

Data and Other Products

Data products delivered separately to the Mojave Inventory and Monitoring Network include 1) a Microsoft Access® database containing all field data on individual surveys and species observations; 2) ArcView® GIS shapefiles of areas covered during general surveys, pitfall trap locations, and voucher specimen locations; 3) updates of the NPSpecies and NatureBib databases for DEVA, updated both online and using the desktop application of NPSpecies; 4) copies of field notes and field data sheets; and 5) photographs (35 mm color slides) of some survey areas and captured animals. Metadata for this inventory is being developed with the assistance of the data manager for the Southern Colorado Plateau Inventory and Monitoring Network (SCPN).

Report Review

In addition to NPS review by the Mojave I&M Network coordinator and staff at DEVA, this report has undergone USGS review in accordance with the USGS Southwest Biological Science Center's (SBSC) peer review policy. This process consists of initial policy review by the station leader at the Colorado Plateau Research Station and the Center Director at SBSC, followed by peer review coordinated by the SBSC Center Director.

Results and Discussion

Overview of Inventory Results

We recorded 37 species (four amphibians and 33 reptiles) during fieldwork at DEVA in 2002–04, and we documented three additional species (Panamint Alligator Lizard, Western Blind Snake, and Glossy Snake) based on our review of the literature and museum specimen records. We documented two new species during the present inventory, Southern Alligator Lizard and Ring-necked Snake. Discussion of distribution and relative abundance of each species is found in the species accounts (Appendix C). Scientific and common names follow Stebbins (2003). Scientific names for all amphibian and reptile species mentioned in this report are presented in Table 1.

We recorded 2,463 individual amphibians and reptiles (not including tadpoles and egg masses) at DEVA that were identified to species, plus 63 others (62 lizards and one snake) that were not seen well enough to identify. Only positively identified individuals are used in analyses. Of these, 2,018 (82%) were lizards, 328 (13%) were amphibians (all frogs and toads), and only 116 (5%) were snakes. We also recorded a single Desert Tortoise (<1%). The most commonly observed species was the Side-blotched Lizard (n = 629), accounting for 26% of all observations. The Western Toad (n = 192) was the most frequently observed amphibian species, accounting for 59% of all amphibian observations. The most frequently observed snakes were the Sidewinder (n = 26) and the Speckled Rattlesnake (n = 21), together accounting for 41% of all snake observations. A summary of the total number of each species observed by each method during this inventory is presented in Table 2. Complete data on all observations can be found in the accompanying Microsoft Access® database.

Literature and Museum Specimen Review

Turner and Wauer (1963) published the most recent and comprehensive summary of the amphibians and reptiles of DEVA, and their list included 38 species (three amphibians and 35 reptiles). When compared to our list, the only amphibian species they did not mention was the Western Toad. This species probably occurs naturally at DEVA only in the vicinity of Darwin Falls, which was not part of the park at the time. In addition, populations of Western Toads currently inhabiting the Furnace Creek area have probably been introduced within the past 40 years (Threloff 1996). Aside from the two new reptile species documented during the present inventory, the only discrepancy between our list and Turner and Wauer's (1963) is their inclusion of Long-tailed Brush Lizard. However, they included the species on their list based on Norris (1958), who described collection localities that while close to DEVA, are probably outside the boundaries of the park.

Stejneger (1893) reported on amphibians and reptiles in what is now DEVA, but the so-called "Death Valley Expedition" collected specimens throughout adjacent regions of California, Nevada, Arizona, and Utah. Banta (1962) conducted extensive pit-trapping surveys throughout the Saline Valley region, before that area was incorporated into DEVA. He recorded one amphibian (Red-spotted Toad) and 24 reptile species, all of which are included on the list presented by Turner and Wauer (1963). Because of Banta's (1962) extensive use of pitfall traps, he recorded species otherwise difficult to observe, including numerous individuals of Gilbert's Skink and Panamint Alligator Lizard, as well as two captures of Southwestern Black-headed Snake, a species rarely reported from DEVA.

Recent literature on the herpetofauna of DEVA includes a report on amphibians in the Furnace Creek region of the park (Threloff 1996) and a Desert Tortoise survey (Boland and Goodlett 1997). Pratt and Hoff (1992) conducted an aquatic invertebrate and amphibian survey of springs in the lower Amargosa River region. Besides common amphibian species, they reported hearing possible calls of Northern Leopard Frogs at Saratoga Spring. Marlow (1996a) reported on reptile pitfall trapping around selected springs at DEVA, but he captured only a few individuals of common reptile species. Marlow (1996b) conducted visual encounter surveys for amphibians at these and other springs, and in addition to common amphibian species he discovered the isolated (probably introduced) population of Black Toads in the Saline Valley.

Our review of specimen records in NPSpecies from CAS, MVZ, and the DEVA natural history collection revealed that all 38 species previously documented from DEVA are represented by one or more voucher specimens. In addition, specimens of the two new species found during the present inventory were collected. The only species known to have occurred in the park that is not represented by a voucher specimen is the Black Toad, which was introduced only about a decade ago, and is possibly now extirpated at DEVA. We examined specimens in the DEVA natural history collection facility,

Table 1. Scientific names and common names of amphibians and reptiles used in the text. Scientific and common names follow Stebbins (2003). Recent studies have proposed changes in the taxonomy of some species found at DEVA, and interested readers should consult Crother (2000) and Crother et al. (2003) for a summary of these proposals.

Common name	Scientific name
Amphibians	
Inyo Mountains Salamander	*Batrachoseps campi*
Ensatina	*Ensatina escholtziii*
Great Basin Spadefoot	*Spea intermontana*
Western Toad	*Bufo boreas*
Black Toad	*Bufo exsul*
Red-spotted Toad	*Bufo punctatus*
Pacific Treefrog	*Hyla regilla*
Bullfrog	*Rana catesbeiana*
Northern Leopard Frog	*Rana pipiens*
Turtles	
Desert Tortoise	*Gopherus agasssizii*
Lizards	
Great Basin Collared Lizard	*Crotaphytus bicinctores*
Long-nosed Leopard Lizard	*Gambelia wislizenii*
Zebra-tailed Lizard	*Callisaurus draconoides*
Desert Iguana	*Dipsosaurus dorsalis*
Desert Horned Lizard	*Phrynosoma platyrhinos*
Mojave Fringe-toed Lizard	*Uma scoparia*
Long-tailed Brush Lizard	*Urosaurus graciosus*
Ornate Tree Lizard	*Urosaurus ornatus*
Side-blotched Lizard	*Uta stansburiana*
Common Chuckwalla	*Sauromalus obesus*
Desert Spiny Lizard	*Sceloporus magister*
Western Fence Lizard	*Sceloporus occidentalis*
Sagebrush Lizard	*Sceloporus graciosus*
Western Whiptail	*Cnemidophorus tigris*
Northern Alligator Lizard	*Elgaria coerulea*
Southern Alligator Lizard	*Elgaria multicarinata*
Panamint Alligator Lizard	*Elgaria panamintinus*
Western Skink	*Eumeces skiltonianus*
Gilbert's Skink	*Eumeces gilberti*
Western Banded Gecko	*Coleonyx variegatus*
Mediterranean Gecko	*Hemidactylus turcicus*
Desert Night Lizard	*Xantusia vigilis*
Gila monster	*Heloderma suspectum*
Snakes	
Western Blind Snake	*Leptotyphlops humilis*
Rubber Boa	*Charina bottae*
Rosy Boa	*Charina trivirgata*
Glossy Snake	*Arizona elegans*
Western Shovel-nosed Snake	*Chionactis occipitalis*
Ring-necked Snake	*Diadophis punctatus*
Night Snake	*Hypsiglena torquata*
Common Kingsnake	*Lampropeltis getula*
California Mountain Kingsnake	*Lampropeltis zonata*
Coachwhip	*Masticophis flagellum*
Striped Whipsnake	*Masticophis taeniatus*
Spotted Leaf-nosed Snake	*Phyllorynchus decurtatus*
Gopher Snake	*Pituophis catenifer*
Long-nosed Snake	*Rhinocheilus lecontei*
Western Patch-nosed Snake	*Salvadora hexalepis*
Western Ground Snake	*Sonora semiannulata*
Southwestern Black-headed Snake	*Tantilla hobartsmithi*
Western Terrestrial Garter Snake	*Thamnophis elegans*
Western Lyre Snake	*Trimorphodon biscutatus*
Western Diamond-backed Rattlesnake	*Crotalus atrox*
Sidewinder	*Crotalus cerastes*
Speckled Rattlesnake	*Crotalus mitchellii*
Mojave Rattlesnake	*Crotalus scutulatus*
Western Rattlesnake	*Crotalus viridis*

Table 2. Amphibian and reptile species observed during herpetofauna surveys at Death Valley National Park in 2002–04, and the numbers of each species observed (not counting amphibian tadpoles or egg masses) by each method. Abbreviations for survey types are: GS = general surveys, NGS = nocturnal general surveys, PF = pitfall traps, ND = night driving surveys, DD = day driving surveys, and RE = random encounters.

Species	GS	NGS	ND	DD	PF	RE	Totals
Western Toad	80	111	1				192
Red-spotted Toad	24		1				25
Pacific Treefrog	47	15	11				73
Bullfrog	29	7	1			1	38
Desert Tortoise			1				1
Zebra-tailed Lizard	238	1	5	67		15	326
Great Basin Collared Lizard	53			51		7	111
Desert Iguana	53		4	2		9	68
Long-nosed Leopard Lizard	14		2	12		7	35
Desert Horned Lizard	40		18	36		20	114
Common Chuckwalla	27			8		6	41
Sagebrush Lizard	75			3	9	2	89
Desert Spiny Lizard	56		2	24		10	92
Western Fence Lizard	101		1	36	8		146
Mojave Fringe-toed Lizard	16						16
Side-blotched Lizard	556	8	2	32	1	30	629
Gilbert's Skink	1				7		8
Western Whiptail	254		1	18		14	287
Southern Alligator Lizard						2	2
Desert Night Lizard	10		1				11
Western Banded Gecko	4	1	38				43
Rosy Boa	1					1	2
Ring-necked Snake						1	1
Western Shovel-nosed Snake			5				5
Night Snake			1	1			2
Common Kingsnake	1		2	1		2	6
Coachwhip	4		2	4		6	16
Striped Whipsnake	2						2
Spotted Leaf-nosed Snake			10			1	11
Gopher Snake	3		1	2		2	8
Long-nosed Snake			2			2	4
Western Patch-nosed Snake	4			1		3	8
Western Ground Snake			1			1	2
Southwestern Black-headed Snake		1					1
Lyre Snake			1				1
Sidewinder	7	1	16	1		1	26
Speckled Rattlesnake	5		12	3		1	21
TOTALS	1,705	145	142	301	25	144	2,463

and re-identified a specimen of Gilbert's Skink (DEVA 158), which had been labeled as a Western Skink. As a result, the NPSpecies park status for Western Skink was changed to "false report."

Sampling Effort and Efficacy of Methods

We spent approximately 1,279 person-hours on 220 days surveying for herpetofauna at DEVA in 2002–04. Methods used, and number of person-hours spent on each method, included general surveys (940 person-hours), nocturnal general surveys (32 person-hours), night driving (228 person-hours), and day driving (79 person-hours). We drove approximately 6,730 km during night driving surveys, and 1,683 km during day driving surveys. Although some driving during the day was recorded as day driving surveys, often this driving was done at higher speeds at which observations were unreliable and times and mileages were not recorded. The pitfall traps at Mahogany Flat and Hummingbird Spring were open for a total of 2,564 and 2,304 trap days, respectively, between July 2003 and September 2004. Finally, we recorded species observations (one or more individuals per observation) during 76 separate random encounters. A summary of effort, including both actual survey time and total person-hours for most methods, is presented in Table 3.

Much of our survey effort was focused in priority sampling areas, identified at the start of the inventory. We searched for new species in the Panamint Range (70 surveys, not counting pitfall trapping effort), the Last Chance Range (22 surveys), the Darwin Plateau (especially the Darwin Falls area; 30 surveys), and the Greenwater Valley and Greenwater Range (38 surveys). Because of the low probability (based on habitat) of new species occurring in the Owlshead Mountains, we conducted only three surveys there. We surveyed extensively in the Amargosa River Valley and Ibex Dunes area in the southern portion of DEVA, because of the probability of undocumented species (Long-tailed Brush Lizard and Mojave Rattlesnake) occurring in that part of the park. Other areas searched on repeated occasions included Saline Valley (especially around the salt marsh and flowing wells), Waucoba Canyon in the foothills of the Inyo Mountains, the Scotty's Castle area, and the Nevada Triangle, especially the area near Strozzi Ranch in the Grapevine Mountains. Complete data on all surveys can be found in the accompanying Microsoft Access® database.

The most species detected by a single method was 28, during general surveys, but we recorded 27 species during night driving surveys (Table 2). Night driving was more effective for finding snakes (11 versus seven species), whereas general surveys recorded more lizards (15 versus 11 species). Taken together, these two methods recorded 34 of the 37 species documented during this inventory. This result is consistent with those of amphibian and reptile inventories at Petrified Forest National Park (Drost et al. 2001) and Wupatki National Monument, Arizona (Persons 2001, Persons and Nowak 2003), in which the combination of daytime general surveys and night driving resulted in inventory completeness of >90% at both parks (unpublished data). Nocturnal general surveys at DEVA recorded only eight species, although this method produced our only observation of a Southwestern Black-headed Snake. In addition, nocturnal general surveys were effective for surveying most amphibian species. For example, on one nocturnal general survey of Darwin Falls we recorded 92 adult Western Toads, whereas repeated daytime general surveys of this area usually produced only 1-5 (maximum 12) adults of this species. Day driving and random encounters recorded the same species observed during general surveys and night driving, with the exception that the two new species documented during the present inventory were recorded as random encounters. However, both of these species were found at a pitfall trap array near Scotty's Castle, as part of a separate study of alligator lizards by the late Dr. David Morafka. Laura Cunningham and Kevin Emmerich, who conducted fieldwork at DEVA for both projects, collected these species during the present inventory.

Table 3. Field effort allocated to each survey method during an inventory of amphibians and reptiles at Death Valley National Park in 2002–04. Abbreviations for survey types are: GS = general surveys, NGS = nocturnal general surveys, ND = night driving surveys, DD = day driving surveys, PF = pitfall traps, and RE = random encounters.

	GS	NGS	ND	DD	PF	RE	TOTALS
Number of Surveys	276	22	77	42	N/A	76	493
Survey Hours	693.7	30.1	170.2	54.9	N/A	N/A	948.9
Person-hours	939.8	31.7	227.8	78.5	N/A	N/A	1,277.8
Kilometers Driven	N/A	N/A	6,730	1,683	N/A	N/A	8,413
Trap Days	N/A	N/A	N/A	N/A	4,850	N/A	4,850

Observation rate (individual animals detected per person-hour) of all amphibians and reptiles was 1.81 for general surveys, 4.57 for nocturnal general surveys, 0.62 for night driving, and 3.83 for day driving. The high observation rate for nocturnal general surveys is attributable to large numbers of Western Toads observed during these surveys at Darwin Falls. Not considering this species, the observation rate for nocturnal general surveys decreases to 1.07 individuals per person-hour. At DEVA, where hundreds of miles of roads exist, day driving was an efficient method for observing many lizards, especially large species that perch on rocks near the road, including Great Basin Collared Lizard, Common Chuckwalla, and Desert Spiny Lizard. This method was also efficient for observing Desert Horned Lizards, which often bask on road surfaces during the day.

Road driving observation rates are usually reported as individuals observed per mile or km driven (e.g., Klauber 1939, Rosen and Lowe 1996). For all species, we recorded observation rates (individuals per 100 km driven) of 2.11 during night driving, and 17.88 during day driving. Most day driving observations were of conspicuous lizard species (e.g., Desert Horned Lizard, Great Basin Collared Lizard, Common Chuckwalla). However, the primary focus of these surveys, especially of night driving, was to find snakes. Considering only snakes, night driving recorded 0.79 individuals per 100 km, while day driving recorded 0.77 individuals per 100 km. Most daytime observations were of a few diurnal species (Coachwhip, Gopher Snake, Western Patch-nosed Snake). Although lower than Klauber (1939) reported for the Anza-Borrego Desert region of southern California, these figures are comparable to other, more recent studies in the Southwest (Persons 2001, Rosen and Lowe 1996).

At the pitfall traps in the Panamint Mountains, we captured only 25 individuals (all lizards) over 4,850 trap days, for a capture rate of only 0.52 captures per 100 trap days. This low capture rate is probably related to the fact that we frequently operated the traps during cool weather in early spring and late fall in an attempt to capture salamanders, when lizards were less active.

Observation rates are not generally comparable between most methods we used at DEVA in this inventory. While some methods are better at sampling particular taxa groups (e.g., night driving for snakes, nocturnal general surveys for amphibians), the combination of all methods was responsible for our overall success at finding species, as indicated by our observation of 37 of the 40 species known from the park.

Estimate of Inventory Completeness

After adding the two new species documented during the present inventory (Southern Alligator Lizard and Ring-necked Snake), the DEVA amphibian and reptile verified species list stands at 40 species (4 amphibians and 36 reptiles). The only species removed from the pre-inventory NPSpecies species list was the Western Skink, whose inclusion was based on two probable false reports (an unvouchered nineteenth century sighting during the Death Valley Expedition (Stejneger 1893), and a mislabeled specimen of Gilbert's Skink in the DEVA collection). At the start of this project, the NPS developed a list of 11 reptile species expected to occur within the park (Long-tailed Brush Lizard, Tree Lizard, Northern Alligator Lizard, Southern Alligator Lizard, Gila Monster, Rubber Boa, Ring-necked Snake, Western Terrestrial Garter Snake, Mojave Rattlesnake, Western Rattlesnake, and Western Diamond-backed Rattlesnake). We removed six highly improbable species from this list (Tree Lizard, Northern Alligator Lizard, Gila Monster, Rubber Boa, Western Terrestrial Garter Snake, and Western Diamond-backed Rattlesnake), and developed our own weighted list of documented (n = 40) and potentially occurring (n = 9) species (Table 4). From this weighted master list we estimate an overall inventory completeness of 92% for amphibians and reptiles at DEVA.

Inventory Completeness of Different Taxa Groups

Using the same weighting methods and data from Table 4, we calculated overall estimated inventory completeness of 73% for amphibians and 95% for reptiles (100% for turtles, 95% for lizards, and 94% for snakes). The Northern Leopard Frog has been rumored to occur at Saratoga Spring (Pratt and Hoff 1992), but reports may be based on unusual vocalizations of Pacific Treefrog. Because the introduced Black Toad had been observed as recently as only a few years ago (Eric Simandle, personal communication), we have given that species a 50/50 chance of occurring at DEVA. However, our observations of habitat destruction at the single known locality (a flowing well in the Saline Valley) and the fact that we did not detect it despite several day and night-time visits during the breeding period, suggest that the species may be extirpated within the park. The Inyo Mountains Salamander, which we documented in Waucoba Canyon less than 1.6 km from the DEVA boundary, may not occur within the park, based on likely unsuitable drier habitat lower in the canyon within the park. Although we have ranked these three species as having a low chance of occurring within DEVA, more intensive surveys will need to be conducted (only after a series of wet years when amphibian populations or at least visibility might increase) in order to conclusively remove these species from the hypothetical list.

Evaluation of Inventory Completeness Through Species Accumulation

A species accumulation curve (plotted per survey day) for 2002–04 data is shown in Figure 3. The asymptotic curve suggests that we are close to detecting all the species present at DEVA, supporting our conclusions based on the master list approach. Species accumulation curves can be valid estimators

Table 4. All amphibian and reptile species found or expected to occur at Death Valley National Park. Ranking of probability of species occurrences 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. For completeness, all species included as hypothetical in the species accounts (Appendix C) are included here, but those species with essentially zero chance of occurring at DEVA are indicated under status as N/A. For all species, NPSpecies checklist fields for residency and nativity are "breeder" and "native," respectively, except for the Bullfrog and Black Toad, whose nativity is "non-native", and the Southern Alligator Lizard, whose nativity is unknown.

Species	Rank	NPSpecies Park Status	NPSpecies Abundance
Inyo Mountains Salamander	1	Unconfirmed	
Ensatina	1	Unconfirmed	
Great Basin Spadefoot	2	Unconfirmed	
Western Toad	SP	Present in Park	Uncommon
Black Toad	2	Historic	
Red-spotted Toad	SP	Present in Park	Common
Pacific Treefrog	SP	Present in Park	Common
Bullfrog	OX	Present in Park	Uncommon
Northern Leopard Frog	1	Unconfirmed	
Desert Tortoise	SP	Present in Park	Uncommon
Zebra-tailed Lizard	SX	Present in Park	Abundant
Great Basin Collared Lizard	SP	Present in Park	Common
Desert Iguana	SP	Present in Park	Abundant
Long-nosed Leopard Lizard	SX	Present in Park	Common
Desert Horned Lizard	SP	Present in Park	Common
Common Chuckwalla	SP	Present in Park	Common
Sagebrush Lizard	SP	Present in Park	Abundant
Desert Spiny Lizard	SP	Present in Park	Abundant
Western Fence Lizard	SP	Present in Park	Common
Mojave Fringe-toed Lizard	SX	Present in Park	Uncommon
Long-tailed Brush Lizard	3	Probably Present	
Ornate Tree Lizard	N/A		
Side-blotched Lizard	SP	Present in Park	Abundant
Gilbert's Skink	SP	Present in Park	Uncommon
Western Skink	N/A	False Report	
Western Whiptail	SP	Present in Park	Abundant
Northern Alligator Lizard	N/A		
Southern Alligator Lizard	SX	Present in Park	Rare
Panamint Alligator Lizard	SP	Present in Park	Rare
Desert Night Lizard	SP	Present in Park	Common
Western Banded Gecko	SP	Present in Park	Common
Mediterranean Gecko	N/A		
Gila Monster	N/A		
Glossy Snake	SP	Present in Park	Rare
Western Blind Snake	SP	Present in Park	Uncommon
Rubber Boa	N/A		
Rosy Boa	SP	Present in Park	Rare
Ring-necked Snake	SX	Present in Park	Rare
Western Shovel-nosed Snake	SP	Present in Park	Common
Night Snake	SX	Present in Park	Uncommon
Common Kingsnake	SX	Present in Park	Common
California Mountain Kingsnake	1	Unconfirmed	
Coachwhip	SP	Present in Park	Common
Striped Whipsnake	SP	Present in Park	Uncommon
Spotted Leaf-nosed Snake	SP	Present in Park	Common
Gopher Snake	SP	Present in Park	Common

Table 4. All amphibian and reptile species found or expected to occur at Death Valley National Park. Ranking of probability of species occurrences 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. For completeness, all species included as hypothetical in the species accounts (Appendix C) are included here, but those species with essentially zero chance of occurring at DEVA are indicated under status as N/A. For all species, NPSpecies checklist fields for residency and nativity are "breeder" and "native," respectively, except for the Bullfrog and Black Toad, whose nativity is "non-native", and the Southern Alligator Lizard, whose nativity is unknown.—Continued

Species	Rank	NPSpecies Park Status	NPSpecies Abundance
Long-nosed Snake	SP	Present in Park	Common
Western Patch-nosed Snake	SP	Present in Park	Common
Western Ground Snake	SX	Present in Park	Uncommon
Southwestern Black-headed Snake	SP	Present in Park	Uncommon
Western Terrestrial Garter Snake	N/A		
Lyre Snake	SP	Present in Park	Uncommon
Western Diamond-backed Rattlesnake	N/A		
Sidewinder	SX	Present in Park	Common
Speckled Rattlesnake	SP	Present in Park	Common
Mojave Rattlesnake	3	Probably Present	
Western Rattlesnake	1	Unconfirmed	
TOTAL RANK 1	5		
TOTAL RANK 2	2		
TOTAL RANK 3	2		
TOTAL DOCUMENTED	40		
WEIGHTED TOTAL	43.5		
ESTIMATED INVENTORY COMPLETENESS	92.0%		

of inventory completeness in situations involving large numbers of species, extensive survey periods, and a wide variety of field methods (e.g., Scott 1994). Even so, given our knowledge of the habitats and local distribution of potential species, we believe the master list approach provides a more precise estimate of inventory completeness at DEVA.

Rare, Exotic, or Sensitive Species

The Desert Tortoise is the only species we recorded at DEVA that is listed under the federal Endangered Species Act (Threatened), and we recorded only one individual, near the southern end of Greenwater Valley. The Panamint Alligator Lizard and Mojave Fringe-toed Lizard, both documented from DEVA, are listed as Species of Special Concern by the state of California, as are the undocumented Inyo Mountains Salamander and Northern Leopard Frog (Jennings and Hayes 1994). The Black Toad, which may be extirpated from the park, is listed as Threatened by the state California (Murphy et al. 2003).

The exotic Bullfrog, which is native to the eastern United States, is uncommon in the golf course ponds at Furnace Creek, but is abundant in the Saline Valley salt marsh. The population of Black Toads at DEVA is also likely introduced, although its native range is just west of the park, in Deep Springs Valley. Preliminary genetic analysis of the Southern Alligator Lizard specimen we collected at Scotty's Castle was inconclusive (Tod Reeder, University of California, San Diego, personal communication), and more specimens from DEVA and throughout its range in southeast California will need to be analyzed to determine if the DEVA population is native or introduced.

Specimens Collected

We collected 11 reptile specimens at DEVA in 2002–04. These included the two new species documented during this inventory (Southern Alligator Lizard and Ring-necked Snake), a specimen of Mojave Fringe-toed Lizard (which is known to occur at DEVA but had not been documented with a voucher), and eight road-killed animals found in good condition. A complete list of these specimens and associated collection and cataloging data is found in Table 5, and a map showing collection locations within DEVA is presented in Figure 4. All of these specimens are deposited in the natural history collection facility at Death Valley National Park (DEVA). Specimens were collected under research permit numbers DEVA-2002-SCI-0010 and DEVA-2003-SCI-0010, and cataloged under

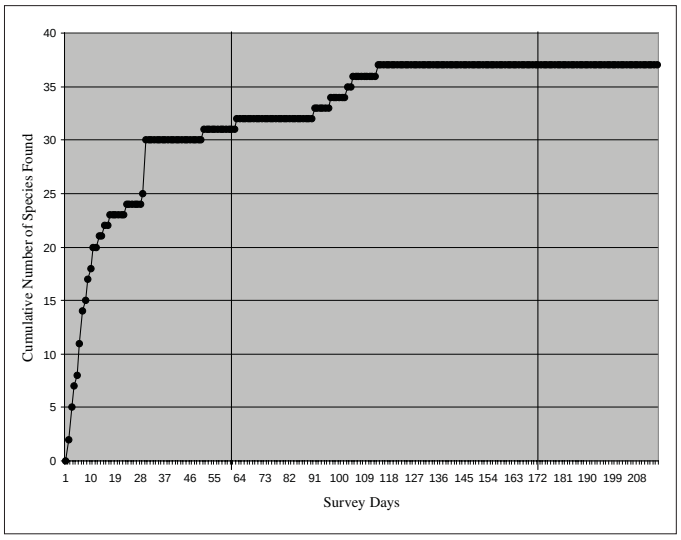

Figure 3. Species accumulation curve for amphibians and reptiles at Death Valley National Park, 2002–04. Vertical lines through the data separate yearly survey days.

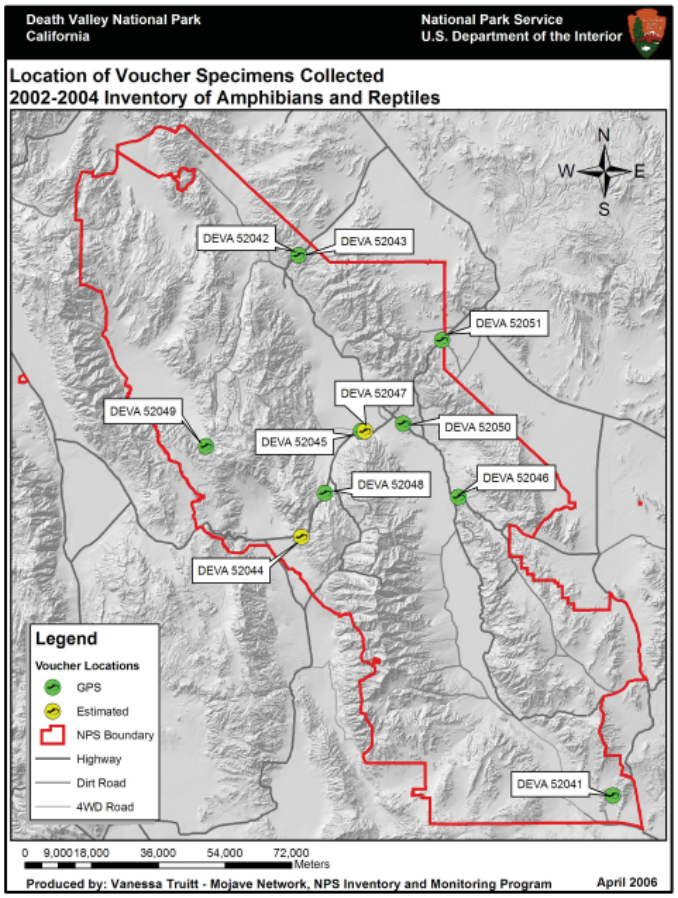

Figure 4. Location of voucher specimens collected during an inventory of amphibians and reptiles at Death Valley National Park in 2002–04.

accession number DEVA-2453 (reptiles). No amphibians were collected, thus accession number DEVA-2493 (amphibians) was not used.

Update of NPSpecies and NatureBib Databases

In January 2004 we certified NPSpecies checklist field data for 37 reptile and five amphibian species known or suspected to occur within the park. At that time, we created entries for two species that are not on our current list of documented species for DEVA. We had included the Black Toad as "present in park," based on recent observations of the species within the park (Eric Simandle, personal communication). However, survey results from the 2004 field season have caused us to question their persistence at DEVA, and we have changed their NPSpecies park status to "historic." We had also included Long-tailed Brush Lizard as "probably present," as this was the undocumented species most likely to occur in the park. In April 2005 we also added Mojave Rattlesnake, the other undocumented species assigned "probably present" status. We added only species entries (i.e., we did not enter subspecies) into the NPSpecies database. We also added literature to the NatureBib database, and linked each species in NPSpecies to these references. Voucher specimen data were added to the NPSpecies online database in April 2005.

Considerations for Future Inventory Work and Long-term Monitoring

Future Inventory Work

We estimate that we have documented >90% of the reptile species present at DEVA, and of reptiles and amphibians combined. Our estimate of 73% inventory completeness for amphibians is probably conservative, as we have included a number of species that may not occur within the park. Future inventory effort for amphibians should be directed towards determining the status of Inyo Mountains Salamander and Black Toad within the DEVA boundaries. Repeated surveys over a number of years at the flowing wells and salt marsh in Saline Valley may provide a stronger indication as to whether the introduced population of Black Toads at DEVA is extirpated. Because the Inyo Mountains Salamander is now known to occur less than 1.6 km from the western boundary of DEVA in Waucoba Canyon, additional survey effort should be conducted at this locality to determine its status within the park. These surveys would be most informative, and have the greatest likelihood of finding the species within DEVA, during wet weather, and particularly after a series of years with average or above average rainfall. During such a period, salamander surface activity, distribution range, and population sizes

Table 5. Specimens collected during an inventory of amphibians and reptiles at Death Valley National Park in 2002–04. Collector initials are: LMC (Laura M. Cunningham), KE (Kevin Emmerich), BTH (Bryan T. Hamilton), LH (Larry O'Hanlon), EMN (Erika M. Nowak), and TBP (Trevor B. Persons). Specimens are housed in the natural history collection facility at Death Valley National Park, and were collected under accession numbers DEVA-2453 (reptiles) and DEVA-2493 (amphibians, none collected). Field numbers are those in the field catalogs of Trevor B. Persons (TBP) and Bryan T. Hamilton (BTH). UTM coordinates are zone 11. Location of TBP 161 is San Bernardino County, California; all others are Inyo County, California.

Field #	NPS Catalog Number	Species	Date	Collectors	Location and Notes
TBP 161	DEVA 52041	Mojave Fringe-toed Lizard	3/26/02	TBP, LMC, EMN	Ibex Dunes. UTM 556258E, 3952389N (NAD27). Adult female.
TBP 165	DEVA 52042	Southern Alligator Lizard	4/8/02	KE, LMC	Grapevine Canyon, ca. 1 mile E Scotty's Castle. UTM 471342E, 4098415N (NAD27). Juvenile, in pitfall trap. 62 mm SVL (fresh dead).
TBP 166	DEVA 52043	Ring-necked Snake	3/29/02	KE, LH	Grapevine Canyon, ca. 1 mile E Scotty's Castle. UTM 471342E, 4098415N (NAD27). Adult male, surface active near pitfall trap array. 44 cm TL, 9 cm VT.
TBP 186	DEVA 52044	Common Kingsnake	6/13/02	TBP	SR 190, 4.5 road miles W of Towne's Pass. Adult, DOR.
TBP 187	DEVA 52045	Sidewinder	6/13/02	TBP	SR 190, 0.9 road miles E Stovepipe Wells settlement. UTM 488321E, 4050866N, EPE 4 m (NAD27). Juvenile, DOR.
TBP 188	DEVA 52046	Night Snake	6/13/02	TBP	SR 190 ca.1 mile E Furnace Creek Inn. UTM 514560E, 4033026N, EPE 6 m (NAD27). Subadult, DOR.
TBP 289	DEVA 52047	Zebra-tailed Lizard	6/11/03	TBP	SR 190, 1.5 road miles E Stovepipe Wells settlement. Adult male, DOR.
TBP 292	DEVA 52048	Long-nosed Leopard Lizard	6/13/03	TBP	SR 190, 3.0 road miles S turnoff to Emigrant Canyon. UTM 478484E, 4034079N, EPE 4 m (NAD27). Adult female, DOR.
BTH 0018	DEVA 52049	Speckled Rattlesnake	3/24/04	BTH	Saline Valley Road, 21.7 miles from SR 190, 4020 feet elevation. UTM 446250E, 4046969N (NAD83). Adult male, DOR.
BTH 0020	DEVA 52050	Sidewinder	3/25/04	BTH	SR 190, 4.2 miles N of Beatty Junction, 100 feet elevation. UTM 499590E, 4053158N (NAD83). Male, DOR.
BTH 0025	DEVA 52051	Zebra-tailed Lizard	6/22/04	BTH	Daylight Pass Road, 0.6 miles W Nevada border. UTM 510068E, 4075691N (NAD83). Adult, DOR.

would likely increase, and habitats just down canyon of where the species is known to occur may become more habitable. Great Basin Spadefoots should be searched for in the northern portion of the park, and survey effort should be targeted to low-lying areas (that would form temporary pools) during or immediately after heavy summer rains, a climatic condition not necessary met annually. Finally, short of greatly expanded pitfall trapping effort, documentation of Ensatina or other salamanders, if present at high elevation sites in the Panamint Mountains, will probably depend on chance observations or targeted cover-flipping surveys during warm, wet weather, such as during or after summer rains. Based on evaluation of habitats in the park, the numerous springs at Hunter Mountain appear to be good habitat for slender salamanders (*Batrachoseps*), and should be searched more extensively. Long-term placement of artificial cover boards (Fellers and Drost 1994) could be an effective method for finding salamanders at DEVA.

Future inventory effort for reptiles should focus on documenting Long-tailed Brush Lizard and Mojave Rattlesnake, the species we have assigned the highest probability of occurring within the park. Both of these species are probably present in the southern part of the park. The Long-tailed Brush Lizard probably occurs in the vicinity of the Ibex Dunes, and may occur in other sandy areas with large creosote bushes or mesquite hummocks along the Amargosa River floodplain.

Extensive searches of bushes and trees in these habitats will be necessary to find this species, which, if present, is apparently rare at DEVA. The Mojave Rattlesnake could occur in the flatter terrain throughout the southern part of the park, including in the same areas that may harbor Long-tailed Brush Lizards. Night driving is probably the method most likely to document this species within the park.

New species may 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. Solid baseline data exist on occurrence of amphibian and reptile species at DEVA, and help of interested staff and volunteers can be directed towards documenting suspected or rare species. Road killed animals (such as Mojave Rattlesnake) 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, and complete collection data (date, collector, and precise location, preferably with UTM coordinates) included in the bags with the specimens.

Long-term Monitoring

Monitoring of rare amphibian and reptile 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 hard to locate. An example of this type of species at DEVA is the Panamint Alligator Lizard, which because of its isolated, relictual distribution in mesic habitats in the park (usually spring areas) might function as an indicator of climate-driven changes in those habitats. However, the extreme difficulty in capturing large enough sample sizes of the species for statistical analysis would probably preclude its use as a monitoring target. Instead, herpetofauna monitoring at DEVA should focus on the entire community where possible, and targeted monitoring should focus on the most common species or species groups. These target species should be common, easily observed and counted, and respond predictably and measurably to fluctuations of climatic variables.

Although only four amphibians (three native, one introduced) have been documented from DEVA, monitoring of amphibians may provide valuable information for the park. It is widely acknowledged that amphibian populations have declined throughout the world (e.g., Houlahan et al. 2003), although their suitability as biological "indicator" species has recently been challenged (Beebee and Griffiths 2005). Factors implicated in declines include habitat destruction, global climate change, chemical contamination, disease, invasive species, and commercial exploitation (Semlitsch 2003). Because natural fluctuations in amphibian populations are often so great from year to year (e.g., Pechmann et al. 1991), long-term studies are often necessary to estimate population status. As well, only long-term monitoring efforts may separate these natural fluctuations from human-caused impacts (Pechmann et al. 1991). In addition, monitoring within natural areas can serve as an important baseline against which to judge population changes in more managed habitats (Adams and Bury 2002), and National Parks are an ideal location for such long-term monitoring (Hall and Langtimm 2001).

We believe the highest priority species for amphibian monitoring at DEVA would be the Western Toad. This species has a patchy distribution in the region, and occurs naturally in DEVA only at Darwin Falls. Although apparently common at Darwin Falls (personal observation), Western Toads have severely declined throughout much of their range, especially in the southern Rocky Mountains (Hammerson 1999, Stebbins 2003). Based on our results, nocturnal walking surveys of the stream below Darwin Falls would probably be the most efficient method to use in long-term monitoring of this species at DEVA. This area is especially critical to monitor because of the introduction of non-native, predatory koi fish (*Cyprinus carpio*) in the headwaters of Darwin Creek at China Garden Springs on Bureau of Land Management land just outside the park boundary. Koi are known to be predators of egg and larval amphibians in other systems (Susie MacVean, Arizona Game and Fish Department, personal communication), and have the potential to spread into DEVA and possibly affect the Western Toad population there. Finally, Red-spotted Toads were known previously from Darwin Falls (Stebbins 2003), and there are recent unverified reports of the species from there (see the Red-spotted Toad species account, Appendix C). In addition, we observed a few individual toads at Darwin Falls that may have been hybrids between Western and Red-spotted Toad. Extensive hybridization between toads has sometimes been linked to anthropogenic changes in aquatic systems. For example, many populations of Southwestern Toads (*Bufo microscaphus*) in Arizona have been replaced by or diluted through hybridization with Woodhouse's Toads (*Bufo woodhousii*) as natural lotic habitats have been dammed and developed a lentic component favored by Woodhouse's Toads (e.g., Sullivan 1993). Long-term monitoring of Western Toads at Darwin Falls should include monitoring of Red-spotted Toads (if present), and of hybridization between these two species. Determination of hybrid toads could probably be accomplished by genetic testing of tissue samples (e.g., toe-clips), through collaborations with university researchers.

Red-spotted Toads and Pacific Treefrogs are widespread at DEVA, and monitoring of these species could include nocturnal call surveys of known breeding areas (e.g., Saratoga Spring for Pacific Treefrog, spring-fed streams in the Furnace Creek area for Red-spotted Toad), or large-scale site occupancy rate monitoring of spring and stream areas throughout the park. For site occupancy monitoring, results could be analyzed using Percent Area Occupied analysis (e.g. MacKenzie et al. 2002). Surveys could be conducted during periods when tadpoles would likely be present, allowing site occupancy to be verified even when no adult animals are observed.

Finally, we suggest monitoring the status of Bullfrogs at DEVA, in an effort to prevent the species from becoming

established elsewhere in the park. We recommend Bullfrogs be eradicated from the park, especially in the more natural aquatic systems in the Saline Valley, as they may severely impact (e.g., eat) native vertebrate species there.

For reptiles, we propose that monitoring should generally encompass communities of species (e.g., diurnal lizards), and focus especially on the most common species (e.g., Zebra-tailed Lizard, Western Fence Lizard, Side-blotched Lizard, Western Whiptail). Exceptions might be Desert Tortoise and Mojave Fringe-toed Lizard, two species that could be monitored separately. Lizards, which are relatively sedentary, usually show relatively rapid and substantial population responses to fluctuations in precipitation and concomitant variation in primary productivity at a site. For this reason, common diurnal desert lizards have been the centerpieces of herpetofauna monitoring at Organ Pipe Cactus National Monument for over a decade (Rosen 2000, Rosen and Lowe 1996). Careful placement of permanent monitoring sites at DEVA could also include other locally common species such as Great Basin Collared Lizard, Common Chuckwalla, and Desert Spiny Lizard. Potential monitoring methods for lizards include time-area constrained searches (Crump and Scott 1994), lizard line transect surveys (Rosen and Lowe 1995, 1996), or pitfall trapping (Campbell and Christman 1982). Because lizard lines (Rosen and Lowe 1995, 1996) use the peak value observed on one of many transect walks conducted at a site during each survey, they help correct for differences in lizard activity throughout the survey period (usually an entire morning). In addition, because they are linear, and only one walk of the transect is used in analysis (per species), they avoid double counting, a potential problem in using time-area constrained searches as a monitoring method.

Swann (1999), using transect methods of Rosen and Lowe (1995, 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. 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 DEVA, 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.

Finally, if snakes are included in herpetofauna monitoring at DEVA, this group should be monitored with night driving surveys. Unlike with diurnal lizards, where sufficient sample sizes of a few common species can be obtained, monitoring of snakes should probably focus on trends in ecological subsets of the snake community, such as lizard-eating snakes, rodent-eating snakes, or egg-laying versus viviparous species (e.g., Price and LaPointe 1990). Trends in these ecological groups may reflect changes in environmental conditions, which are in turn affecting predator or prey availability, or moisture regimes affecting snake reproduction (e.g., dessication of egg clutches). In general, night driving within the lowest parts of Death Valley is not very productive. Based on our results, potential road transects for snake monitoring at DEVA include SR 178 between Ashford Mill and Shoshone, the Dante's View road, and the Emigrant Canyon and Wildrose Canyon roads. These roads generally had little or no traffic at night, were paved and not too steep (unlike the road over Towne's Pass), and yielded greater numbers and diversity of snake species when compared with other roads in the park.

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effort, helped us to initially orient ourselves at DEVA, both geographically and herpetologically. Her extensive knowledge of the distribution and ecology of amphibians and reptiles at DEVA and throughout the region helped us to prioritize our field efforts and evaluate the potential status of many species in the park.

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Appendix A. Data Form

Figure A-1. Data form (following two pages) developed for herpetofauna surveys in the Southern Colorado Plateau I&M Network, and also used for most surveys at Death Valley National Park. There are two pages, meant to be photocopied back to back.

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 _____

Figure A-1. Data form (following two pages) developed for herpetofauna surveys in the Southern Colorado Plateau I&M Network, and also used for most surveys at Death Valley National Park. There are two pages, meant to be photocopied back to back.—Continued

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		

Appendix B. Contact Information for Experts Consulted

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Appendix C. Annotated List of Amphibians and Reptiles at Death Valley National Park

The following is an annotated list of amphibians and reptiles at Death Valley National Park, including all documented and hypothetical species. Because we do not have data on population sizes or density of species at DEVA, the use of the terms abundant, common, uncommon, and rare (the available abundance categories in NPSpecies) are necessarily somewhat subjective. They are designed to describe the relative abundance of a particular species, compared with other, similar species at DEVA, and also with the same species elsewhere throughout its range. Status of all documented and hypothetical species at DEVA, as well as NPSpecies checklist field assignments, are presented in Table 4. All documented species are represented by at least one voucher specimen in an institutional collection, as detailed in the voucher section of the online NPSpecies database for DEVA.

Species Documented from Death Valley National Park

Western Toad (*Bufo boreas*)

This species, which is often associated with high elevation montane habitats (e.g., Hammerson 1999), has a spotty distribution in desert areas of southern California (Stebbins 2003). At DEVA, Western Toads occur naturally only along the stream at Darwin Falls, where they appear to be common. They also occur in the Furnace Creek area, but this population is likely the result of an introduction (Threloff 1996). Turner and Wauer (1963) did not mention Western Toad, suggesting the species was introduced sometime in the past 40 years (Threloff 1996). Previously, Western Toad was known to hybridize with the Red-spotted Toad at Darwin Falls, but the Red-spotted Toad may no longer occur there (Stebbins 2003).

Red-spotted Toad (*Bufo punctatus*)

Turner and Wauer (1963) stated that this species was known from Saratoga Spring, Eagle Borax Works, Furnace Creek, Cow Creek, all Texas Spring drainages, and canyon springs in the Panamint Mountains. We observed Red-spotted Toads (adults or tadpoles) at a number of localities in the Furnace Creek and Cow Creek areas, at Scotty's Castle, and at two areas in the Saline Valley (Hunter Creek and Grapevine Canyon). Banta (1962) also caught these toads in Hunter Canyon. Threloff (1996) determined that Red-spotted Toads were abundant only in two areas (Furnace Creek Wash and Nevares Spring area) in the Furnace Creek and Cow Creek areas at DEVA. Previously, this species was known to hybridize with the Western Toad at Darwin Falls, but the Red-spotted Toad may no longer occur there (Stebbins 2003). However, Mike Bogen (Oregon State University) reported observing Red-spotted Toads at Darwin Falls on the night of 14 June 2003 (Laura Cunningham, personal communication), raising the possibility that the species still occurs there. In addition, we observed a few toads at Darwin Falls that may have been hybrids between these two species. Turner (1959a) studied the ecology of the species at DEVA.

Pacific Treefrog (*Hyla regilla*)

We only recorded Pacific Treefrogs from Scotty's Castle, Saratoga Spring, and a number of canyons in the Panamints (Happy, Johnson, Pleasant, and Surprise canyons), a distribution similar that described by Turner and Wauer (1963). Banta (1962) did not find them in the Saline valley area, and Threloff (1996) did not record them in the Furnace Creek area. Although we did not observe them, they have been seen at Darwin Falls (Laura Cunningham, personal communication).

Bullfrog (*Rana catesbeiana*)

This species, which is native to the eastern United States, has been widely introduced in the west, often to the detriment of native amphibians and reptiles (e.g., Rosen and Schwalbe 2002). At DEVA, Bullfrogs are uncommon in ponds around the golf course at Furnace Creek, but are abundant in the salt marsh in Saline Valley. The species was introduced in the Furnace Creek area around 1920 (Turner and Wauer 1963). Macey and Papenfuss (1991) and Pister (1975) reported Bullfrogs from the Saline Valley salt marsh, but the species was not mentioned by Banta (1962), suggesting an introduction sometime between 1962 and 1975.

Desert Tortoise (*Gopherus agasssizii*)

We observed only one Desert Tortoise during our surveys and recorded sign on two other occasions, all in the southern end of Greenwater Valley. Boland and Goodlett (1997) conducted an extensive survey for Desert Tortoises throughout the park. They found tortoises to be moderately common in Greenwater Valley, but rare elsewhere where they occurred in the park. Boland and Goodlet (1997) also found that the species was primarily distributed in the southern half of the park, consistent with the known northern range limit for the species in the region. The Mojave Desert population (includ-

ing DEVA) of Desert Tortoise is listed as Threatened under the federal Endangered Species Act.

Great Basin Collared Lizard (*Crotaphytus bicinctores*)

We observed over a hundred Great Basin Collared Lizards at DEVA during our surveys, about half of which were seen perched on rocks on the roadside during daytime driving surveys. This conspicuous species is common in rocky areas throughout the park, from low elevation creosote desert habitats up into the pinyon-juniper zone.

Long-nosed Leopard Lizard (*Gambelia wislizenii*)

This relative of the collared lizards is moderately common at DEVA, and is usually found in more open and less rocky terrain. The Long-nosed Leopard Lizard is found from the lowest elevations up into the pinyon-juniper zone at DEVA (Turner and Wauer 1963).

Zebra-tailed Lizard (*Callisaurus draconoides*)

This was the second most common species observed during our surveys. Zebra-tailed Lizards are abundant in desert habitats at DEVA, and are especially common near dunes, in open creosote bush desert, and along sandy washes and dirt roads.

Desert Iguana (*Dipsosaurus dorsalis*)

Turner and Wauer (1963) associated this species at DEVA with the presence of mesquite thickets, although the important habitat components in these areas are more likely the combination of open areas and sandy hummocks with shade and rodent burrows (Stebbins 2003). We found Desert Iguanas to be most common in dune areas, such as at Ibex Dunes, Stovepipe Wells, and the sand dunes in the Saline Valley. They were often spotted basking on low rocks or graded dirt berms along roads at DEVA.

Desert Horned Lizard (*Phrynosoma platyrhinos*)

Despite its cryptic appearance, the Desert Horned Lizard was one of the most common species we observed during our surveys. The species primarily occurs in the creosote bush habitats on the bajadas and alluvial fans at DEVA (Turner and Wauer 1963). The majority of our observations of horned lizards were made while driving, as the species frequently basks on road surfaces (including at night).

Mojave Fringe-toed Lizard (*Uma scoparia*)

This species, like other fringe-toed lizards, lives only on dunes and other areas of fine, windblown sand (Stebbins 2003). The northern limit of its distribution is the Ibex Dunes at DEVA and the nearby Dumont Dunes, just east of the park. These two populations are genetically distinct from other populations of Mojave Fringe-toed Lizard to the south, and may warrant recognition as a distinct species (Trepanier and Murphy 2001; David Morafka, personal communication). As such, the Ibex Dunes population at DEVA may be especially important to conservation of this lineage. Although more limited in area, the Ibex Dunes are protected from off-road vehicle use, which can be detrimental to fringe-toed lizards (Stebbins 2003). The Mojave Fringe-toed Lizard is listed as a Species of Special Concern by the state of California (Jennings and Hayes 1994).

Side-blotched Lizard (*Uta stansburiana*)

This was the most abundant species observed during our surveys, and was found from the lowest valleys up into the pinyon-juniper habitats in the Panamint Mountains.

Common Chuckwalla (*Sauromalus obesus*)

Chuckwallas were common at lower elevations in rocky habitats of outcrops or boulders at DEVA, and were often observed basking on rocks along roadsides. We observed numerous Chuckwallas during surveys in Greenwater Canyon, in the Greenwater Range.

Desert Spiny Lizard (*Sceloporus magister*)

Desert Spiny Lizards were usually observed in the same rocky habitats as Chuckwallas at DEVA. However, Desert Spiny Lizards have a wider ecologic distribution in the park, occurring in creosote bush, canyons, and sagebrush habitats. Although usually observed on rocks, some were found on the ground or climbing in bushes. One individual near Scotty's Castle was observed 30 feet up a telephone pole.

Western Fence Lizard (*Sceloporus occidentalis*)

This species is common at intermediate and higher elevations at DEVA. Like the Desert Spiny Lizard it is usually found climbing on rocks and, especially in the pinyon-juniper woodlands, trees.

Sagebrush Lizard (*Sceloporus graciosus*)

This species, which is much more ground-dwelling than the other two *Sceloporus* at DEVA, is common in the pinyon-juniper woodlands in the park. It is the only species known from the boreal habitats above the pinyon-juniper zone at DEVA (Turner and Wauer 1963).

Western Whiptail (*Cnemidophorus tigris*)

This was the third most abundant species observed during our surveys, and was common throughout the park in all habitats below the pinyon-juniper zone.

Southern Alligator Lizard (*Elgaria multicarinata*)

This species is widespread in coastal southern California and the Sierra Nevada (Stebbins 2003), and was previously known only as close to DEVA as the central Owens Valley (Macey and Papenfuss 1991b). In 2001, Dr. David Morafka captured (but did not collect) two individuals of this species in pitfall traps at a spring about a mile east of Scotty's Castle (Laura Cunningham, personal communication). Two more individuals were captured at this site in 2002, one of which was collected for the present inventory. Unverified sight records elsewhere in the region suggest the possibility that isolated populations of Southern Alligator Lizards may exist in mountain ranges east of their known distributional range (Laura Cunningham, personal communication). Preliminary genetic analysis (from tail tips) of the Scotty's Castle specimens was inconclusive, as the DEVA samples clustered with both a coastal San Diego County group and a nearby Inyo County/Sierra Nevada group (Tod Reeder, University of California, San Diego, personal communication). More specimens from DEVA and throughout its range in southeast California will need to be analyzed to determine if the DEVA population is likely native or introduced. If introduced at Scotty's Castle, the species may have been brought in inadvertently during importation of large plantings of California fan palms in the 1930's or oleanders in the 1970's from nurseries in Los Angeles or San Bernardino, respectively (Laura Cunningham, personal communication).

Panamint Alligator Lizard (*Elgaria panamintina*)

This species was first described from Limekiln Spring in Surprise Canyon (Panamint Mountains), just west of the DEVA park boundary (Stebbins 1958). Currently, the species is known from a number of canyons in the Panamint, Nelson, Inyo, Argus, Coso, and White Mountains (Banta et al. 1996). Within DEVA, it has been collected or observed in the Panamint Mountains in Surprise Canyon (Brewery Spring), Johnson Canyon, Wildrose Canyon, and Hanaupah Canyon, and in the Nelson Mountains in Grapevine Canyon (Banta et al. 1996, Stebbins 2003, Laura Cunningham, personal communication). Panamint Alligator Lizards probably occur at other sites in DEVA, as suitable habitat exists at Darwin Falls, springs near Emigrant Canyon, and elsewhere. The Panamint Alligator Lizard is listed as a Species of Special Concern by the state of California (Jennings and Hayes 1994).

Gilbert's Skink (*Eumeces gilberti*)

We observed only eight Gilbert's Skinks, all at Hummingbird Spring in the Panamint Mountains; seven of these were caught in our pitfall traps. Turner and Wauer (1963) reported the species from Johnson and Hanaupah canyons and Harrisburg Flat, and Banta (1962) caught numerous Gilbert's Skinks in pitfall traps along Grapevine Canyon in the Nelson Mountains, between about 1220 and 1830 m elevation. The species probably occurs in spring areas throughout the Panamint Mountains.

Western Banded Gecko (*Coleonyx variegatus*)

This nocturnal lizard was found in various desert habitats throughout the park, and was especially common during night driving surveys in rocky areas, such as the Dante's View road the road through Grapevine Canyon near Scotty's Castle.

Desert Night Lizard (*Xantusia vigilis*)

Turner (1959c) first reported this small, secretive species from DEVA. We observed Desert Night Lizards only at Leadfield in the Grapevine Mountains, and at Last Chance Spring. Turner and Wauer (1963) stated that it had been found in Monarch Canyon, near Dante's View, and in the pinyon-juniper woodlands as high as 2935 m elevation in the Panamint Mountains. Banta (1962) captured five night lizards in pitfall traps along Grapevine Canyon near the Saline Valley. Although the species is often associated with Joshua trees (*Yucca brevifolia*), these yuccas are absent from most sites at DEVA where the species has been found. The Desert Night Lizard is probably more widespread within the park.

Western Blind Snake (*Leptotyphlops humilis*)

This small, secretive, burrowing species has been found throughout DEVA, including at Saratoga Spring, Salt Creek, Wildrose Canyon, Cow Creek, Darwin Falls, Grapevine Canyon (Nelson Range), and Eureka and Saline valleys (Banta 1962, Turner and Wauer 1963, Kay 1970, voucher records in NPSpecies). We did not observe Western Blind Snake during our surveys.

Rosy Boa (*Charina trivirgata*)

Turner (1959b) first reported this species from DEVA, and Turner and Wauer (1963) listed Hanaupah and Emigrant canyons as the only two known localities in the park. It has been collected along SR 190 on the Darwin Plateau, including at Darwin Falls (voucher records in NPSpecies). We observed

two Rosy Boas during our surveys, both along the canyon below Darwin Falls. There is an unverified sight record of a Rosy Boa in the Grapevine Mountains near Scotty's Castle (*fide* Laura Cunningham, personal communication).

Glossy Snake (*Arizona elegans*)

This was one of only three species documented from DEVA that we did not observe during our surveys. The only specimen from DEVA known to us was collected in 1949 near Daylight Pass in the Grapevine Mountains (MVZ 63626). Banta (1962) did not observe it in the Saline Valley region. Salvage by NPS staff of road-killed snakes could help document this species from other areas of the park.

Western Shovel-nosed Snake (*Chionactis occipitalis*)

We observed only five Western Shovel-nosed Snakes, all during night driving surveys. Two of these were found just outside the park on the Panamint Valley road, two others on SR 178 at the southern end of the Greenwater Valley, and another on SR 190 near Emigrant Canyon. In addition, we found tracks probably made by this species on the Panamint and Ibex dunes. Other areas in the park where the species has been found include the Dantes's View road, Saline Valley and Grapevine Canyon, and the Darwin Plateau area, including Darwin Falls (Banta 1962, Turner and Wauer 1963, voucher records in NPSpecies). Based on results from pitfall trapping, Banta (1962) suggested that the Western Shovel-nosed Snake was perhaps the most abundant snake species in the Saline Valley. It probably is common throughout much of DEVA.

Ring-necked Snake (*Diadophis punctatus*)

This species has a spotty, relictual distribution in the Southwest. Prior to our surveys it was not known from the DEVA area, the closest records being from the Spring Mountains in Nevada to the east and the Clark and Providence Mountains to the south (Stebbins 2003). We collected a specimen of Ring-necked Snake from the vicinity of a spring about a mile east of Scotty's Castle (Emmerich and Cunningham 2003), the site of a pitfall trap array operated by the late Dr. David Morafka. This species requires permanent subsurface moisture (Stebbins 2003), and isolated populations may occur at other such locations at DEVA.

Night Snake (*Hypsiglena torquata*)

We observed only two Night Snakes during our surveys, both dead on the road. One of these was on Daylight Pass, the other near the Furnace Creek Inn. At DEVA, they have also been collected in the Eureka Valley, Saline Valley, and Wildrose Canyon (Banta 1962, voucher records in NPSpecies). This strictly nocturnal species is probably common at lower and intermediate elevations throughout the park.

Common Kingsnake (*Lampropeltis getula*)

We observed this species on Towne's Pass, on the Darwin Plateau (including one at Darwin Falls), at Brewery Spring in Surprise Canyon, and in the Greenwater Valley. Common Kingsnakes are probably fairly common throughout the intermediate elevations throughout the park.

Coachwhip (*Masticophis flagellum*)

This large, fast snake is common throughout DEVA below the pinyon-juniper zone, and is one of the only snakes commonly found in the lowest parts of Death Valley (Turner and Wauer 1963).

Striped Whipsnake (*Masticophis taeniatus*)

We observed only two Striped Whipsnakes during our surveys, both on the trail to Telescope Peak. The species has been collected in Tuber Canyon and Willow Creek in the Panamint Mountains, and in the Grapevine Mountains in the Nevada Triangle (Turner and Wauer 1963, voucher records in NPSpecies). This snake occurs in canyons and in the pinyon-juniper zone at DEVA, but is apparently uncommon.

Spotted Leaf-nosed Snake (*Phyllorynchus decurtatus*)

Once thought to be rare, the advent of night driving as a herpetofauna survey method showed this species to be abundant in many desert areas in the Southwest (e.g., Klauber 1939). We observed this snake on roads near Scotty's Castle, on the Dante's View road, and on SR 190 on the Darwin Plateau. The range of the Spotted Leaf-nosed Snake is closely associated with that of the creosote bush (Stebbins 2003). This species probably occurs throughout creosote bush desert habitats at DEVA.

Gopher Snake (*Pituophis catenifer*)

This widespread, generalist species occurs throughout DEVA from the alluvial fans up into the pinyon-juniper woodlands in the Panamint Mountains (Turner and Wauer 1963).

Long-nosed Snake (*Rhinocheilus lecontei*)

We observed only four Long-nosed Snakes during our surveys: one on Towne's Pass, one in the Last Chance Range, and two on the road over Daylight Pass. Banta (1962) observed one in lower Grapevine Canyon (Nelson Range), and additional specimens have been collected from Lee Flat,

the Eureka Valley, and numerous locations in the Panamint Mountains (voucher records in NPSpecies). The species is probably fairly common in desert, canyon, and sagebrush habitats at DEVA.

Western Patch-nosed Snake (*Salvadora hexalepis*)

This diurnal species occurs in desert and shrub habitats below the pinyon-juniper zone at DEVA (Turner and Wauer 1963). We observed eight Western Patch-nosed Snakes at scattered locations, and the species has been collected throughout the park (Banta 1962, voucher records in NPSpecies).

Western Ground Snake (*Sonora semiannulata*)

We observed only two Western Ground Snakes during this inventory, one on the road in Emigrant Canyon, and one at a pitfall trap site in Hanaupah Canyon operated by the late Dr. David Morafka. Other locations for the species at DEVA include Grapevine Canyon (Nelson Range), the Grapevine Mountains, Wildrose Canyon, Towne's Pass, and the Eureka Valley (Banta 1962, Turner and Wauer 1963, voucher records in NPSpecies). Western Ground Snakes probably occur in lower and intermediate elevations throughout DEVA, in areas with some subsurface moisture (Stebbins 2003).

Southwestern Black-headed Snake (*Tantilla hobartsmithi*)

We observed a single Southwestern Black-headed Snake during a nocturnal general survey at Darwin Falls. The only other locations for this species at DEVA are Surprise Canyon, Grapevine Canyon (Nelson Range), and on SR 190 on the Darwin Plateau (Banta 1962, Turner and Wauer 1963, voucher records in NPSpecies). Southwestern Black-headed snakes occur in a variety of habitats in the region (Stebbins 2003), and it seems likely that this small, secretive species occurs in other places at DEVA.

Western Lyre Snake (*Trimorphodon biscutatus*)

The only Western Lyre Snake observed during our surveys was seen on the road in Emigrant Canyon, which is apparently the first record for the Panamint Mountains. Most records from DEVA are from the Darwin Plateau (voucher records in NPSpecies), although its occurrence to the east in the Amargosa Range at Daylight Pass, Grapevine Canyon, and Furnace Creek Wash (Turner and Wauer 1963, voucher records in NPSpecies) would suggest it might be more widespread in the park. This species is generally found in rocky habitats in deserts and lower mountain slopes (Stebbins 2003), and may occur throughout the foothills and bajadas of the Panamint Range.

Sidewinder (*Crotalus cerastes*)

This was the most frequently observed snake species during our surveys, and was found in sandy and gravelly desert habitats throughout the park. Macey and Papenfuss (1991b) note that Sidewinders appear to be absent from Saline Valley, and our surveys support that notion.

Speckled Rattlesnake (*Crotalus mitchellii*)

This was the second most frequently observed snake during the present inventory. Speckled Rattlesnakes occur from the creosote bush desert on the alluvial fans up into the pinyon-juniper woodlands at DEVA (Turner and Wauer 1963). We found this species in a similar range of habitats, including in desert scrub at the northern end of the Greenwater Valley and in pinyon-juniper habitat at the Charcoal Kilns in the Panamint Mountains. Many of our observations were from the Emigrant Canyon and Towne's Pass areas of the park.

Species That Possibly Occur at Death Valley National Park

Slender Salamanders (*Batrachoseps*)

Robert Stebbins believes slender salamanders could be found in moist spring habitats within Surprise Canyon (*fide* Laura Cunningham, personal communication). Other canyons in the Panamint Mountains or at Hunter Mountain may contain suitable habitat as well, and slender salamanders found in these areas would possibly represent new, undescribed species.

Inyo Mountains Salamander (*Batrachoseps campi*)

The northernmost records for this species, which is endemic to the Inyo Mountains, are from Waucoba Canyon, just west of DEVA (Jockusch 2001). We surveyed the DEVA section of Waucoba Canyon on multiple occasions, but found no salamanders. Bryan Hamilton (personal communication) observed Inyo Mountains Salamanders in Waucoba Canyon in 2004, less than a mile above the DEVA boundary, very near where they have been collected previously in the canyon (MVZ 150400-7). This location, an extensive seep area in the canyon bottom, was much wetter and cooler than spring and seep sites further down the canyon within DEVA (Bryan Hamilton, personal communication), suggesting that the species may not currently occur within the boundaries of the park. The Inyo Mountains Salamander is listed as a Species of Special Concern by the state of California (Jennings and Hayes 1994).

Ensatina (*Ensatina escholtzii*)

Robert Stebbins believes that an unconfirmed report of a salamander seen on Telescope Peak in the Panamint Mountains in the 1950's may represent an Ensatina (*fide* Laura Cunningham, personal communication). Although our pitfall traps at Mahogany Flat and Hummingbird Springs caught only lizards, this or another salamander species may occur at high elevations in the Panamints. We recommend additional targeted cover-flipping surveys near springs and seeps, particularly during wet weather, to search for salamanders in the Panamint Mountains at DEVA.

Great Basin Spadefoot (*Spea intermontana*)

In the vicinity of DEVA, this widespread species occurs in the Owens Valley to the west, Deep Springs Valley to the north, and in Nevada to the east (Macey and Pappenfuss 1991a, Stebbins 2003). Although it has never been reported, this toad may occur within the park near the northern or eastern boundaries, in areas such as northern Eureka or Saline valleys, the foothills and canyons of the Last Chance Range, or the Nevada Triangle between the Grapevine Mountains and Beatty, Nevada. The species usually inhabits Great Basin scrub in the DEVA region, but also occurs in creosote bush habitats near Owens Lake in the Owens Valley (Macey and Pappenfuss 1991a).

Black Toad (*Bufo exsul*)

This close relative of the western toad occurs naturally in Deep Springs Valley, north of DEVA (Fellers 2005, Murphy et al. 2003, Stebbins 2003). Black Toads were introduced about ten years ago, for unknown reasons, into the flowing well about 3.2 km north of Salt Lake in Saline Valley (Fellers 2005, Eric Simandle personal communication). DNA analyses have determined that these toads came from the Buckhorn/Corral Springs complex in Deep Springs Valley (Eric Simandle, personal communication). They were apparently still at the DEVA site in May 1998, when Eric Simandle collected tissue samples from 30 individuals for DNA analysis (Eric Simandle, personal communication), but we did not find them during our surveys in 2004. Although the site is fenced, burros have gotten in, and severely degraded the habitat. Based on the poor quality of the habitat combined with our failure to find this species during multiple surveys, we believe that Black Toads may be extirpated at DEVA. The Black Toad is listed as Threatened by the state of California (Murphy et al. 2003).

Northern Leopard Frog (*Rana pipiens*)

The nearest populations of this highly aquatic species are in the northern Owens Valley (Macey and Pappenfuss 1991a). Pratt and Hoff (1992) twice reported hearing a "chortle or chuckle" at Saratoga Spring that they described as being similar to the call of the Northern Leopard Frog. However, Pacific Treefrogs give a variety of calls (Davidson 1995), and Pratt and Hoff (1992) may have simply heard an unusual Pacific Treefrog call. They noted that Pacific Treefrogs were abundant at Saratoga Spring during their surveys. The Northern Leopard Frog is listed as a Species of Special Concern by the state of California (Jennings and Hayes 1994).

Long-tailed Brush Lizard (*Urosaurus graciosus*)

In his discussion of sympatry between *Urosaurus* and *Uma* (fringe-toed lizards), Norris (1958) reported collecting Long-tailed Brush Lizard at the "Sperry Canyon Dunes." This locality is probably along the Amargosa River near the northern part of the Dumont Dunes (near the Sperry site), just east of the southeast corner of DEVA. Based on their occurrence at this site, we had expected to find them at the Ibex Dunes at DEVA, which is only about six miles west of the Dumont Dunes. Long-tailed Brush Lizards favor areas of loose sand and scattered shrubs and trees, especially large creosote bushes (Stebbins 2003), habitat elements found at both the Dumont and Ibex dunes. In addition, although habitat at DEVA for the Mojave Fringe-toed Lizard is probably limited to the Ibex Dunes, much of the habitat along the Amargosa River in the southern part of DEVA appears to be good brush lizard habitat, primarily in the area between Ashford Mill and Saratoga Spring. We searched a number of sites within this area that contained large creosote bushes and, especially, mesquite trees growing on sandy hummocks within the Amargosa River floodplain. Boland and Goodlett (1997) reported observing a Long-tailed Brush Lizard during DEVA Desert Tortoise surveys in Greenwater Valley (Laura Cunningham, personal communication). We surveyed throughout Greenwater Valley, but the habitat is marginal for brush lizards, as the soil is generally rocky or gravelly and the creosote bushes are shorter in stature than most areas where the species is found. We suspect Boland and Goodlett's observation may have been based on a misidentification of a Side-blotched Lizard. More surveys of these areas during wetter periods may be more productive, but even in good years Long-tailed Brush Lizard may be uncommon, since it is at the edge of its range in the DEVA area.

Ornate Tree Lizard (*Urosaurus ornatus*)

This species was on the original NPS list of potential reptile species for DEVA, but it almost certainly does not occur in the park. Tree Lizards do not occur very close to DEVA (Stebbins 2003), and the distribution of the species in Nevada is generally confined to rocks and trees near the Colorado River (Alex Heindl, personal communication).

Northern Alligator Lizard (*Elgaria coerulea*)

This species was on the original NPS list of potential reptile species for DEVA, but it almost certainly does not occur in

the park. The nearest records are from above 8000 feet elevation along the crest of the Sierra Nevada, and from streams in the Carson City area of Nevada (Laura Cunningham, personal communication). This species occupies cooler, more mesic habitats than other alligator lizards, and thus if disjunct native populations of alligator lizards (aside from Panamint Alligator Lizard) were to be found in northern DEVA, they would probably be Southern Alligator Lizards.

Western Skink (*Eumeces skiltonianus*)

This close relative of the Gilbet's Skink was previously listed in NPSpecies and elsewhere (e.g., DEVA interpretive reptile checklist) as occurring in the park. However, this was based on two probable false reports: an unvouchered sighting during the Death Valley Expedition (Stejneger 1893) and a mislabeled specimen of Gilbert's Skink in the DEVA collection. The Western Skink is known from high elevation areas in the White Mountains, and could conceivably occur in the Panamint Mountains as well (Jonathan Richmond, personal communication), although only Gilbert's Skinks are currently known from the latter.

Mediterranean Gecko (*Hemidactylus turcicus*)

NPS staff had reported a gecko climbing a wall in the built-up area around Scotty's Castle, suggesting the possibility of a naturalized population of Mediterranean Geckos (Laura Cunningham, personal communication). Introduced populations of this species are well established in many southwestern metropolitan areas such as Phoenix and Tucson, Arizona, and Las Vegas, Nevada (Stebbins 2003), and the species could easily have been transported to DEVA in ornamental plantings from nurseries. However, repeated nocturnal searches during this inventory revealed no geckos on buildings at Scotty's Castle. The initial report probably represented a sighting of a Western Banded Gecko, a native species common in the Scotty's Castle area.

Gila Monster (*Heloderma suspectum*)

Gila Monster was on the original NPS list of potential reptile species for DEVA, but it almost certainly does not occur in the park. Isolated populations of Gila Monsters occur in a number of mountain ranges in California to the south of DEVA, including the Clark, Kingston, Piute, and Providence mountains (Stebbins 2003). Although fairly close to the southeastern corner of DEVA, the Kingston Range receives more summer rainfall and supports diverse succulent vegetation (cacti, yucca, agave) absent from DEVA. Jeff Lovich and Kent Beaman (unpublished data) have suggested that the distribution of Gila Monsters in California is limited to sites that receive enough summer rainfall to exhibit a strongly biphasic precipitation regime, which may be important in the foraging ecology of the species.

Rubber Boa (*Charina bottae*)

The Rubber Boa was on the original NPS list of potential reptile species for DEVA, but it almost certainly does not occur in the park. The closest records east of the Sierra Nevada are from June Lake, Mono County, California, in dense mesic pine-fir forests (Laura Cunningham, personal communication). The species is usually associated with moist coniferous forests (Stewart 1988), and habitats at DEVA are probably too dry.

California Mountain Kingsnake (*Lampropeltis zonata*)

Although there have been no reports of this species from DEVA, there is a slight possibility it may occur in moist canyons or high elevation areas within the park, as it is distributed disjunctly on mountain islands elsewhere in southern California, and is more widespread in the Sierra Nevada range (Stebbins 2003). Greene and Luke (1996) suggested that this species could occur in the Clark, Kingston, New York, or Providence mountains in the East Mojave Desert. If present at DEVA, possible habitats include well-watered canyons (e.g., Darwin Falls, Hanaupah Canyon, Surprise Canyon), as well as high elevation pinyon-juniper forests throughout the Panamint Mountains.

Western Terrestrial Garter Snake (*Thamnophis elegans*)

The Western Terrestrial Garter Snake was on the original NPS list of potential reptile species for DEVA, but it probably does not occur in the park. The species occurs in the Owens and Fish Lake valleys, west and north of DEVA (Macey and Papenfuss 1991b), and there are unconfirmed reports from the upper Amargosa River meadows of Oasis Valley north of Beatty, Nevada (Laura Cunningham, personal communication). Laura Cunningham (personal communication) observed a Western Terrestrial Garter Snake in Wyman Creek in the southern White Mountains, on the north side of Deep Springs Valley. This site is only about 10 miles from the northern edge of DEVA, but there does not appear to be suitable habitat in this part of the park. Only a few sites within DEVA appear to have enough water to support garter snakes (e.g., Surprise Canyon, Darwin Falls, Saratoga Spring), and the lack of reports of this conspicuous, diurnal species suggests it is probably absent from the park.

Western Diamond-backed Rattlesnake (*Crotalus atrox*)

This rattlesnake was on the original NPS list of potential reptile species for DEVA, but it almost certainly does not occur in the park. Heindl (1999) studied the distribution of this species in southern Nevada, and found it to be associated with

relatively mesic, well-vegetated sites, when compared with the Mojave Desert generally. DEVA is outside the distributional range of the species, and habitats within the park are probably too dry.

Mojave Rattlesnake (*Crotalus scutulatus*)

There is a high probability that this rattlesnake occurs in the southern portion of the park, especially in the region of the Amargosa River. Mojave Rattlesnakes are most common in areas of scattered scrubby creosote bush and mesquite (Stebbins 2003), and these habitats are found throughout much of the southern part of DEVA. This species is present south of DEVA on the Fort Irwin National Training Center (Laura Cunningham, personal communication), and Beth Tomlica (BLM, Las Vegas) may have seen one in Lemonade Canyon in the Greenwater Range at DEVA (Laura Cunningham, personal communication).

Western Rattlesnake (*Crotalus viridis*)

The Great Basin subspecies (*C. v. lutosus*) of the Western Rattlesnake occurs to the north of DEVA, in Queen Valley (Macey and Papenfuss 1991b). Isolated populations may occur in mountains in the northern portion of the park, including the Last Chance Range, Grapevine Hills (in Nevada), Grapevine Mountains, the Nevada Triangle, or the Big Pine Road (northern Saline Valley entrance).

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