CONFIRMED OTTER TRACK
ESPEJO CREEK ISLAND
1999-2000

THREATENED AND ENDANGERED SPECIES SURVEY; RIVER AND RIMS GRAND CANYON NATIONAL PARK

INTERIM REPORT RIVER CORRIDOR SURVEY

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Science Center
1999 SMALL GRANTS PROGRAM

PROPOSED PROJECT DESCRIPTION

The 1999 Grand Canyon Small Grant Program funded the Threatened and Endangered Species Survey through the Grand Canyon National Park Foundation for the sum of $12,050. The intent of the proposed two-year project was to have the park biologists, assisted by volunteers from other agencies, survey the river and rims for endangered, threatened, former Category 2 (Species of Special Concern, USFWS) and species listed on the State, Navajo and Hualapai List of Protected Species that are found within park boundaries.

The design of the trip was to inventory sample areas on an ecosystem approach. This would encompass, in each sampling area, the data collection of herpetofauna, vertebrate and invertebrate species, and their correlation with other habitat components such as the botany of the area. This concept is termed "bioblitz". At the heart of a bioblitz is a gathering of scientists, and dedicated volunteers who have an interest or expertise in the finding and identifying of plant and animal species. A bioblitz can refine a region's species richness and the need to properly conserve and manage that richness. This can be a powerful tool for biodiversity awareness as well as education.

May was selected for the trip since many flowering plants attract insect and bat species that may not be present when blooming has ceased. Areas designated for sampling would result in a more complete picture of the habitat and species filling various niches of the sample area.

This information would be utilized in order to provide park biologists with baseline information that can be assessed and eventually lead to future concentrated efforts regarding specific species that are in the scope of our budget and expertise. The significant observations will also be used to prioritize future funding needs. This report documents significant findings from the river corridor. A similar survey will be conducted along the rims, specific areas of the Tonto, and selected portions of the Esplanade in the year 2000, followed by a final report that includes all information compiled from the two years.

YEAR ONE PROJECT ACCOMPLISHMENTS

A river trip launched in May 1999 that consisted of the two park wildlife biologists and volunteers from other national park units throughout the country, U.S. Fish and Wildlife Service, Arizona Game and Fish Department and the Bureau of Reclamation. Navajo and Hualapai biologists were invited but the trip conflicted with their previously set field schedules.

The trip launched May 3, 1999 from Lee's Ferry and consisted of four oar-powered rafts that took out at Diamond Creek on May 20th. The study plan called for the following areas of focus: mist netting of bats, a preliminary search along sand bars and suitable habitat for any sign of river otter presence, an amphibian inventory of suitable side canyon pools and streams with primary emphasis on leopard frog tadpole presence or absence, and range determination for two subspecies of Grand Canyon pink rattlesnakes.

This report addresses specific species of interest that require future attention from park biologists in order to restore or protect them from various impacts.

BAT MONITORING

Bats are a tremendously successful group of mammals with an evolutionary history stretching back more than 50 million years. Within Grand Canyon National Park there are at least seventeen species of bats, all are insectivorous but one, the Mexican long-tongued bat which is nectivorous. The elevation range and the associated vegetative communities of the park combine to make the park ideal habitat for bats. Although bat inventories occurred in the last two summer seasons along the river corridor, much remains to be learned about this unique group of mammals.

The park is currently experiencing increased recreational activity along the rims and river corridor in relation to cave and mine exploration. This increased visitation may have the potential to disturb roosting bats. This trip focused on roost site searches in order to provide baseline data on the status of bats and their critical roost sites. Survey methods included mist netting and mine and cave diurnal roost surveys.

The project resulted in several significant findings. Although the spotted bat (*Euderma maculatum)* has been collected on the South Rim of the park, it has only been recorded through use of the Anabat II system (records bat sonar signals) along the river corridor. The first spotted bat ever physically collected along the river occurred on May 17th at Mohawk Canyon. This bat was a healthy, lactating female. Information regarding this collection was shared with the Hualapai natural resource managers who were mist netting on the rims during this same period. After analyzing the topography and ecology of foraging spotted bats and the collection and foraging pattern of the collected bat, an assumption can be made that the spotted bat roost site exists along the opposite side of the river corridor from where the bat was collected (Stairway Canyon). This would explain roost site exit, dropping down for water in the drainage at Mohawk and possibly foraging in the pinyon and over water tanks on the rim in the Hualapai reservation.

A roost site search was also conducted for the western mastiff bat (*Eumops perotis*) in conjunction with a joint project between the North Kaibab Forest biologists and Grand Canyon National Park biologists. An exit count of a roost site was conducted below Great Thumb Mesa on the left side of the river. Bats from this site have been radio tagged and are foraging in the forested North Rim areas of the park and adjacent forest. In addition, an increase in the collection of Townsend's big-eared bats (*Corynorhinus townsendii*) occurred from Havasupai Canyon through river mile 225.

A disturbing observation at Stanton's Cave occurred during a roost site survey. Stanton's Cave is restricted to visitation by an angle iron gate that allows for easy access by free-flying bats but does not allow for access by visitors from the popular backpacking and river camp at South Canyon. This gating project was initiated by the park in 1995 due to the extirpation of the Townsend's big-eared bat which utilized the cave as a historical roost site. Extensive damage and theft had depleted cultural and cave resources over the course of the last thirty years. Following installation of the gate, bat monitoring in 1997 and 1998 showed a return of the bats to the cave and evidence suggested that it had once again served a role as a roost site to nearly thirty Townsend's big-eared bats and four other bat species. The May 1999 survey proved otherwise. Only one small bat was found occupying the cave. An evening exit survey counted zero bats exiting the cave to forage.

A thorough search of the cave floor found several handfuls of firecrackers that had been thrown in through the bars of the gate. This disturbance alone would be enough to flush the bats from the cave, possibly on a permanent basis. Since the time of the last cave bat survey in 1998, visitors to the area tried to dig under the gate structure and attempt to intrude the cave. This was photodocumented and reported to park dispatch.

In this same location at the South Canyon campsite, the northernmost range record for the nectivorous Mexican long-tongue bat (*Choeronysteris mexicana*) was recorded in previous surveys. Since 1906, fewer than 500 of these bats have been documented in the United States. Because of a need to obtain new information, the species was listed by Region 2 of the U.S. Fish and Wildlife Service (USFWS) as an information concern under the Species at Risk Program. Of the less than 500 records of this species in the United States, only 24 historical localities exist in Arizona. These historical records suggest that this species roosts in caves, wide rock crevices and overhangs and occasionally in mines or abandoned buildings-all near a reliable water source and sometimes near riparian areas.

Future bat monitoring efforts should continue to include the presence and abundance or absence of Townsend's at Stanton's Cave, distribution and abundance of spotted bats and roost site searches, and more concentrated efforts on additional observations of Mexican long-tongue bats.

HERPETOFAUNAL INVENTORY

Although several reviews and lists of the reptiles and amphibians of the Grand Canyon have been generated, the distribution of many species in the canyon are still poorly understood and several species are commonly misidentified by observers. Since 1997, river guides, visitors and park staff have provided photographic records and localities of the snakes they have encountered while in the canyon. To date, this database includes over 130 records of nine different species, with records of two species previously unreported from the canyon and known localities for other known species. This data augment information collected from a companion study by two biologists from the University of Arizona. Their data suggested that several snakes are commonly misidentified in the park, and these combined efforts have provided information that has allowed for a refinement of the distribution of these species. The commonly confused Southwestern speckled rattlesnake (*Crotalus mitchelli pyrhuss*) and the Grand Canyon rattlesnake (*Crotalus viridis abyssus*) can both be found along the river corridor and in some areas at slightly higher elevations. Andrew Holycross, herpetologist from University of Arizona was invited on the trip to gather additional information on the distribution of these snakes and other reptiles.

Methodology for reptile collection included ground searches, drift nets and pitfall traps, giving careful consideration to humane treatment of all specimens and to intrusive methods such as pitfall traps and drift nets where archeological resources were a concern. All snakes collected were weighed, measured, sexed and fitted with a P.I.T. (physical identification tag) tag. These tags, inserted subcutaneously, provide a number and/or letter documentation that through future monitoring efforts, will help establish knowledge regarding home range size and genetics in several species. In addition to the above data collected, blood samples were withdrawn from all rattlesnakes to initiate the creation of a DNA database. Each specimen collected was then released back to the site where it was originally collected.

As a result of this project, a publication is being written to address the significant findings relevant to the Grand Canyon pink rattlesnake. Below is the abstract of the paper that will be sent to the Journal of Wildlife Management for review and publication.

Confusion in Grand Canyon: Identity and Distribution of the "Grand Canyon Pink" Rattlesnake

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Distributions of the southwestern speckled rattlesnake (*Crotalus mitchelli pyrrhus*) and the Grand Canyon rattlesnake (*Crotalus viridis abyssus*) are poorly understood within Grand Canyon. This is due primarily to a paucity of vouchered localities along the river corridor, as well as from frequent confusion of the two species by scientists and layperson alike. Both (as well as *C. v. concolor* of the upper basin Colorado and Green River corridors) display a variety of ground colors other than the salmon hue characteristic of Grand Canyon. Likewise, characteristic dorsal patterns (i.e., bands in *C. m. pyrrhus* and blotches in *C. v. abyssus*) fade considerably with age in both species. As a result, guides, park personnel, and biologists refer to any salmon-colored rattlesnake in Grand Canyon by the sobriquet "Grand Canyon pink" (or simply "pink"). Implicit in this common name is the assumption that "pinks" are *C. v. abyssus*. As a result, *C. m. pyrrhus* is believed to be rare within Grand Canyon and limited to its westernmost reaches. Conversely, *C. v. abyssus* is believed to be more common and distributed much more broadly along the river corridor than voucher records substantiate. Herein, we re-define distributions of both species in Grand Canyon, using museum acquisitions, scientific/popular literature, and vouchered photographic evidence.

The evidence collected and subsequent communications with river runners and guides suggest that there is a serious threat to the genetics of the unique rattlesnake populations within the park. There is a common practice of these river runners, guides and the boating community to move rattlesnakes from campsite to the opposite sides of the river. From a genetic standpoint, the river is a major barrier to gene flow for many organisms and this must be respected.

If a rattlesnake is utilizing habitat that is also suitable for camping, a snake should always be moved less than 0.5 miles when relocated and never relocated across the river. The park should actively discourage this practice. Based on the genetic work by Andy Holycross (pers. comm.), rattlesnakes appear to have fairly finite "genetic neighborhoods". This means that there can be discrimination between rattlesnake "subpopulations" that can be as close as 5 km from one another (and these have no apparent barriers to gene flow between them). Much more information is needed regarding the genetic structure of different species and subspecies. The canyon's unique physiography lends itself to the study of gene flow, therefore natural patterns

that are continually being disrupted by boaters or others that relocate snakes, are, in the long term, destroying the uniqueness of a canyon species.

Presumably due to logistics, the Grand Canyon and its tributaries have never been thoroughly surveyed for amphibians, particularly for northern leopard frogs (*Rana pipiens*). There are numerous records of various amphibian species from within the canyon and n the rims, but no comprehensive stream by stream survey. During the reptile and amphibian search, at least two observations of leopard frog tadpoles in side streams or tributaries were recorded.

Of the amphibians known from the Grand Canyon region, northern leopard frogs are in the greatest danger of disappearing. This species was once widely distributed across much of the United States and Canada. However, since the 1970's, declines of leopard frogs have been documented in every state in the Rocky Mountain region and in large parts of Canada. This species reaches the southern extent of its range in Central Arizona and New Mexico. In Arizona, it is a Candidate Species on the State List of Threatened Wildlife (Arizona Game and Fish Department 1999) (AGFD) and is on the Endangered Species List for the Navajo Nation (2000). In Arizona, some populations of the species have declined and others have been lost entirely, but reasons for the decline are unknown at this time.

Previous records from within the park are from 1982 at Cardenas Marsh and Ribbon Falls in the Bright Angel Creek in 1989. The recent findings of two tadpoles are significant. Each area where the tadpoles were discovered experience high visitor use. More information on the distribution of leopard frogs is needed in order to assess various impacts.

Below is a draft abstract for publication submission regarding additional significant amphibian observations.

***BUFO PUNCTATUS* AND *BUFO WOODHOUSII* (Red-spotted Toad and Woodhouse's Toad). HYBRIDIZATION. Many anurans are known to hybridize in nature and toads, genus *Bufo*, have long been subjects of hybridization research (Blair 1972, Evolution in the genus *Bufo*. University of Texas Press, Austin. 459 pp.). Hybridization between *B. punctatus* and *B. woodhousii* explains morphologically intermediate toads collected from Lava Canyon (River Mile 65.5) of the Grand Canyon (Arizona State University 28398) and Glen Canyon (Museum of Northern Arizona Z6.527-528) in Arizona (Malmos, Reed, and Starrett 1995. Great Basin Naturalist 55:368-371). Furthermore, other similarly distantly related toad species (e.g., *Bufo alvarius* x *B. woodhousii* and *Bufo cognatus* x *B. woodhousii*) are known to hybridize in Arizona (Gergus, Malmos, and Sullivan 1999. Copeia 1999:281-286). Although discovery of hybrids in nature implies mismating between species, heterospecific amplexus is rarely observed (KBM pers. obs.). Here we report backcross amplexus between a hybrid *B. punctatus* x *B. woodhousii* and *B. woodhousii* and heterospecific amplexus between *B. punctatus* and *B. woodhousii*.**

On 12 May 1998 at 10:37 hrs, a male *B. punctatus* x *B. woodhousii* (verified as hybrid by B. K. Sullivan from photo, Fig. 1) was observed in amplexus with a female *B. woodhousii* in Nankoweap Twin Springs, ca. 4.0 km above the Colorado River (RM 52). The pair was found in shallow water over cobble. The male was diagnosed as a hybrid by possession of morphological characteristics intermediate to the two species: dorsum with some red warts, lack of a

mid-dorsal stripe and dorsal blotches, parotoid gland wedge-shaped, weak cranial crests, and slightly flattened head. Two additional *B. woodhousii* were observed among cattails at the spring, but no other *B. punctatus* were found nearby.

On 11 May 1999 at 20:40 hrs, a male *B. punctatus* was observed in amplexus with a female *B. woodhousii* in Hermit Creek, within 100 meters of the Colorado River (RM 95). The pair was found in shallow water flowing over exposed gravel. Water and air temperature were 19° C and 25.5° C. Approximately 12 *B. punctatus* were calling at this site, and no further *B. woodhousii* were seen or heard at this aggregation.

Lack of enlarged, darkened thumb pads and failure to give release calls when the pair was in hand, indicated the *B. woodhousii* was female in both cases. During handling, the males never released females and amplexus continued after release. It is not known whether eggs were deposited in either case. Females of the less abundant species mating with males of the more common species is a typical pattern in hybridization (Wirtz 1999. Animal Behavior 58:1-12).

RIVER OTTER SIGN SURVEY

The muskrat, beaver and river otter are three of the many native animals integral to aquatic communities in Arizona. All are native inhabitants to Arizona, though none are considered numerous or well known. The least known of these three mammals is the Arizona river otter (*Lutra canadensis sonora*). The Office of Endangered Species of the U.S. Fish and Wildlife Service (USFWS) is presently investigating its status because of its limited distribution, low numbers, and potentially threatened or endangered status in Arizona. The river otter was listed by the USFWS as a Species of Special Concern, a designation given to those species that warrant further biological research and field study to ascertain their potential for listing under the Endangered Species Act. However, this designation no longer affords official federal consideration. The river otter is listed as Threatened Native Wildlife by AGFD and is considered extirpated by the Navajo Nation.

The May trip surveyed for any sign of river otter presence: scat, scent stations or tracks. A series of tracks were photographed which appeared to be those of an otter on an island near Espejo Creek.

A workshop was recently held in Flagstaff, sponsored by the Museum of Northern Arizona, which brought together otter experts from around the United States. The photograph of the track was confirmed by experts as an otter. However, this brought up a new question: is the track from the Sonoran subspecies or from a dispersing male from a reintroduced population?

As a result of this significant finding of an otter track, funding has been secured to conduct an extensive river otter sign search from Lee's Ferry to Pearce Ferry this spring. The survey will include experts from USFWS, AGFD, Colorado Division of Wildlife and several experts from Universities throughout the country. The survey will

include the use of infrared cameras systems where appropriate, search for signs, scat, tracks and scent stations, DNA analysis, and mapping of suitable habitat.

Results from this survey will enable the park wildlife biologists to make sound and scientific recommendations regarding future restoration or reintroduction efforts pertaining to the river otter within the Grand Canyon aquatic ecosystem.

SMALL MAMMAL TRAPPING

Nocturnal rodent population assessment and monitoring has been shown to be an efficient way to document and monitor overall habitat conditions. By serving as a major prey base for bird, reptile and mammal predators, as well as fulfilling an important role in soil aeration and seed dispersal, nocturnal rodents and their population dynamics can serve as a tool for making assessments of general ecosystem health. Nocturnal rodents are particularly efficient to study because they (1) are found in most habitats, (2) respond quickly to changes in primary production of plants, (3) can have several litters per year, (4) are easily captured, (5) have a relatively small home range, and (6) can be easily identified.

Nocturnal rodents were monitored using capture, mark, release, and recapture methods. An average of 50 3 x 3.5 x 9-in. Sherman live-traps were baited with oat flakes and set on anywhere from 2 to 7 mammal grids located at each study site. Trap stations on each grid were given alphanumeric designations of A1 through G7 (A1=southwest grid corner; G7=northeast grid corner). This designation is useful in tracking species microhabitat selection and species distribution over time. Trapping was conducted during 2 consecutive nights at most sites with rodent processing (weighing, sexing, and marking) beginning at 0500 hrs.

Hantavirus pulmonary syndrome is a serious, often deadly, respiratory disease that has been found mostly in the rural areas of the western United States. This disease is caused by the hantavirus that is carried by rodents and passed on to humans through infected rodent urine, saliva or droppings. The deer mouse is the primary carrier of the virus that causes hantavirus pulmonary syndrome. Since there have been confirmed reports of rodent carriers in the park, a blood sample was drawn from each deer mouse (*Peromyscus*) collected. Out of the two hundred and fifty-four samples of blood tested by the state lab, only one tested positive for the virus. This was collected at Mohawk Canyon, on river left, from a canyon mouse (*Peromyscus crinitus*). Although 13 canyon mice were collected at that study site, only one tested positive for the virus.

The list below represents the diversity of species collected. A total of 338 small mammals were collected throughout the course of the trip. The final report for this

project will include information on species composition, biomass, density, success percentages, data sheets and monitoring results.

Small Mammal Species Diversity
Family *Cricetidae*
Canyon mouse ***Peromyscus crinitus***
Cactus mouse ***Peromyscus erimicus***
Deer mouse ***Peromyscus maniculatus***
Pinon mouse ***Peromyscus truei***
Brush mouse ***Peromyscus boylii***
Desert wood rat ***Neotoma lepida***
Stephen's wood rat ***Neotoma stephensi***
White-throated wood rat ***Neotoma albigula***
Bushy-tailed wood rat ***Neotoma cinerea***
Western harvest mouse ***Reithrodontomys megalotis***
Family *Heteromyidae*
Long-tailed pocket mouse ***Perognathus formosus***
Silky pocket mouse ***Perognathus flavus***
Ord's kangaroo rat ***Dipodomys ordii***
Total Species Collected: 13

In addition to the river survey, young volunteers ranging in ages 10-16, with keen interests in wildlife biology, assisted in small mammal trapping throughout the course of the summer at Lee's Ferry and Jackass Canyon. This information was added into the river corridor small mammal trapping database.

Two significant small mammal collections were made during this survey. The long-tailed pocket mouse has only been recorded on the north side of the river and only from the areas of Kwagunt Creek, Nankoweap and Deer Creek. Two collections were made during this trip on the south side of the river. The other significant observation is that of the kangaroo rat. They have previously been collected only on the south side of the river just below the rim and were thought to not inhabit the canyon. This study collected two such specimens on the north side of the river at Lee's Ferry.

INVERTEBRATES

Invertebrates were sampled at each study site in coordination with the work that Dr. Larry Stevens is currently undertaking. Methodologies for data collection included

blacklighting, pit fall traps, sticky traps, and netting. Over 700 samples were collected The data is currently being compiled and assessed. Preliminary analysis has suggested the first collection of the largest moth in the park, the black witch moth (see letter below).

Ms. Elaine Leslie, Wildlife Technician
Grand Canyon National Park Science Center
P.O. Box 129
Grand Canyon, AZ 86023

26 December 1999
Dear Ms. Leslie:

This letter is a year-end report on my invertebrate inventory activities during 1999. Thank you for your support during 1999 with my studies of the invertebrates of the Colorado River corridor. Ms. Kirsten Rowell and I participated on three research river trips, on which we were able to collect approximately 2000 invertebrate specimens. These trips included your May trip, our 2-17 July backwaters trip, and my participation in the Grand Canyon Honors Semester (through NAU) in October.

I have been preparing, identifying and curating specimens during this fall and winter. Although I am making good headway with this process, it is time-consuming and this project is only funded by myself, so additional time is needed to complete identifications. The specimens are being curated at the Department of Biological Sciences Invertebrate Museum at Northern Arizona University in Flagstaff.

Thus far, I have completed taxonomic identifications on two groups: the butterflies/skippers and the Orthoptera. Those data are included with this report, to add to your NPS database. I have included the data on the enclosed diskette in Excel format. I intend to pursue the Odonata and Hymenoptera next.

In addition to those groups, we collected the first records of several species in the Park. We found a single specimen of black witch moth (Noctuidae: *Ascalapha (Erebus) odorata*) (your trip)– this is the first record of our largest moth in the Park to my knowledge. I collected the second record of an aging tadpole shrimp (Notostraca: *Triops longicaudatus)* from an ephemeral pool in North Canyon. Also of interest, we collected the first record of an amblypygid (near *Paraphrynus*), a tailless whipscorpion, and the first I've seen on the Colorado Plateau.

As you know, I am compiling a list of invertebrates of the Grand Canyon, and these are important records to add to the growing list. I will continue to keep you informed of my progress on the curation and data compilation process, and please let me know if you have any questions regarding this report.

Sincerely,
Lawrence E. Stevens, Consulting Ecologist

Encl: 2 Excel files on a 3.5" diskette
Future efforts should be made to continue this collection of much needed data.

PELLET STATIONS

Ungulate populations are difficult to monitor. Techniques include direct observations, monitoring of tracks, or monitoring fecal pellet groups. Most methods reveal population trends rather than determine absolute population levels. Population trends are of interest because management activities will have differing impacts on increasing or decreasing populations. The use of pellet stations for monitoring deer require several assumptions. Of primary importance is the assumption that the deer defecation rate stays constant over time and can be averaged over various ages. A rate of between 12 and 15 pellet groups per day is a viable average used for southwestern ungulate species. The other assumption is that the sample transects are representative of the entire area being studied, and represent a large enough area to limit sampling error.

Deer from the North Kaibab Forest have experienced a decline in suitable winter range habitat in the last few years due to a wildfire in the Bridger-Knoll area of the North Rim. Deer and bighorn are quite often observed utilizing habitat along the river corridor, particularly in winter. The area of the Nankoweap Delta and Mesa is believed to be utilized as significant winter range by deer and followed by predators. This area has evidence of established mountain lion territories by both a male and female.

In order to obtain long-term information regarding habitat use by deer and bighorn sheep along the river corridor, pellet stations were established in the Saddle Mountain through Carbon Creek area. Due to time constraints, transects were established only on the right side of the river. Lines were demarcated with wooded stakes and permanently affixed with the use of a global positioning satellite system. The average density of transects is slightly greater than one transect per linear mile. All start and end points were documented with global positioning satellite equipment for future reference. Each transect is a linear series of ten 0.01-acre circular plots, approximately 1 chain (66 feet) apart. The transects are straight and plots evenly spaced except where topographic features necessitate changing direction or the distance between plots. Each plot was cleared of deer and sheep pellets and will be read in spring and cleared and read again in the fall of 2000 and each season thereafter (theoretically).

The transects ideally should be sampled two times a year (spring and fall or winter and summer). This information will yield data from only 1.0 acres of ground covered. Additional transects should be established in the future to obtain maximum useful information with an eventual yield of 3.0 acres of ground, representing a subsample of the total study area. To enhance the information obtained from these transects, vegetation sampling should be conducted in correlation with winter habitat use. Following several years of data collection, the study will be analyzed considering the sample size, risk of error and magnitude of change. Recommendations will be made regarding a long-term monitoring scheme for predator-prey relationships, bighorn and deer habitat use and potential recreational impacts to the area.

RECOMMENDATIONS

Information gathered in this study will be compiled into the final two-year report. The significant observations aforementioned should have immediate attention by the park. These projects include the following: (1) Arizona river otter presence or absence and subspecies determination, (2) northern leopard frog distribution and abundance, (3) spotted and Mexican long-tongue bat roost site identification, (3) continuation of Grand Canyon pink rattlesnake subspecies distribution and DNA sampling, (4) continued monitoring of ungulate pellet stations, and (5) continue monitoring the status of the Townsend's big-eared bat in Stanton's Cave.

The final report will include all information compiled throughout the course of this study, inclusive of data sheets, slides and further recommendations.