BAT INVENTORY OF THE U.S. ARMY YUMA PROVING GROUND, ARIZONA: 1995

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INTRODUCTION

Bats play an important role in nearly every ecosystem in the world, and the Southwest is no exception. Arizona's 28 species of bats are major predators of insects, including those that feed on agriculture. Also, two species are the primary pollinators of agave and columnar cacti.

The main threat to most bats is loss of roosting and foraging habitat. Many types of roosts exist, such as mines, caves, buildings, cliffs, and trees, but not all species are adapted to roost in all of them. Several species rely exclusively on underground structures for roosts, forming colonies numbering thousands and even millions of individuals. Many or all of the bats in an area may be concentrated in one roost, so the loss of even one roost can have serious impacts. Historically caves served as roosts, but human disturbances have made many caves uninhabitable. Forced out of traditional roosts, many bats now use human-made structures such as abandoned mines. Loss or altering of habitats can also threaten the future of bats in an area. If traditional food sources, such as insects or agaves and columnar cacti, are unavailable, the area may become uninhabitable.

The Arizona Game and Fish Department (Department, or AGFD) recognized the need to conserve bat resources, and in 1990 created a bat management project within its Nongame and Endangered Wildlife Program. One of the field projects undertaken was to conduct a bat inventory of the U.S. Army Yuma Proving Ground (YPG, or Post). This project was designed to document species occurrence and locate roosts. An initial survey was conducted during 1992 and 1993 (Castner et al. 1993), followed by a more intensive survey during summer 1995.

The objectives of the second survey were to inventory any significant mines or caves not visited during the 1992/93 survey, document occurrence of additional species via mine/cave surveys or mist netting, compare bat use of water sites before and after the monsoon rains in July, and compare capture rates and species distribution with the data collected during the previous survey. This report details the results of the 1995 survey and provides a summary of data from both years. In addition, management recommendations are provided for roost sites and critical habitats located on the Post.

HISTORY OF OCCURRENCES

Historically, very few bat records existed for the YPG. The first known records from the vicinity of the Post were those by H. Allen in 1864 "from Old Fort Yuma, Imperial County, California, opposite present town of Yuma, Arizona," which included a California leaf-nosed bat (*Macrotus californicus*), Yuma myotis (*Myotis yumanensis*), and western pipistrelle (*Pipistrellus hesperus*) (Hoffmeister 1986, Cockrum et al. in press. The only documented

collection on the Post was a pallid bat (*Antrozous pallidus*) collected from Mohave Wash (Hoffmeister 1986). Museum collections at the University of Arizona, Arizona State University, and Northern Arizona University do not include any specimens from the YPG. Dr. E. Lendell Cockrum (pers. comm.) reports no occurrence records for the Post.

Recently, however, bat records for the area around the YPG have been greatly augmented by information from the Department's 1992/93 YPG survey, the 1994 survey of Imperial National Wildlife Refuge (INWR), and informal surveys of other lands nearby (Castner et al. 1994 and Castner et al. 1995). During these surveys, 87 roosts were discovered, including at least one for each of seven species: big brown bat (*Eptesicus fuscus*), *Macrotus californicus*, California myotis (*Myotis californicus*), cave myotis (*Myotis velifer*), *Myotis yumanensis*, *Pipistrellus hesperus*, and Mexican free-tailed bat (*Tadarida brasiliensis*). Also, netting records have documented possible occurrence of a yellow bat (*Lasiurus ega*).

Based on these records, we have compiled a list of all bat species likely to occur on the YPG along with suggested range and habitat information (Table 1).

Survey Area

The YPG is in southwestern Arizona, in Yuma and La Paz counties (Fig. 1). It occupies more than 3450 km^2, in a "U" shaped tract. The topography is highly varied, including flats, low rolling hills, alluvial fans, and steep desert mountains. Elevations range from near sea level to 878 m. Average rainfall is about 8.8 cm, and mean temperatures range from 16°C in December to 30°C in July (weather data supplied by the Atmospheric Sciences Laboratory, YPG Central Meteorological Observatory).

Vegetation consists of Arizona Upland and Lower Colorado subdivisions of the Lower Sonoran Life Zone (see Brown 1994), which includes creosotebush flats, desert and dune grasslands, paloverde (*Cercidium* spp.), saguaro (*Carnegiea gigantea*), and desert wash flora. It can be divided into two basic types: vegetation along drainages, and the uplands and flats. The drainage vegetation is much denser and more diverse in species composition, being dominated by large ironwood (*Olneya tesota*), paloverde, and mesquite (*Prosopis* sp.). Catclaw (*Acacia greggii*) and smoketree (*Psorothamnus spinosa*) are present in the major washes. The uplands and flats are dominated by creosotebush (*Larrea tridentata*), bursage (*Ambrosia dumosa*), saguaro, and smaller paloverde (Brown 1994).

Table 1. Bat species likely to occur on the U.S. Army Yuma Proving Ground, Arizona. Status: TNW = *Threatened Native Wildlife in Arizona* (AGFD 1988), SC = State Candidate.

Species	TNW	Habitat	Primary Roost
California leaf-nosed bat *Macrotus californicus*	SC	Sonoran Desertscrub below 1222 m	Caves/mines
Yuma myotis *Myotis yumanensis*	-	Desert to Pinyon-Juniper, forages over open water	Caves/mines, buildings
Cave myotis *Myotis velifer*	-	Desert; may hibernate in mines/caves above 1828 m	Caves/mines, bridges
Occult little brown bat *Myotis lucifugus occultus*	-	Desert to Pine	Caves/mines tree cavities
California myotis *Myotis californicus*	-	Desert to Pine	Caves/mines, crevices
Western pipistrelle *Pipistrellus hesperus*	-	Desert to Pine	Caves/mines, crevices
Big brown bat *Eptesicus fuscus*	-	Desertscrub to Mixed Conifer	Caves/mines, buildings
Western red bat *Lasiurus blossevillii*	SC	Broad-leafed Woodlands, Riparian	Tree foliage
Southern yellow bat *Lasiurus ega*	SC	Desert to Oak Woodland	Tree foliage (palm trees)
Hoary bat *Lasiurus cinereus*	-	Desertscrub to Mixed Conifer	Tree foliage, Bark
Spotted bat *Euderma maculatum*	SC	Desertscrub to Pine, near cliffs	Cliff crevices
Townsend's big-eared bat *Plecotus townsendii*	-	Desert to Pine	Caves/mines, buildings
Pallid bat *Antrozous pallidus*	-	Desert to Pine	Caves/mines, buildings
Mexican free-tailed bat *Tadarida brasiliensis*	-	Desert to Pine	Caves/mines, buildings
Pocketed free-tailed bat *Nyctinomops femorosaccus*	-	Desert to Chaparral	Cliffs, buildings
Big free-tailed bat *Nyctinomops macrotis*	-	Desertscrub to Pine	Cliffs
Western mastiff bat *Eumops perotis*	-	Desert to Pine	Cliffs

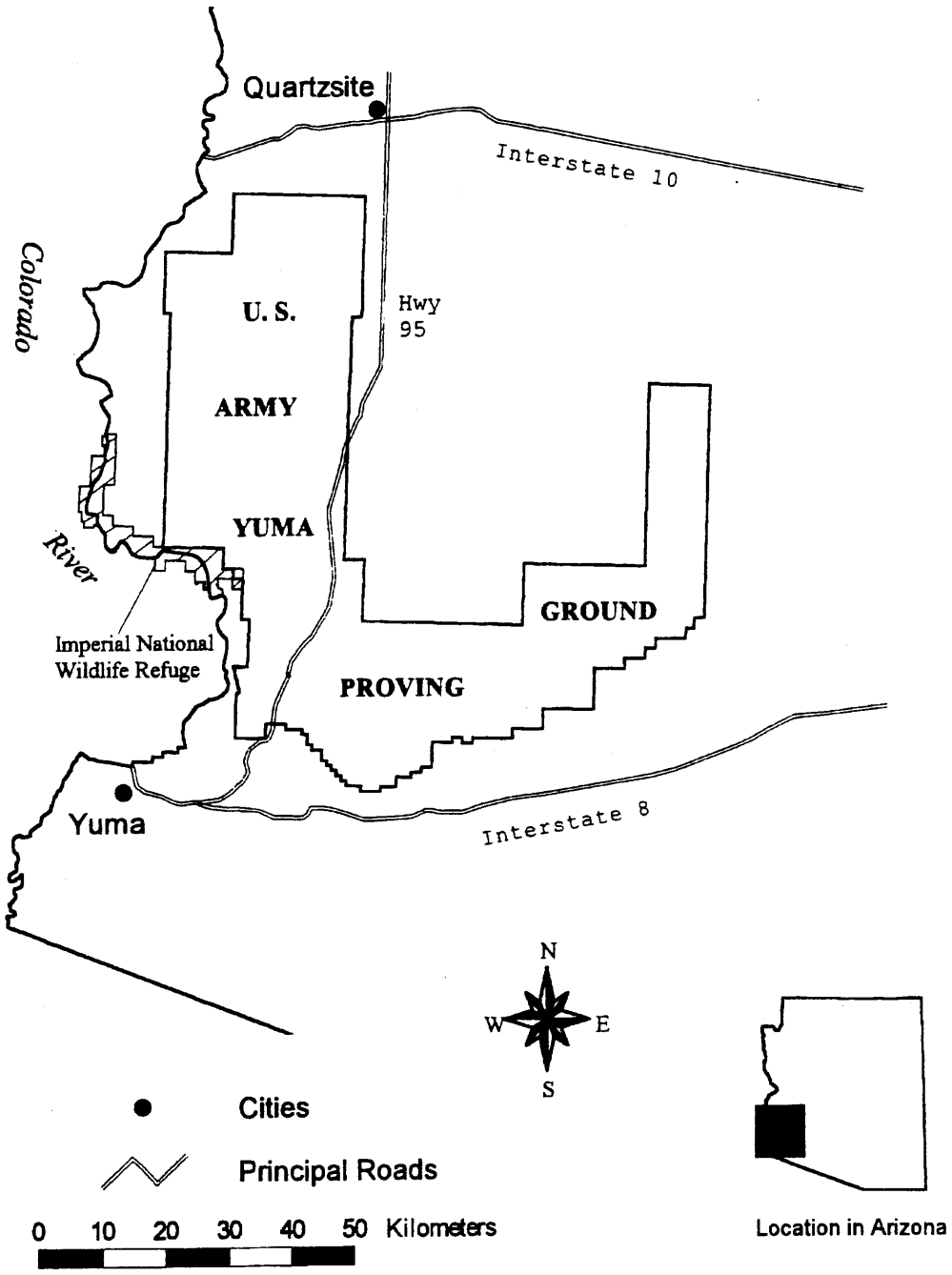

Figure 1. Map of the U.S. Army Yuma Proving Ground, Arizona, and surrounding area.

METHODS

A variety of methods were employed, depending on the type of survey being conducted. With this in mind, we have categorized our discussion of methods by their respective survey type or structure. The categories include mine and cave surveys, mist netting, and exit counts.

Mine Surveys

Mines were located by reviewing United States Geological Survey 7½ minute topographic maps, consulting with the YPG personnel, and from visual observations. The mines investigated during our survey included adits, shafts, and prospects. The mine site classification system used was based on field experience and symbols found on USGS topographic maps and is as follows:

> Adits - horizontal tunnels that vary in length from 3 m to hundreds of meters. These can be straight or with many twists and turns. It is possible to have additional drifts (horizontal passageways) within adits. The USGS topographic symbol is "Y."
>
> Shafts - vertical entrances with depths greater than 3 m. These may be straight or declining with varying slopes and may or may not contain drifts. Vertical shafts often can not be completely surveyed due to safety precautions. The USGS topographical symbol is a half-shaded box.
>
> Prospects - small, shallow holes or scrapes constructed to prove claims or explore new areas. These do not exceed 3 m in depth when shaft-like or length when adit-like. The USGS topographic symbol is "X."

Our survey consisted of exploring all mines for evidence of bat use such as bat presence, guano deposits, skeletal remains, and prey remains. Data collected included date, observer(s), site location and name, type (adit, shaft, prospect), aspect of entrance, temperature, relative humidity, species, and number of bats present. Hand nets were used to capture bats when species identification could not be made from visual observations. We also mapped the internal configuration noting specific bat roosting locations, sightings of other wildlife, and signs of human disturbance. A sling psychrometer was used to measure relative humidity.

In addition, we assessed each site according to the following guano accumulation index: (1) no guano, (2) scattered or small piles (less than 30 cm in diameter or 3.8 cm deep), (3) large piles (greater than 30 cm in diameter or 3.8 cm deep), or complete coverage of the floor.

Cave Surveys

There are many caves on the YPG, but they are not extensive, typically being less than 3 m in depth. Caves were surveyed in the same manner as mines.

Mist Netting

Sites were divided into two types; major artificial water tanks and dry washes. Wet sites were netted once during June and once in August. Dry washes were netted once.

We used 30-50 denier, 2 ply black nylon nets with 3.8 cm mesh. Net number and size used varied according to characteristics of each site. Data collected at each site included date, location, legal description, habitat description, weather conditions, number and size of nets used, participants, starting and ending time, and diagram of the net set. Data collected for each bat included species, sex, age, reproductive condition, weight, length of forearm, and time of capture.

Exit Counts

Exit counts were conducted to determine colony size at sites where internal surveys were not possible. Prior to sunset, observers were stationed at all openings to ensure that all exiting bats were counted. Night vision equipment was used to improve accuracy. Observers who did not have access to night vision equipment used flashlights with a red lens filter.

RESULTS

During June, August and September 1995, 78 sites were surveyed on the YPG. We located 20 new bat roosts based on bat presence or a guano accumulation rating of (2) or (3). Only *Macrotus californicus* was verified occupying these sites. Our ten nights of mist netting resulted in the capture of seven species and 45 individuals. In addition, exit counts documented the occurrence of two roosts where complete internal surveys were not possible.

Mine and Cave Surveys

Mine and cave surveys were conducted at 78 sites during this survey (Table 2). Only sites not visited during the 1992/93 field season were surveyed. Of these, eight had bats present and 20 showed evidence of bat use. Six mines and one cave were classified as significant based on the number of bats or amount of guano present. *Macrotus californicus* was the only species detected during the 1995 survey.

Exit Counts

Exit counts were conducted at three sites; two in June and one in August. All three were shafts too dangerous to physically enter. The count in June resulted in seven bats exiting. They were apparently all *Macrotus californicus*, but the observer was uncertain about the identification. No bats were observed exiting the shafts during the two August counts, however, approximately 50 bats were seen circling in one of them. These bats were all *Macrotus californicus*.

Table 2. Results of mine and cave surveys conducted on the U.S. Army Yuma Proving Ground, Arizona, during 1995.

Quad Name	Sites Surveyed	Guano Rating[1]			Sites With Bats	Species Present	Month Of Survey
		1	2	3			
Cunningham Mtn	3	2	1	0	0	none	June
Dome Rock Mts SW	3	1	1	1	2	*Macrotus californicus*	June, August
Hidden Valley	2	0	1	1	0	none	August
Middle Mountains North	1	0	1	0	0	none	June
Middle Mountains South	5	4	1	0	1	*Macrotus californicus*	June
Mohave Peak	3	3	0	0	0	none	June
North of Roll	9	6	1	2	2	*Macrotus californicus*	August
North Trigo Peaks	41	33	5	3	2	*Macrotus californicus*	June
Palomas Mountains NW	4	2	2	0	1	*Macrotus californicus*	September
Tweed Mine	7	7	0	0	0	none	June
Total	78	58	13	7	8	*Macrotus californicus*	June, August, September

[1] Guano rating: 1) none. 2) scattered or small piles. 3) large piles or covering the floor.

Mist Netting

Mist netting was conducted over ten nights at eight sites (Fig. 2). The Amphibious Test Pond was netted during August because the Main Post Overflow Pond was dry. Seven nights were spent at wet sites and three in dry washes. A total of 73.75 net hours (number of nets x total hours) resulted in capture of 45 individuals representing seven species (Table 3), including: *Antrozous pallidus*, *Eptesicus fuscus*, *Myotis californicus*, *M. yumanensis*, *Pipistrellus hesperus*, and *Tadarida brasiliensis*. We also captured one pocketed free-tailed bat (*Nyctinomops femorosaccus*), which is a new record for this species on the Post. See Appendix 1 for detailed mist netting data.

Additional Surveys

In conjunction with the surveys conducted on INWR during summer 1994, 23 mines were surveyed on YPG as part of the Department's ongoing mine survey program (Castner et al. 1995). These sites are located along the INWR and YPG boundary west of Yuma Wash. Of

these, 12 were considered potential roosts. These were defined as mines with underground horizontal passage of any length or vertical depths greater than 3 m. Two mines had bats present and guano accumulations; one supported a maternity colony of *Myotis velifer* and possibly *Myotis californicus*, and a bachelor colony of *Macrotus californicus*. The other contained a bachelor colony of *Macrotus californicus*. A third mine contained a single *Pipistrellus hesperus*, but no guano was present.

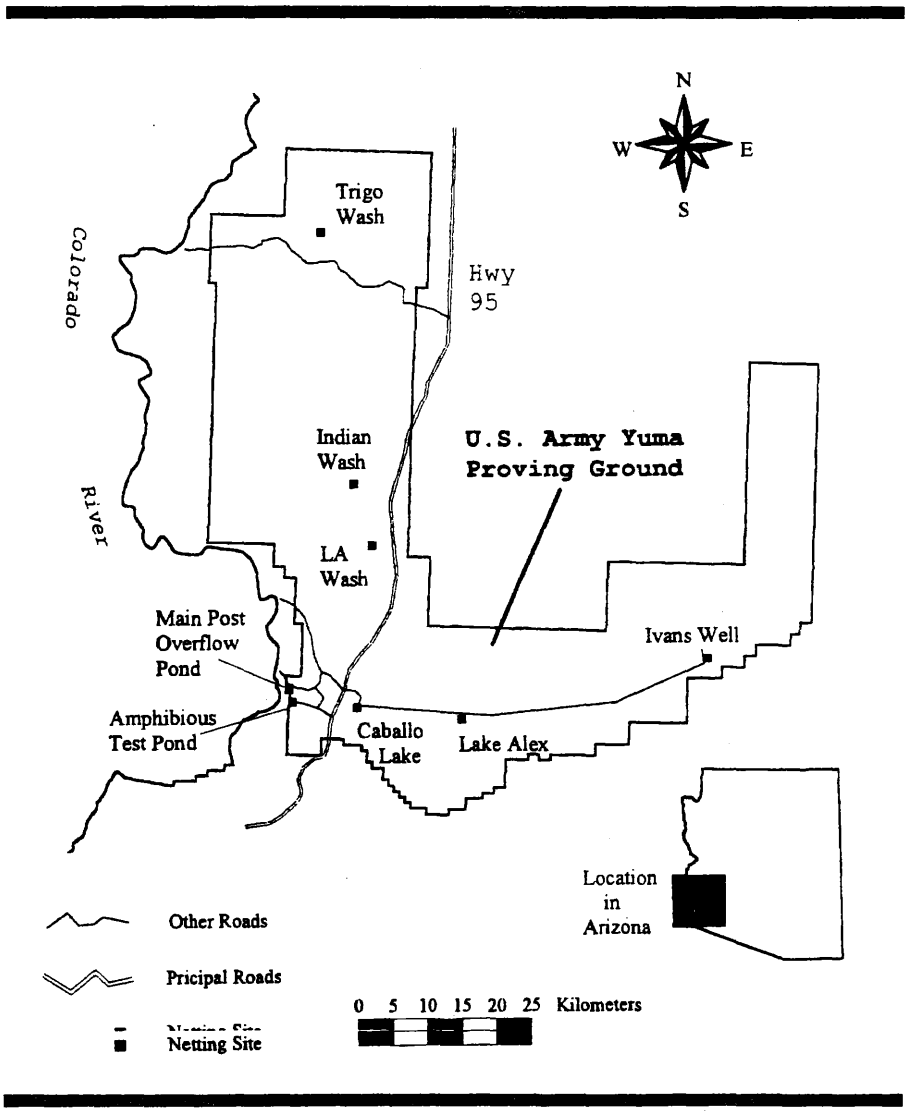

Figure 2. Location of mist netting sites on the U.S. Army Yuma Proving Ground, Arizona 1995.

Table 3. Results of mist netting conducted on the U.S. Army Yuma Proving Ground, Arizona, during 1995.

Netting Location	Legal Description (UTM)	Date	# of Nets Set	Net Time (hrs)	Total Net Hours	Netting Conditions[1]	Total Caught	Capture Results
Main Post Overflow Pond	739350, 3637860	6/19	2	4	8	good	10	*Antrozous pallidus* (1) *Pipistrellus hesperus* (8) *Tadarida brasiliensis* (1)
Amphibious Test Pond	739460, 3637490	8/7	3	3	9	fair	3	*Eptesicus fuscus* (1) *Nyctinomops femorosaccus* (1) *Pipistrellus hesperus* (1)
Lake Alex	738030, 3639170	6/20	3	2.75	8.25	poor	2	*Myotis yumanensis* (1) *Pipistrellus hesperus* (1)
		8/1	3	2.5	7.5	poor	2	*Antrozous pallidus* (1) *Myotis californicus* (1)
Trigo Wash	740600, 3704400	6/21	2	2	4	excellent	0	none caught
Ivans Well	738760, 3644110	6/26	4	4.5	18	fair	15	*Myotis californicus* (15)
		8/2	2	3	6	poor	3	*Myotis californicus* (3)
Indian Wash	749600, 3668410	6/27	1	3	3	poor	2	*Myotis californicus* (2)
Caballo Lake	747980, 3634750	8/8	2	2.5	5	poor	7	*Myotis californicus* (1) *Pipistrellus hesperus* (6)
Los Angeles Wash	747170, 3657460	8/10	2	2.5	5	poor	1	*Myotis californicus* (1)
Totals			24	29.75	73.75	N/A	45	*Antrozous pallidus* (2) *Eptesicus fuscus* (1) *Myotis californicus* (23) *Myotis yumanensis* (1) *Nyctinomops femorosaccus* (1) *Pipistrellus hesperus* (16) *Tadarida brasiliensis* (1)

[1] Netting conditions: excellent-no adverse conditions, good-one adverse condition for less than 25% of net time, fair-one or more adverse condition for less than 50% of net time, poor-one or more adverse condition for more than 50% of net time.

DISCUSSION

In this discussion, all data the Department has collected on YPG are combined. This includes both formal YPG surveys and the informal survey conducted during the INWR project. By combining data, we offer a complete perspective of the status of bats occurring on the Post. Discussion of roost surveys and netting efforts is provided in the appropriate sections below.

Mine and Cave Roosts

A total of 121 sites have been surveyed, leaving only three shafts and one adit unsurveyed. Three of these mines are isolated; time limitations prevented us from visiting them. The other shaft is in an impact area where entry is prohibited by YPG. Unsurveyed prospects exist, however, they are usually not extensive and rarely support large bat colonies.

There are many caves on the Post, but they are primarily wind formed and seldom extensive. Bats commonly use this type of cave as a roost, however, typically only a few bats use them at the same time. A complete survey of these caves would be impractical; many are in remote locations, thus requiring extensive hiking to visit them. All the mountains and hills that potentially have caves would have to be walked in their entirety to ensure a complete survey.

During this project, we located many new roosts. A total of 25 mines and six caves (20.6% of the 121 mines and caves visited) have been documented to serve as roosts. Of these, we consider 11 (9.1%) to be significant, based on the number of bats or amount of guano present. These percentages include mines with no underground workings that are not bat habitat, and mines with minimal underground workings that are poor habitat because of size, temperature, or humidity limitations. If these sites were omitted, the percentage would be much higher.

These percentages are similar to those found in other areas (Castner et al. 1994, Castner et al. 1995). However, we recognize that this is not an accurate assessment of the quality of bat habitat on the YPG. Many factors, such as roost microhabitat requirements, forage availability, and carrying capacity of the area, are involved in evaluating bat habitat. We do not have all of the necessary species data, nor do we know all the requirements of the system. What we can say is that mines are critical to the future of bats on YPG, especially for *Macrotus californicus*. This species resides in Arizona year-round, and roosts only in warm mines and caves.

Bats roosting on YPG benefit from public access restrictions, which make most sites less susceptible to disturbance. However, the northern end of the Cibola arm appears to receive public visitation. Specifically, Ehrenberg Wash appears to receive regular visitation. The road there was much more heavily traveled than others on the Post. The mines on the North Trigo Peaks quadrangle also appear to receive visitation, but we observed less sign of vehicular travel there than in Ehrenberg Wash.

Mist Netting and Species Occurrence

We netted the best sites, those with standing water or major drainages with substantial vegetation, on the Post. Of the potential 17 bat species in the area, we captured nine. We also know *Myotis velifer* is present, because we found a small maternity colony on the Post during the INWR survey. This leaves seven species unrecorded. We offer the following explanation for why we did not capture more species.

Weather conditions can affect the number and diversity of bat species captured in mist nets. Conditions such as wind, rain, storm fronts, moonlight, and temperature decrease the productivity of netting. Wind causes the nets to move and stretch, making them more detectable by bats. A stretched net will not easily collapse on a bat entering the net, allowing them to escape. Moonlight makes the nets more visible to bats. Adverse weather conditions can also cause bats to have shorter foraging trips or remain in the roost.

We assessed adverse netting conditions (wind, rain, and moon) at each location, recording the time each condition began and its duration (Table 3). Netting conditions were classified as follows:

Excellent	no adverse conditions.
Good	one adverse condition for less than 25% of net time.
Fair	one or more adverse conditions for less than 50% of net time.
Poor	one or more adverse condition for more than 50% of net time.

Wind was the most common adverse condition, usually occurring during the first few hours of netting. This is the time when the majority of bats are usually captured. Moonlight was also a factor, but the moon usually rose later in the evening, after bat activity had decreased. Of the ten net nights, six were classified as poor, two as fair, one as good, and one as excellent. This indicates that our potential for capturing bats was less than optimal.

Many bat species forage at altitudes higher than our nets, so only when they come down to drink are they caught [most notably, all of the free-tailed bats and the spotted bat (*Euderma maculatum*)]. Netting dry washes will not produce these species. The water sites on the Post are limited and have a small surface area, which makes capturing the large free-tailed bats difficult to impossible. Free-tailed bats require a longer flight path than other species because they fly faster and are less maneuverable. Therefore, they typically drink at sites with a surface area much greater than the ones on the Post. Also, the nearby Colorado River provides bats with another, possibly more favorable option, especially for the larger, less maneuverable species.

There is little suitable roosting habitat for tree-roosting bats on the YPG, who typically roost in large cottonwoods or willows. Also, several of these species are uncommon to rare in the area, such as the spotted bat, occult little brown bat (*Myotis lucifugus occultus*), big free-tailed bat

(*Nyctinomops macrotis*), and greater western mastiff bat (*Eumops perotis*). The Townsend's big-eared bat (*Plecotus townsendii*) should roost on the base, but it was not captured during netting or observed in any mine or cave. This bat is not often caught in mist nets because it detects them easily and its slow flight enables it to avoid nets. However, roost monitoring at various times during different seasons may locate this species.

When we compared the results of the two surveys (Table 4), it was obvious that we captured more bats during the 1992/93 survey. The dry washes produced similar numbers, however the captures were lower at several ponds. The reason for the discrepancy at Lake Alex seems to be apparent. The saltcedars (*Tamarix chinensis*) bordering the pond, which propagated insect prey and provided night roosts, have been removed. Bat activity was drastically lower during both visits in 1995.

At Ivans Well, the number of bats captured was similar, but fewer species were caught. About 15 m of saltcedar was removed from the west side of the pond. This inadvertently created an ideal flyway and should make the site more appealing.

Both fewer species and number of individuals were observed at Caballo Lake. This site differed little from its condition in 1993. One possible reason for the difference is that the sites were netted at different times (May in 1993 as opposed to June and August in 1995). Conditions are harsher during mid-summer and the bats may be using more productive areas. Another cause could be that netting conditions were less optimal during 1995.

The results of the 1995 survey suggest different bat activity patterns before and after the summer monsoons, although one night at each site during June and August is not enough to provide a definite description. At Lake Alex, none of the same species were captured during June and August. This may indicate a seasonal use pattern for these species. *Myotis californicus* was the only species captured at Ivans Well in 1995, but fewer individuals (20% less) were captured during August than in June. This suggests that this site may be more important to this species before the monsoon rains. The Main Post Overflow and Amphibious Test ponds, while very close to each other, are very different in size, water quality, and emergent vegetation, so direct comparison of the results is not valid.

Table 4. Comparison of mist netting results on the U.S. Army Yuma Proving Ground, Arizona.

Netting Location	Date	Capture Results	Date	Capture Results	Date	Capture Results
Trigo Wash	1992/93 survey		June 1995 Survey		August 1995 Survey	
	10/22/92	none caught	6/21/95	none caught	not netted	
	5/20/93	*Myotis californicus* (1)				
Caballo Lake	10/26/92	*Pipistrellus hesperus* (4)	not netted		8/8/95	*Myotis californicus* (1) *Pipistrellus hesperus* (6)
	4/28/93	*Eptesicus fuscus* (3) *Myotis californicus* (2) *Pipistrellus hesperus* (6)				
Lake Alex	5/10/93	*Antrozous pallidus* (5) *Myotis californicus* (3) *Macrotus californicus* (5) *Pipistrellus hesperus* (27)	6/20/95	*Myotis yumanensis* (1) *Pipistrellus hesperus* (1)	8/1/95	*Antrozous pallidus* (1) *Myotis californicus* (1)
Indian Wash	5/19/93	*Antrozous pallidus* (2) *Eptesicus fuscus* (1) *Myotis californicus* (2)	6/27/95	*Myotis californicus* (2)	not netted	
Amphibious Test Pond	5/24/93	*Myotis yumanensis* (1) *Pipistrellus hesperus* (1)	not netted		8/7/95	*Eptesicus fuscus* (1) *Nyctinomops macrotis* (1) *Pipistrellus hesperus* (1)
Ivans Well	5/25/93	*Myotis californicus* (3) *Macrotus californicus* (1) *Pipistrellus hesperus* (2) *Tadarida brasiliensis* (2)	6/26/95	*Myotis californicus* (15)	8/2/95	*Myotis californicus* (3)
Los Angeles Wash	5/27/93	*Antrozous pallidus* (1) *Myotis californicus* (2)	not netted		8/10/95	*Myotis californicus* (1)
Main Post Overflow Pond	not netted		6/19/95	*Antrozous pallidus* (1) *Pipistrellus hesperus* (8) *Tadarida brasiliensis* (1)	not netted	

MANAGEMENT RECOMMENDATIONS

These recommendations include most of those made following our 1992/93 survey (Castner et al. 1993). All recommendations relating to bat surveys should be implemented by experienced personnel. Any persons handling bats must have the appropriate permits. A more comprehensive survey, netting more sites, more often, and over several years, is needed to compare pre and post monsoon bat activity. In addition, further surveys are needed to determine the extent of habitat utilization by all species on the YPG.

Mines and Caves

All of the mines and caves with bat sign are important to the bats using them. Presently, it appears that only *Macrotus californicus* relies heavily on the mines of the area. This does not mean that the mines are not important or vital to other species. Monitoring roosts and surveys at sites we were unable to visit should be conducted to determine the extent of bat use. Due to restricted public access at the YPG, most of the roosts probably do not need special measures to protect them from human disturbance. Sites with human disturbance, or those that pose physical hazards to the public, should be secured (see Conservation).

Additional Surveys

The mines not surveyed during this project, along with prospects, caves, and newly discovered mines, should be surveyed when possible. The preferred method for this type of survey is daytime entry. However, precautions must be taken for safety of surveyors and bats. Mines and caves should be entered slowly and quietly, watching carefully for bats, other wildlife, hidden shafts, loose rock or collapsing walls, ceilings, or portals. Should entry disturb the bats, or if the tunnel looks precarious, an exit count should be conducted instead of entering.

Special precautions should be taken if surveys are conducted during May-July or December-February. From May-July, young may be present. Human disturbance may result in death of young, by the mothers abandoning the roost without their pups or the pups falling to the ground, where they will likely die from starvation or predation. During December-February, bats may be hibernating; disturbances then will cause them to increase their metabolic rate and use some of their fat reserves to escape. Since hibernating bats do not store enough fat for repeated arousals, too many disturbances may cause them to starve to death before spring.

Monitoring

Monitoring bat roosts is critical for conservation of bats on the Post. It may be impossible, as well as impractical, to regularly monitor all sites with bat sign. We suggest monitoring as many roosts as resources allow, omitting sites with the least amount of bat sign. Any monitoring at sites with sign of bat use should be performed during each season until the species and season(s)

of use is determined. For example, *Macrotus californicus* will often use different sites during summer and winter. Significant sites should be monitored on a yearly basis during each season of use. Roosts on the periphery of the base subject to public disturbance, like those in Ehrenberg and on the North Trigo Peaks quadrangle, should be monitored seasonally for signs of human disturbance and population fluctuations.

Exit counts are the preferred method of monitoring known roosts. They should be conducted at the entrance of the roost at the same time each year during each season of use to document population fluctuations. The following issues should be addressed for each site monitored:

- Which species use the site.
- Population size for each species.
- Season(s) of use for each species.
- Type of roost (maternity, hibernaculum, bachelor, etc.).
- Potential threats.

Exit counts and general monitoring can begin to answer some of these questions. The following guidelines are suggested for any monitoring activities undertaken:

- Conduct counts at least once each year during each season of use.
- Night vision equipment increases the accuracy of the count and should be used if available, but red-filtered flashlights are acceptable. White light should not be used.
- Each entrance must be accounted for. Entrances may be temporarily covered, if observers are not available for each opening.
- If desired, and possible, conduct a brief walk-through after the exodus to record any remaining bats, other wildlife use, or signs of human disturbance past the entrance.
- Record any sign of human disturbance during each visit. Signs are usually obvious near the entrance so internal searches may not be required. Common signs are footprints, trash, graffiti, shell casing, fireworks, and fire residues.

Conservation

Protecting roosts is the most effective means to conserve bats. Most of the mines and caves probably receive enough protection via enforced restricted access. Equipment testing or training maneuvers should not occur in the vicinity of sites designated significant (no ground disturbance within 100 m if possible). Regular disturbance and/or a declining population may necessitate implementing a more aggressive management strategy.

Protecting roosts from human disturbance or ensuring public safety at hazardous sites can be accomplished in several ways. Which type to be used should be evaluated on a case by case

basis. Barbed wire can be installed inexpensively, easily, and quickly, but it is less noticeable and can be easily removed or breached. Chain link fencing is more noticeable, but also can be removed or breached. Steel reinforced "bat-friendly" gates are recommended at roosts because of their permanence and protective qualities, but they can be expensive. These types of measures are the only ones we recommend.

Permanent closure of dangerous mines is another way to protect the public, however, this option should be avoided. Sites with bats should never be permanently closed. Even mines not currently used by bats may have been habitat in the past or could be in the future.

The shafts at the Copper Giant (1), Copper Chief (3), and Cinnabar (5) in Ehrenberg Wash need to be addressed immediately regarding physical hazards to the public. None of these mines are posted with warnings, nor do they have any type of barrier restricting the public. They should all be posted with signs depicting the dangers associated with open shafts. In addition, we recommend that a barrier be erected around each vertical entrance.

Three of these mines; two at the Copper Chief and one at the Cinnabar, are situated so that a vehicle can be driven into them without hinderance. During our survey we actually drove into the middle shaft at the Copper Chief. This shaft appeared to have been closed in the past, but has reopened. It is situated in the middle of the road as you approach the adit/shaft complex and is difficult to see.

Mines on the North Trigo Peaks quadrangle are not as hazardous as those in Ehrenberg Wash. Most of them are prospects or short, single drift adits. The shafts are much less extensive and none of them have a road leading directly to the entrance. All of the adits and shafts should be posted with warning sings. In addition, the shafts should have a barrier erected for public safety.

Netting

Continued mist netting by qualified personnel to document the occurrence of additional species is necessary, as evidenced by capture of *N. femorosaccus* during the 1995 survey. Most of the effort should be directed at previously netted sites to identify trends in numbers or species diversity. New sites should be netted to identify other areas important to bats. Sites should also be netted during different seasons to determine the time of year each species uses the Post.

Habitat

Even though the YPG's primary mission is military testing, bat conservation should be an important consideration when operational decisions are made. However, some areas are more critical than others, and should receive protection.

1. The water sites located on the Post should be maintained. If possible, allow emergent and shoreline vegetation, especially native species, to persist at an acceptable level. This increases the attractiveness of the site by providing forage insects and water.

2. Ground disturbing activities should be restricted in the immediate area around bat roosts, water locations, foraging areas, and flyways.

3. Activities in major drainages should be scheduled during the day. These are important flyways and foraging corridors. The period from April to September is most critical because the majority of bat activity occurs during this time.

CONCLUSIONS

We confirmed occurrence of one species, *Nyctinomops femorosaccus*, that was not detected during two prior surveys of the area, and located 20 new roosts on the YPG. Exact locations of roosts have been omitted from this report, in accordance with guidelines recommended by the American Society of Mammalogists' Conservation of Land Mammals Committee (Sheffield et al. 1992). Land management agencies requiring more specific data should contact the Department's Heritage Data Management System.

It is extremely important for the continued existence of bats on YPG and safe operation of the testing facility to protect bat roosts and critical watering and foraging areas. While the information provided in this report is valuable, additional netting, roost surveys, and monitoring would provide more accurate information, such as seasonal use, population trends, and management needs. Also, detailed data on specific foraging areas, local movements, flight corridors, and migrational patterns can be obtained using light tagging or radio telemetry techniques. These types of studies are time consuming and require highly technical equipment, however, the data gathered is specific and accurate.

Projects like this one are beginning to answer some of the many questions regarding the life history, habitat requirements, and seasonal movements of Arizona's bats. Through persistent efforts, collaborative surveys, and cooperative funding, similar to what took place during this project, we will begin to answer some of these questions and confidently devise management strategies that will conserve bats in Arizona and other areas inhabited by these species.

LITERATURE CITED

Brown, D.E. 1994. Biotic Communities: Southwestern United States and Northwestern Mexico. University of Utah Press. Salt Lake City, Utah.

Castner, S.C., T.K. Snow, and D.C. Noel. 1993. Bat inventory of the U.S. Army Yuma Proving Ground. Nongame and Endangered Wildlife Program Technical Report. Arizona Game and Fish Department, Phoenix, Arizona.

Castner, S.C., T.K. Snow, and D.C. Noel. 1994. Bat inventory and monitoring in Arizona, 1992-1994. Nongame and Endangered Wildlife Program Technical Report 54. Arizona Game and Fish Department, Phoenix, Arizona.

Castner, S.C., T.K. Snow, and D.C. Noel. 1995. Bat inventory of the Imperial National Wildlife Refuge. Nongame and Endangered Wildlife Program Technical Report. Arizona Game and Fish Department, Phoenix, Arizona.

Cockrum, E.L., B. Musgrove, and Y. Petryszyn. In press. Bats of Mohave County, Arizona: Populations and Movements. Texas Tech University Press, Lubbock, Texas.

Hoffmeister, D.F. 1986. Mammals of Arizona. The University Of Arizona Press and The Arizona Game and Fish Department.

Sheffield, S.R., J.H. Shaw, G.A. Heidt, and L.R. McClenaghan. 1992. Guidelines for the protection of bat roosts. Journal of Mammalogy. 73(3):707-710.

Appendix 1. Results of bat mist netting conducted on the U.S. Yuma Proving Ground, Arizona, during 1995.

Table Key

JM - juvenile ♂, **JF** - juvenile ♀, **AM** - Adult ♂ (non-reproductive), **TD** - adult ♂ testes descended), **AF** - adult ♀ (non-reproductive), **LF** - adult ♀ (lactating), **PLF** - adult ♀ (post-lactating), **?** - unknown sex and age. All net dimensions are in feet.

Main Post Overflow Pond **June 19, 1995** **UTM E739350, N3637860**

Set two nets, one 7' x 60' and one 7' x 42', in a 'V' pattern over water at a 70' x 40' oval pond. No vegetation around pond except for a small stand (20' in diameter) of cattail at the east end of the pond. Nearby vegetation mainly creosotebush and paloverde, with scattered saltcedar. Nets opened at 2000 h and taken down at 2400 h. Clear skies. Intermittent light breeze (up to 3 mph after 2200 h). No moon.

Species	Total	JM	JF	AM	TD	AF	LF	PLF	?
Antrozous pallidus	1	-	-	1	-	-		-	-
Pipistrellus hesperus	8	-	-	1	-	-	5	-	2
Tadarida brasiliensis	1	-	-	1	-	-	-	-	-

Lake Alex **June 20, 1995** **UTM E738030, N3639170**

Set three nets (three 7' x 60') over water at 100' x 60' rectangular pond. Two nets set in a 'V' at west end and one across the east end of the pond. No vegetation around pond (saltcedar along north and east shore of pond has been removed). Nearby vegetation primarily creosotebush, paloverde, and bursage, with some ironwood. Nets opened at 2015 h and taken down at 2300 h. Clear skies. Continuous light breeze (1-3 mph) until 2200 h, when it increased to 6-10 mph. No moon. Bat activity much lower than our summer netting session of 1993.

Species	Total	JM	JF	AM	TD	AF	LF	PLF	?
Myotis yumanensis	1	1	-	-	-	-	-	-	-
Pipistrellus hesperus	1	-	1	-	-	-	-	-	-

Trigo Wash **June 21, 1995** **UTM E740600, N3704400**

Set two nets (one 7' x 60', one 10' x 60') between trees perpendicular to the dry wash. Vegetation along wash is ironwood, paloverde, smoke tree, mesquite, and creosotebush. Nets opened at 2015 h and taken down at 2215 h. Clear skies. No wind. No moon. Bat activity very low (only about 10 passes on bat detector all night). No bats captured.

Ivans Well **June 26, 1995** **UTM E738760, N3644110**

Set four nets (one 7' x 42', one 7' x 30', and two 7' x 18'). The 42' net was set in an opening between saltcedars on the west shore, the 30' net was set on the east side of the pond extending from the saltcedars away from the pond, and the two 18' nets were stacked, one on top of the other, over water at the south end of the pond in an opening between the saltcedars. Saltcedar surrounds the pond except for a small opening on the south end and a large opening on the west side (the west side opening has recently been cleared). Nearby vegetation dominated by creosotebush, bursage, and paloverde. Nets opened at 2015 h and taken down at 0145 h. Clear skies. Windy (5-15 mph) until 2200 h, calm afterward. No moon. Captured great horned owl in net at 2300 h.

Species	Total	JM	JF	AM	AF	LF	PLF	?
Myotis yumanensis	15	4	5	-	-	1	-	5

Indian Wash **June 27, 1995** **UTM E749600, N3668410**

Set one 7' x 60' net across wash between two ironwood trees. Nets opened at 2000 h and taken down at 2315 h. Monsoon-like weather in area. Heavy rains nearby, but only light sprinkles at net site. Very windy (5-10 mph with gusts up to 25 mph). Clear skies. No moon.

Species	Total	JM	JF	AM	AF	LF	PLF	?
Myotis californicus	2	-	-	1	-	1	-	-

Lake Alex **August 1, 1995** **UTM E738030, N3639170**

Set three nets (two 7' x 60' and one 7' x 42') over water at 100' x 60' rectangular pond. Two nets set at west end and one across the east end of the pond. No vegetation around pond (saltcedar along north and east shore of pond has been removed). Nearby vegetation primarily creosotebush, paloverde, and bursage, with some ironwood. Nets opened at 2000 h and taken down at 2230 h. Clear skies. Continuous light breeze (0-5 mph). Quarter moon. Bat activity much lower than our summer netting session of 1993. Second net night of 1995.

Species	Total	JM	JF	AM	AF	LF	PLF	?
Antrozous pallidus	1	1	-	-	-	-	-	-
Myotis californicus	1	1	-	-	-	-	-	-

Ivans Well **August 2, 1995** **UTM E738760, N3644110**

Set two nets (one 7' x 42' and one 7' x 18'). The 42' net was set in an opening between saltcedars on the west shore and the 18' net was over water at the south end of the pond in an opening between the saltcedars. Saltcedar surrounds the pond except for a small opening on the south end and a large opening on the west side (the west side opening has recently been cleared). Nearby vegetation dominated by creosotebush, bursage, and paloverde. Nets opened at 2000 h and taken down at 2300 h. Clear skies. Breezy (0-5 mph). Quarter moon. Second net night of 1995.

Species	Total	JM	JF	AM	AF	LF	PLF	?
Myotis californicus	3	-	-	-	1	-	-	2

Amphibious Test Pond **August 7, 1995** **UTM E739460, N3637490**

Set three nets (two 7' x 60' and one 7' x 18') at water edge. No vegetation near waters edge. Nearby vegetation mainly creosotebush and paloverde, with scattered saltcedar. Nets opened at 2000 h and taken down at 2300 h. No moon. Clear skies. Intermittent breeze (0-5 mph). Main Post Overflow Pond was dry.

Species	Total	JM	JF	AM	AF	LF	PLF	?
Eptesicus fuscus	1	-	1	-	-	-	-	-
Nyctinomops femorosaccus	1	-	-	-	-	-	1	-
Pipistrellus hesperus	1	1	-	-	-	-	-	-

Caballo Lake **August 8, 1995** **UTM E720720, N3658380**

Set two 7' x 18' nets in a 'V' over water, covering the east and west openings in the vegetation. Vegetation around the pond primarily willow. Nearby vegetation dominated by creosotebush, bursage, and paloverde. Nets opened at 2000 h and taken down at 2230 h. Clear skies. Full moon. No wind. Captured two great-horned owls in net.

Species	Total	JM	JF	AM	AF	LF	PLF	?
Myotis californicus	1	-	-	-	1	-	-	-
Pipistrellus hesperus	6	-	-	1	1	-	4	-

Los Angeles Wash **August 10, 1995** **UTM E747980, N3657460**

Set two nets (one 7' x 60' and one 7' x 30') across wash between vegetation and the drainage wall. Vegetation in drainage ironwood and paloverde, with creosotebush, bursage, and paloverde on the uplands. Nets opened at 1930 h and closed at 2200 h. Full moon. Clear skies. No wind. Captured one non-reproductive adult male *Myotis californicus*.