



Inventory for bats (Chiroptera) at Canyonlands National Park, Utah

Final Report

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Introduction

Historically, the Colorado Plateau has been the subject of many geological and biological explorations. J. W. Powell explored and mapped the canyon country of the Colorado River in 1869 (Powell [reprinted] 1961). C. H. Merriam, V. Bailey, M. Cary, W. H. Osgood, and other employees of the Bureau of Biological Survey conducted biological explorations of the area in the late 1800's. In recent times, mammalogists including S. D. Durrant (1952), D. M. Armstrong (1972), J. S. Findley et al. (1975), D. F. Hoffmeister (1986) and Fitzgerald et al. (1994) have made considerable contributions to our understanding of the fauna of the Colorado Plateau. Armstrong (1982) provided considerable new information on mammals in the "Canyon Country," including Canyonlands National Park (CANY). Nonetheless, details of distribution and abundance for many species of plants and animals of the plateau remain poorly known.

In an effort to address such deficiencies, the National Park Service (NPS) initiated a nationwide program to inventory vascular plants and vertebrates on park lands (e.g., NPS 2000). The U.S. Geological Survey (USGS), Fort Collins Science Center, Arid Lands Field Station in Albuquerque became a cooperator on this effort in 2001 when we began mammalian inventories on nine parks within the NPS Northern Colorado Plateau Network (NCPN; Haymond et al. 2003) and five parks within the NPS Southern Colorado Plateau Network (SCPN; Bogan et al. 2004). We subsequently initiated surveys at three additional parks within the SCPN (Geluso and Bogan 2005). Existing baseline data on mammal occurrences in these 17 parks varied from sparse to moderate, with little information available for most parks. In almost all cases information was insufficient to assess the status of potential species of local concern.

In early 2004, we were asked by the staff of the NCPN to undertake an inventory of the bats (Chiroptera) of Canyonlands National Park. Earlier review sessions of the NCPN had noted that additional information on bats from this park would be desirable. Although a variety of biological studies have been conducted at CANY, including several on mammals (e.g., Armstrong 1974, 1979, 1982, Johnson 1981), no detailed inventory for bats is available. Following several discussions of the scope of the proposed inventory, an Interagency Agreement between NPS and USGS was finalized in the spring of 2004 and funds transferred to the Fort Collins Science Center so work could begin. It was agreed that the inventory effort would occur over two years to maximize opportunities to capture bats and to minimize the effects of local variations in climate that might affect our ability to capture bats. This, then, is the final report on field work conducted at CANY from May 2004 through October 2005.

Available evidence suggests that 16, perhaps 17, species of bats may occur at CANY (Armstrong 1974, Armstrong 1982, Mollhagen and Bogan 1997, Bogan and Ramotnik unpublished reports to NPS, see Table 1). Only ten species of bats appear to have been reported at CANY (Armstrong 1974, Armstrong 1982), including California myotis (*Myotis californicus*), long-eared myotis (*Myotis evotis*), fringed myotis (*Myotis thysanodes*), Yuma myotis (*Myotis yumanensis*), hoary bat (*Lasiurus cinereus*), western

pipistrelle (*Pipistrellus hesperus*), big brown bat (*Eptesicus fuscus*), Townsend's big-eared bat (*Corynorhinus townsendii*), Allen's big-eared bat (*Idionycteris phyllotis*), and pallid bat (*Antrozous pallidus*). The little brown myotis (*M. lucifugus*) has been reported from adjacent Glen Canyon National Recreation Area at French Spring (Armstrong 1982).

Additional information is lacking about bats in CANY, but Mollhagen and Bogan (1997) documented 16 species of bats from the Henry Mountains and surrounding areas in southeastern Utah, and Schafer (1991) reported the occurrence of six species of bats (*M. evotis*, *M. ciliolabrum*, *M. volans*, *Lasionycteris noctivagans*, *E. fuscus*, and *L. cinereus*) in the nearby Abajo Mountains.

Although they are long-lived (5-20yrs), bats as a group are potentially of concern because they have low reproductive output (1 young/female/yr) and may roost in large groups (hundreds to thousands) where they are susceptible to human disturbance (e.g., O'Shea and Bogan 2004). Furthermore, much of the existing data on supposed population trends is of limited use, either because of methodological problems involved in collecting the data, limited time periods when data were collected, or inadequate sample sizes for statistical analysis (O'Shea and Bogan 2004 and papers therein). This current inventory will provide the NPS baseline information on occurrence, relative abundance, and reproductive activity on bats in the region. Ultimately, this should assist NPS in identifying rare or uncommon species which might then become subjects of long-term monitoring so that appropriate data on population trends can be amassed.

Objectives

The primary objective of this inventory, in keeping with NPS nation-wide goals, was to attempt to document the occurrence of at least 90% of the bats expected to occur within the various units of CANY by means of a two-year field effort and examination of existing pertinent records and specimens. We also wanted to better define the distribution and abundance of all species of bats in the park, especially potential species of special concern (although there are no federal Threatened and Endangered species, other agencies, including the state of Utah, have listed some species as being of concern). Overall, the goals of the bat inventory were:

- To document through existing, verifiable data and new, targeted field investigations the occurrence of at least 90 percent of the species of bats currently estimated to occur in the park;
- To describe the distribution, nature of occurrence (e.g., resident, breeding status, etc.) and abundance of bat species occurring within park boundaries;
- To provide baseline information so NPS can develop and implement a general monitoring strategy; and
- To provide data in formats that are compatible with the Inventory and Monitoring Program, and that are easily accessible to park managers, resource managers, scientists and the public.

Study Area

The Colorado Plateau is a geologically and topographically distinct region with numerous plateaus and highlands that, strictly speaking, are drained by the Colorado River and its numerous tributaries. It is situated between the arid Great Basin to the west and the montane forests of the Rocky Mountains to the east and covers approximately 130,000 mi². From the perspective of the National Park Service, it extends from southwestern Wyoming, through much of eastern Utah, and includes parts of western Colorado, northern Arizona, and northwestern New Mexico.

Canyonlands National Park was established on September 12, 1964 and as stated in Public Law 88-590, was established "...to preserve an area in the State of Utah possessing superlative scenic, scientific, and archeological features for the inspiration, benefit, and use of the public. . . ." This is the overriding legal mandate which guides the resource management program of the park today. The park now consists of 136,530 hectares (337,370 acres) more or less surrounding the confluence of the Green and Colorado rivers in Grand, Garfield, San Juan, and Wayne counties, near Moab, Utah.

The rivers divide the park into three geographical districts: the Island in the Sky District is the triangle of land between the two rivers, the Needles District lies east of the Colorado River and the Maze District lies to the west of the Colorado and Green Rivers. The Horseshoe Canyon Detached Unit is managed as part of the Maze District. In addition, the Green and Colorado River corridors are managed as a separate River District of the park. In summary, the park is divided into the Island in the Sky, Maze, Needles and River districts. The elevation within the park ranges from approximately 1,189 meters (3,900 feet) on the Colorado River south of Cataract Canyon to 2,188 meters (7,180 feet) above Big Pocket in the Needles District.

The park is characterized by sedimentary rock, which has been deformed by anticlines, synclines and monoclines. Uplift of the Colorado Plateau and concurrent water erosion have produced the extensive, deep canyon systems which are the defining features of the park and of the physiographic section (Lammers 1991).

The climate of Canyonlands National Park is arid. It is characterized by hot, dry summers and cool to cold winters. Temperatures in the park vary with altitude and latitude (Brough et al. 1987). In the Needles District at an elevation of 1,536 meters (5,040 feet) the average maximum temperature is 68.30° F, the average minimum is 37.80° F. The average annual precipitation is 219 millimeters (8.62 inches). In the Island in the Sky at an elevation of 1807 meters (5,930 feet) the average maximum temperature is 64.10° F, and the average minimum temperature is 42.20° F. The normal annual precipitation is 235 millimeters (9.27 inches). Potential evapotranspiration exceeds precipitation, making effective soil moisture a critical environmental factor. Precipitation peaks occur in March and August and snow falls between November and March.

Loope (1977) mapped the distribution of six relatively distinct vegetation types in relation to substrate. These types include (1) shrublands dominated by blackbrush

(*Coleogyne ramosissima*) on shallow (<50 cm depth), weakly developed calcareous soils formed from sandstone or sandy shales, (2) shrublands dominated by shadscale (*Atriplex confertifolia*) on shallow soils formed from shales with high clay content, (3) grasslands dominated by needle and thread grass (*Stipa comata*), indian ricegrass (*Stipa hymenoides*), galleta grass (*Hilaria jamesii*), various species of dropseed (*Sporobolus* spp.), and cheatgrass (*Bromus tectorum*) on deep (>50 cm depth) soils where plant roots cannot reach the water table or capillary zone, (4) shrublands dominated by 4-wing saltbush (*Atriplex canescens*) and sagebrush (*Artemisia tridentata*) on deep sandy soils where roots seasonally access the capillary zone, (5) communities dominated by cottonwood (*Populus fremontii*), willow (*Salix* spp.), tamarisk (*Tamarix ramosissima*) and other shrubs in riparian zones where there is immediate root access to the water table, and (6) sparse woodlands dominated by piñon (*Pinus edulis*) and juniper (*Juniperus osteosperma*) on lithic soils where water availability is controlled by hydrological effects of bedrock joints and outcrops.

Other plant communities include: snakeweed/shadscale/Mormon tea (*Gutierrezia sarothrae*/*Atriplex confertifolia*/*Ephedra viridis*), purple sage/shinnery oak/Utah juniper (*Poliomintha incana*/*Quercus harvardii*/*Juniperus osteosperma*), and greasewood/four-wing saltbush (*Sarcobatus vermiculatus*/*Atriplex canescens*). Springs and seeps are also scattered throughout the park and often support communities of maidenhair fern/Jones reedgrass (*Adiantum capillus-veneris*/*Calamagrostis scopulorum*). There are a number of small communities scattered throughout the park in unique microsites. These include relictual Douglas fir (*Pseudotsuga menziesii*) and aspen (*Populus tremuloides*) sites. [Much of the foregoing section was taken from NPS 2000.]

Methods

The basic inventory methods used in this study are based on, and consistent with, those detailed in the Northern Colorado Plateau Network Inventory Study Plan (NPS, 2000). Thus, we sought to acquire historical data on status and occurrence of bats at CANY by examining existing specimens where feasible, obtaining lists of voucher specimens from museums, and reviewing available information on bats in the vicinity of CANY (lists, data, theses, reports, etc.), including reports of other agencies (e.g., state fish and game departments). Additionally, species were to be documented through new field inventories and acoustic surveys throughout the park. Voucher specimens were to consist of digital images of captured bats to the extent possible, rather than specimens preserved as standard museum vouchers.

Initially, we prepared a list of bats (“master list”; Table 1) for CANY that included all species that might occur in the park. Primary references for this list were Armstrong (1982), Durrant (1952), Hall (1981), Haymond et al. (2003), Mollhagen and Bogan (1997), and a series of unpublished reports by Bogan and cooperators who have inventoried mammals on southern Utah national parks. This original list (Table 1) included 17 species. At the conclusion of the study, we compiled a final list of documented species (Table 2) in which species were designated as unconfirmed (i.e., unlikely to occur), probably present (i.e., species likely to occur; range includes or is near

the park), or present (i.e., documented in some fashion) for the park. Using that updated list, we assessed our progress toward documenting 90% of likely species occurring on the park, using Durrant (1952) and Armstrong (1982) as starting points.

High-priority sites for bat inventory included existing water tanks and open pools; selected sites along or across rivers, streams, and arroyos; and other sites of likely bat occurrence. In general the objectives of this work cannot be accomplished with the use of random surveys and so we worked with staff of NCPN and CANY to help select sites for examination. An initial set of such sites was mapped onto park topographic maps in cooperation with biologists from CANY and SEUG. In general we did not search for roosts. In 2004 our methods relied on mist netting of open water sources on the park and on adjacent lands each month from May through September during the time of the new moon, when nights are darkest. In 2005 we used mist nets from April to October, but also conducted acoustic surveys (see Haymond 2005; attached) in two districts in May and June. Acoustic surveys were of particular value in the Island in the Sky and Maze districts where availability of open water is limited. All field sites were subjectively evaluated for their potential to serve as long-term monitoring sites because of their uniqueness in terms of species diversity, endemism, or presence of sensitive species.

Our plan was to conduct bat inventories on a park-wide basis (all three upland districts of the park) as well as within specific habitats. In 2004, most work was done in the Needles District as there is more open water there. We also worked at several sites in and near the Maze District. Sites off the park included Glen Canyon National Recreation Area (French Spring at GLCA), Dugout Ranch, and the Hanksville and Monticello districts of the Bureau of Land Management (BLM). In 2005 we focused primarily on sites in the Needles in an attempt to document selected species, but we also worked elsewhere. In particular, we conducted acoustic surveys in the Maze and Island in the Sky districts. We tabulated information on visits to the park, including levels of effort (Table 3).

Mist-net Surveys. Mist nets were deployed across and around bodies of water and sometimes in perceived flyways to capture bats coming in to drink or feed on insects flying over the water (Kunz and Kurta 1988). The lengths of nets ranged from 3-20 m (9-60 ft) and numbers of nets deployed on any single evening varied from one to five, depending on the area and shape of the body of water. Mist nets were set up shortly before sunset and tended for several hours until activity declined; in some cases nets were observed throughout the night. Nets were never left untended. Mist netting is especially effective when sources of water in the landscape are limited, as this causes bats to be concentrated in a relatively small area where they are more susceptible to capture. Effort was recorded as net-nights (number of mist nets multiplied by number of nights).

We removed bats from nets immediately following capture and recorded time of capture, species, sex, reproductive condition, and any miscellaneous comments on standardized data sheets. Bats were generally released unharmed within minutes of capture in the net. All participants in this work were experienced and knowledgeable in capturing, handling, and identifying bats. (Appendix 1). Typically the first time a species was captured it was photographed with a Canon EOS Rebel© digital camera (6 megapixel) to document

occurrence; these images serve as photographic vouchers. Capture and handling of bats was performed in accordance with a written Standard Operating Protocol developed by Tom O'Shea and Mike Bogan (approved by the USGS Fort Collins Science Center, Animal Care and Use Committee). Personnel handling bats previously had taken the standard pre-exposure rabies immunization and had demonstrated titers indicating rabies antibody activity. Permits for this work were provided by the National Park Service.

We calculated the number of species documented, relative abundance of species (percent of all individuals detected), and prevalence (percent of all possible date and location combinations that a species was captured) for the park. We also computed a summary of effort including person-days and mist-net nights (Table 3).

Acoustic Surveys. In May 2005, three sites were sampled, Maze Overlook (Maze District), Willow Flat Campground (ISKY), and West Lavender Canyon (Needles). In June 2005, four sampling sites were selected within Island in the Sky: Willow Flat Campground, Syncline Loop, Neck Spring, and Cabin Spring. One additional site located in the Big Mesa camping area on Bureau of Land Management (BLM) land 15.9 km north of Island in the Sky was sampled. Two sampling sites were selected at Needles: Big Spring and the Graywater facility (Haymond 2005).

Acoustic surveys entailed the use of a bat detector and compact flash storage zero-crossing analysis interface module (Anabat II bat detector, Anabat CF ZCAIM, and associated hardware; Titley Electronics, Ballina, New South Wales, Australia) that recorded echolocation calls at a division ratio set at 16. One bat detector-ZCAIM recording system was positioned at each sampling point for 1 to 2 nights. Bat detectors were either placed on the ground or attached to a tripod extended about 0.5 m. Bat detector microphones were positioned at approximately 45 degrees to the horizon and trained at areas of interest (e.g. water sources, flight corridors) and away from areas of high clutter (e.g., dense vegetation; Sherwin et al. 2000). Systems were programmed to begin passively recording approximately 30 minutes prior to sunset and terminate recording approximately 30 minutes prior to sunrise. Sensitivity of detectors was set to 6.

A bat detector produces audible output from the ultrasonic calls emitted by echolocating bats. The ZCAIM interfaced the audio-frequency signal from the detector to a memory card. Files were then converted to a frequency (kHz)-time (ms) display using Anabat software (Analook). Displays were used to identify species based on qualitative analysis of call parameters (e.g., shape, minimum frequency of calls, maximum frequency of calls, body of calls, change in slope, time between calls) compared to reference calls from known individuals (Haymond 2005).

Number of call sequence files recorded, percent of call sequence files that were identifiable to species, level of activity for each sampling site (number of files recorded per hour), and relative abundance of each species (percent of all call sequence files recorded) were determined. A tally of sampling-hours (number of hours of recording) was also generated (Table 3; Haymond 2005). Copies of all files were provided to NPS.

Location Data. Each site where we sampled was given a waypoint name, a “shorthand” name, and more formal name (Table 4). GPS coordinates, elevation, and EPE were acquired for each locality with Garmin 12 GPS units (or GPSMap 76S, for acoustic sites) set to record coordinates in UTMs (NAD27 datum), in accordance with NPS protocol. Elevations were reconciled against USGS quad maps and when there was a discrepancy between sources, values interpolated from maps were used. Narrative descriptions of all study locations are given in Appendix 2. We recorded all data onto printed datasheets in the field and later entered the data into a relational database (Access; provided by the Northern Colorado Plateau Network); we also used Excel as an adjunct to create some tables. In addition we made daily journal entries when in the field.

Results

2004

Following an initial coordination meeting in Moab on 18 May 2004, we commenced work in the Needles District; we returned to the park each month through September 2004 just before or during the new moon (Table 3). In 2004, we amassed a total of 131 person-days in the field and a total of 96 net-nights of effort on the park.

We netted bats at a total of 20 different sites in 2004. Of these sites, 12 were in the Needles, 3 in the Maze, 1 on Glen Canyon National Recreation Area, 3 on adjacent property of Bureau of Land Management, and 1 on private land. “Off-park” sites were netted as they offered the opportunity to obtain information on bats when no nearby water source occurred on the park. We do not know if bats netted at off-park sites occur or roost on the park but there is some possibility that they do. In turn, there is no guarantee that bats captured on the park are not foraging or roosting off the park.

Our efforts in 2004 resulted in capturing 1,053 individuals of 14 (82%) of the 17 species then thought to occur at CANY (Table 1). Additionally, we suspected that we heard the audible cries of another species, the spotted bat, making a total of 15 (88%) of 17 species. Our average catch per night was almost 28 individuals of over 4 species; the maximum catch on a single night was 104 individuals of 9 species (at the junction of Salt and Horse creeks in the Needles District in June). Only once did we not capture any bats (Granary Spring, BLM, in June). Digital photographs of netting sites and selected individuals of all but one captured species were taken. These images were provided to NPS.

The most abundant species in 2004 was the western pipistrelle (550 individual captures), followed by the pallid bat (198) and California myotis (129). All three are arid-adapted species and would be expected to be common at CANY. There were six species for which we netted from 11 to 49 individuals and five species for which we netted fewer than 10 individuals. The least abundant species are hoary bat (3 captures), silver-haired bat (9), long-eared myotis (6), big free-tailed bat (2), and Brazilian free-tailed bat (1). All but the long-eared myotis are suspected to be migratory in Utah and this may account for some variation in capture numbers. However, a more likely reason probably involves habitat preferences of the bats. Male hoary and silver-haired bats tend to be resident at

higher elevations in the mountains in the summer (e.g., Mollhagen and Bogan 1997). Maternity colonies of big free-tailed bats are known from sites near CANY (e.g., Arches National Park and Natural Bridges National Monument, Bogan et al., unpublished reports to NPS). The status of the Brazilian free-tailed bat in Utah is poorly known (Oliver 2000).

The most prevalent species across sites and netting episodes was the California myotis (86.8% of all netting episodes), followed by the western pipistrelle (76.3%) and pallid bat (71.1%). Seven species were present from 15 to 47% of episodes, including Allen's big-eared bat (37%), a species often regarded as uncommon. We captured this species every month and at most sites. The least prevalent species included the hoary bat, silver-haired bat, and both species of free-tailed bats. It is possible that these four species find it difficult to maneuver at many of the relatively small pools of water where we netted and thus seek water and insects elsewhere.

2005

In 2005 we commenced our inventory of bats in April and returned to the park each month through October, again at the time of the new moon. We amassed a total of 95 person-days in the field and a total of 73 net-nights of effort in the park. Most of our effort in 2005 was spent in the Needles District as we thought this district would provide the best opportunity of capturing the western small-footed myotis (*Myotis ciliolabrum*), little brown myotis (*M. lucifugus*), and spotted bat (*Euderma maculatum*), 3 species that have not been captured in CANY. We believe that some of the most suitable habitat in the region for these species occurs in the nearby Abajo Mountains.

We netted bats at a total of 16 different sites in 2005. Thirteen of these sites are in the Needles District and 3 sites are off the park but nearby (i.e., Indian Creek, BLM lands; Dugout mines). The off-park sites were netted as they offered the opportunity to obtain additional information on bats in the area.

Our netting efforts in FY2005 resulted in capturing 664 individuals of 13 (76.5%) of the 17 species then believed to occur at CANY. In 2005 we captured the same species as in 2004, except we did not capture the Brazilian free-tailed bat (*Tadarida brasiliensis*). In April, we captured 19 individuals representing 4 species; in May, 4 individuals of 2 species; in June, 91 individuals of 10 species; in July, 469 individuals of 11 species; in August, 65 individuals of 7 species; in September, 5 individuals of 2 species, and in October, 10 individuals of 5 species (Table 5). Our average catch per night was 27 individuals of 4 species, which is similar to results from last year. Our maximum catch on a single night was 134 individuals of 10 species at the junction of Salt and Horse creeks in the Needles District on the 3 July sampling.

In 2005, the most abundant species was the western pipistrelle (361 individual captures, Table 4), followed by the California myotis (120) and pallid bat (80). These species also were the 3 most abundant species captured in 2004. There were 4 species for which we netted from 11 to 23 individuals, and these included the silver-haired bat (23 captures),

big brown bat (17), fringed myotis (12), and Allen's big-eared bat (11). In 2005 we captured more silver-haired bats than in 2004, and we attribute this increase to our netting efforts earlier in the season (April). Silver-haired bats are a migratory species with both males and females residing across the southern and eastern parts of the United States during winter (Cryan 2003). In spring, individuals migrate either to more northerly locations or habitats higher in elevation (see Hoffmeister 1986). We suspect our 15 captures on 12 April reflect seasonal migratory movements. In addition, there were six species for which we netted fewer than 10 individuals in 2005. These species included the Yuma myotis (7 captures), Townsend's big-eared bat (6), hoary bat (6), long-legged myotis (6), long-eared myotis (3), and big free-tailed bat (1).

In 2005, the most prevalent species across sites and netting episodes was the western pipistrelle (47.4% of all netting episodes), followed by the California myotis (42.1%) and pallid bat (34.2%). There was a suite of species that was present at 10 to 18.4% of episodes, including Allen's big-eared bat (18.4%, the fourth highest), a species often regarded as uncommon. We captured this species in June, July, and August but audible calls were heard at most netting sites during July and August by K. Geluso. The least prevalent species in 2005 included the long-eared myotis and big free-tailed bat. Long-eared myotis likely are more common at higher elevations, while big free-tailed bats probably find it difficult to maneuver at many of the relatively small pools of water and thus seek water elsewhere. As with Allen's big-eared bats, the audible calls of big free-tailed bats were heard almost every night during netting efforts in July and August by K. Geluso.

2004-2005

In total, we amassed 226 person-days of effort, 169 net-nights of capture effort, and 17 "acoustic nights" during the study. As a result of these efforts we confirmed the presence of 16 species of bats at CANY (Table 2). The earliest capture effort was in April of 2005 and the latest was in October of 2005 (Table 3). Twelve people (Appendix 1) contributed significantly to this effort during the two years of the study. We worked at 34 different sites across all three districts of the park (Table 4). Six of these sites (BGMSCG, CABNSG, MZOVLK, NECKSG, SYNCLP, and WLFTCG, Table 4) were used only for acoustic surveys, three sites (BIGSG1, GRWATR, and LAVEN1, Table 4) for both mist net and acoustic surveys, and the remainder (Table 4) used only for mist-net surveys. The most frequently visited site was SALTHO (10 visits), followed by SALT3 (6), SALT2 and GRWATR (5), and SALT1 (4, Table 5). Elevations of the sites ranged from 1,417m (Horseshoe Canyon, Lower 2, and the 2 sites on Indian Creek) to 1,990m at French Spring at GCNRA (Table 5).

Overall, we captured 1,717 bats, 1,715 of which were released unharmed at the site of capture; two voucher specimens (*M. californicus* and *C. townsendii*) were retained. These bats represented 14 different species (Table 5). The maximum catch on a single event was 134 bats (SALTHO, 3 July 2005), minimum was zero (GRANSG, IDNCK2, SQUCN1 and SQUCN2), and average catch was just over 26 bats per night. The

maximum number of species captured on a single event was 10 (SALTHO, 3 July 2005) and the average number of species captured per event was slightly greater than 4.

The most commonly captured species was the western pipistrelle (912 individuals, 53.1% of total), followed by pallid bat (278, 16.2%), California myotis (250, 14.6%), fringed myotis (64, 3.7%), big brown bat (57, 3.3%), Allens big-eared bat (36, 2.1%), silver-haired bat (35, 2.0%), Townsends big-eared bat (23, 1.3%), Yuma myotis (22, 1.3%), long-legged myotis (17, 1.0%), hoary bat (10, 0.6%), long-eared myotis (9, 0.5%), big free-tailed bat (3, 0.2%), and Brazilian free-tailed bat (1, 0.1%).

The percentage of times at least one individual of a species was identified among the separate sampling locations and dates is the prevalence of that species. The most prevalent species during mistnetting was California myotis (76.9%), followed by western pipistrelle (73.8%), pallid bat (61.5%), fringed myotis (38.5%), Allens big-eared bat (32.3%), big brown bat (29.2%), Yuma myotis (23.1%), and Townsends big-eared bat (20.0%). The least prevalent species were Brazilian free-tailed bat (1.5%), big free-tailed bat (4.6%), silver-haired bat and long-eared myotis (12.3%), hoary bat (13.8%), and long-legged myotis (16.9%).

We view prevalence as an index of how widespread a species is, but the actual values are likely also a product of how truly abundant a species is (i.e., mistnetting does not yield population numbers) and perhaps how relatively easy it is to capture a species in mist nets. For example, it is possible that California myotis is the most prevalent species not because it is thinly scattered across more locations but because it really is numerically dominant as well. However, perhaps we catch more western pipistrelles because they are easier to catch. Allens big-eared bat, a species viewed as uncommon by some, is clearly quite common in Canyonlands. It is sixth in numbers and fifth in prevalence, results that we think would surprise some of our colleagues.

Although we did not capture the spotted bat during this survey, we believe the species to be present on the park as we are confident that we heard its distinct, audible calls on several occasions. On 14 September 2004, Dave Worthington heard audible calls at Burro Seep near the Maze District. He commented that the calls were consistent with calls of spotted bats he has heard at other locations. On 3 August 2005 at the junction of Salt and Horse creeks in the Needles District, one of us (KG) heard an audible call that was different from the distinctive audible calls of big free-tailed bats or Allen's big-eared bats in the area. This individual flew over the netting site on three separate occasions during the evening but did not attempt to drink. We returned to the same site on 7 August 2005, and netted other sites in the area on the same trip, and did not hear that distinctive audible call again. We believe that the audible call heard on 3 August was likely that of a spotted bat. Then, on the evening of 13 October 2005, again at the junction of Salt and Horse creeks, another one of us (MAB) heard the recognizable call of a spotted bat. We believe these calls substantiate the presence of this species in CANY although the species may be uncommon in the park.

We also did not capture the western small-footed myotis during the study. It seems likely that most of the sites where we worked at CANY were too low in elevation for this species to be common. It is possible that the species is not common in much of southern Utah; for example Mollhagen and Bogan (1997) captured only eight during their work in the Henry Mountains. However, the acoustic surveys did reveal the presence of the western small-footed myotis in the Needles and we thus consider this species to be present on the park as well.

We conducted acoustic sampling at three sites in May and at six sites in June, 2005 (Table 6). A total of 15 acoustic samples were taken. One site (WLFTG) was sampled three times (in May and June), four sites were sampled only once (BGMSCG, LAVEN1, MZOVLK, and SYNCLP), while the remaining four sites were sampled twice. The recorder was on for the duration of the night on all dates and all locations, except at LAVEN1. Bogan and Mollhagen sampled in May, while Haymond (2005) sampled in June and analyzed both the May and June recordings.

Haymond (2005) identified a total of 3,751 recordings of 11 species (Table 6). The maximum number of identifiable individual calls recorded from a single night was 825; the greatest number of species was 9. Average values were, respectively, 250.1 calls and 5.7 species; minimum values, 8 calls and 4 species. California myotis accounted for more than half (52.3%) the calls, western pipistrelle was second (42.9%), and pallid bat was a very distant third (1.9%). No other species contributed more than 1.0% of the total recorded calls. Recordings of California myotis and western pipistrelle were taken from every location (100% prevalence), while pallid bat and big brown bat were less widely distributed (80%). Of the remaining species, only Brazilian free-tailed bat was recorded at more than half (53.3%) the sampling sites. This species likely flies too high to be routinely captured where we set our mist nets.

We used selected data from tables 5 and 6 to compare the results of mist-net and acoustic sampling (Table 7). Data from both methods suggest western pipistrelle, California myotis, and pallid bat are the most abundant and most widespread species. California myotis ranked third (14.6%) behind western pipistrelle (53.1) and pallid bat (16.2) in total net captures while it ranked first (52.3%), ahead of pipistrelles (42.9) and pallid bats (1.9) in number of identified calls. California myotis also shows a slightly higher prevalence value than western pipistrelle in captures (76.9% vs. 73.9). These data suggest that California myotis may be more common than actual captures suggest, perhaps because it is more difficult to capture. Both sampling methods reflect the abundance of western pipistrelle. Pallid bat seems less abundant than the preceding two species, but is apparently widespread and, if present, has a high likelihood of being captured. There were three species ranked lower in both abundance and prevalence by net sampling than by acoustic sampling. These three species, big brown bat, big free-tailed bat, and Brazilian free-tailed bat are strong fliers that may fly and forage well above the ground and thus their presence may be more likely to be detected by acoustic sampling. Additional details of captures, seasonal occurrence, natural history, and reproduction are included in the tables and in the Species Accounts (Appendix 3).

Discussion

It seems clear that inventory results are more rigorous when both mist-net and acoustic surveys are used. Our mistnetting yielded four species not recorded acoustically, whereas one species (western small-footed myotis) was only documented acoustically. (Calls of the spotted bat are audible and are not included in this discussion.) Each sampling method has different inherent strengths and biases. Acoustic sampling typically returns more data per unit of time than netting (3,751 identified calls over 17 acoustic nights) and may sample a greater distance above the ground, at least for some species (for other details on acoustic sampling see Haymond 2005). However, not every recorded call is from a different bat, rather, the opposite is likely true. Mistnetting chiefly samples bats foraging or drinking over water, usually below 3 meters (1,717 bats during 169 net nights) and is unlikely to capture the same bat twice. It should be noted that numbers of bats captured in mist nets have no known relationship to actual population numbers.

Local climatic or other features may impact the usefulness of either method. Any factor (wind, rain, moonlight, cool temperatures) that may alter behavior of bats will influence results obtained from mistnetting or acoustic sampling. Where data are needed from remote areas and logistics are a problem, acoustic sampling may be especially useful. Barclay (1999) discusses a variety of “do’s and don’ts” for acoustic sampling. Alternatively, where more information is desired from individual bats, then mist-net capture is the method of choice as data on sex, age, reproductive condition, color, molt, and external measurements can be obtained.

It is, perhaps, a matter of opinion how many species new to the park were documented during our work as it depends on what reference is taken as a starting point. The dated work by Durrant (1952) does not list any records from areas that now are in CANY so relative to Durrant, we have documented the presence of 16 additional species. Durrant (1952) does list several species that were taken at a location 5mi E Moab, including the small-footed myotis. Unfortunately, we have not been able to find specimens from this locality during our travels to museums in Utah.

Armstrong (1982:41) stated 11 species were documented from the park with the possibility that an additional seven species also might occur. However, in the species accounts Armstrong (1982) appears to unequivocally consider only eight species to have been documented from the park: long-eared myotis, fringed myotis, California myotis, western pipistrelle, big brown bat, Townsend’s big-eared bat, Allen’s big-eared bat, and pallid bat. He further notes that the hoary bat was observed at Cave Spring and that the little brown myotis (*M. lucifugus*) was documented from French Spring, west of the Maze. This totals to 10 species. We have documented a total of 16 species for the park, not including the red bat and little brown myotis which do not occur in the area. This total of 16 species is consistent with the results of surveys in the Henry Mountains by Mollhagen and Bogan (1997). Several factors affect these calculations, not the least of which is exactly what list of species should be used as the measuring stick against which documentation is assessed. Our original list (Table 1) included species we thought were

“probably present” (i.e., likely to occur), based on our prior work, our knowledge of mammals of the Colorado Plateau, and pertinent references.

What species of bats that possibly occur in the region do not occur at CANY? Armstrong (1982) mentioned at least two additional species that might occur, the little brown myotis, supposedly captured at French Spring at GCNRA, and the red bat. The status of the little brown myotis, *M. lucifugus*, in southern Utah remains conjectural (Mollhagen and Bogan 1997); we have examined the specimen (University of Colorado Museum 15207) from French Spring and it is *M. volans*, not *M. lucifugus*. Thus, the report of *M. lucifugus* from near CANY is a false report. That *M. lucifugus* does occur in southern Utah is demonstrated by specimens we have examined from Fremont River in the vicinity of Bicknell and Donkey Lake on Boulder Mountain (both Wayne County; specimens in Utah Museum of Natural History). Hasenyager (1980) lists two “occurrences” of *M. lucifugus* from Bluff City, San Juan County; we have not found specimens to document these records during our travels to Utah museums. As Oliver (2000) notes, recent studies of bats across southern Utah have failed to document the occurrence of *M. lucifugus* and it seems parsimonious to assume the species is absent from much of this area.

Armstrong (1982) also listed the red bat (*L. borealis*) as of possible occurrence and referred to a record from Price (Carbon County, presumably Kenilworth Mine; Hardy 1941) and also mentioned records from Washington County (La Verkin Cave; St. George). We have searched for the specimen(s) from near Price to no avail. Our guess is that the specimens were in Hardy’s personal collection, the location of which is unknown to us. We are thus uncertain whether they truly represent eastern red bats (*L. borealis*) or western red bats (*L. blossevillei*), as now recognized (Oliver 2000). Although the Carbon County specimens could have been eastern red bats, the absence of any records of this species since 1937 from anywhere near CANY suggests this species should not be considered as part of the regional bat fauna (nearest records are in northeastern Colorado). Conversely, there continue to be reports of *L. blossevillei* from southwestern Utah as well as a young-of-the-year male from Springville, Utah County (Mollhagen and Bogan 1997, also see Oliver 2000). Nonetheless, considerable field work has been conducted in areas (e.g., Kane, Garfield, Wayne, and San Juan counties) that might be seasonally inhabited by western red bats and no captures have occurred; we thus regard this species as of unlikely occurrence in the area as well.

In terms of bat habitat at CANY, several sites stand out as being areas of exceptional value to bats. Pre-eminent among them is lower Salt Creek, starting at the large pool above Peekaboo campground and extending downstream to just below the junction of Salt and Horse creeks. We captured 1,069 bats (62% of the total) at the four sites in this area. Clearly there is more water available to net in this area than most other areas of the park and we exploited this abundance of water. However, the fact that bats were often abundant in lower Salt Creek, even though water also was abundant, suggests that it may be the presence of nearby roosting sites and good foraging areas that make the area attractive to such an array of bats. Other sites of note (Table 5) are the alcove pond on the 2.3 mile loop trail (one night of 46 bats), the graywater pool at the maintenance facility (29 and 77 bats on consecutive nights in 2004 and one night of 79 in 2005), Burro

Seep (27, off the park), lower Horseshoe Canyon (15, 30), Water Canyon off Horseshoe Canyon (28), Lavender Canyon (nights of 20 and 29 at different sites), and Robber's Roost (10, 26, and 35 bats on different occasions, off the park). Most of these sites are relatively isolated and may provide the only water available in the immediate area, thus presumably attracting bats from some distances.

The sites in lower Salt Creek also exhibited relatively high species diversity (1-10 species, average of 6), suggesting again that a diverse array of species are able to meet their resource needs in the area. Other sites with good diversity included "2.3mi loop," Burro Seep, Horseshoe 1, Water Canyon, Lavender 1 and 3, Upper Jump, and Robber's Roost (Table 5). It was Tim Graham who first alerted us to the uniqueness of Salt Creek and his prediction that it would be "good" for bats has been proven correct. The presence of a large and diverse bat community in lower Salt Creek is worth noting as future management plans are developed for this area.

In 2004, one museum voucher specimen of a Townsend's big-eared bat was prepared. This bat suffered a wing injury when it struck the net or while it was entangled in the net and was sacrificed. In 2005, a single museum voucher specimen of a small species of myotis was prepared. This individual was retained because its identification was in question. Although coloration of the bat resembled that of a California myotis, the tail protruded beyond the posterior end of the tail membrane, a character more typical of the western small-footed myotis (*M. ciliolabrum*), a species not verified at CANY at that time. We now believe the individual to represent *M. californicus*. Both specimens are deposited in the USGS collection at the Museum of Southwestern Biology.

Long-term climate trends, as well as local weather conditions, can affect inventory efforts. Locally, inclement weather depresses activity of small mammals (and mammalogists) and the efficiency of methods used to inventory them. Likewise, subtle seasonal changes in natural history of species or the physical environment may influence our success. Bat activity appears to be depressed by rainfall and bright moonlight. Netting success is also diminished by moonlight and even modest breezes. The good results from our first season of work were in large measure the consequence of remarkably favorable weather conditions during all our monthly trips. The reader is cautioned that this kind of productivity is not common.

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Table 1. Original master list of 17 species of bats (Chiroptera) suspected to occur on Canyonlands National Park. “Present” refers to the status of 14 species we captured plus 2 species detected acoustically at CANY during this study. All captured species were photographed. The comments in brackets note eight species that Armstrong (1982) appeared to unequivocally capture at CANY during his work. Scientific and common names follow Baker et al. (2003).

Myotis californicus (California myotis) Present [Needles and Island (Armstrong 1982)]
M. ciliolabrum (Western small-footed myotis) Present, Acoustic surveys 2005
M. evotis (Long-eared myotis) Present [Needles (Armstrong 1982)]
M. lucifugus (Little brown myotis) Reported from French Spring by Armstrong (1982)
M. thysanodes (Fringed myotis) Present [Needles District (Armstrong 1982)]
M. volans (Long-legged myotis) Present, netted 2004, 2005
M. yumanensis (Yuma myotis) Present, netted 2004, 2005
Lasionycteris noctivagans (Silver-haired bat) Present, netted 2004, 2005
Lasiurus cinereus (Hoary bat) Present [observed in Needles (Armstrong 1982)]
Pipistrellus hesperus (Western pipistrelle) Present [Needles (Armstrong 1982)]
Eptesicus fuscus (Big brown bat) Present [“parkwide” (Armstrong 1982)]
Euderma maculatum (Spotted bat) Present, audible calls 2004, 2005
Corynorhinus townsendii (Townsend’s big-eared bat) Present [Needles (Armstrong 1982)]
Idionycteris phyllotis (Allen’s big-eared bat) Present [Needles (Armstrong 1982)]
Antrozous pallidus (Pallid bat) Present [“parkwide” (Armstrong 1982)]
Tadarida brasiliensis (Brazilian free-tailed bat) Present, netted 2004
Nyctinomops macrotis (Big free-tailed bat) Present, netted 2004, 2005

Table 2. List of bat species present at CANY and selected attributes for use in NPSpecies database. See Table 1 for full list of scientific and common names and additional information. Please note that most resident females are in reproductive condition (= “breeder”) and are occupying maternity roosts during the summer months and raising young. Many captured females were noted as pregnant, lactating, or post-lactating and young of the year bats were captured late in the summer. Actual mating in these species occurs during fall and winter and may or may not occur on the park, depending on the natural history of the species.

Species	Status	Abundance	Residency	Nativity	Evidence
<i>M. californicus</i>	Present	Abundant	Breeder	Native	2004 capture, photo.
<i>M. ciliolabrum</i>	Present	Uncommon	Resident	Native	2005 acoustic survey
<i>M. evotis</i>	Present	Uncommon	Breeder	Native	2004 capture, photo.
<i>M. thysanodes</i>	Present	Common	Breeder	Native	2004 capture, photo
<i>M. volans</i>	Present	Uncommon	Breeder	Native	2004 capture, photo
<i>M. yumanensis</i>	Present	Uncommon	Breeder	Native	2004 capture, photo
<i>L. noctivagans</i>	Present	Uncommon	Resident	Native	2004 capture, photo
<i>L. cinereus</i>	Present	Uncommon	Resident	Native	2004 capture, photo
<i>P. hesperus</i>	Present	Abundant	Breeder	Native	2004 capture, photo
<i>E. fuscus</i>	Present	Common	Breeder	Native	2004 capture, photo
<i>E. maculatum</i>	Present	Uncommon	Resident	Native	2004-5 audible calls
<i>C. townsendii</i>	Present	Uncommon	Breeder	Native	2004 capture, photo
<i>I. phyllotis</i>	Present	Common	Breeder	Native	2004 capture, photo
<i>A. pallidus</i>	Present	Abundant	Breeder	Native	2004 capture, photo
<i>T. brasiliensis</i>	Present	Common	Resident	Native	2004 capture, photo
<i>N. macrotis</i>	Present	Uncommon	Breeder	Native	2004 capture, photo

Table 3. Dates, districts, observers, and levels of effort during inventories for bats in Canyonlands National Park and vicinity in 2004-2005. Information is arranged in chronological order and dates include travel time from Albuquerque. Person days are the number of days in the field multiplied by the number of persons in the crew. Net nights are the number of nets deployed multiplied by the number of nights 1 or more nets were out. "Anabat nights" are the number of recording units deployed multiplied by the number of nights one or more units were set out.

No.	Dates	District(s) Visited	Observers	Person Days	Net Nights	Anabat Nights
1	17-27 May 04	Needles, Maze, Island in the Sky, BLM	Bogan, Mollhagen, Worthington	27	15	0
2	11-21 Jun 04	Needles, Maze, Island in the Sky, BLM	Bogan, Mollhagen	22	17	0
3	8-14 Jul 04	Needles, Maze	Bogan, Geluso, Hoffman, Ligon, Mink, Ramotnik	40	25	0
4	14-21 Aug 04	Needles, Maze, BLM, GCNRA	Geluso, Mollhagen, Weise	24	23	0
5	9-16 Sep 04	Needles, Maze, BLM, GCNRA	Bogan, Mollhagen, Worthington	18	16	0
6	11-14 Apr 05	Needles	Bogan, Mollhagen	6	4	0
7	3-11 May 05	Needles, Maze, Island in the Sky, BLM	Bogan, Mollhagen	16	2	3
8	2-12 Jun 05	Needles	Bogan, Mollhagen	20	14	0
9	13-19 Ju 05	Needles, Island in the Sky	Haymond	7	0	14
10	2-10 Jul 05	Needles, BLM (net)	Geluso, Ligon	16	22	0
11	2-8 Aug 05	Needles	Geluso, Mollhagen	12	16	0
12	8-12 Sep 05	Needles	Bogan, Ramotnik	8	6	0
13	10-14 Oct 05	Needles	Bogan, Mollhagen	10	9	0
TOTAL				226	169	17

Table 4. Descriptors for the 34 sampling sites visited in the 2004-05 field seasons in and near Canyonlands National Park. Sites are listed alphabetically by waypoint name. The same waypoint name for each site is utilized on GPS devices, the capture summary, and the database. Other abbreviations in the table are as follows: BLM = Bureau of Land Management; GCNRA = Glen Canyon National Recreation Area; ISKY = CANY, Island in the Sky District; Map = GPS device unable to obtain fix, coordinates taken from map, no EPE available; MAZE = CANY, Maze District; NEED = CANY, Needles District; PRIV = Private Land.

No.	Waypoint	Name	Unit	Easting	Northing	EPE	El. (M)	Publication Locality
1	2PONT3	Pool on 2.3 mi. Reach of Hiking Trail	NEED	06 03 300	42 20 114	10M	1597	Utah: San Juan Co.; Canyonlands NP, Big Spring Canyon, 5240'.
2	BGJNPR	Big Juniper Camp	NEED	06 08 162	42 15 000	6M	1625	Utah: San Juan Co.; Canyonlands NP, Salt Creek, 5330'.
3	BGMSGC	Big Mesa Campground	BLM	06 04 051	42 76 677	7M	1623	Utah: Grand Co., Bartlett Flat, 5325'.
4	BIGSG1	Big Spring Canyon	NEED	06 03 489	42 26 020	10M	1463	Utah: San Juan Co.; Canyonlands NP, Big Spring Canyon, 4800'.
5	BUROSP	Burro Seep	BLM	05 71 693	42 36 559	Map	1839	Utah: Wayne Co.; Horseshoe Canyon, Spur Fork, Burro Seep, 6035'.
6	CABNSG	Cabin Spring	ISKY	06 01 381	42 55 323	10M	1720	Utah: San Juan Co.; Canyonlands NP, Grays Pasture, 5643'.
7	DUGTMN	Mine Entrances on Dugout Ranch	PRIV	06 25 188	42 15 831	14M	1608	Utah: San Juan Co.; Indian Creek, mine entrances on Dugout Ranch, 5275'.
8	FRCHSG	French Spring	GCNRA	05 74 649	42 32 189	6M	1990	Utah: Wayne Co.; Glen Canyon National RA, Millard Canyon, French Spring, 6530'.
9	GRANS	Granary Spring	BLM	05 62 095	42 43 810	7M	1783	Utah: Wayne Co.; San Rafael Desert, Granary Spring, 5850'.
10	GRWATR	Graywater Pond, Maint. Facility	NEED	06 07 588	42 23 154	8M	1522	Utah: San Juan Co.; Canyonlands NP, SE flank Squaw Butte, 4995'.
11	HRSHU1	Horseshoe Canyon, Lower 1	MAZE	05 70 628	42 58 406	7M	1426	Utah: Wayne Co.; Canyonlands NP, Horseshoe Canyon, 4680'.
12	HRSHU2	Horseshoe Canyon, Lower 2	MAZE	05 70 749	42 58 431	11M	1417	Utah: Wayne Co.; Canyonlands NP, Horseshoe Canyon, 4650'.
13	IDNCK1	Indian Creek Cataract	BLM	06 16 258	42 29 846	5M	1417	Utah: San Juan Co.; Indian Creek, 4650'.
14	IDNCK2	Indian Creek Plunge Pool	BLM	06 15 932	42 30 143	8M	1417	Utah: San Juan Co.; Indian Creek, 4648'.
15	KRKCBN	Kirk's Cabin	NEED	06 10 247	42 04 479	10M	1804	Utah: San Juan Co.; Canyonlands NP, Salt Creek, 5920'.
16	LAVEN1	Lavender Canyon, W. Fork	NEED	06 14 743	42 06 627	11M	1704	Utah: San Juan Co.; Canyonlands NP, W. fork Lavender Canyon, 5590'.
17	LAVEN2	Lavender Canyon, E. Fork, Cleft Arch	NEED	06 15 059	42 04 785	5M	1715	Utah: San Juan Co.; Canyonlands NP, E. fork Lavender Canyon, 5625'.
18	LAVEN3	Lavender Canyon, E. Fork, side cany.	NEED	06 15 695	42 05 422	5M	1690	Utah: San Juan Co.; Canyonlands NP, E. fork Lavender Canyon, 5545'.
19	LITSG1	Little Spring	NEED	06 05 361	42 24 570	5M	1513	Utah: San Juan Co.; Canyonlands NP, Little Spring Canyon, 4965'.
20	LITSG2	Little Spring Canyon Bridge	NEED	06 05 177	42 24 298	5M	1522	Utah: San Juan Co.; Canyonlands NP, Little Spring Canyon, 4995'.
21	LOSCN1	Lost Canyon	NEED	06 07 541	42 19 942	5M	1548	Utah: San Juan Co.; Canyonlands NP, Lost Canyon, 5080'.
22	MZOVLK	Maze Overlook	MAZE	05 87 397	42 31 914	6M	1570	Utah: Wayne Co.; Canyonlands NP, Maze Overlook, 5150'.
23	NECKSG	Neck Spring	ISKY	06 02 616	42 55 370	10M	1730	Utah: San Juan Co.; Canyonlands NP, Grays Pasture, 5676'.
24	ROROSG	Robbers Roost Spring	BLM	05 54 846	42 45 722	7M	1655	Utah: Wayne Co.; San Rafael Desert, Robbers Roost Spr., 5430'.
25	SALTC1	Salt Creek 1	NEED	06 09 618	42 19 538	8M	1515	Utah: San Juan Co.; Canyonlands NP, Salt Creek, 4970'.
26	SALTC2	Salt Creek 2	NEED	06 09 445	42 19 456	5M	1542	Utah: San Juan Co.; Canyonlands NP, Salt Creek, 5060'.
27	SALTC3	Salt Creek 3	NEED	06 08 971	42 18 981	7M	1544	Utah: San Juan Co.; Canyonlands NP, Salt Creek, 5065'.
28	SALTHO	Salt, Horse Canyons, jct.	NEED	06 09 585	42 20 429	12M	1513	Utah: San Juan Co.; Canyonlands NP, Salt Creek, 4963'.
29	SQUCN1	Squaw Canyon Main Pool	NEED	06 06 008	42 22 303	6M	1536	Utah: San Juan Co.; Canyonlands NP, Squaw Canyon, 5040'.
30	SQUCN2	Squaw Canyon Lower Pool	NEED	06 06 117	42 22 382	6M	1535	Utah: San Juan Co.; Canyonlands NP, Squaw Canyon, 5036'.
31	SYNCLP	Syncline Loop Pothole	ISKY	05 94 409	42 55 647	12M	1632	Utah: San Juan Co.; Canyonlands NP, Upheaval Dome, 5354'.
32	UPPJMP	Upper Jump	NEED	06 08 756	42 10 704	10M	1722	Utah: San Juan Co.; Canyonlands NP, Salt Creek, 5650'.
33	WLFTCG	Willow Flat Campground	ISKY	05 97 168	42 48 848	7M	1849	Utah: San Juan Co.; Canyonlands NP, Willow Flat Campground, 6065'.
34	WTRCN1	Water Canyon 1	MAZE	05 69 932	42 56 781	7M	1481	Utah: Wayne Co.; Canyonlands NP, Water Canyon, 4860'.

Table 5. Data from mist-net sampling showing species captured at each site and time. See Table 4 for specific waypoint identifications. The abbreviations for species of bats are: Anpa, *Antrozous pallidus*; Coto, *Corynorhinus townsendii*; Epfu, *Eptesicus fuscus*; Idph, *Idionycteris phyllotis*; Laci, *Lasiurus cinereus*; Lano, *Lasionycteris noctivagans*; Myca, *Myotis californicus*; Myev, *M. evotis*; Myth, *M. thysanodes*; Myvo, *M. volans*; Myyu, *M. yumanensis*; Nyma, *Nyctinomops macrotis*; Pihe, *Pipistrellus hesperus*, and Tabr, *Tadarida brasiliensis*. The columns on the right side of the table indicate the total number of bats and total bat species identified for each combination of locality and date. Summaries at the bottom of the table include the total individuals of each species recorded, the percentage that species comprises of the 1717 total bat captured, and the percentage of times at least one individual of that species was identified among the 65 separate sampling locations and dates (prevalence). The smaller matrix at the end of the table depicts maximums, averages, and minimums of total records and species for all netting locations and dates.

Waypoint	Date	Anpa	Coto	Epfu	Idph	Laci	Lano	Myca	Myev	Myth	Myvo	Myyu	Nyma	Pihe	Tabr	Bats Capt.	Spec. Capt.
2PONT3	11-Jul-04	18	1	16	2	-	-	4	-	1	-	-	-	4	-	46	7
	17-Aug-04	1	-	-	-	-	-	4	-	-	-	-	-	7	-	12	3
	11-Sep-04	-	-	-	-	-	-	-	-	-	-	-	-	13	-	13	1
BGJNPR	6-Jun-05	-	-	-	-	-	-	1	-	-	-	-	-	1	-	2	2
BIGSG1	08-Jul-04	-	-	-	-	-	-	2	-	-	-	-	-	6	-	8	2
BUROSP	14-Sep-04	4	-	1	-	-	-	2	-	-	1	1	-	18	-	27	6
DUGTMN	12-Sep-04	-	6	-	-	-	-	4	-	1	-	-	-	-	-	11	3
	11-Oct-05	-	2	-	-	-	-	-	-	3	-	-	-	-	-	5	2
FRCHSG	19-Aug-04	-	-	-	1	-	-	1	-	-	-	-	-	1	-	3	3
	15-Sep-04	1	-	-	-	-	-	1	-	-	-	-	-	-	-	2	2
GRANSO	14-Jun-04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
	19-Aug-04	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2	1
GRWATR	11-Jul-04	11	-	-	-	-	-	5	-	-	-	-	-	13	-	29	3
	12-Jul-04	27	-	-	-	-	-	6	-	-	-	-	-	44	-	77	3
	4-Jul-05	7	-	-	-	-	-	25	-	2	-	-	-	45	-	79	4
	5-Aug-05	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	1
	10-Sep-05	-	-	-	-	-	-	-	-	-	-	-	-	4	-	4	1
HRSHU1	20-Aug-04	4	1	-	-	-	-	2	-	1	-	2	-	5	-	15	6
HRSHU2	13-Sep-04	12	-	-	2	-	-	2	-	2	-	-	-	12	-	30	5
IDNCK1	8-Jul-05	9	-	-	-	-	-	8	-	2	-	-	1	23	-	43	5
	4-Aug-05	-	-	-	-	-	-	2	-	2	-	-	-	27	-	31	3
	11-Oct-05	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	1
IDNCK2	11-Sep-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0

Table 5. continued.

Waypoint	Date	Anpa	Coto	Epfu	Idph	Laci	Lano	Myca	Myev	Myth	Myvo	Myyu	Nyma	Pihe	Tabr	Bats Capt.	Spec. Capt.
KRKCBN	4-Jun-05	-	-	-	-	-	-	2	-	-	-	2	-	-	-	4	2
LAVEN1	19-Jun-04	5	-	2	1	-	-	2	-	-	1	-	-	9	-	20	6
	9-May-05	2	-	-	-	-	-	-	-	-	-	-	-	2	-	4	2
LAVEN2	9-Jun-05	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	1
LAVEN3	8-Jun-05	2	-	4	-	1	3	2	-	-	3	-	-	14	-	29	7
LITSG1	21-May-04	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2	1
LITSG2	11-Jun-04	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
LOSCN1	11-Jul-04	-	-	-	1	-	-	3	1	-	-	-	-	-	-	5	3
ROROSG	13-Jun-04	-	1	-	-	-	-	4	-	4	-	1	-	-	-	10	4
	18-Aug-04	4	-	-	-	-	-	15	-	3	-	2	-	2	-	26	5
	15-Sep-04	9	1	-	1	-	-	10	-	13	-	-	-	1	-	35	6
SALTC1	22-May-04	1	-	-	-	-	-	1	-	-	-	-	-	1	-	3	3
	16-Jun-04	4	-	1	-	-	2	-	1	-	-	-	-	13	-	21	5
	10-Jul-04	9	-	-	-	-	-	7	1	3	-	-	-	29	-	49	5
	5-Jul-05	2	1	1	2	-	-	5	-	-	-	-	-	7	-	18	6
SALTC2	18-Jun-04	3	-	-	-	-	-	5	-	1	-	2	-	51	-	62	5
	10-Jul-04	8	-	3	-	-	-	1	-	1	1	-	-	43	-	57	6
	14-Aug-04	12	-	-	1	-	-	5	1	2	4	-	1	56	-	82	8
	09-Sep-04	-	2	-	1	-	-	3	1	2	1	1	-	6	-	17	8
	6-Jul-05	5	-	-	-	-	-	4	-	-	-	-	-	17	-	26	3
SALTC3	17-Jun-04	3	-	-	-	-	-	-	-	-	1	1	-	27	-	32	4
	13-Jul-04	21	1	1	-	1	-	6	-	3	-	-	1	27	-	61	8
	16-Aug-04	1	-	1	2	-	-	6	1	3	-	-	-	20	-	34	7
	10-Sep-04	-	-	-	-	-	-	2	-	-	-	-	-	7	-	9	2
	7-Jul-05	11	-	-	1	1	-	7	-	1	-	-	-	35	-	56	6
	6-Aug-05	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	1

Table 5. Continued.

Waypoint	Date	Anpa	Coto	Epfu	Idph	Laci	Lano	Myca	Myev	Myth	Myvo	Myyu	Nyma	Pihe	Tabr	Bats Capt.	Spec. Capt.
SALTHO	20-May-04	4	-	-	2	1	1	3	-	1	-	1	-	14	-	27	8
	15-Jun-04	3	-	1	2	2	6	3	-	-	2	3	-	82	-	104	9
	10-Jul-04	15	2	5	5	-	-	11	-	1	-	-	-	31	-	70	7
	12-Apr-05	-	-	2	-	-	15	1	-	-	-	-	-	1	-	19	4
	10-Jun-05	4	-	2	1	1	3	1	-	-	1	-	-	26	-	39	8
	3-Jul-05	10	1	5	3	1	-	28	-	1	1	1	-	62	-	113	10
	9-Jul-05	20	3	2	1	1	-	26	-	4	-	1	-	76	-	134	9
	3-Aug-05	5	1	-	2	-	-	-	-	-	1	-	-	13	-	22	5
	7-Aug-05	1	-	-	1	-	-	5	-	-	-	-	-	2	-	9	4
	13-Oct-05	-	-	-	-	-	3	-	-	-	-	-	-	1	-	4	2
SQUCN1	19-May-04	1	-	2	1	-	-	2	-	1	-	-	-	6	-	13	6
	11-Apr-05	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
SQUCN2	9-Sep-05	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	1
UPPJMP	5-Jun-05	2	-	1	-	1	2	2	2	-	-	2	-	4	-	16	8
WTRCN1	24-May-04	6	-	2	-	-	-	1	-	-	-	1	-	-	1	11	5
	09-Jul-04	10	-	5	3	-	-	2	-	6	-	-	-	2	-	28	6
Total		278	23	57	36	10	35	250	9	64	17	22	3	912	1	1717	14
% of Total		16.2	1.3	3.3	2.1	0.6	2.0	14.6	0.5	3.7	1.0	1.3	0.2	53.1	0.1		
Prevalence (%)		61.5	20.0	29.2	32.3	13.8	12.3	76.9	12.3	38.5	16.9	23.1	4.6	73.8	1.5		

	Bats	Spec.
Maximum Catch	134	10
Average Catch	26.4	4.2
Minimum Catch	0	0

Table 6. Data from acoustic sampling including species recorded at each site and time. See Table 4 for specific waypoint identifications. Abbreviations are: Anpa, *Antrozous pallidus*; Epfu, *Eptesicus fuscus*; Idph, *Idionycteris phyllotis*; Myca, *Myotis californicus*; Myci, *M. ciliolabrum*; Myth, *M. thysanodes*; Myvo, *M. volans*; Myyu, *M. yumanensis*; Nyma, *Nyctinomops macrotis*; Pihe, *Pipistrellus hesperus*, and Tabr, *Tadarida brasiliensis*. June data were extracted from the report of Haymond (2005). May samples were obtained by Mollhagen and Bogan but analyzed by Haymond. The columns on the right side of the table indicate the total number of bat calls and total bat species identified for each combination of locality and date. Summaries at the bottom of the table include the total individual calls of each species recorded, the percentage that species comprises of total bat recordings, and the percentage of times at least one individual of that species was identified among the 15 separate sampling locations and dates (prevalence). The smaller matrix depicts maximums, averages, and minimums of total records and species for all acoustic samplings.

Waypoint	Date	Anpa	Epfu	Idph	Myca	Myci	Myth	Myvo	Myyu	Nyma	Pihe	Tabr	Total Calls	Total Spec.
BGMSCG	13-Jun-05	-	1	-	2	-	-	-	-	-	4	1	8	4
BIGSG1	18-Jun-05	2	1	-	21	2	-	-	-	-	112	-	138	5
	19-Jun-05	1	2	-	36	1	-	-	-	-	56	-	96	5
CABNSG	15-Jun-05	8	-	1	100	-	-	3	1	-	59	-	172	6
	16-Jun-05	8	5	2	141	-	-	1	-	-	50	1	208	7
GRWATR	18-Jun-05	18	3	-	320	3	2	-	5	2	468	4	825	9
	19-Jun-05	18	2	1	193	-	1	-	2	5	456	2	680	9
LAVEN1	9-May-05	1	1	2	101	-	-	-	-	-	86	-	191	5
MZOVLK	5-May-05	-	-	2	8	-	-	-	-	-	9	2	21	4
NECKSG	15-Jun-05	1	4	-	292	-	1	-	-	-	102	-	400	5
	16-Jun-05	2	1	-	692	-	-	-	-	-	21	-	716	4
SYNCLP	14-Jun-05	7	2	-	24	-	-	-	9	-	100	1	143	6
WLFTCG	8-May-05	3	6	-	7	-	-	-	-	-	6	2	24	5
	14-Jun-05	-	7	-	23	-	-	-	2	6	76	3	117	6
	17-Jun-05	2	-	-	3	-	-	-	-	2	5	-	12	4
Total		71	35	8	1963	6	4	4	19	15	1610	16	3751	11
% of Total		1.9	0.9	0.2	52.3	0.2	0.1	0.1	0.5	0.4	42.9	0.4		
Prevalence (%)		80.0	80.0	33.3	100.0	20.0	20.0	13.3	33.3	26.7	100.0	53.3		

	Calls	Spec.
Maximum	825	9
Average	250.1	5.6
Minimum	8	4

Table 7. Comparison of results from mistnetting and acoustic sampling methods. Sample sizes for mist-net sites and acoustic sampling sites differ and thus prevalence values for species detected by acoustic methods are larger. *L. noctivagans*, *C. townsendii*, *L. cinereus*, *M. evotis* are not included in the table because these species were detected by netting only; *M. cililolabrum* is not included because it was detected only acoustically; *E. maculatum* is not included as it was detected only from audible calls. Only the top 10 ranks are included in this listing.

Rank	PERCENT OF TOTAL		PREVALENCE	
	Netting	Acoustic	Netting	Acoustic
1	Pihe (53.1)	Myca (52.3)	Myca (76.9)	Myca (100.0)
2	Anpa (16.2)	Pihe (42.9)	Pihe (73.9)	Pihe (100.0)
3	Myca (14.6)	Anpa (1.9)	Anpa (61.5)	Anpa (80.0)
4	Myth (3.7)	Epfu (0.9)	Myth (38.5)	Epfu (80.0)
5	Epfu (3.3)	Myyu (0.5)	Idph (32.3)	Tabr (53.3)
6	Idph (2.1)	Tabr (0.4)	Epfu (29.2)	Idph (33.3)
7	Myyu (1.3)	Nyma (0.4)	Myyu (23.1)	Myyu (33.3)
8	Myvo (1.1)	Idph (0.2)	Myvo (16.9)	Nyma (26.6)
9	Nyma (0.2)	Myth (0.1)	Nyma (4.6)	Myth (20.0)
10	Tabr (0.1)	Myvo (0.1)	Tabr (1.5)	Myvo (13.3)

Appendix 1. List of personnel that assisted with bat inventory at CANY during 2004. Dr. Mollhagen is Emeritus Professor at Texas Tech University, and Mr. Worthington, Mr. Schelz, Ms. Nance and Ms. Bland are employed by NPS. All other personnel listed were employees or contractors of U.S. Geological Survey.

Name	Title	Telephone No.	City
Michael A. Bogan	Co-PI, Wildl. Res. Biol.	505-277-8171	Albuq., NM
Tony R. Mollhagen	Co-PI, Mammalogist	806-787-0161	Lubbock, TX
Cindy Ramotnik	Collection Manager, USGS	505-277-5369	Albuq., NM
Keith Geluso	Wildlife Biologist, USGS	505-346-2870	Albuq., NM
Christa Weise	Graduate Student, UNM	505-346-2870	Albuq., NM
Justin Hoffman	Graduate Student UN-L	916-294-9705	Lincoln, NE
Jeff Mink	Instructor, Albuq. TVI	254-214-5317	Albuq., NM
Rusty Ligon	Student, Pomona College	909-607-5760	Claremont, CA
Dave Worthington	Wildlife Biologist, CARE	435-425-3791	Fruita, UT
Charlie Schelz	Biologist, SEUG	435-719-2135	Moab, UT
Elizabeth Nance	Biologist, NCPN	435-719-2352	Moab, UT
Cath Bland	Biologist, CANY	435-259-4711	Needles, CANY
Shauna Haymond	Acoustic Contractor	757-722-2158	NewportNews, VA

Appendix 2. Descriptions of the localities where mist-net or acoustic sampling occurred during 2004-2005 are given below. Localities are arranged alphabetically by the acronyms used for their GPS waypoints (Table 3). Information in the accounts was gleaned from field notes and the data sheets completed on the first visit to each site. The kinds and frequency of sampling at each site may be ascertained from tables 5 and 6. Photographs of most sites are on digital media that accompany this report.

2PONT3. This site is in the Needles District of CANY. It is an unnamed spring and plunge pool under a ledge in a draw crossed by the 2.3 mi segment of the hiking trail between Squaw Flat and Elephant Hill. The general habitat is piñon-juniper. The pool is marked by a small riparian area beside the trail that is missed by all but the most observant hiker. At the locality are birch, skunkbrush, grass, and other unrecognized woody species. We accessed the site first from the Squaw Flat trailhead, but didn't net on that occasion. Thereafter we drove to the Elephant Hill parking area and walked back to, and up, the host drainage. While the water level fluctuated over a range of 1 meter or more among our visits, we believe it to be perennial. The pool has the potential to be too deep for working nets below the pouroff. Temporary pools downstream from the main pool were noted on hikes to the spring but were never netted. A lion-killed deer was observed under a tree on the way from the site in July of 2004. We never caught *Myotis yumanensis* at the site but 1-3 individuals of this species were observed hawking the water surface well before dark on nearly every visit.

BGJNPR. The Big Juniper site was the last camp and netting site on our hike down Salt Creek in June 2005. It is located in middle Salt Canyon in the Needles District. It was visited only once. Bats were captured over a small scour pool just above the crossing of Salt Creek by the hiking trail. The only conspicuous feature at the place is the very large juniper located beside the trail, above and east of the crossing. Camp was organized in the shade of this tree. The upland habitat is generally piñon-juniper woodland, mostly juniper. The creek bottom is a riparian community supporting scattered willow and cottonwood. At our visit, the water was stagnant and we doubt it regularly exists throughout the summer. There were some larger, and perhaps more ideally-nettable pools in the mile or so above this site, but they were bypassed to shorten the hike out of the canyon the next day.

BGMSCG. Big Mesa campground area is on BLM land off a side road from State Highway 313. It is 15.9 km north of the Island in the Sky boundary. It was acoustically sampled while camping at the site. It is sparsely vegetated with junipers and sagebrush.

BIGSG1. This site is in the Needles District. The upland habitat around Big Spring is generally piñon-juniper woodland. The vegetation at the spring and below consists of cottonwood, willow, salt cedar and four-wing saltbush. Access is on the paved road to the Big Spring overlook. The area worked was the plunge pool, spring, and stream in the canyon below the overlook. The well-marked footpath from the vehicle parking lot passes along the ledge above the plunge pool. A 13-foot ladder was transported in and used to access the canyon floor from the ledge. The depth of the plunge pool was not determined. The site seemed to have great potential for high bat activity but the size of the pool and brush along the stream prevented effective netting. Haymond took acoustic samples at this locality.

BUROSP. Burro Seep is on land administered by the BLM. It is in the Spur Fork of upper Horseshoe Canyon. There is a shallow pool in a cove at the head of a very steep-walled north-facing canyon. The pool is supplied by water from a small spring and from a pouroff some 200+ feet above. The habitat is riparian imbedded in piñon-juniper woodland. Plants identified included willow, oak, *Mahonia*, grass, rabbitbrush, birch, and wildrose. This is a lovely place but our party passed an unpleasant night because we did not come prepared for the September cold of this shaded canyon. Access to the site is by vehicle from the Hans Flat Ranger Station, along the trail out onto Hans Flat, to a brush corral on the west side of the trail. From there, hike northeasterly past the pouroff above the spring, to a ridge extending out into the canyon. Descend into the canyon and hike back up the canyon to the spring. There is no marked trail and the canyon descent and ascent are not for the unfit or faint-hearted. A map and detailed instructions on the hike may be obtained at the ranger station. This is one of the places where *Euderma maculatum* was heard foraging during the night.

CABNSG. Cabin Spring is in the ISKY District. The sampling site was in a small, narrow canyon near a large pool of water and several smaller pools. The head of the canyon is a cove where spring water rises at several locations. The overall habitat is piñon-juniper. This supports a riparian woodland having an abundance of Gambel oak (*Quercus gambeli*) and various grasses. Maidenhair fern (*Adiantum capillus-veneris*) was also observed. This is one of the acoustic-only sampling sites. From the Neck parking lot, there is a well-marked trail that circles through and above the canyon harboring both Cabin and Neck springs.

DUGTMN. The Dugout Ranch mines are east of the Needles District. We understand that some of the workings are on BLM property and others are on Dugout Ranch land. The obviously disturbed mining area is on both sides of the trail to Beef Basin, about a half mile after leaving the paved road (State Highway 211). There is no active mining at present. There are two mines with gated entrances. Both entrances were netted but were treated as one locality. The coordinates in Table 3 are for the most obvious (southern) entrance; it has a tag bearing the number 14IO1. Rabbitbrush is the dominant vegetation, but there is also greasewood. The second mine entrance is concealed by large saltcedars.

FRCHSP. French Spring is just barely on land administered by GCNRA. The Hans Flat Ranger Station oversees visitation at the site. It is accessed by driving southeast from the ranger station and following signage. There is a round stock tank that has never had water at any of visits. The small trough and the area around it were netted. Overall, the area is high piñon-juniper woodland, but there was considerable herbaceous vegetation interspersed with *Mahonia* and rabbitbrush. This site was visited by Armstrong when he was working the region in the 1970s.

GRANSP. Granary Spring is on land administered by BLM. It is accessed by a track east from the road to Hans Flat Ranger Station. One can easily drive to the site if the way is known, but without a GPS device, directions should be solicited at the ranger station. The netting site was two small steel tanks and a pool beside them. Cattle will drink there in the evenings, necessitating striking and redeploying the nets when the cows come in. The rise of the spring appears to be in an enclosure about 100 yds. up the draw. Although the site is in a draw, there no evidence of vegetation one might associate with a

spring or a riparian area. In fact, there is very little herbaceous or grassy vegetation at all. However, habitat in the vicinity is generally piñon-juniper woodland.

GRWATR. The vinyl-lined graywater pond is at the maintenance/generation facility in the Needles District. This part of the park is piñon-juniper woodland, the closest vegetation to the pond is sage, saltcedar and saltbush. Vegetation growing in the pond suggests it is a permanent water source. There is a light on the generating building that remains on all night. Bats forage at the light and drink and forage over the pond. We had some of our best and worst netting nights at this site. Two nights of acoustic sampling were very productive, including recording calls of *Myotis ciliolabrum*.

HRSHU1. This is one of three sites sampled in Horseshoe Canyon, a detached unit of the Maze District. This particular site is a series of scour pools (tinajas) in the sandstone canyon bottom. The pools are 0.7 mi down the canyon from the point where the hiking trail crosses the canyon bottom. The habitat on benches in the canyon and the canyon rim is piñon-juniper woodland, but the netting site has very little vegetation because of water action in this narrow part of the canyon. There is Russian thistle, seep willow, and a small cottonwood where sand accumulates. Blackbrush, rabbitbrush, and *Ephedra* were observed on the trail into canyon.

HRSHU2. This site is a little more than 100 yds downstream of HRSHU1. This is also a scour pool but lies in sandy, alluvial deposits among some large rocks. These deposits sustain cottonwood, willow, *Salsola*, cocklebur, grass, and saltcedar. The setting (sheltered canyon, abundant vegetation, and water) suggest this might be a productive netting site. On our only visit to this place a peregrine falcon was observed at dusk, diving on bats foraging below the canyon rim.

IDNCK1. This site is on BLM land, outside the east boundary of the Needles District. At base flow, this part of Indian Creek is a series of quiet pools in a bend above a modest cataract. Saltcedar with an occasional cottonwood occur on the banks of the stream; rabbitbrush and sage dominate the upland. It seems a dry, dusty unattractive place but in August 2005 the insects were abundant and bats captured were so full from feeding they appeared gravid and hardly resisted handling.

IDNCK2. This site is about 0.3 mi (by rd.) below IDNCK1 and above the plunge pool and ford of the stream. The only visit to this site was on a cold September night when no bats were captured.

KRKCBN. Kirks Cabin is in the Needles District, in upper Salt Canyon. It was our first camp on our hike down the canyon in June 2005. The net locations were pools above the cataract and the margin only of the very large pool below. On an uncomfortably cool evening we captured nothing remarkable among the few bats taken. However, this locality could be a premium sampling site as it is the first open water on the descent from the highest elevations in CANY. There is considerable riparian habitat (with subsurface water) for some distance above the site. The area is generally piñon-juniper woodland. Cottonwood and willow are at the stream margins; sage and rabbitbrush occur upland. This site should be netted at other times of the warm season.

LAVEN1. This site is in West Lavender Canyon, in the Needles District. This and the other two localities in Lavender Canyon were sampled because they were the most accessible higher-elevation localities in the park. They are all accessed by following signage from state road 211 through BLM land. This site is at the end of a two-track trail that follows the floor of the canyon. The very small pools are at and

below a spring beside the trail. They are shallow, but likely permanent. However, in the driest of periods the pool would shrink and water would be accessible only to the most agile of bats. We were able to drive to the site every time we tried but, because the canyon bottom is subject to flashfloods, some vehicles might not always be able to pass. There is another small scour pool about 100 yards up the canyon that may periodically hold enough water for netting. Overall the locality is piñon-juniper woodland, but there are ponderosa pines high on the canyon walls. Cottonwood, oak, willow, broom snakeweed, and grasses occur in the immediate vicinity. On the evening of 9 May 2005, under conditions too windy to net effectively (although there were some periods of calm), two nets and an Anabat recorder were set out for approximately three hours. Only 4 bats were netted, 2 Pihe and 2 Anpa. However, a total of 191 bat calls were identified for the same sampling period: 86 Pihe; 101 Myca; 2 Idph; 1 Epfu; and 1 Anpa.

LAVEN2. This site is in the Needles District in the east (main) fork of Lavender Canyon. It is near the end of the drivable trail, essentially below Cleft Arch. The pool netted was in the road; other nets were placed on the bench to the south, to capture foraging bats. The habitat is generally piñon-juniper woodland, with willow, cottonwood in the canyon bottom. The stream is intermittent above and below the site, but spikerush and cattail along this reach indicate that subsurface water is present throughout the year.

LAVEN3. This locality is also in the Needles District in the east (main) fork of Lavender Canyon, about 0.8 mile (by road) below LAVEN2. The netting site is indicated by water draining from a side canyon and forming a small pool at the side of the trail. This pool and another larger one about 40 yards to the south were netted. The overall habitat is generally piñon-juniper woodland; willow, cottonwood, horsetail, and cattail mark the watercourse. The stream is intermittent above and below the site, but the vegetation along this reach suggests that subsurface water is present throughout the year.

LITSP1. This site is in the Needles District. Little Spring is an ephemeral seep that drains to a scour pool in the bottom of Little Spring Canyon, about 400 yards down the canyon from the bridge on the NPS road to the Big Spring Overlook. It dries up during the summer. We visited it several times but found nettable water only on our first visit in May 2004 and again in September 2005. It is accessed by hiking down from the bridge or by a short hike directly north from the road. In general the habitat is piñon-juniper woodland. There is cottonwood, willow, rabbitbrush, and grasses in the vicinity of the scour.

LITSP2. This site in the Needles District is the bridge over the draw and upstream from LITSG1. Stains on the concrete beams on the east end suggested the structure was being utilized as a bat roost. This was later confirmed by netting and observation. The habitat is piñon-juniper woodland. We never saw water under the bridge but there is willow and cottonwood in the canyon bottom.

LOSCN1. This site is in Lost Canyon, in the Needles District. It is a plunge and scour pool among boulders in alluvial sand. It was a substantial pool when we scouted it in May 2004, but it was dry at subsequent visits in July and September of the same year. It was netted only part of one evening in July. The area is piñon-juniper woodland, with sage, cottonwood, willow, native grasses and forbs at the margins of the dry stream bed. Rush, horsetail, and cattail in the dry pool bottom suggest subsurface water.

MZOVLK This site is in the Maze District and is accessed by following the Flint Trail to its terminus at two campgrounds on the rim of the canyon. We had been told

there were pools in the floor of the canyon suitable for netting and later confirmed this from the hiking trail. We did not net, nor even complete the descent into the canyon, because we encountered a drop for which we were not equipped to negotiate on the ascent back out. A green snake (*Ophiodytes*) was observed on the trail. Bat calls were recorded on 5 May 2005, under windy conditions, threatening rain. The recorder was left out all night, but because of the weather, it was placed inside a box which probably limited the number and clarity of recordings. A total of 21 calls of the following species were identified: Pihe, 9; Myca, 8; Tabr, 2; and Idph, 2.

NECKSG. The Neck Spring sampling site is in the ISKY District. It is situated in a small, narrow canyon near several small pools of water. The casual hiker should be aware that in the immediate vicinity there are at least three other narrow canyons with small springs. Why one was singled out for naming is unclear, unless it is the more permanent water source. The vegetation immediately around the Neck Spring sampling site consisted of oak, juniper, *Mahonia*, maidenhair fern (*Adiantum capillus-veneris*), and various grasses. There is less oak and more juniper here compared to the Cabin Spring area, further up the canyon. This is one of the acoustic-only sampling sites. From the Neck parking lot, there is a well-marked trail that circles through and above the canyon harboring both Cabin and Neck springs.

ROROSG. Robbers Roost Spring is on land administered by BLM. It is accessed from the road to Hans Flat Ranger Station. There is no signage so directions should be solicited at the ranger station. One can drive to the site if the way is known, but there are two areas of blow sand across the trail that can trap an unwary visitor. Most bats were caught while attempting to drink from the old wooden trough, or from the foul-smelling pool in front of it. There were other netting locations above the trough, over pools in the lower part of the draw draining Silvertip Spring. There is a huge skunkbrush that overhangs the trough. There are large cottonwoods adjacent to the draw, just upstream from the trough. Other vegetation includes blackbrush, broomweed, and rabbitbrush. Pronghorns and feral horses were observed during the day and cattle show up to drink any time during the night. On a cool, windy night with the dust blowing, this is an unpleasant place.

SALTC1. This and the following three sites are in lower Salt Canyon in the Needles District. They are all within a two-mile reach of the creek, beginning at the lowermost, SALTHO, at the outfall of Horse Canyon into Salt Creek. SALTC1 is a little more than 0.75 mi (by rd.) above SALTHO. In wet season there may be a single pool that may extend for 100 yds beginning at a sharp turn of the channel/road to the right (southwest). Later in the season it is a series of pools that disappear by late summer. The upland is piñon-juniper woodland, with considerable riparian that includes cottonwood, willow, and saltcedar along the channel. Sagebrush occurs on the benches.

SALTC2. In early season this might be regarded as part of SALTC1, but later the water is discontinuous. This is the first series of pools in the trail and creek downstream from the Peekaboo campsite. The uppermost netting site is where the trail drops into the stream bed. Upland vegetation is piñon-juniper woodland generally, with grasses, willow, cottonwood, and cattail next to the road.

SALTC3. This is the uppermost of the sampling sites in lower Salt Canyon. It is a spring and scour pool in alluvium among large boulders. It is accessed with a short hike up the canyon, even shorter if you go through the "Peekaboo" behind the campsite.

Water lasted into September; the vegetation in the bottom suggests it is a perennial pool. It is piñon-juniper woodland with cottonwood, cattail, spikerush, willow, saltcedar, grasses, and sage in the vicinity.

SALTHO. This site of exceptional numbers and diversity of bats is a series of scour pools in the road below the intersection of Horse Canyon with Salt Canyon. It is the lowermost of four netting locations in lower Salt Canyon. There are 2-6 pools in the trail, depending on season and precipitation. When the pools are present, this is a productive netting locality. Upland is piñon-juniper woodland with cottonwood, saltcedar, rabbitbrush, and grasses marking the canyon bottom. Late summer floods in 2005 changed the configuration of this site to some extent. This is one of the sites where *Euderma* was heard.

SQUCN1. Squaw Canyon is in the Needles District, in sight of the Squaw Flat Campground. The netting site is about a quarter mile down the drainage from the location of Squaw Spring on maps. There is a seep here and a large (20 x 50') scour pool in the bottom of the shallow canyon. The pool was hip deep in May 2004 but by June the water was gone. The site is piñon-juniper woodland with grass, spikerush, and cattail near the water. Cottonwood, willow, and other woody vegetation occur short distances above and below the site. This locality can be accessed from the campground or after a short hike from the park road.

SQUCN2. This site is approximately 130 m below SQUCN1, near some trees. We netted here only in September of 2005; no bats were captured.

SYNCLP. The Syncline Loop sampling site was located near a small pothole of water on the north side of the loop. The drainage included a riparian area with intermittent pools of water. Vegetation included piñon and Utah juniper with occasional salt cedars (*Tamarix ramosissima*), and willows. The understory included ricegrass (*Stipa hymenoides*), four-wing saltbush (*Atriplex canescens*), and Mormon tea (*Ephedra viridis*).

UPPJMP. This site is in upper Salt Canyon, in the Needles District. It is a cataract and large pool about a mile SE of the Upper Jump shown on the map. On the hike down the canyon it is the next rise of water after Kirks Cabin. The habitat is generally piñon-juniper woodland with willow and cottonwood at the streamside. Like Kirks Cabin, this site warrants additional netting during the warmer months.

WLFLCG. Willow Flat Campground is in the ISKY District. It is a developed, rather open campground situated on the mesa top amidst scattered piñon (*Pinus edulis*), Utah juniper (*Juniperus osteosperma*), and sagebrush. This site was acoustically sampled twice.

WTRCN1. Water Canyon is a side canyon off Horseshoe Canyon in the Maze District and on our first visit in May 2004 was the only water we found in the canyon. The netting site consists of a series of scour pools amongst sand and boulders. There is a small stand of *Tecate* in the vicinity. As elsewhere, the upland vegetation is piñon-juniper woodland with riparian species including, cottonwood, willow, horsetail, salt cedar, and spikerush. There also is some oak, rabbitbrush, and grass in the vicinity.

Appendix 3. Species accounts for bats known to occur in Canyonlands National Park (CANY), Utah.

Myotis californicus (California myotis)

The California myotis occurs throughout most of Utah, except some areas in the northern and central parts of the state (Oliver 2000). In Utah and other southwestern states, the California myotis is common from lower elevations in deserts and riparian habitats to higher elevations generally below ponderosa pine woodlands (Bogan 1975, Findley et al. 1975, Hoffmeister 1986, Oliver 2000, Geluso and Geluso 2004). The California myotis previously has been documented in CANY in the Island in the Sky and Needles districts (Armstrong 1982). Armstrong (1982) predicted it also occurs in the Maze District as well. In 2004 and 2005, we commonly captured *M. californicus* in the Needles and Maze districts of the park; we did not mistnet for bats in the Island in the Sky District. In 2004, it was the third most common species captured in CANY, and in 2005 it was the second most common species. In total, it ranked as the third most abundant species of 14 species captured in the park. California myotis were detected during acoustic sampling in all three park districts and their calls comprised 51% of all calls recorded in 2005. We captured adult males and females throughout the summer. Females apparently bear and raise young in the park. We captured pregnant females from 15 June to 10 July, lactating females from 3 July to 13 July, and volant young from 4 August to 13 September. Males with swollen epididymides were observed starting in July but generally were more common in August and September.

Myotis ciliolabrum (Western small-footed myotis)

The western small-footed myotis likely occurs statewide in Utah, typically at higher elevations forested by ponderosa pine or mixed coniferous forest. Mollhagen and Bogan (1997) took eight individuals in the Henry Mountains from sites between 2,335 to 2,713 m. Our highest-elevation site in CANY was Willow Flat Campground at 1849 m so most of our work was below elevations of likely occurrence for *M. ciliolabrum*. Although we did not capture any of these bats, we did detect them during acoustic sampling at Big Spring in the Needles. These little bats may be more common in the Abajo Mountains although they do not seem to be very common anywhere in southeastern Utah.

Myotis evotis (long-eared myotis)

The long-eared myotis is known throughout Utah (Oliver 2000) and uses a wide range of habitats, including lowland riparian habitats, sagebrush, piñon-juniper woodlands, ponderosa pine forests, and mixed coniferous forests. In New Mexico and Arizona, however, the long-eared myotis generally occurs in montane areas from ponderosa pine to spruce-fir forests (Findley et al. 1975, Hoffmeister 1986). In CANY, only a single record previously was known from the park. Armstrong (1982) reported an individual from Cave Spring in the Needles District, but suggested this species occurs throughout the park. We captured 9 individuals during our survey, 6 in 2004 and 3 in 2005. All animals were adult females except for one volant young-of-the-year male. Some lability in the reproductive period is indicated by the capture of a lactating female on 11 July 2004 and a volant young on 10 July 2004. This species ranked as the twelfth

most abundant species of 14 species of bats captured in CANY. All of our captures were from the Needles District, the district closest to higher elevations of the Abajo Mountains where the species may be more common. In the Henry Mountains, the long-eared myotis was the second most commonly captured species with adults of both sexes captured at elevations from 1,433 to 2,713m; males were three times more common than females (Mollhagen and Bogan 1997). Long-eared myotis were not detected acoustically.

Myotis thysanodes (fringed myotis)

The fringed myotis occurs mainly in southern and eastern Utah and is absent from northwestern parts of the state (Oliver 2000). In much of the state, records of *M. thysanodes* are few and scattered. It seems to be more common in southern Utah, where it has been captured from deserts to mixed coniferous forests (Oliver 2000). In the Henry Mountains, the fringed myotis was captured at elevations ranging from 1,295m to 2,713m but was somewhat more common at lower elevations (Mollhagen and Bogan 1997). In Arizona, *M. thysanodes* is found from chaparral to ponderosa pine, but oak woodlands appear to be the preferred habitat (Hoffmeister 1986). Armstrong (1982) reported captures only in the Needles District but suspected it occurs across the park. We captured individuals in both the Needles and Maze districts, along with other locations outside park boundaries to the east and west. In 2004 we captured 49 individuals, and in 2005, 12 individuals. We captured adult males and females throughout the summer. Females apparently bear and raise young in the park. We captured lactating females from 4 July to 13 July, and volant young from 4 August to 9 September. Males with swollen epididymides were observed in August and September. This species ranked as the fourth most abundant species of 14 species of bats captured in CANY. During the acoustic surveys it was detected in Island in the Sky and Needles districts. Findley et al. (1975) reported that this species is one of the more agile fliers in New Mexico. We suspect it may commonly elude capture in mist nets and is more widespread in the park.

Myotis volans (long-legged myotis)

The long-legged myotis occurs throughout Utah in a variety of habitats (Oliver 2000). Although it is known from low elevations in desert and riparian habitats to high elevations in ponderosa, aspen, and mixed coniferous forests, most records are from habitats in sagebrush to higher elevations in montane forests (Oliver 2000). In the Henry Mountains of southeastern Utah, Mollhagen and Bogan (1997) reported that their captures of *M. volans* were below 2,012m in May and above 2,335m in June, July, and August, suggesting that this species migrates to upper elevations in summer. In CANY, Armstrong (1982) did not report this species from the park, but he suggested it occurs in all three districts. We captured a total of 17 individuals during our survey, 11 in 2004 and 6 in 2005. At CANY, we captured both adult females (12 individuals) and adult males (3 individuals). A lactating female was captured on 10 July 2004 and two volant young (both females) were captured on 14 August 2004. This species ranked as the tenth most abundant species of 14 species captured in CANY. We captured individuals in both the Maze and Needles districts. Many of our individuals were captured along Salt Creek and areas adjacent to the Abajo Mountains. We also detected the species acoustically at Cabin Spring (1720 m) in Island in the Sky District.

Myotis yumanensis (Yuma myotis)

The Yuma myotis may occur across Utah, but most records are from southern and eastern parts of the state in a variety of habitats from deserts to mixed coniferous forests (Oliver 2000). In Arizona and New Mexico this species commonly is associated with lower elevations along permanent watercourses (Findley et al. 1975, Hoffmeister 1986). On 27 July 1972, a male *M. yumanensis* was captured at Squaw Spring in the Needles District of the park (Armstrong 1974). Later, Armstrong (1982) commented that this species probably occurs in all three districts of CANY. We captured the Yuma myotis in the Needles and Maze districts, as well as on BLM lands west of CANY. We captured a total of 22 individuals during our survey, 15 in 2004 and 7 in 2005. We captured both adult females (5 individuals) and adult males (10 individuals). A pregnant female was captured on 18 June 2004 and volant young were captured on 18 August 2004 (one male and one female), 20 August 2004 (one male), and 9 September 2004 (one male). Two others escaped before we determined sex, age, or reproductive status. This species ranked as the eighth most abundant species of 14 species captured in CANY and we suspect it is more common at CANY than our captures suggest. We detected Yuma myotis at Island in the Sky and Needles districts during acoustic surveys. This species forages over water and may be more abundant along the Colorado and Green rivers. We observed individuals foraging and hawking above the water surface at a pool in Big Spring Canyon on two occasions and at the pool on the 2.3mi loop trail nearly every time we netted there. They were out in the late afternoon and continued their activities until dusk, oblivious to our presence and easily avoiding our nets.

Lasionycteris noctivagans (silver-haired bat)

The silver-haired bat occurs throughout Utah and has been documented in a variety of habitats (Oliver 2000). Most Utah records are of males taken in mountainous areas (Mollhagen and Bogan 1997). This species is known to migrate and hibernate (Jones et al. 1983), with both sexes inhabiting southern and eastern parts of the United States during winter (Cryan 2003). Cryan (2003) mapped migratory patterns of *L. noctivagans* at the continental scale from specimens housed in museums, and he observed that spring movements in western parts of its distribution were to the north. In Utah, it appears only a few females are known, one of which was a subadult taken in August (Oliver 2000). In New Mexico, both sexes are present during periods of migration, but only males are present in the summer, primarily in mountainous areas (Findley et al. 1975, Findley 1987). In Arizona, both sexes have been captured throughout the year, but males are much more abundant in summer than females (Hoffmeister 1986). In summer in Arizona, individuals are encountered most often in montane meadows surrounded by conifers, but in winter they are known from lower elevations in the mountains of southeastern parts of the state (Hoffmeister 1986). In the Southwest, there is no evidence that females bear and raise young in the region (Findley et al. 1975, Hoffmeister 1986, Oliver 2000, Cryan 2003). Mollhagen and Bogan (1997) captured only males in the Henry Mountains of southeastern Utah and surmised that males were regular summer residents at upper elevations in the mountain range. Armstrong (1982) reported that *L. noctivagans* was undocumented from CANY, but should be expected along the rivers. We captured a total of 32 individuals, 9 in 2004 and 23 in 2005. In April 2005, we captured 15 individuals consisting of 3 males and 12 females; in May, 1 male; in June, 16

males; and in July, August, and September, no individuals. This species ranked as the seventh most abundant species of 14 species of bats captured in CANY. The increase in captures in 2005 is likely due to increased netting efforts earlier in the season (April), during migration. The absence of this species from July through September suggests that males remain at higher elevations during this time, as noted by Mollhagen and Bogan (1997). The species was not detected during acoustic surveys. No information is available regarding reproduction of silver-haired bats in the park.

Lasiurus cinereus (hoary bat)

The hoary bat is a summer resident across the state and is thought to migrate to areas south of Utah in winter (Oliver 2000). Monthly distribution maps of hoary bats at a continental scale demonstrate that most winter records are from southern California and Mexico (Cryan 2003). During migration in spring and autumn, both sexes are reported from states in the Southwest (Findley et al. 1975, Hoffmeister 1986). In New Mexico, males appear in May, are very common in woodland and forested areas in June, are found only in northern mountains in July, and occur only in small numbers through October (Findley et al. 1975). In Utah, hoary bats are uncommon in summer and occur in many habitats throughout the state (Oliver 2000). Only a single previous record of *L. cinereus* is known from CANY. On 18 July 1972, an individual was observed near Cave Spring in the Needles District (Armstrong 1982). During our inventory, we captured a total of 10 individuals, all of which were males. Four individuals were captured in 2004 and 6 in 2005. In May, we captured 1 individual; in June, 5; and in July, 4. This species ranked as the eleventh most abundant species of 14 species captured in CANY; it was not detected during the acoustic surveys. Hoary bats might be more common in wooded habitats of the adjacent Abajo Mountains, although this species was a rare summer resident in the nearby Henry Mountains (Mollhagen and Bogan 1997).

Pipistrellus hesperus (western pipistrelle)

The western pipistrelle likely occurs across Utah, at least at lower elevations (Oliver 2000). This species has not been documented in extreme north-central and northwestern parts of the state (Oliver 2000), but records are known from northeastern Nevada and south-central Idaho (Davis 1939, Ports and Bradley 1996). In New Mexico, Findley et al. (1975) reported 98% of specimens came from grasslands, deserts, and woodlands (piñon-juniper and oak). In Arizona, Hoffmeister (1986) reported individuals from a variety of habitats, including fir-spruce forests, but commented that western pipistrelles were never far from rocky canyon walls, cliffs, or rocky outcrops. In CANY, the western pipistrelle first was reported on 27 July 1972 in the Needles District, where two lactating females were captured at Squaw Spring (Armstrong 1974). Armstrong (1982) also mentions captures at French Spring in Glen Canyon National Recreation Area (GCNRA) west of the Maze District. The western pipistrelle was the most frequently captured species in CANY; we captured a total of 911 individuals, 550 in 2004 and 361 in 2005. We also detected this species during the acoustic surveys in Needles and Island in the Sky districts where their calls accounted for almost 42% of all calls recorded. Both sexes were captured during the summer and females appear to bear and raise their young at the park. Pregnant females were observed from 15 June to 12 July, lactating females were observed from 3 July to 5 August, and volant young were captured from 3 August

to 15 September. Males with swollen epididymides in their uropatagium were observed starting in July but generally were observed in August and September.

Eptesicus fuscus (big brown bat)

The big brown bat occurs across Utah in a variety of habitats from deserts to coniferous forests (Oliver 2000). In New Mexico and Arizona, this species is most common in wooded areas (Findley et al. 1975, Hoffmeister 1986). On 27 July 1972, a male *E. fuscus* was captured at Squaw Spring in the Needles District of CANY (Armstrong 1974). This species also was reported from the Maze District (Armstrong 1982). We captured a total of 57 individuals during our inventory, 40 in 2004 and 17 in 2005. We captured adult males and adult females in summer, and females apparently raise young in the park. Two lactating females were captured on 9 July 2004 in Water Canyon in the Maze District, but volant young were not captured in the park. This species ranked as the fifth most common species of bat captured in CANY. In the Henry Mountains of southeastern Utah, it was the most commonly captured species (Mollhagen and Bogan 1997). At CANY the species was detected acoustically in both eastern districts of the park. We suspect this species occurs throughout the park and probably is more common in wooded and forested habitats of the nearby Abajo Mountains.

Euderma maculatum (spotted bat)

The spotted bat probably occurs across Utah (Oliver 2000), but as in many western states, its distribution is patchy and abundance is uncommon (Hoffmeister 1986, Fitzgerald et al. 1994, Perry et al. 1997, Geluso 2000). This species may be more abundant in Utah than capture rates in mist nets suggest because *E. maculatum* tends to forage high above the ground (Wai-Ping and Fenton 1989). Many records of spotted bats in Utah are from southern parts of the state (Poché 1981, Oliver 2000). Armstrong (1982) reported spotted bats as undocumented in CANY but expected the species to occur in the park. Although we did not capture this species, we are confident that we heard their audible calls on the park. On 14 September 2004, Dave Worthington heard audible calls around Burro Seep near the Maze District; he commented that these calls were consistent with calls of spotted bats he has heard at other locales. On 3 August 2005 at the junction of Salt and Horse creeks in the Needles District, one of us (KG) heard an audible call that was different from the distinctive audible calls of big free-tailed bats or Allen's big-eared bats. This individual flew over the netting site on three separate occasions during the evening but did not attempt to drink. We believe that this audible call was that of a spotted bat. Then, on the evening of 13 October 2005, again at the junction of Salt and Horse creeks, another one of us (MAB) heard the recognizable call of a spotted bat. We believe these calls substantiate the presence of this species in CANY although the species may be uncommon in the park. In the Henry Mountains, Mollhagen and Bogan (1997) captured only a single gravid female, although the species was heard elsewhere. It would be informative to listen for spotted bats along the Green and Colorado rivers to determine if this species is more common in those areas. Navo et al. (1992) documented that spotted bats were locally common at five locations in canyons of the Green River at Dinosaur National Monument in northwestern Colorado. Bogan (unpublished reports to NPS) has documented *E. maculatum* at Capitol Reef National Park and Natural Bridges National Monument.

Corynorhinus townsendii (Townsend's big-eared bat)

Townsend's big-eared bats occur throughout Utah from deserts to ponderosa pine forests (Oliver 2000). Throughout the Southwest, it commonly inhabits caves and mines which are used as day, night, and maternity roosts (Findley et al. 1975, Hoffmeister 1986, Oliver 2000). In CANY, Armstrong (1982) reported that *C. townsendii* probably occurs throughout the park, but was documented only in the Needles District. We captured a total of 21 individuals during our efforts in the Needles and Maze districts, as well as on BLM lands to the west and private land to the east of the park. Fifteen individuals were captured in 2004 and 6 in 2005. On 12 September 2004, we captured 6 adults (3 males, 3 females) at two mine entrances east of the park at the Dugout Ranch mines. On 11 October 2005 we captured two more individuals at this site. Lactating females were captured on 3 and 5 July 2005. Males with swollen epididymides in their uropatagium were observed in July, August, and September. This species ranked as the ninth most common species in CANY. Although we captured Townsend's big-eared bats relatively infrequently, we suspect this species is more common in the region but individuals elude capture in mist nets (Findley et al. 1975, Oliver 2000) due to nimble and versatile flight (Hoffmeister 1986). The species was not detected acoustically.

Idionycteris phyllotis (Allen's big-eared bat)

On 12 June 1969, the first Allen's big-eared bat from Utah was captured north of Blanding in a piñon-juniper woodland (Black 1970). Since then, this species has been captured in most counties of southeastern Utah and in Washington County in southwestern Utah (Oliver 2000). Mollhagen and Bogan (1997) suggested that this species is likely more common than generally recognized in south-central Utah, and noted additional records from the Henry Mountains, Capitol Reef National Park, and Natural Bridges National Monument (Mollhagen and Bogan 1997, Haymond et al. unpublished report to NPS, Bogan unpublished reports to NPS). In Utah, *I. phyllotis* has been captured from desert and lowland riparian habitats to areas of piñon, ponderosa pine, and narrowleaf cottonwood (Oliver 2000). In New Mexico and Arizona, Allen's big-eared bats have been captured in a variety of habitats from low elevations in deserts to higher elevations in ponderosa pine and white fir forests (Findley et al. 1975, Hoffmeister 1986). To date, relatively little is known about the life history of this species, and only in a few locations have many individuals been captured (Findley et al. 1975, Hoffmeister 1986). On 24 July 1972, Armstrong (1974) captured the first two individuals from CANY, and at that time they represented only the second and third records of this species in Utah. Other individuals have since been captured in the park--southwest of Cave Spring and in Horse Canyon Wash (Armstrong 1982). Armstrong (1982) only reported captures in the Needles District but suggested that *I. phyllotis* occurs throughout CANY. We captured Allen's big-eared bats in the Needles and Maze districts of the park, as well as in GCNRA and BLM lands west of the park. Of the 36 individuals we captured, 25 were in 2004, and 11 in 2005. This species ranked as the sixth most abundant species of 14 species captured in CANY. During the acoustic surveys, the species was detected in Needles and Island in the Sky districts. All individuals captured by Armstrong (1974, 1982) were male. We mainly captured adult males (28 individuals), but we also captured 4 adult females. On 19 June 2004, one of the females was pregnant.

We also captured volant young on 3 August 2005 (female), 7 August 2005 (male), 14 August 2004 (female), and 16 August 2004 (female). These data suggest that females bear and raise young in the park. Due to the paucity of information on this species in the United States and its relative abundance at CANY, the park would be a desirable location to gather additional information on this species.

Antrozous pallidus (pallid bat)

The pallid bat occurs across much of Utah, although records are lacking from northern and some central parts of the state (Oliver 2000). Hasenyager (1980) reported that *A. pallidus* occurs in the southern two-thirds of the state. In Utah, pallid bats are fairly common in arid regions such as deserts and sagebrush habitats (Oliver 2000). In CANY, Armstrong (1982) reported pallid bats from all three districts of the park in a variety of habitats. We captured a total of 278 individuals during this study, 198 individuals in 2004 and 80 in 2005. This species ranked as the second most abundant species at the park. Acoustic sampling in Island in the sky and Needles districts revealed the presence of pallid bats in both areas, although they accounted for only a small proportion (1.9%) of total calls. We captured adult males and females, pregnant females from 16 June to 10 July, and lactating females from 3 July to 13 July. Volant young were captured from 8 July to 15 September. Males with swollen epididymides were observed in July, August, and September.

Tadarida brasiliensis (Brazilian free-tailed bat)

The Brazilian free-tailed bat is known throughout most of Utah, except the northernmost counties and highest elevations (Hasenyager 1980) and generally occurs in arid habitats below ponderosa pine forests (Oliver 2000). It is reported as abundant in Utah with most individuals reported from the southernmost parts of the state (Oliver 2000). Armstrong (1982) did not document the species from CANY, but expected it to occur in the park. In CANY, we captured only a single individual, a male, on 24 May 2004 in Water Canyon in the Maze District. Thus it was the least abundant of 14 species of bats captured in CANY, however, their echolocation cries were detected fairly commonly in Needles and Island in the Sky districts. In the nearby Henry Mountains, Mollhagen and Bogan (1997) captured 50 individuals, 44 of which were captured on 19 May 1996 and likely represented migrating individuals. It would be informative to listen for this species along the Green and Colorado rivers using ultrasonic detectors. This species probably uses larger sources of water than we commonly netted.

Nyctinomops macrotis (big free-tailed bat)

The big free-tailed bat is known only from southern Utah (Hasenyager 1980, Oliver 2000) and relatively few captures have been documented in the state. The species is known from deserts, lowland riparian areas, and montane forests (Oliver 2000). Armstrong (1982) suspected its occurrence in CANY because of records from Grand Junction, Colorado, and three localities in southwestern Utah. We captured 3 individuals during our efforts at CANY: 13 July 2004, an adult non-reproductive female in Salt Creek upstream of Peekaboo Campground; 14 August 2004, a volant young male in Salt Creek downstream of Peekaboo Campground; and 8 July 2005, an adult non-reproductive female along Indian Creek east of the park. The volant young suggests that maternity

colonies are in or near the park. This species ranked as the thirteenth most abundant species of bat captured in CANY. Although our capture data suggests that this species is uncommon in CANY, we heard the distinctive audible calls of this species almost nightly and sometimes continually throughout the night in July and August. Individuals generally were heard flying above the tops of canyons where they may have been foraging. At the graywater pond in the Needles District, for example, multiple individuals could be heard feeding above the area, but not once in four nights of netting did an individual come down to drink. Their calls also were heard at Willow Flat in the Island in the Sky District. We think these audible calls suggest that this species may be fairly common in CANY; it likely avoids smaller pools of water to drink from due to its rapid flight. The earliest published record of this species in southeastern Utah is that of Zimmerman (1970) who took two adult females in Comb Wash, southwest of Blanding, in 1968. Interestingly, in the SEUG collection, we found 3 specimens (ARCH 884-5, 888; 2 males, 1 female) of this species from the "Arches NM headquarters area" incorrectly identified as Brazilian free-tailed bats. Two of these animals were taken in 1964 and the third in 1966, all in August, suggesting the species has occurred in Utah for some time. Maternity colonies of big free-tailed bats now are known from Comb Wash, Arches National Park and Natural Bridges National Monument (Haymond et al., Bogan et al., unpublished reports to NPS).

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