Final Report for 2003 and 2004 Mammal Inventories on Selected National Park Service Southern Colorado Plateau Network Parks:

Hubbell Trading Post National Historic Site

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ABSTRACT

Holistic Wildlife Services NM was contracted by the Navajo Nation Department of Fish and Wildlife to conduct biological inventories for mammals at Hubbell Trading Post National Historic Site (HUTR) as part of the National Park Service Inventory and Monitoring Program. The goals of this study were to document at least 90% of the mammals using verifiable documentation and taxa-specific field surveys, provide distributional information, estimates of species richness, and relative abundance of mammals, and provide baseline information and make recommendations to develop future management and monitoring schemes of zoological resources. There had been no baseline mammal work conducted at HUTR prior to these surveys. A total of 23 mammal species were estimated to inhabit the park based on species-area models; however we estimated 39 species for HUTR based on known specific ranges and available museum records. Field inventories extended from 26 June to 28 August 2003, and 10 May to 17 June 2004. We used a variety of survey methods including live-trapping, mist netting and acoustic surveys for bats, track-scat surveys, and opportunistic observations. We documented a total of 32 species (Chiroptera, 8 species; Lagomorpha, 2 species; Rodentia, 15 species; Carnivora, 6 species; and Artiodactyla, 1 species). Our survey efforts documented 82% of the 39 species we considered potential to occur, and we documented over 30% more than the 23 species predicted by species-area models. The piñon mouse was the most abundant species of mammal at HUTR during 2003 (17.8% of all captures), while deer mice were the most abundant species (almost 40% of all captures) in 2004. No federal or Navajo Tribal-listed endangered species were documented during this study.

Key Words: Hubbell Trading Post National Historic Site, inventory, Inventory and Monitoring Program, mammal, National Park Service.

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INTRODUCTION

The Colorado Plateau of the southwestern United States is a topographically diverse region that accommodates the highest native mammalian species richness in the country (Mac et al. 1998). In particular, Arizona's landscape of pine forests, cactus deserts, high plateaus, and deep canyons has resulted in the presence of more than 140 mammalian species (Hoffmeister 1986). With such a large number of species, this area became the focus of many biological studies. Dr. C.B.R. Kennerly collected specimens and recorded observations in 1853 and 1854 as part of a survey team seeking railroad routes to the Pacific Coast. Dr. Samuel Woodhouse was a naturalist and part of an expedition to study the Colorado and Little Colorado rivers in 1851. Many naturalists were also associated with military outposts in Arizona during the mid 1800's. Dr. Elliot Coues collected mammals around Fort Whipple and wrote the first published account of the mammals of Arizona in 1867. When the United States Biological Survey was established in the late 1800s, mammal collecting intensified and many biologists were sent to Arizona, intending to prepare a report on the mammals of Arizona. Vernon Bailey, C. Hart Merriam, and E. A. Goldman were just a few of the federal mammalogists that spent many years collecting in the state.

Interest in the biological resources of Arizona has continued to the present day with many persons and institutions conducting scientific research and making collections in the region. Despite nearly two hundred years of scientific interest in Arizona, some areas remain relatively unstudied. As part of the National Park Service Inventory and Monitoring (NPS I&M) program Hubbell Trading Post National Historic Site (HUTR), part of the Southern Colorado Plateau Network (SCPN), was identified as having significant natural resources that were not well documented. No baseline mammal work had been conducted there and estimated completeness

was 0% for HUTR (Stuart 2000) prior to this work. This park needed full, directed surveys conducted by experienced investigators. This report provides a description of the results of biological inventories for mammals conducted on HUTR during 2003 and 2004.

Objectives

The overall goal of the inventory phase of the NPS I&M program was to provide park resource managers with systematically rigorous baseline information that could be used in the development of a monitoring strategy. Considering that goal, there were several objectives of the mammal inventory including:

1. Document at least 90% of the mammals using verifiable documentation and taxa-specific field surveys with methods consistent with other NPS units in the SCPN.
2. Provide distributional information, as well as estimates of species richness and relative abundance.
3. Provide baseline information and make recommendations to develop future management and monitoring schemes of zoological resources.

STUDY AREA

The Colorado Plateau is a geologically and topographically distinct basin. It is situated between the arid Great Basin to the west and the lush forests of the Rocky Mountains to the east, covering approximately 130,000 mi^2 from southeastern Utah and western Colorado, to northern Arizona and northwestern New Mexico (Wheeler 1990). The region lies in the zone of arid-temperate climates in North America. This type of climate is characterized by periods of drought and irregular precipitation, relatively warm to hot growing seasons, and long winters with

sustained periods of freezing temperatures. Winters are dominated by Pacific region storm patterns, while summers (on the southern portions of the Plateau) are dominated by monsoonal moisture from the Gulf of Mexico. Low, open woodlands of drought-adapted conifers at higher elevations and extensive areas of drought-tolerant shrubs and grasses at lower elevations characterize the vegetation.

Hubbell Trading Post includes 64.8 ha (160 ac) of old agricultural land, structures, and a small portion of Pueblo Colorado wash. It is located in Ganado, in Apache County, Arizona. The wash is currently undergoing a restoration project to replace non-native vegetation with native vegetation. Elevation on the site ranges from 1920 m to 1940 m (6300 ft to 6365 ft).

The current vegetative structure includes old agricultural fields that are dominated by four-wing saltbush, rabbitbrush, snakeweed, shad scale, and Russian thistle. Cottonwoods and planted fruit trees are also present. The developed areas include various native and exotic trees, shrubs, and herbaceous plants and grasses. Vegetation in and along Pueblo Colorado wash and the arroyo west of the housing area includes rabbitbrush (*Chrysothamnus spp.*), willows (*Salix spp.*, many of which have recently been planted), sedges (*Carex* spp. , and horsetail (*Equisetum* sp.). Much of the saltcedar (*Tamarix* sp.) and Russian olive (*Eleagnus angustifolia*) along the wash had been recently removed, but a narrow row of saltcedar and Russian olive remains north of the wash. Several junipers (*Juniperus* spp.) are also found on the park.

METHODS

In order to meet our objectives, we implemented the following methods:

Objective 1

The NPS Inventorying and Monitoring Planning Team (NPSIMPT, see Stuart 2000) used species-area models to predict the number of mammalian species that would inhabit each park. They predicted that HUTR would include 23 species of mammals. We compiled an additional list of species likely to occur in the park based on known specific ranges and available museum records. This list was developed by studying known ranges and habitat associations of mammals in Arizona, and through consulting museum records and other accessible databases that might include more recent information. Through these efforts, we produced a potential species pool of 39 species for HUTR.

We used these lists to calculate percent documentation and assess inventory completeness. Field surveys for specific groups of mammals were conducted in a manner consistent with other SCPN parks as follows:

Small terrestrial mammal inventories

Inventories for rodents and other small mammals were conducted using Sherman live traps arranged in traplines (Wilson et al. 1996). Traplines generally consisted of 20 paired trap stations placed at 15 m (50 ft) intervals for a minimum distance of 300 m (984 ft). Traps were baited with dry oatmeal and left open overnight, and sometimes during diurnal hours.

Trapping areas were selected so that each major type of habitat within a given park was sampled. Traplines were stratified by habitat with randomly selected starting points and, where feasible, extend through only one habitat (Stuart 2000). Effort is reported as number of trap-nights (total number of traps multiplied by number of days).

Bat inventories

Bats were inventoried using mist nets and acoustic surveys. Mist nets were strung across and around bodies of water in order to capture bats coming in to drink or feed on insects flying over the water (Kunz 1988). Size of nets ranged from 6-20 m (18-60 ft) and number of nets varied depending on the area of the body of water. Mist nets were set up shortly before sunset and tended for several hours or until sunrise. This method is especially effective when sources of water in the landscape are limited, as this causes bats to be concentrated in a relatively small area allowing them to be more easily captured.

Acoustic surveys entailed the use of a bat detector and zero-crossing analysis interface module (ZCAIM; Anabat II hardware, Anabat software version 6.3f; Titley Electronics, Ballina, New South Wales, Australia) with a laptop computer, which recorded echolocation calls. A bat detector produces audible output from the ultrasonic calls emitted by echolocating bats. The ZCAIM interfaces the audio-frequency signal from the detector to a computer. Analyses were performed using Analook software (version 4.8n, Titley Electronics, Ballina, New South Wales, Australia). The frequency-time display generated by the software from detected echolocation call sequences was used to identify species based on qualitative analysis of call parameters compared to reference calls from known individuals (Fenton and Bell 1981; O'Farrell et. al. 1999). This method is useful when no water is available over which to net or when water is too ample to effectively concentrate bats over a small enough area for capture. Acoustic surveys are also useful for detecting species that are not easily captured in mist nets.

Effort was recorded as net-nights (number of mist nets multiplied by number of nights) and acoustic hours (total number of hours spent recording echolocation calls).

Carnivore inventories

Carnivores were documented primarily through track and scat surveys. Track and scat surveys entailed area searches on foot in locales likely to attract animals and show evidence of animals, such as around water sources, in canyon bottoms, in sandy soils, and around areas where humans leave refuse (e.g. campgrounds and housing areas). Effort for carnivore inventories was quantified as estimated distance surveyed (km).

Opportunistic observations

Anytime a species or sign of a species (e.g. tracks, scat, middens) was observed that was not documented by trapping or other means, it was noted. Location was recorded for all opportunistic observations, and when possible a voucher photograph was obtained. Opportunistic observations are the predominant means of documenting ungulates, but many other species are also documented in this manner.

We also confirmed the presence of some species using reliable park observation files and by talking to knowledgeable park staff and local residents.

Objective 2

Species richness (number of species documented) and relative abundance of species (percent of all individuals detected) was calculated for HUTR. We also provided summaries of effort including person-days, trap-nights, mist net-nights, acoustic hours and survey distance, as appropriate. We also updated the mammal species list based on captures, observations, and historical records.

Objective 3

Data for HUTR analyzed and summarized for this report to the Navajo Natural Heritage Program (NNHP) following the completion of two seasons of fieldwork. Then, we made management and monitoring recommendations pertaining to any species of concern or interest documented during this study.

RESULTS

Objective 1

Following two years of mammal inventories at HUTR, we calculated that we documented 82% of the 39 mammal species that potentially occur on the park (Tables 1 and 2).

We documented 8 bat species (73% of the total number of potential bat species), 2 lagomorphs (100%), 15 rodents (88%), 6 carnivores (75%) and 1 ungulate (100%).

Copies of all data sheets, photographs, and field journals were provided to Navajo Nation Department of Fish and Wildlife. Voucher specimens were deposited in the U.S. Geological Survey mammal collection at the Museum of Southwestern Biology, University of New Mexico.

Objective 2

Efforts at HUTR yielded 21 person days, 1,456 trap nights, 14 mist net nights, 31.9 hours of acoustic surveys, and 27.4 km of track and scat surveys (Tables 3 and 4). Live trapping success rate was approximately 2.6% in 2003 and 21.8% in 2004. Current level of species richness at HUTR is 32 species. The National Park Service Inventory and Monitoring Planning Team estimated that 23 species of mammals likely occur at HUTR (Stuart 2000).

The piñon mouse was the most abundant species of mammal at HUTR during 2003 when

it accounted for 17.4% of all captures. The second most abundant species was the deer mouse which accounted for 10.9% of all captures. All other individual species accounted for <7% of total captures (Table 4).

During 2004, deer mice were the most abundant species captured, comprising almost 40% of all captures. The second most abundant species captured was the western harvest mouse, which accounted for nearly 30% of all individuals captured.

During the first year of inventories, efforts to document species were evenly distributed among different habitat types. We found that at HUTR, both species abundance and richness were highest in locations surrounding Pueblo Colorado Wash. As a result, much of the effort during the second year of inventories was targeted on those areas (Figure 1). We also focused our second year-efforts on documenting less common carnivores, bats, and rodents as these groups had the greatest promise of increasing the level of documentation.

Some species appeared to have noticeable habitat associations within the park. The rocky slope of Hubbell Hill was the only place we captured white-throated woodrats. Piñon mice were also common there. Gunnison's prairie dogs and Ord's kangaroo rats were limited to the old agricultural fields, while mounds of Botta's pocket gophers were only observed in Pueblo Colorado Wash and the arroyo. Northern grasshopper mice were frequently captured among the shrubs along the gravel roads in the park. Species richness (7 species) was highest in the rabbitbrush along the south bank of Pueblo Colorado Wash and in the saltcedar and Russian olive trees along the north bank. Species documented primarily from this area include brush mice and western harvest mice. Pueblo Colorado Wash is also important for bats and large mammals, in that it provides water for drinking and a corridor along which to travel. Desert cottontail and deer mice were widespread.

Objective 3

Several Species of Concern (as listed by the Arizona Natural Heritage Data Management System, January 2003) were documented at HUTR: western small footed myotis, long-legged myotis, Yuma myotis, and big free-tailed bat. We did not find any mammal species of concern as listed by the Navajo Nation Department of Fish and Wildlife (March 2001 list).

DISCUSSION AND RECOMMENDATIONS

The overall goal of the inventory phase of the NPS Inventory and Monitoring Program was to provide park resource managers with systematically rigorous baseline information that may result in the development of a monitoring strategy. Considering that goal, there were several objectives for the mammal inventories conducted at HUTR.

Objective 1 *- document at least 90% of the mammals using verifiable documentation and taxa-specific field surveys with methods consistent with other NPS units in the SCPN.*

Interestingly, we confirmed more species than was predicted by the NPSIMPT. The 32 species documented at HUTR is over 30% greater than the 23 species predicted by NPSIMPT. The NPSIMPT used species-area models alone to predict the number of mammalian species that would inhabit each park. This application invokes principles of island biogeography through which park (island) area is used to predict species diversity. The NPSIMPT estimates of mammalian diversity assume that either landscape heterogeneity plays no role in species diversity, or that there is always a positive correlation between park size and habitat diversity. By using this model they seemed to assume that parks represent insular units, surrounded by

landscapes of unusable habitat, whereby park area alone determines species diversity. These assumptions have been controversial since the first publication of "The Theory of Island Biogeograpy" by MacArthur and Wilson (1963), and it has since been determined that species area relationships lose sensitivity at small spatial scales (for example, see Simberloff 1982). Additionally, the NPSIMPT estimates are ambiguous as they fail to discern residents from vagrants or clearly define species presence (i.e., breeding populations). Regardless, the fact that we confirmed higher mammalian diversity than predicted by the NPSIMPT clearly indicates that, at least for these parks, species-area models alone underestimated mammalian diversity. Alternatively, the broad approach of the sampling design may not have accounted for conditions of individual parks nor taken advantage of investigators' specialized knowledge of species or habitats in predicting species richness.

Had we merely accepted the NPSIMPT estimates, we would have conducted far less intensive monitoring and subsequently underestimated the mammal diversity of the park. By creating our own lists of potential species we were prompted to conduct more intensive sampling than that recommended by the NPSIMPT. We documented 32 species of mammals at HUTR (82% of 39 species on our list). Percentages of documentation varied by mammalian order, with highest levels of documentation occurring in groups that occupy lower trophic levels (primary consumers), as they tend to occur in high local densities relative to organisms higher up the food web. Within the primary consumers, we found highest levels of documentation among species that are easily observed such as large bodied, ungulates (100%), and lagomorphs (100%). High levels of documentation were also found in primary consumers with small home ranges and limited capability for dispersal such as rodents (88%). Lowest levels of detection were found in species that represent secondary and tertiary consumers (predators). We documented 75% of

carnivores from our species list at HUTR. Similarly, we confirmed 73% of bats at HUTR. Both carnivores and bats live predatory lifestyles and are dependent on primary consumers as prey items.

Because energy is lost between each trophic level, the total biomass (i.e., number of individuals) decreases by between 84-96% for each step up the food web. Therefore, by definition, fewer predators will be found per unit area relative to primary consumers, and individuals will likely have much larger home ranges than will prey species. An inverse relationship generally exists between species abundance and detectability, and between home range size and detectability. Because predators are both less abundant and function over larger spatial scales than prey items, it is likely that some undetected species of carnivores and bats from our species pool use HUTR but their presence was masked by low densities, or they may use the park occasionally, and in a transitory fashion, and were simply not present during the period of this study.

Objective 2 - *provide distributional information, as well as estimates of species richness and relative abundance using field surveys with methods consistent with other NPS units in the SCPN.*

As a result of these surveys we were able to document species richness at HUTR as 32 species. Patterns of abundance and distribution of mammal species varied between years included in this study. The piñon mouse was the most abundant species of mammal at HUTR during 2003 accounting for 17.8% of all captures. The second most abundant species was the deer mouse accounting for 11.1% of all captures. All other individual species accounted for <7% of total captures (Table 4). During 2004, deer mice were the most abundant species

captured, comprising almost 40% of all captures. The second most abundant species captured was the western harvest mouse, which accounted for nearly 30% of all individuals captured. Temporal variation in relative abundance of rodent species is not uncommon as populations of rodents are sensitive to local food abundance (i.e., seed production), have high reproductive output and are profoundly impacted by density-dependent pressures. As a result, many species of rodents can explode in numbers during some years, and be virtually absent during others.

At HUTR, both species abundance and richness were highest in locations surrounding Pueblo Colorado Wash. Some species appeared to have noticeable habitat associations within the park. For example, the rocky slope of Hubbell Hill was the only place we captured white-throated woodrats, and piñon mice were also common there. Gunnison's prairie dogs and Ord's kangaroo rats were limited to the old agricultural fields, while mounds of Botta's pocket gophers were only observed in Pueblo Colorado Wash and the arroyo. Northern grasshopper mice were frequently captured among the shrubs along the gravel roads in the park. Species richness (7 species) was highest in the rabbitbrush along the south bank of Pueblo Colorado Wash and in the salt cedar and Russian olive trees along the north bank, with brush mice and western harvest mice documented primarily from this area. Pueblo Colorado Wash is also important for bats and large mammals, in that it provides water for drinking and a corridor along which to travel.

The highest levels of species abundance and richness at HUTR were found in areas with extensive vegetative cover, regardless of plant species. For example, areas of highest richness at HUTR were in Pueblo Colorado Wash, in areas where extant vegetation is currently dominated by invasive species such as salt cedar and Russian olive. These species are not generally associated with high levels of diversity and, generally lead to a simplification of animal communities through habitat simplification and decay. However, Pueblo Colorado Wash is

currently in the midst of an aggressive and ambitious restoration project, through which much of the non-native vegetation has been cleared. This has left much of the wash with very limited ground cover possibly focusing specific distributions to the remnant vegetation in the wash. It is likely that as restoration activities continue and native vegetation becomes established that the mammal community will become more evenly distributed throughout the wash, and that this area will continue to be critical to the maintenance of a diverse mammal community.

Objective 3 - *provide baseline information and make recommendations to develop future management and monitoring schemes of zoological resources.*

Baseline information for HUTR is included in the results section and associated tables and figures. Based on the information collected during these surveys we strongly recommend the park prioritize, maintain, and promote vegetative diversity within their park boundaries. The fact that HUTR has higher levels of species richness than would be expected based on park size is likely, at least in part, due to the habitat diversity there, and the incredible diversity of the landscapes in which it is situated. Additionally, the dynamic nature of mammal communities observed in these surveys (variation in trapping success, relative abundance of species, and detectability) illustrates the importance of multi-year sampling for establishing baseline data. We recommend that any future monitoring at this park be established over the long-term so that natural variation in community dynamics does not become confused with population trends (declines or increases).

As much of the diversity at HUTR was associated with the Pueblo Colorado Wash, and the fact that the NPS is conducting an aggressive restoration project on the wash provides the NPS with a unique opportunity to investigate the effects of riparian alteration on mammalian

diversity. Through establishing an ambitious monitoring program in conjunction with the restoration project the NPS would collect invaluable data regarding the effects of river restoration on mammal communities that would be relevant throughout the Southern Colorado Plateau Network. We recommend that HUTR continue with riparian restoration activities in the Pueblo Colorado Wash and establish permanent sampling locations both within and outside of the restoration area. Small terrestrial mammals (i.e., rodents) are valuable indicators of small scale habitat modification as their territories are generally small; they have high reproductive potential, low dispersal abilities, and strong habitat associations. Therefore, habitat perturbations are often quickly reflected by changes in community structure providing invaluable data regarding short and long-term effects of habitat modification. The most appropriate sampling scheme for small terrestrial mammals involves establishment of permanent sampling grids that include trap stations as described by Wilson et al. (1996). Capture/recapture techniques should then be used to investigate the responses of small terrestrial mammals to restoration activities.

Additionally, because all of the Arizona Natural Heritage Species of Concern found at HUTR were bats (see results), and the Pueblo Colorado Wash was found to represent important foraging habitat to this taxa, it is critical that data regarding the response of bats to changes in the riparian corridor be collected. This could be achieved through the establishment of two permanent acoustic stations in the riparian corridor that would collect echolocation calls from flying bats. These data would ultimately provide valuable information regarding the impacts of river corridor alteration on bats.

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Table 1. Level of documentation for major groups of mammals on Hubbell Trading Post National Historic Site and overall level of documentation for all mammals.

Order	Number of species possible	Number of confirmed species	Percent of possible species
Chiroptera	11	8	73
Lagomorpha	2	2	100
Rodentia	17	15	88
Carnivora	8	6	75
Artiodactyla	1	1	100
Total	39	32	82%

Table 2. Mammals of Hubbell Trading Post National Historic Site, including currently known park status.

Common Name	Park Status	Reference/Observation
California myotis	Present	This inventory, 2003 (Table 4); acoustic
Western small-footed myotis	Present	This inventory, 2004 (Table 4); voucher
Fringed myotis	Probable	Hoffmeister 1986
Long-legged myotis	Present	This inventory, 2003 (Table 4); voucher
Yuma myotis	Present	This inventory, 2004 (Table 4); voucher
Townsend's big-eared bat	Probable	Hoffmeister 1986
Big brown bat	Present	This inventory, 2004 (Table 4); capture
Pallid bat	Present	This inventory, 2004 (Table 4); voucher
Lasiurus cinereus	Present	This inventory, 2004 (Table 4); voucher
Brazilian free-tailed bat	Probable	Hoffmeister 1986
Big free-tailed bat	Present	This inventory, 2003 (Table 4); acoustic
Desert cottontail	Present	This inventory, 2003 (Table 4); observed animal
Black-tailed jack rabbit	Present	This inventory, 2003 (Table 4); observed animal
White-tailed antelope squirrel	Probable	Hoffmeister 1986
Colorado chipmunk	Probable	Hoffmeister 1986
Rock squirrel	Present	This inventory, 2003 (Table 4); observed animal
Spotted ground squirrel	Present	Hoffmeister 1986, near Ganado
Gunnison's prairie dog	Present	This inventory, 2003 (Table 4); observed animals
Botta's pocket gopher	Present	This inventory, 2003 (Table 4); observed mounds
Silky pocket mouse	Present	This inventory, 2004 (Table 4); voucher
Ord's kangaroo rat	Present	This inventory, 2004 (Table 4); capture
Western harvest mouse	Present	This inventory, 2004 (Table 4); voucher
Canyon mouse	Present	Hoffmeister 1986, Ganado
Brush mouse	Present	This inventory, 2004 (Table 4); voucher
Deer mouse	Present	This inventory, 2003 (Table 4); voucher
Piñon mouse	Present	This inventory, 2003 (Table 4); voucher
Northern grasshopper mouse	Present	This inventory, 2003 (Table 4); capture
White-throated woodrat	Present	This inventory, 2003 (Table 4); capture
Stephen's woodrat	Present	Hoffmeister 1986, Ganado
Porcupine	Present	NPS observation; observed quills
Coyote	Present	This inventory, 2003 (Table 4); heard howling
Kit fox	Probable	Hoffmeister 1986
Red fox	Present	NPS observation 2003; observed animal
Gray fox	Present	NPS observation 2001; road kill in park
Raccoon	Present	This inventory, 2003 (Table 4); observed tracks
Badger	Probable	Hoffmeister 1986
Striped skunk	Present	This inventory, 2003 (Table 4); observed tracks
Bobcat	Present	Hoffmeister 1986, Ganado
Mule deer	Present	This inventory, 2003 (Table 4); observed tracks

Table 3. Field schedule for 2003 and 2004 Hubbell Trading Post National Historic Site (HUTR) mammal inventories, in chronological order, indicating dates, parks visited, observers, effort and sampling methods.

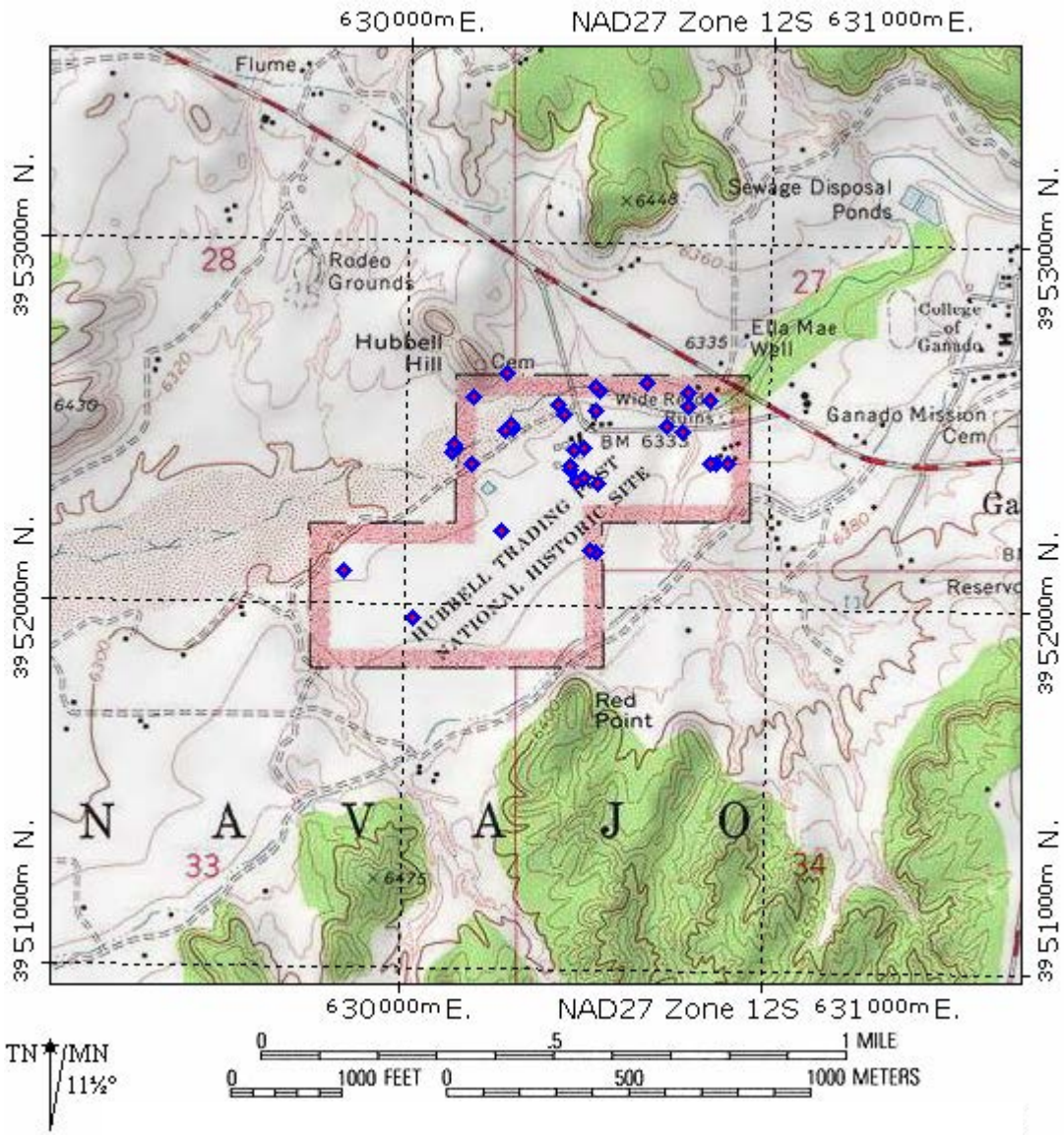
			Effort					
Date(s)	Park visited	Observer(s)	Person days	Trap nights	Net nights	Acoustic hours	Track/scat survey distance (km)	Sampling method(s)
26-29 June 2003	HUTR	S. Haymond, R. Sherwin	6	237		11.5	4.9	Sherman live traps, acoustic surveys, track/scat surveys, opportunistic observations
30 July-2 August 2003	HUTR	S. Haymond	3	280	2		4.7	Sherman live traps, mist nets, track/scat surveys, opportunistic observations
25-28 August 2003	HUTR	S. Haymond	3	245	6	8.7	3.8	Sherman live traps, mist nets, acoustic surveys, track-scat surveys, opportunistic observations
		Total (2003)	41	2621	23	43.0	245.8	
10-13 May 2004	HUTR	S. Haymond, D. Tinnin	6	514	2	2.6	7.0	Sherman live traps, acoustic surveys, track/scat surveys, opportunistic observations
14-17 June 2004	HUTR	S. Haymond	3	180	4	9.1	7.0	Sherman live traps, mist nets, track/scat surveys, opportunistic observations
		Total (2004)	39	2416	15	21.7	42.0	

Table 4. Relative abundance of mammal species captured and observed at Hubbell Trading Post National Historic Site during 2003 and 2004 inventories.

	2003		2004		Total	
Species Common Name	Number Captured and Observed	% Relative Abundance	Number Captured and Observed	% Relative Abundance	Number Captured and Observed	% Relative Abundance
California myotis	1	2.2			1	0.4
Western small-footed myotis	3	6.5	6	3.3	9	4.0
Long-legged myotis	1	2.2	7	3.9	8	3.5
Yuma myotis	2	4.3	3	1.7	5	2.2
Big brown bat			3	1.7	3	1.3
Pallid bat			2	1.1	2	0.9
Hoary bat			2	1.1	2	0.9
Big free-tailed bat	1	2.2			1	0.4
Desert cottontail	2	4.3	1	0.6	3	1.3
Black-tailed jackrabbit	1	2.2			1	0.4
Rock squirrel	2	4.3			2	0.9
Gunnison's prairie dog	2	4.3	1	0.6	3	1.3
Botta's pocket gopher	2	4.3			2	0.9
Silky pocket mouse			2	1.1	2	0.9
Ord's kangaroo rat	3	6.5	4	2.2	7	3.1
Western harvest mouse			54	29.8	54	23.8
Brush mouse	1	2.2	1	0.6	2	0.9
Deer mouse	5	10.9	72	39.8	77	33.9
Pinon mouse	8	17.4	10	5.5	18	7.9
Unknown mouse	2	4.3			2	0.9
Northern grasshopper mouse	2	4.3	10	5.5	12	5.3
White-throated woodrat	2	4.3			2	0.9
Porcupine	1	2.2			1	0.4

	2003		2004		Total	
Species Common Name	Number Captured and Observed	% Relative Abundance	Number Captured and Observed	% Relative Abundance	Number Captured and Observed	% Relative Abundance
Coyote	1	2.2			1	0.4
Red fox			1	0.6	1	0.4
Raccoon	2	4.3	1	0.6	3	1.3
Striped skunk	1	2.2			1	0.4
Mule deer	1	2.2	1	0.6	2	0.9
Total	46	100.0	181	100.0	227	100.0

Figure 1. Approximate locations of mammal inventory sampling points (mist nets, beginnings of traplines, acoustic sampling stations, beginnings or track and scat surveys) at Hubbell Trading Post National Historic Site.



Appendix A. Common and scientific names of mammals used in this report. Nomenclature follows Baker et. al., 2003.

Common Name	Scientific Name
Chiroptera	
California myotis	*Myotis californicus*
Western small-footed myotis	*Myotis ciliolabrum*
Long-eared myotis	*Myotis evotis*
Little brown bat	*Myotis lucifugus*
Fringed myotis	*Myotis thysanodes*
Long-legged myotis	*Myotis volans*
Yuma myotis	*Myotis yumanensis*
Hoary bat	*Lasiurus cinereus*
Silver-haired bat	*Lasionycteris noctivagans*
Western pipistrelle	*Pipistrellus hesperus*
Big brown bat	*Eptesicus fuscus*
Spotted bat	*Euderma maculatum*
Townsend's big-eared bat	*Corynorhinus townsendii*
Allen's big-eared bat	*Idionycteris phyllotis*
Pallid bat	*Antrozous pallidus*
Brazilian free-tailed bat	*Tadarida brasiliensis*
Big free-tailed bat	*Nyctinomops macrotis*
Lagomorpha	
Desert cottontail	*Sylvilagus audubonii*
Black-tailed jackrabbit	*Lepus californicus*
Rodentia	
Colorado chipmunk	*Neotamias quadrivittatus*
Hopi chipmunk	*Neotamias rufus*
White-tailed antelope squirrel	*Ammospermophilus leucurus*
Spotted ground squirrel	*Spermophilus spilosoma*
Rock squirrel	*Spermophilus variegatus*
Gunnison's prairie dog	*Cynomys gunnisoni*
Botta's pocket gopher	*Thomomys bottae*
Plains pocket mouse	*Perognathus flavescens*
Silky pocket mouse	*Perognathus flavus*
Ord's kangaroo rat	*Dipodomys ordii*
Western harvest mouse	*Reithrodontomys megalotis*
Brush mouse	*Peromyscus boylii*
Canyon mouse	*Peromyscus crinitis*
Deer mouse	*Peromyscus maniculatus*
Pinon mouse	*Peromyscus truei*
Northern grasshopper mouse	*Onychomys leucogaster*
Western white-throated woodrat	*Neotoma albigula*
Bushy-tailed woodrat	*Neotoma cinerea*

Appendix A. Continued.

Common Name	Scientific Name
Desert woodrat	*Neotoma lepida*
Mexican woodrat	*Neotoma mexicana*
Stephens's woodrat	*Neotoma stephensi*
North American porcupine	*Erethizon dorsatum*
Carnivora	
Coyote	*Canis latrans*
Kit fox	*Vulpes macrotis*
Red fox	*Vulpes vulpes*
Gray fox	*Urocyon cinereoargenteus*
American black bear	*Ursus americanus*
Ringtail	*Bassariscus astutus*
Northern racoon	*Procyon lotor*
Badger	*Taxidea taxus*
Western spotted skunk	*Spilogale gracilis*
Striped skunk	*Mephitis mephitis*
Mountain lion	*Puma concolor*
Bobcat	*Lynx rufus*
Artiodactyla	
Mule deer	*Odocoileus hemionus*